4 Existing environment, potential impacts and environmental safeguards

This chapter provides an overview of the existing environment. Figure 4.1, which is the same as Figure 1.1, depicts the project area and impact sites. Appendices C, D and E provide more detailed information on the various aspects of the study area's environment through specialist reports commissioned for the PER by DPI.

The structure of this section is based on the NT EPA Guidelines. It includes review of the baseline (existing conditions) for each key topic, followed by documentation of the potential impacts and consideration of the management and mitigation measures and commitments. Each of the mitigation measures discussed is a definite commitment to be established by DPI during the conduct of the project.

4.1 CLIMATE

The study area is located in a subtropical, monsoonal climate, with distinct wet and dry seasons, but with lower humidity than that experienced further north. Of the annual mean rainfall of 938.5 mm for Timber Creek, 85% occurs between December and March inclusive. The highest rainfall events typically occur during storms in the late wet season and during intense, low-pressure monsoon events such as cyclones. Less than 1% of the rain falls during June to August (Bureau of Meteorology 2005). The dry season is typically between May and September.

Humidity varies according to the season and follows the same pattern as rainfall, with low humidity during the dry season and high humidity during the build-up to and during the wet season. Temperatures are usually within a relatively narrow range of 19°C to 25°C (daily minimum) to about 30°C to 36°C (daily maximum).

The dry season is dominated by south-easterly trade winds and breezes, while north-westerlies dominate the wet season. Tropical cyclones occur during most years and the maximum winds, usually 180 to 250km/h, occur during these phenomena.

Impact

The key impact on the project associated with the climate regime is the presence of distinct wet and dry seasons. These will influence many aspects of the project, including the:

- need for the project
- time available for much of the construction programme
- availability of and access to sites and resources

- potential impacts of construction, especially those associated with water management and accelerated erosion control and dust management
- the biological environment, especially the occurrence of species and their habitats
- timing and extent of environmental management and mitigation activities.

Mitigation

Each of the mitigation measures associated with climate is considered in more detail under the relevant sections of this chapter.

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4.2 LANDFORM

4.2.1 Terrain and land systems, geology and geomorphology

The area is dominated by spectacularly weathered, deeply incised Proterozoic rocks (i.e. bluffs, escarpments, and valleys), with Cainozoic sediments confined to the footslopes, riparian landforms and alluvial channels. A copy of the geological map of the region is included in Appendix B.

The Pinkerton land system dominates the project area, with the Ivanhoe land system at the very western end of it (Stewart et al. 1970). The Dinnabung land system is barely represented in the project area. The Pinkerton system is characterised by rugged stony country with ridges, cuestas and structural plateaux. These typical landforms form the high ground adjacent to the project area and visually dominate the area. At the western end of the project area, the Ivanhoe system is represented by the fine-textured fluvial plains and broad flood plains of the Victoria River.

The Highway traverses gently undulating to undulating terrain, largely associated with the footslopes of the rocky escarpments, flood plains of the riparian systems and drainage depressions of the Victoria River and its tributaries.

The Victoria Highway avoids the steep gradients associated with the plateaux and upper slopes of the Pinkerton land system.

Cut surfaces (cut batter slopes) and fill surfaces (fill batter slopes), especially those associated with the raising of the Highway, pose accelerated erosion risks unless adequate stabilisation and prevention measures are undertaken. Despite this issue, few other constraints or impacts exist for terrain and land systems.

Impact

The key potential impact is the loss of soil and potential destabilisation of cut and fill surfaces, followed by accelerated erosion.

The development and implementation of adequate management techniques can limit the potential, size and extent for cut surfaces to become destabilised. Destabilisation of cut surfaces and associated footslopes and fill areas on a slope is a medium risk issue.

Management

The following mitigation measures are proposed.

Cut faces will be planned and constructed so as to minimise the potential for accelerated erosion and catastrophic failure of the slope. This will include selecting a cut slope (also referred to as a batter slope) that will be stable in the type of parent rock or soil material that comprises the cut face. If the material is highly weathered, fractured, unconsolidated or unstable, the batter slope will need to be flatter; that is, at a lower angle than if the material is sound, stable and not fractured. In order to supplement the information previously obtained by DPI, additional geotechnical assessment of these areas will be undertaken by the contractor.

At the top of all cut slopes a cut-off table drain will be constructed to intercept water that would otherwise flow over the slope and cause accelerated erosion. The cut-off

drain will redirect water away from the cut face of the slope, thereby minimising erosion. The cut-off drain may be lined with non-erosive materials (e.g. rock or an erosion control material such as bio-degradable matting). The choice of technique and materials will depend on the slope of the ground in which the drain is built. The ends of the cut-off drain will be 'flared' in order to divert and disperse the water intercepted along the contour of the slope. If this is not possible, the outlet(s) will have a protective layer of rock placed over the soil surface in the drain to prevent accelerated erosion.

The width of fill slopes, and therefore the fill batter slope, will be largely controlled by the proximity of the Restricted Work Areas associated with Sacred Sites. If the slope face then becomes too steep to be stabilised with conventional revegetation techniques, specific engineering solutions will be required. These could include retaining walls, gabions or rock armouring, geogrid, crib walling and similar techniques and materials. Stabilisation of fill slopes could be an issue at Joe Creek, where the restricted area of the site limits the work to 40 m from the existing road centreline.

All bare areas and slopes resulting from construction will be revegetated using native plant species from the local area as part of the construction programme. This will involve maintaining stockpiles of vegetation and topsoil cleared from each construction area as the basis of site revegetation programme.

4.2.2 Soils

The soils of the study area are principally skeletal soils of the Pinkerton land system (Stewart 1970). Alluvial soils are associated with the Victoria River and some of the larger creeks of the system. Heavier clays, potentially cracking clays, are associated with the section of the Highway around Lost Creek and for some distance westward from there.

For many of the sites, the soils are moderate to free draining, with low to moderate accelerated erosion/erodibility (although erodibility is greater if vegetation has been cleared). The sites with heavier soils (e.g. Sites 7 and 8) tend to have poor to moderate drainage with moderate to high erodibility. Areas of alluvial soils have variable drainage and very high erodibility when disturbed (Stewart 1970). Management of surface run-off will be particularly important in areas of alluvial and heavy clay soils.

Appendix C contains additional information on the area's geology, geomorphology and soils.

The key soil constraints are the alluvial sediments associated with the Victoria River system (particularly either side of the Victoria River itself), and the heavy clays of the Ivanhoe land system in the vicinity of Lost Creek.

The alluvial sediments have little cohesive structure and are highly prone to accelerated soil erosion, particularly following removal of vegetation and disturbance. Hence, any earthworks along the Victoria River and its tributaries, in particular, must incorporate adequate controls on machinery and vehicle movements and erosion protection measures.

Owing to the extent of surface water run-off that potentially can occur during the wet season, management of all disturbed areas will be required to minimise and prevent accelerated soil erosion.

Impacts

The key potential impacts are:

- loss of soil, including its seed bank, nutrients and soil fauna
- development of unstable erosion surfaces and accelerated erosion
- generation of nuisance dust from exposed and disturbed surfaces.

Construction activities can be managed so as to minimise the potential, size, extent, and duration of erosion occurring. Accelerated soil erosion is a low to medium risk issue, depending on the specific area of impact.

Mitigation measures

The following mitigation measures are proposed:

- most earthmoving will be undertaken during the dry season and specific erosion control measures will be addressed in the contractor's Erosion Management Plan.
- surface water run-off will be managed to prevent potential accelerated soil erosion incidences
- construction activities will be managed to avoid or minimise accelerated soil erosion, particularly in areas of high soil erodibility (e.g. unconsolidated alluvium adjacent to Victoria River)
- dry, exposed surfaces will be watered to prevent dust generation.

4.2.3 Gravel borrow material

An estimated 30,000 m^3 of gravel is required for the works associated with raising road levels for flood protection. However, this will expand to 80,000 m^3 if the scope of the construction contract includes pavement rehabilitation (strengthening and widening) between Ch 186 km and Ch 220 km at a later stage.

There are two major potential sources available, terrestrial and riparian deposits. At this stage of the project it is not clear which source, or combination of sources, will be used for the extraction and processing of gravel. The reasons for this are explained in Section 2.4.5. In summary, the uncertainty is primarily due to the location of Sacred Sites at some potential borrow sites. NLC and AAPA assessments of new sites are being undertaken with the Traditional Owner representatives; however, this process has not been completed at the time of compiling the PER.

As shown in Figure 4.1, both terrestrial and riparian gravel sources are available in the project area. The choice of which borrow area or areas will be used to obtain gravel will initially depend on the outcome of the Sacred Site clearances, and, secondly, on the outcomes of the additional archaeological, biological and geotechnical investigations that have yet to be undertaken of these defined areas.

The results of these assessments and the final choice of gravel source sites will be provided to the EPA when available.

A summary of the likely impacts for each major potential gravel source is discussed below.

Riparian source (RG3)

The quantity of rock and gravel available from the proposed site on Coolibah Station (RG3), which is adjacent to but not part of the Victoria River, is well in excess of 80,000 m^3. Bed load replenishment of this gravel source is known to occur annually during the wet season owing to the movement of materials downstream and into deposition beds. Williams (2006) of NRETA has undertaken a detailed study of the Victoria River to determine the amount, replenishment and type of material present at RG3. Appendix C contains the complete report, a summary of which is provided here.

Surveys were undertaken during February 2006 during a flood event in order to determine the bed load transport rate of the river and to collect data for the calibration of a bed load transport model. Sediment transport rates were determined using acoustic Doppler techniques.

During floods, a thin layer of material of material moves downstream close to the river bed. During the survey period this layer was approximately 100 mm thick. The majority of the material moving downstream is sand, gravel and cobbles. Most of this material bounces along the streambed during floods, a process that is called 'saltation'.

Field measurements of the Victoria River from the Victoria River Inn downstream to Coolibah Station in the vicinity of RG3 indicated a bed load transport movement volume of about 360,000 m^3/year. These rates are in the range of four commonly used bed load transport models (based on median sediment particle size of 20 mm).

The proposed amount of gravel to be extracted (between 30,000 and 80,000m^3) would be easily replenished during the following wet season by new material moving down the river during flood flows.

Gravel extraction from the river bed, if undertaken in accordance with gravel extraction guidelines, will not cause river bed or river bank erosion or changes to river bed geomorphology in the long term.

Terrestrial sources (Lost Creek)

The existing potential borrow areas identified by CPM (2005) are discussed in Section 2.4.5. An additional large area adjacent to Sandy Creek is likely to contain suitable gravel sources within its boundaries. The exact borrow areas proposed to be used have yet to be assessed. Following Sacred Site investigations and the definition of areas that are cleared of Scared Sites, archaeological, biological and geotechnical investigations will take place. The results of these assessments and the final choice of gravel source sites will be provided by DPI to the EPA when available.

Figure 4.1 illustrates the location of each new area currently under review.

Impacts

The potential key impacts are:

- changes to the hydrology of the Victoria River, including accelerated erosion and deposition sites
- introduction and assisted dispersal of pest plant material and animals
- changes to the habitat diversity and abundance of fauna within the Victoria River
- vegetation clearance to enable access to gravel sources and for crushing and blending plant and equipment
- impacts on cultural heritage sites.

The predictability and manageability of the size, extent, duration and likelihood of impacts for extracting and transporting gravel material from riparian and terrestrial deposits is high. Construction activities can be managed so as to minimise the potential, size, extent, and duration of impacts.

If gravel material is sourced from terrestrial sites and transported to the Victoria Highway then the acquisition and use of gravel borrow material is probably a low risk issue (subject to the additional investigations currently underway). If it is obtained from the Victoria River, based on the reports by Williams (2006) and de Lestang & Wedd (2006), it is also a low risk issue. About 10 ha will be required to be disturbed for gravel borrow areas.

Mitigation measures

Material sourced from existing and new terrestrial quarry sites will be extracted and rehabilitated by the contractor in accordance with DPI's environmental management Specification for borrow materials extraction area rehabilitation (Appendix B). Routine and mandatory management and mitigation measures are specified and these will be employed to minimise risks.

The following mitigation measures are proposed if gravel material is quarried from the Victoria River:

- the second stage of the aquatic fauna survey and an additional assessment for archaeological sites will be undertaken and the findings and management recommendations reported on to the EPA
- river bed material will be extracted in accordance with accepted standards and published guidelines
- extraction of river bed material will only be conducted in the dry season and extraction will not be within 20 m of river banks
- the maximum depth of excavation will not be greater than 1m and will follow natural river bed contours, and slopes on excavations will not to be steeper than 4:1 (H/V). Extraction techniques must not cause deep depressions that induce turbulent eddies when the river flows. If this occurs it will compromise river bend stability

- material will be extracted following natural contours to ensure that river bank and bed stability is not adversely affected. Impacts to outer bends of the river will be avoided so that natural flow areas are preserved
- channel bed deposits will be mined selectively and carefully. Measures to manage impacts will include
  - avoiding all archaeological sites and biologically sensitive areas along the banks. These will be marked in the field and maps as 'No Go areas'
  - recording the profile and characteristics of the proposed excavation sites by survey plans and photographs prior to excavation. These plans and photographs will be used as the baseline for reinstatement of sites after gravel extraction has been completed
  - not quarrying deposits on the channel bank, some of which are relatively stable. Rock and gravel will be skimmed off the top of the point bar deposits in a thin layer down to a predetermined contour
  - not making holes, since these could induce turbulence in water flows
  - creating a smooth profile and outline of the final excavated shape
  - avoiding pools and riffles and all biologically sensitive areas
  - constructing the excavated shape to mimic the original shape to ensure river stability is maintained, accelerated bank erosion does not occur and biological function is maintained
- all extraction areas will be graded to ensure that water drains freely and does not form pools
- hydraulic function (water flow characteristics) in the river will be maintained to avoid downstream erosion and ensure nil or minimal impact on the ecosystem
- all borrow sites will be operated and managed using best practice techniques and the extraction site and disturbed areas will be rehabilitated using best practice techniques.

4.2.4 Fill (soil) borrow material

Approximately 430,000 m^3 of fill material is required. This is proposed to be extracted from a general area south of the Victoria Highway, near Lost Creek and/or north of the Highway around Skull Creek (Figure 4.1). Fill material will be sourced to a maximum depth of 2 m, and from an area of approximately 25–30 ha. The process for defining the exact location of borrow areas is as follows:

- continue negotiations with the NLC, AAPA and Traditional Owners to ensure fill material extraction areas do not impact Sacred Sites
- undertake geotechnical assessment of the general areas to define preferred borrow sites

- concurrent with the geotechnical assessment, conduct archaeological and biological surveys on prospective cleared by AAPA and likely preferred areas for fill to ensure that archaeological sites are not impacted, that there is no disturbance of threatened species, and that minimal impact occurs to the biological environment.

The potential key impacts are:

- clearance of native vegetation to enable extraction of material
- loss of habitat
- introduction and assisted dispersal of weeds and pest animals
- preferential colonisation of the site by weeds
- borrow areas not rehabilitated.

The risks of adverse impacts from sourcing fill material from the proposed sites are probably low. However, the exact areas have yet to be defined and investigated in detail for impacts on biological resources. There will be no impact on any Sacred Sites or archaeological sites because they will be avoided. Based on the information obtained about these factors to date, and the predictive models established for the region, the risk is likely to remain low.

Mitigation measures

The following mitigation measures are proposed:

- undertaking of further assessment of the potential environmental impacts of the proposed use of the areas as sources of borrow material
- provision to the EPA of the results for all of the surveys and development of specific management measures (if required)
- extraction of fill material carried out in accordance with DPI environmental Specifications for borrow pits and rehabilitation
- operation and management of borrow sites using best practice techniques
- rehabilitation of borrow sites using best practice techniques.

The management of weeds and pest animals at these sites is discussed in Section 4.4.

4.3 HYDROLOGY AND WATER QUALITY

4.3.1 Water resources and rainfall

The Victoria River has a large catchment area of 77,230 km^2 (Commonwealth of Australia 2005). Within the study area, the main tributaries of the Victoria River are Ryan Creek, Matt Wilson Creek, Sullivan Creek, Lost Creek, Skull Creek, Joe Creek and Sandy Creek.

As a result of the large catchment area and intense rainfall during the wet season, the Victoria River system regularly floods and causes road closures for parts of most wet seasons. During the dry season, the tributaries of the Victoria River stop flowing and the River becomes very low late in the dry season. During most years the River maintains some flow throughout the dry season (G. Fischer, Chief District Ranger NTPWS, pers. comm., 2005).

Some larger tributaries retain remnant pools of water for all or most of the dry season. However, the size and number of pools will vary with the seasons, especially the extent of the wet season.

The Victoria River system provides significant habitat for all faunal groups, particularly those areas of the system that maintain permanent pools of water during the dry season. Some of these pools may be spring-fed.

The heavy monsoonal rains and associated high volumes and velocities of surface water run-off that the study area receives are conducive to accelerated soil erosion in disturbed areas. Some construction activities, especially earthworks, at the end of the dry season or during the wet season could potentially result in significant areas of accelerated soil erosion at construction sites; that is, where vegetation clearance and soil disturbance have occurred. Heavy rains may also cause the loss of fill material before it is fully compacted and stabilised.

Impacts

The key potential impacts are:

- loss of topsoil, including its associated seed bank, nutrients and soil microfauna
- transfer of weeds, especially into important habitat for threatened fauna and into areas that were previously weed free
- accelerated erosion and deposition of soil in unwanted areas; for example, on roads, 'choke points' of creeks and culverts, and into fauna habitat.

Construction activities will be managed so as to minimise the size, extent, duration and likelihood of erosion. Accelerated soil erosion is considered to be a low risk issue generally, although there may be some sites with a higher risk.

Management

The following mitigation measures are proposed:

- an EMP will be developed, implemented and audited for all of the project. A key plan in the EMP will be management of accelerated erosion by the contractor in accordance with DPI's contract Specification (Appendix B)
- the main construction activities, particularly those that cause surface disturbance (e.g. earthworks) will be undertaken during the dry season to eliminate the potential for accelerated soil erosion from storm events
- stabilisation, rehabilitation and revegetation of disturbed areas will be undertaken progressively to ensure that erosion events are also minimised in the wet seasons following construction.

4.3.2 Flood events

Much of the Victoria Highway that this project considers is subject to flooding from the Victoria River, and back-up of waters in creeks and tributaries. Potential flooding events will have impacts upon what construction activities can be undertaken during the wet season, and flooding events will cause delays in construction.

Impacts

The key potential impacts are:

- restrictions on what construction activities can be undertaken during the wet season
- destruction of construction or setbacks in construction progress owing to flooding
- limitations on construction activities owing to flood events.

Construction activities can be managed so as to minimise the size, extent, duration and likelihood of setbacks and delays as a result of flooding. Flood events are a low risk issue for the proposal.

Mitigation measures

The following mitigation measures are proposed:

- a schedule of construction activities and timing will be developed by the contractor to determine what activities (if any) can safely be undertaken during higher risk periods for flooding
- weather reports will be monitored during the wet season to determine the potential for flood events to occur in the near future.

4.3.3 Remnant pools and surface water

During the dry season, the tributary creeks of the Victoria River stop flowing, and the Victoria River has a much reduced flow. However, pools of water are retained (do not completely dry out) in some tributaries and areas of the River system for the duration of the dry season. These pools provide significant habitat and water resources for many groups of wildlife.

Within the impact area of the new bridge realignments, remnant pools may be adversely impacted or destroyed as a result of construction activities. Pools outside of the impact area are No Go zones, and will not be impacted.

Remnant pools may also be attractive for sourcing water for construction activities. Within the tributaries of the Victoria River, no remnant pool will be used as a source of construction water. Within the Victoria River, water may be obtained for construction purposes when the water level in the river provides sufficient capacity. This will require approval from and ongoing consultation with the Advisory and Regulatory Services (Water), Conservation and Natural Resources, NRETA.

Impacts

The key potential impacts are:

- direct impacts on aquatic species
- loss of habitat for aquatic species, such as invertebrates, reptiles and fish
- loss of important water resources for terrestrial fauna.

Remnant pools are a low risk issue.

Mitigation measures

The following mitigation measures are proposed:

- remnant pools of water in watercourses will not to be used as a source of construction water. This will be established as a condition of contract applicable to the contractor
- water from any remnant pools of water adjacent to construction sites will be No Go areas so as to minimise impact on native fish populations and native fauna that use the pools as a source of drinking water. This will be established as a condition of contract applicable to the contractor
- water within the Victoria River may be used for construction purposes subject to approval from NRETA. It will not be depleted to such levels as to cause adverse impacts on fauna
- extraction of water from the Victoria River is subject to the necessary approvals from Advisory and Regulatory Services (Water), Conservation and Natural Resource, NRETA.

4.3.4 Underground water resources

The study area is located in the Ord–Victoria groundwater province. Groundwater yields and quality vary considerably in this province and in the project area. Regular replenishment of groundwater occurs during the wet season.

DPI is currently investigating the availability of existing groundwater bores to supply water for construction. The locations of these are provided in Table 4.1. Additional unregistered water bores are known to be present. If registered bores will not provide the required amount of water, or if they are located too far from construction sites, new bores may be required.. The potential locations of new bores, the potential impacts of establishment, and the amount of water that will potentially be sourced from bores for construction purposes has not been determined at this stage. These matters will be subject to further discussions, review and approval from Advisory & Regulatory Services (Water) Conservation and Natural Resources NRETA.

Table 4.1 Registered groundwater bores in the project area

EBore No.	Depth of bore(m)	Owner name	SWL value*	Yield (L/sec)	Locality
RN00629	70.70	Ngaliwurru/Nungali Aboriginal Land Trust	16.80	0.50	Fitzroy Station
RN006324	122.00	Ngaliwurru/Nungali Aboriginal Land Trust	0.00	Unknown	Fitzroy Station
RN006348	31.10	DPI (NT Transport & Works)	4.00	0.63	Sullivans Camp
RN007739	45.70	Victoria River Inn	21.30	4.54	Victoria River Inn Motel
RN021375	43.00	Victoria River Inn	20.00	2.75	Victoria River Inn
RN021529	54.00	Victoria River Inn	0.00	3.15	Victoria River Inn
RN022531	71.00	Victoria River Inn	0.00	2.52	Victoria River Inn
RN026747	45.00	Parks & Wildlife — Gregory National Park	19.00	0.55	Gregory National Park
RN027079	70.00	DPI (NT Transport & Works)	0.00	3.30	Victoria Highway (Gregory National Park)
RN027081	120.00	N.T Transport & Works	0.00	0.30	Victoria Highway (Fitzroy Station)

** SWL = surface water level below ground in metres; 0.00 = no data available.*

Impacts

The key potential impacts are:

- unacceptable water table drawdown on existing or new bores
- contamination of bores
- environmental disturbance as a consequence of establishing new bores.

The use of underground water resources is a low risk issue.

Mitigation measures

The following mitigation measures are proposed:

- an assessment of existing bore quantity, quality and drawdown effects for any bores proposed to be used is to be undertaken by the construction contractor
- the contractor will consult with and seek approval from Advisory and Regulatory Services (Water), NRETA regarding extraction rates, licensing requirements, contamination prevention measures and conditions of extraction for sourcing construction water from underground water sources.

4.4 BIOLOGICAL ENVIRONMENT AND ECOLOGY

A Protected Matters database search was completed of the DEH website. This indicated that no World Heritage Places, National Heritage Places, Ramsar sites, Commonwealth Marine Areas, Commonwealth Lands, Commonwealth Heritage Places, Places on the Register of the National Estate or Commonwealth Reserves are located within the project area or were likely to be impacted by the proposal. No threatened ecological communities, whales and other cetaceans or critical habitats were listed as being within the area or are likely to be impacted by the proposal.

The search report provided a range of species and habitats listed under the EPBC Act. A review of the NT biological databases for the project area and the wider region was also undertaken. All of these data established the baseline review for the proposal. Additional field assessments of the project area were undertaken by specialist consultants were then undertaken over 2005 and 2006. Each component of the biology and ecology of the project area is discussed in this section.

4.4.1 Vegetation communities of conservation significance

The vegetation of the Highway corridor contains a number of major communities, with minor variations and changes in species occurrence, dominance and composition in accordance with landform, soil type and water availability.

The broad-scale distribution of native vegetation communities in the project area is based on Wilson et al. (1990) and from an additional survey (Lewis et al. 2006). The communities include:

- *Eucalyptus tectifica* (northern box), *Corymbia terminalis* (bloodwood) woodland with *Sehima nervosum* (white grass) and *Chrysopogon fallax* (golden beard grass) grassland understorey
- *Corymbia dichromophloia* (variable-barked bloodwood), *Eucalyptus miniata* (Darwin woolly butt) low open woodland with *Triodia pungens* (curly spinifex) open hummock grassland understorey
- *Terminalia arostrata* (nutwood) low open woodland with *Chrysopogon fallax* (golden beard grass) and *Dichanthium* (bluegrass) grassland understorey
- *Eucalyptus microtheca* (coolibah) open woodland with *Sehima nervosum* (white grass), *Panicum decompositum* and *Chrysopogon fallax* (golden beard grass) grassland.

The distribution of these communities is displayed in Figure 4.2. In addition to these broad scale communities, there are areas of *Chionachne cyathopoda* and/or *Mnesithea rottboellioides* tall grassland (cane grass), which are associated with the flood plain woodland of the Victoria River and its tributaries. The distribution of these areas in the project area is in the specialist report produced by HLA-Envirosciences (2005).

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The vegetation communities were identified as being common and widespread throughout the Top End in DPI (2005), consequently none was considered to be of particular conservation significance. This conclusion was investigated by Lewis et al. (2006) and their assessment of the project area and region was based on vegetation mapping information from NRETA.

The area proposed for development is relatively small and is not located in the Gregory National Park. It is located in areas already affected by human disturbance (i.e. the Victoria River Highway disturbance corridor and pastoralism) (Lewis et al. 2006).

As explained in Section 2.4.5, a number of general locations have been selected for the extraction of borrow materials (gravel and fill). These sites are located in habitats of least concern when considering vegetation communities of conservation significance in the region (Lewis et al. 2006).

Disturbance in these vegetation communities will result in the loss of the immediate vegetation cover at impact sites and also the loss of habitat elements that support wildlife.

Impacts

The key potential impacts associated with the removal of native vegetation are:

- the removal of a maximum of 72.05 ha from the impact sites along the Victoria Highway and an estimated maximum of about 40 ha of native vegetation through the clearing of borrow areas
- a 5 ha reduction in the distribution and abundance of the regionally restricted vegetation community, cane grass grassland
- temporary removal of aquatic habitat
- accelerated soil erosion from cleared sites
- opportunities for colonisation by weeds
- fragmentation of habitat for wildlife
- indirect loss or adverse changes in the habitat.

The potential for adverse impacts on vegetation communities is considered to be a low risk matter for the proposal.

Mitigation measures

The following mitigation measures are proposed:

- the extent and level of disturbance, particularly in restricted vegetation communities, will be limited to that only necessary to complete the works
- vegetation outside the impact corridor will not be disturbed
- weeds will be controlled
- the old road and bridge sites will be rehabilitated and appropriately revegetated with local indigenous species similar to the adjoining vegetation

- rehabilitation and revegetation works will be implemented during or directly after construction. All borrow areas will be rehabilitated in accordance with DPI's standard Specification for this (Appendix B)
- rehabilitated and revegetated areas will be monitored on a regular basis during construction and for one year following construction.

4.4.2 Flora species of conservation significance

No threatened flora species (i.e. Critically endangered, Endangered or Vulnerable status) listed under the EPBC Act were recorded in the project area or region. A review of the NRETA Northern Territory Herbarium database indicates 471 plant species have been recorded from the wider region including the study area. The majority of these species are not of particular conservation significance (Lewis et al. 2006).

The review identified thirteen species of conservation significance in accordance with the Species Survival Commission of the International Union for the Conservation of Nature (and Natural Resources) (IUCN) Red List Categories. Use of the IUCN classification system is a requirement of the *Territory Parks and Wildlife Conservation Act 2003* (TPWC Act). A full list of these species together with the definitions of status applicable is provided in the specialist report in Appendix D.

Gleichenia sp. Victoria River and *Adiantum capillus-veneris* are classified as Vulnerable, and both are restricted to habitats on permanent springs at the bases of sandstone cliffs. No development or access is proposed to occur in these habitats; therefore, no direct threat is envisaged as a consequence of the proposal.

Eleven species are classified as Near Threatened or Data Deficient. Five of these species are endemic to the NT and three of these species are Near Threatened, including *Melaleuca triumphalis, Stenostegia congesta* and *Isotropis* sp. Joe Creek. The three species are present in the region, although they have not been identified in areas proposed for development. Consequently, no significant threat to these species is expected.

The Near Threatened or Data Deficient categories have no legislative status; however, ongoing monitoring of these taxa in the future may lead to a Threatened Status qualification. Data Deficient indicates a lack of data for these species and more information is required to show if a threatened classification is appropriate. All species in these categories are found in habitats represented and widely distributed throughout the Top End; therefore, no significant threat to these species is predicted to occur.

A list of these species is provided in the specialist report in Appendix D.

The AAPA will issue a Clearance Certificate for the final locations of borrow areas once specific locations have been inspected and approved by the Traditional Owners as being clear of Sacred Sites. A flora survey of these sites will then be commissioned to substantiate the assessment of Lewis et al. (2006)

Impacts

Based on the findings of Lewis et al. (2006), the size, extent, duration and likelihood of the impact on flora species of conservation significance is acceptable. This is a low risk issue.

The key potential impacts are:

- the presence of unrecorded populations of threatened species
- if threatened species are present, a potential reduction in the abundance and potential distribution of these species.

Mitigation measures

The following mitigation measures are proposed:

- when the preferred borrow areas (for gravel and fill material) are identified and agreed by AAPA, surveys for Near Threatened or Data Deficient plant species, as defined by the TPWC Act, will be undertaken before works commence
- if these surveys identify areas of threatened plant species, then these areas will be avoided.

4.4.3 Weeds

Thirty-four introduced plant species have been recorded in the Gregory National Park and twenty-five have been recorded in the study area (DPI 2005a), of which 10 are formally declared weeds under the Weeds Management Act. Table 4.2 summarises those declared weeds recorded in the study area based on information from the DPI flora database, observations in the field, and data from the Gregory National Park draft plan of management (PWCNT 2001) as updated by G. Fischer (Chief District Ranger, Victoria River District, NTPWS). A number of other species are considered to be environmental weeds; that is, they have the potential to successfully compete and eliminate native species or to adversely change the local environment through shading, smothering or changing soil properties.

Table 4.2 Declared and environmental weeds known from the study area

Species	Common name	Comments
Acanthospermum hispidum	Star burr*	Not seen
Aerva javanica	Pillow weed	Not seen
Alternanthera pungens	Khaki weed*	Has been recorded in the vicinity of Victoria Highway Inn
Calotropis procera	Rubber bush*	Turning area at Ch 192.65 km at Victoria River. Also recorded on adjacent pastoral land
Chloris gayana	Rhodes grass	Present along the road verge for much of the route
Clitoria ternatea	Butterfly pea	Along much of the route, especially along watercourses. Turning area at Ch 192.65 km at Victoria River
Cynodon dactylon	Couch grass	Around Victoria River Inn. Note: considered by some to be indigenous
Desmodium sp.		Common along the road verge for much of the route
Hyptis suaveolens	Hyptis*	Minor infestations noted in floodways. Larger infestation at approximately Ch 213 km
Jatropha gossypifolia	Bellyache bush*	Infestation at Lost Creek, Ch 208.45 km
Leucaena leucocephala	Coffee bush	Located at Joe Creek, approx. Ch 204.3 km
Martynia annua	Devil's claw*	Not seen, but reported to be present
Parkinsonia aculeata	Parkinsonia*	Reported to be present along the Highway
Passiflora foetida	Wild passionfruit	Located around the Victoria River, Ch 192.3 km and as isolated occurrences elsewhere, including areas of cane grass (e.g. Joe Creek)
Pennisetum polystachion	Mission grass	Occasionally present along the roadside. Potential to become a dominant species
Ricinus communis	Castor oil plant*	Occasional occurrence along roadside in drainage lines (culverts). Mostly located outside of the road corridor (e.g. at Site 3 Ch 195.5 to 196.5 km)
Sesbania cannabina	Sesbania	Native species, but weedy characteristics. Present along much of the roadside
Stylosanthes hamata	Hamata, Clover	Present along most of the Highway roadside
Tribulus terrestris	Caltrop*	Present at Victoria Highway Inn
Xanthium strumarium	Noogoora burr*	Common in many riparian areas and abundant at Coolibah Station, including the potential gravel source site RG3

** — Declared weed under the Northern Territory Weeds Management Act 2001.*

Construction activities (e.g. plant and equipment being bought in to the area, vegetation clearance and soil disturbance) have the potential to introduce new weeds and assist the dispersal of existing weeds.

All species warrant control within the weed management plan that is developed as part of the EMP for the project. However, species of greatest risk are:

- rubber bush (*Calotropis procera*)
- Parkinsonia (*Parkinsonia aculeata*)
- devil's claw (*Martynia annua*)
- Noogoora burr (*Xanthium strumarium*)
- bellyache bush (*Jatropha gossypifolia*)
- wild passionfruit (*Passiflora foetida*), especially in the areas of cane grass.

The introduction and dispersal of weeds as a result of construction activities could result in adverse impacts on the pastoral and conservation industries and resources, and adversely impact on species of conservation significance.

DPI's policy requirements for weeds management are provided in Appendix B.

Impacts

The key potential impacts are:

- the introduction of weed species not currently present or established in the region, including the Gregory National Park
- the assisted dispersal of weed species via construction activities
- an increased pressure on native species due to increased competition
- elimination of native flora through changes in the local environment or excessive competition with weeds
- adverse impacts on the habitat of native fauna
- changes to the local environment that result in the establishment of unfavourable habitat for native plants and animals.

Weeds can be managed and controlled and the spread and introduction of weeds is considered to be a low to medium risk issue.

Mitigation measures

The following mitigation measures are proposed:

- DPI's policy for weeds management will provide the basis of the management actions (see Appendix B). DPI's existing Specification contains strict requirements for machinery cleanliness when entering and working adjacent to National Parks
- declared and environmental weeds will be identified and areas of infestation will be marked in the field and on construction maps prior to construction
- the weed management plan will be developed in consultation with staff of the NTPWS at Timber Creek (through the Chief Ranger) to assist in identifying best management and preferred practices for the control of weed species

- the weed management plan will accord with the weed management priorities and actions developed for the Gregory National Park (PWCNT 2001)
- a weed management plan will be developed and implemented for construction whilst these areas are operational and for one year post-construction, for species and populations considered to be moderate to high risk weeds
- the weed management plan will address the issues of plant, equipment and personal hygiene to eliminate the transfer of weed material.

4.4.4 Fauna species

A review of the DPI fauna database indicated a large number of records for most faunal groups. Fish species data were provided by MAGNT and de Lestang and Wedd (2005). A comprehensive list of all fauna species previously recorded in the study area is provided in Appendix D.

The numbers of species according to taxonomic group are 38 mammals (six introduced), 147 birds (one introduced), 51 reptiles (one introduced), and 20 amphibians (one introduced) have been recorded in the study area. About 40 species of fish and elasmobranchs (rays, which are a close relative to sharks) have been recorded in the Victoria River system (H. Larson, NT Museum, pers. comm. 2005, de Lestang and Wedd 2005).

DPI commissioned detailed assessments of the potential terrestrial and aquatic impact areas. These reports are:

- Horner and Archibald (2005), terrestrial fauna
- HLA–Envirosciences (HLA) (2005), purple-crowned fairy-wren
- de Lestang and Wedd (2005), aquatic fauna.

A summary of the findings of each report is included below. A copy of each of the complete reports is provided in Appendix D.

Terrestrial fauna

Four major fauna habitats were present and assessed in the project area. These are described below.

- Riparian. Variable, but usually dense, tall river-side vegetation along the Victoria River channel. It characteristically includes vegetation such as *Barringtonia acutangula, Pandanus aquaticus, Eucalyptus camaldulensis, Nauclea orientalis* and *Melaleuca leucadendra.*
- Cane grass. Dense stands of *Chionachne cyathopoda* and *Mnesithea rottboellioides* on clay soils. Found alongside riparian areas of the Victoria River and some of its tributaries.
- Eucalyptus woodland. Woodlands, dominated by *Eucalyptus* and *Corymbia* spp., occur on a range of soil types and are the major habitat in the area. This habitat is dominant on the loam plains that separate the Victoria River channel from the surrounding sandstone ranges and outcrops.

- Escarpment scree slope. Rocky slopes, supporting low open *Eucalyptus* woodland with an understorey of *Triodia* hummock grassland. This habitat borders short sections of the Victoria Highway between the Victoria River Bridge and Lost Creek.

All habitats along the Victoria Highway corridor have been impacted by human disturbance, such as the Highway, pastoral activities and associated tracks and roads, introduced and pest plants, feral animals (43% of mammal species observed) and fire.

Of the habitats surveyed, most are widely distributed through the NT's Top End and elsewhere in the project area and region. It is considered that the relatively small area that will be impacted by the project is of limited consequence to fauna.

One habitat that is of conservation significance is cane grass. This habitat is regionally significant in that it occurs as dense grassland alongside some stretches of the Victoria River and Highway and supports populations of the nationally threatened purple-crowned fairy-wren and a number of other species. In the survey area, relatively large cane grass areas were present at the Victoria River Bridge, Lost Creek Bridge and on the river bank adjacent to the proposed gravel site RG3 on Coolibah Station.

The survey identified cane grass as the most biologically rich (species diversity and abundance) environment with 33 species of terrestrial vertebrates recorded, 15 of which were recorded only in that habitat. A number of these fauna species are known to commonly occupy other habitats. Some bird species favoured this habitat, especially finch species such as *Neochmia phaeton, Lonchura flaviprymna* and *L. castaneothorax* and Cisticola (*Cisticola exilis*).

In the Victoria River region, cane grass stands are threatened by:

- feral animals, such as pigs and buffaloes, which force their way through the stands thereby opening them and baring the soil surface to erosion
- weeds, which often colonise and infest these areas after disturbance impacts have occurred.

Populations of the introduced rodent black rat (*Rattus rattus*) occurred in the cane grass stands at Lost Creek and adjacent to RG3. Black rat is a species that is usually associated with human settlement and disturbed environments. Its presence in cane grass habitat increases the risk to purple-crowned fairy-wren, as the rat is an expert climber, omnivorous and a known predator of bird eggs and hatchlings.

The key recommendation of the fauna survey was to minimise disturbance impacts to the areas of cane grass.

A list of the threatened species, including nationally significant species recorded in the area, is provided in Section 4.4.5.

Purple-crowned fairy-wren

Purple-crowned fairy-wren (*Malurus coronatus coronatus*, which is the western subspecies) is known from a number of records in the study area (Appendix D). Garnett and Crowley (2002) indicate that the species has declined throughout much of its former range. The Victoria River District is now a key stronghold for the species, which is listed as Vulnerable under the EPBC Act and as Near Threatened under the TPWC Act.

The current population of the species is estimated to be between 7,000 and 12,000 birds in seven sub-populations. HLA (2005) indicates that the lower population estimate is likely to be the more accurate of the two.

The breeding period of the fairy-wren is dependent on climatic conditions, including the length of the wet season and the amount of local flooding, which inundates the cane grass habitat. The species may raise two to three clutches per year and about 75% of nests occur over July to September. Breeding may also take place during January to May. At the end of the breeding season young birds disperse into other areas.

Based on these records and the location of the potential impacts of the project on the species, a detailed supplementary survey for the purple-crowned fairy-wren was undertaken by HLA (2005). The assessment included all areas adjacent to the Victoria Highway between Ch 185 km and 220 km, and each of the riparian areas; that is, all 44 culverts, and the Victoria River, Escarpment Creek, Joe Creek, Lost Creek and Sandy Creek (Appendix D contains the full report).

The survey identified 13 sites with cane grass (*Chionachne cyathopoda*), of which seven were found to have fairy-wrens present. The greatest number of individual birds was recorded at Lost Creek, Victoria River and Escarpment Creek. HLA (2005) did not have detailed construction drawings of all sites at the time of the investigation and several of their sites were incorrectly identified, including the location of Escarpment Creek. Consequently, its estimate of direct impacts on cane grass over-estimated the potential damage on this habitat.

The key potential impacts are:

- direct loss of individuals through their displacement from areas of cane grass habitat
- disruption to breeding activities, which mostly occur during the dry season (when construction will be undertaken)
- loss of key breeding and foraging habitat totalling approximately 5ha at Victoria River and Lost Creek
- fragmentation of habitat, resulting in less suitable habitat being available for adults and reducing the chance of successful dispersal of young birds
- indirect loss of individuals through increased competition for resources and potential increased predation.

Aquatic fauna at site RG3

de Lestang and Wedd (2005) completed a survey of the aquatic fauna in the project area. Most of the investigation was along and in the channel of the Victoria River. This site, RG3, is one of the areas currently proposed to be used for the extraction of gravel for the project.

Thornburn et al. (2002) describe freshwater sawfish (*Pristis microdon*) and dwarf sawfish (*Pristis clavata*) from this region. These species are listed as vulnerable in Schedule 1, Conservation Status of Animals of the Northern Territory, with *Pristis microdon* listed as Vulnerable by the EPBC Act. Following preliminary site investigations in early November 2005, an intensive aquatic survey was carried out in December 2005 to determine:

- the presence of aquatic fauna listed as Threatened under the TPWC Act (in Schedule 1 of the Conservation Status of Animals of The Northern Territory) and the EPBC Act, including the freshwater sawfishes (*Pristis microdon* and *Pristis clavata*), freshwater whip ray (*Himantura chaophrya*) and spear-toothed sharks (*Glyphis* spp.)
- the potential effects of stream bed disturbance on the aquatic habitat and fauna
- the potential impacts of gravel extraction from an elevated, seasonally dry channel bed deposit (RG3) and mitigation measures to avoid or reduce these impacts.

This report details the species composition and relative abundance of the aquatic fauna in the channel of the Victoria River adjacent to the extraction site. It compares the data for this site to a control site located about 20 km upstream of the proposed extraction area, where no disturbance will occur.

Twenty-seven species of fish, four species of reptile and one elasmobranch (ray) were recorded and there was no major difference in the abundance or species composition between the two sites. The elasmobranch, a freshwater whip ray, was the only species recorded in the pools adjacent to the proposed borrow site that is listed as Data Deficient in Schedule 1, Conservation Status of Animals of the Northern Territory 2003.

However, previous research (Thornburn et al. 2002) and anecdotal evidence from the local community and traditional owners indicate that both of the listed sawfish species occur in the pools adjacent to the proposed gravel excavation site and at the Victoria River Bridge during the year, usually at the end of the wet season.

Gravel will be not be extracted from any permanent pool within the Victoria River. Only those materials within the raised channel bed deposit (RG3) may be extracted.

The report suggests that the proposed extraction of material from the Victoria River site RG3 would have little or no impact if:

- extraction occurs in the dry season
- the area is rehabilitated to allow existing river flows to be maintained
- depressions caused by works are removed to allow water to drain freely to the river channel
- small areas of vegetation along the water edge, which are potential freshwater crocodile and turtle nesting sites, are avoided.

These recommendations are accepted by DPI and they will be implemented.

Fauna habitat

Key habitat areas for faunal groups along the Victoria Highway are:

- riparian areas, especially those with tall grasslands, of which cane grass is particularly important
- flood plain woodland
- rocky escarpment footslopes
- specific small areas associated with the Victoria River, such as remnant pools of water that persist through the dry season and that may occur in or adjacent to construction sites.

The riparian areas provide significant wildlife habitat. During the dry season, any remnant pools present along the drainage lines and the Victoria River provide important sources of drinking water for animals. These riparian areas also have a mild microclimate compared with the open woodland of the flood plains and slopes. Remnant pools of water also provide important refuge habitat for fish, some reptiles and amphibians, and aquatic invertebrate populations during the dry season. However, it appears that few pools remain in any of the tributaries of the project area during the mid to late dry season.

Cane grass (as either *Chionachne cyathopoda* or *Mnesithea rottboellioides*) grasslands are known to be important habitat for a number of mammal and bird species (DPI 2005). HLA (2005) and Horner and Archibald (2005) indicate that this tall grassland habitat occurs in dense stands alongside some stretches of the Victoria River and at a few other riparian sites. This habitat supports populations of the nationally threatened sub-species of the purple-crowned fairy-wren (DPI 2005). The recent fauna survey carried out by Horner and Archibald (2005) noted that 33 species of terrestrial vertebrates were recorded in cane grass habitat, 15 of which were confined to this habitat.

Some of the large trees of the drainage lines are in 'fire shadows' and are hollow-bearing trees. Hence, they provide important roosting and/or breeding locations for bats, birds, large reptiles and small mammals such as possums. Following vegetation clearance in many other regions of Australia it is appropriate to retain the sections with hollows and relocate them to nearby areas. This assists in maintaining some elements of the habitat lost through clearance. However, relocating hollows in a fire-prone area provides limited long-term benefits (G. Fischer, NTPWS, pers. comm., 2005).

The rocky escarpment footslopes and scree slopes provide habitat for small mammal and reptile fauna, although this area is the least sensitive of all habitats.

Small areas along the edge of RG3 may provide nesting sites for freshwater turtles and freshwater crocodiles. Any small remnant pools in the main stream adjacent to RG3 and the Victoria River Bridge may provide habitat for threatened sawfish and elasmobranch species.

An end-of-wet-season survey for aquatic fauna and a dry season fauna survey of terrestrial species will be undertaken later in 2006 to assess seasonal variation of habitats and species composition.

Impacts

The key potential impacts are:

- loss of habitat
- potential loss of individuals due to a reduction in habitat availability and fragmentation
- displacement of individuals due to fragmentation, with subsequent increased potential for predation
- increased competition for resources that are reduced in distribution and abundance.

Habitat is a medium risk issue, primarily in relation to loss of cane grass habitat and dependent species.

Mitigation measures

The following mitigation measures are proposed:

- a dry season assessment of the project area to be undertaken for terrestrial fauna in 2006
- development of specific mitigation measures to be incorporated in the construction environmental management plan based on the outcomes of the assessment
- minimisation of the impact on vegetation (i.e. habitat) to that area necessary to complete works.

4.4.5 Conservation significant fauna species (threatened species)

Threatened species of particular concern are those listed under the EPBC Act and Schedules to the TPWC Act. A number of these species are known to occur in the project area, including the area of the Victoria River system in which the project will be undertaken. These species are listed in Table 4.3.

Table 4.3 Fauna species and their habitat of conservation significance that occur, or potentially occur, in the project area

Common name	Scientific name	NT status*	EPBC Act status
Terrestrial species			
Bare-rumped sheathtail bat	*Saccolaimus saccolaimus nudicluniatus*	–	Critically endangered
Magpie goose	*Anseranas semipalmata*	–	Listed marine
Fork-tailed swift	*Apus pacificus*	–	Listed marine
Great egret	*Ardea alba*	–	Listed marine
Cattle egret	*Ardea ibis*	–	Listed marine
Oriental plover	*Caradrius veredus*	–	Migratory wetland; listed marine
Gouldian finch	*Erythrura gouldiae*	Endangered	Endangered; migratory
Oriental pratincole	*Glareola maldivarum*	–	Migratory wetland; listed marine
White-bellied sea-eagle	*Haliaeetus leucogaster*	–	Migratory; listed marine
Purple-crowned fairy-wren (western sub-species)	*Malurus coronatus coronatus*	Near threatened	Vulnerable
Rainbow bee-eater	*Merops ornatus*	–	Listed marine
Star finch	*Neochmia ruficauda clarescens*	–	Near threatened
Little curlew	*Numenius minutes*	–	Migratory wetland; listed marine
Derby white-browed robin	*Poecilodryas superciliosa cerviniventris*	–	Migratory
Australian painted snipe	*Rostratula australis*	Vulnerable	Vulnerable; listed marine
Painted snipe	*Rostratula benghalensis* s. lat.	–	Migratory marine
AQUATIC SPECIES ()			
Freshwater crocodile	*Crocodylus johnstonii*	–	Listed species
Estuarine crocodile	*Crocodylus porosus*	–	Migratory marine; listed
Speartooth sharks**	*Glyphis* spp. (sp. A and *Glyphis* sp. C)	Vulnerable	Critically Endangered and Endangered
Freshwater whip ray	*Himantura chaophrya*	Data deficient	–
Freshwater sawfish	*Pristis microdon*	Vulnerable	Vulnerable
Dwarf sawfish	*Pristis clavata*	Vulnerable	–
Angalarri grunter	*Scortum neili*	Vulnerable	–

** — Status as per PWCNT (2005a). ** = Undescribed species. - no listed status.*

In general, the proposed works will result in some loss and fragmentation of habitat, and potential loss of individuals of conservation significant species. These impacts may place increased pressure on populations and species which are already stressed.

In addition to the species considered in Table 4.3, the following eight species are considered by Horner and Archibald (2005) to be of Near Threatened status on a regional level, although they are common and widespread species without specific habitat requirements.

Flood plain monitor (*Varanus panoptes*) is widespread through northern Australia this species occurs in a broad range of habitats. As a frog predator, it is considered to be under threat from the cane toad invasion that is currently occurring in the region. It was recorded near Sandy Creek.

Bush stone-curlew (*Burhinus grallarius*) is common across northern and north-eastern Australia. Usually found in woodland habitats, this species was commonly seen throughout the project area.

White-quilled rock-pigeon (*Petrophassa albipennis*) is locally common on sandstone escarpments through the Kimberley and Ord-Victoria regions of Northern Australia. Very habitat specific, this species was observed on escarpment scree slopes near Joe Creek.

Red-tailed black-cockatoo (*Calyptorhynchus banksii*) is common across much of Australia. It is nomadic and migratory and may be found in a broad range of habitats. In the project area numerous specimens were observed in *Eucalyptus* woodland near Lost Creek.

Yellow-rumped mannikin (*Lonchura flaviprymna*) is generally uncommon but can be locally abundant. Several specimens of this species were observed in cane grass habitat at Lost Creek, intermixed with groups of the more numerous chestnut-breasted mannikin (*Lonchura castaneothorax*).

Ningbing false Antechinus (*Antechinus ningbing*) is locally common on rocky habitats through the Kimberley and Ord–Victoria regions of northern Australia. The species was recorded from escarpment scree slope habitat near Joe Creek in May 1986.

Western chestnut mouse (*Pseudomys nanus*) is common in northern Northern Territory and the Kimberley region of Western Australia. Prefers woodland habitat, but was observed in cane grass and escarpment scree slope habitats within the project area.

Pale field rat (*Rattus tunneyi*) has a widespread distribution through northern Australia. Found in a broad range of habitats, this species was observed in cane grass and *Eucalyptus* woodland habitats within the project area.

The Victoria River region is not considered to be a significant area for migratory birds. These species are usually associated with suitable habitats along the coast or large areas of freshwater, such as Lake Argyll at Kununurra.

One species of migratory bird, Oriental plover (*Charadrius veredus*), was recorded. The species breeds in the northern hemisphere and usually arrives in northern Australia in October. It disperses widely throughout northern Australia where it inhabits open grasslands, claypans, gibber plains and occasionally tidal mudflats. Within the project area several specimens were observed on the bank of the Victoria River near the RG3 potential gravel site.

Most of the species listed in Table 4.3 are very unlikely to occur in the project area and therefore are low risk species. These species are not discussed. The final EMP will include mitigation measures for these species, will be implemented if they are recorded during construction. Only those species recorded in the project area are reviewed in this section.

Purple-crowned fairy-wren (*Malurus coronatus coronatus*, western sub-species)

The western sub-species is listed as Vulnerable under the EPBC Act, and near threatened under the TPWC Act.

Based upon NT fauna database records and the potential impacts of the project on the species, a detailed supplementary survey for the purple-crowned fairy-wren was undertaken by HLA (2005) at Victoria River, Escarpment Creek, Joe Creek, Lost Creek and Sandy Creek and 44 culverts along the section of the Victoria Highway included in the proposal (HLA 2005 is included in Appendix D).

The survey identified 13 sites with cane grass (*Chionachne cyathopoda*) of which seven sites were found to have resident populations of purple-crowned fairy-wrens. The greatest number of birds were recorded at Victoria River, Lost Creek and an unnamed creek adjacent to the escarpment walk. A key finding of the survey was that the volume of cane grass in a patch must be more than about 3,000 m^3 to provide suitable habitat for the fairy-wren. If the grassland is less than this threshold amount then the area is not used by the species.

Details of each of these three key populations and other sites potentially impacted follow. Appendix B includes all construction sites referred to in this section.

Victoria River Bridge

Purple-crowned fairy-wren was identified both upstream and downstream on both sides of the existing bridge by HLA (2005). The report noted that the impact would be similar for the new bridge on both sides and recommended transplanting grassland habitat from the affected areas.

Preferred Location: As the fairy wren occurs both upstream and downstream of the proposed bridge, other constraints determine that the preferred location for the new Victoria Bridge is 20 m downstream of the existing bridge.

Lost Creek Bridge

Numerous purple-crowned fairy-wrens and areas of fairy-wren habitat were identified downstream of the existing bridge, and a few wrens only were identified upstream by HLA (2005). The report recommended constructing the realignment on the upstream side. Purple-crowned fairy-wren was also recorded here during a fauna survey conducted by Horner and Archibald (2005).

Preferred Location*:* In consideration of the above constraints, the preferred location for the new Lost Creek Bridge is within 20–30 m upstream of the existing crossing, which will minimise impact on the purple-crowned fairy-wren. However, further discussions with AAPA must be undertaken to confirm whether realignment upstream into the known avoidance area is acceptable.

Unnamed Creek adjacent to the escarpment walk

The start of this site is about 1.6 km west of the Victoria Highway Inn. The proposed roadworks at this site involve raising the Highway. Eight fairy-wrens were present downstream and four birds upstream in a relatively large area of cane grass habitat. The road is located on a narrow isthmus between the escarpment and the slope and riparian plain of the Victoria River. Consequently it is extremely difficult to revise the location of the works at this site without causing greater environmental damage or at a cost that is not economical.

Culvert sites

Fairy-wrens were recorded at four other sites—culverts 7, 14, 15 and 16. These comprised small groups of two to four birds, the largest comprising eight birds, both upstream and downstream of culvert 14.

Where the road is to be raised, the culverts will be lengthened upstream and downstream along the drainage line. This work will affect the habitat owing to the road earthworks being larger as a result of batter slopes.

RG3 gravel extraction site

Large areas of cane grass are present on the banks near the extraction site. However, this plant species is not present at or adjacent to the area proposed for the extraction of gravel. A worksite for processing the extracted materials (e.g. crushing and screening), a gravel stockpile site, and a site for blending gravel with earth are required for the proposal. As a consequence of the distribution of cane grass at RG3, all these processing sites will not be located in or adjacent to areas of cane grass. The processing site will be located at a site nominated by the station owner, at the intersection of the Victoria Highway and access to Fitzroy Station. The stockpile and blending sites will be located at the same site (Figure 4.1).

Impacts

The key potential impacts are:

- direct loss of individuals through displacement during the roadworks
- disruption to breeding activities and the success of breeding
- direct loss of breeding and foraging habitat (about 5 ha for all of the proposal)
- fragmentation of areas of limited habitat, causing less suitable habitat to be available and reduction in dispersal capability of birds
- indirect loss of individuals through increased competition for resources, reduced dispersal corridors and potential increased predation.

Risk assessment

With appropriate and effective implementation of management strategies, the impacts can be managed to a reasonable level in most impact areas. However, the Victoria River crossing site will potentially require some localised rehabilitation and restoration works to alleviate the impacts on the local population of the species.

The purple-crowned fairy-wren is a low risk issue for most of the project area, a medium risk issue for the Lost Creek site, and a high risk issue for the Victoria River bridge site.

Mitigation measures

Mitigation measures will include the following:

- investigation of possible opportunities for protection of cane grass areas in the near vicinity of the project
- investigation of fencing of the road reserve boundary to prohibit cattle and feral pigs from entering cane grass areas along the reserve
- rehabilitation of old areas of road (following completion of new bridges and removal of the old structures) by transplanting cane grass clumps removed from the sites of the new bridges
- enhancement of sparse areas of cane grass by the addition of transplanted cane grass clumps.
- development of a species-specific management plan as part of the EMP, including:
  - contingency measures to manage sightings of purple-crowned fairy-wren within the impact area(s) during construction
  - education of the workforce on the importance of the species and its habitat (this will be included in the Induction Programme for the project for all of the contractor's workforce
  - rehabilitation of areas of cane grass habitat that have been disturbed by temporary roadworks, once roadworks have been completed
  - transplanting of cane grass clumps to other (potential and/or existing but sparse) cane grass habitat areas to improve existing habitat quality prior to commencing construction
  - erosion control of stream banks, to increase the chances of cane grass re-establishing
  - construction of an access track to the site, including clearing of vegetation to enable that construction. The track would be of minimal width, sufficient to allow trucks to access the site (about 5 m wide)
  - weed control, particularly in areas of cane grass rehabilitation and transplantation
- investigation and, where practical, implementation of the exclusion of stock and large feral animals, which may include fencing of cane grass habitat areas, both inside and outside the road reserve, and particularly adjacent to major watercourses
- control of feral animals such as buffalo, cattle and pigs during construction (proposed to be managed through the NTPWS).

The contractor will be required to employ a suitably qualified and competent person (as agreed to by the Biodiversity Conservation Unit, NRETA) for undertaking environmental management of the project.

Star finch (western sub-species)

This species had been previously recorded in cane grass areas in the Gregory National Park and the wider region (DPI 2005, Horner and Archibald 2005). The western sub-species of the star finch (*Neochmia ruficauda clarescens*) was recorded adjacent to the Victoria Highway in cane grass habitat at Lost Creek and in woodland near the Coolibah Station turn-off on the Victoria Highway (DPI 2005, Horner and Archibald 2005). The species is listed as Near Threatened under the TPWC Act.

Impacts

The key potential impacts are short-term disturbance and potential displacement of individuals in the area owing to construction activities.

The star finch is a low risk issue.

Mitigation measures

The following mitigation measures are proposed:

- the extent and level of disturbance, particularly in key habitat, will be limited to that only necessary to complete the works
- the contractor will employ a suitably qualified and competent person (as agreed to by Biodiversity Conservation Unit, NRETA) for undertaking environmental management of the project.

White-bellied sea-eagle

The white-bellied sea-eagle (*Haliaeetus leucogaster*) has been recorded in the study area (DIPE 2005b) and recorded breeding in the 15-16°S 130-131°E latitude–longitude square (Blakers et al. 1984, Barrett et al. 2003). White-bellied sea-eagles favour habitat along major creeks and rivers, such as the Victoria River, and are highly mobile. The species was observed in riparian habitat during April 2005 and during the fauna survey by Horner and Archibald (2005).

White-bellied sea-eagles are very timid when nesting and will abandon a nest if disturbed (Clunie 1994). Their breeding season is April to August. Pairs will re-use nest sites from previous years.

Impacts

The key potential impacts are:

- short-term disturbance and potential displacement of individuals in the area owing to construction activities
- disturbance leading to desertion of nests during breeding
- loss of nesting trees.

The white-bellied sea-eagle is a medium risk issue if present at a nesting site in the construction area along the Victoria River.

Mitigation measures

The following mitigation measures are proposed:

- the extent and level of disturbance, particularly in restricted vegetation communities, will be limited to that only necessary to complete the works
- construction activities will be reduced and/or delayed if white-bellied sea-eagles are found to be nesting nearby
- known previous nesting trees will be avoided by clearing activities where possible.

Freshwater crocodile

The freshwater crocodile (*Crocodylus johnstonii*) is recorded in the study area (DPI 2005a). The species inhabits billabongs and upper reaches of coastal rivers, with the Gregory National Park providing significant habitat (PWCNT 1999). It was observed on the banks of the Victoria River at Coolibah Station, in and adjacent to RG3 (Horner and Archibald 2005, de Lestang and Wedd 2005). It is a relatively large animal that is mobile and able to move away from disturbances. Potential nest sites will be mapped at RG3 during the 2006 dry season.

Impacts

The key potential impacts are:

- disturbance owing to construction activities
- reduced water quality, and hence habitat, owing to construction activities.

Risk assessment

The size, extent, duration and likelihood of the impacts of construction can be determined with a moderate to high level of certainty. The impacts can be managed.

The freshwater crocodile is a low risk issue.

Mitigation measures

The following mitigation measures are proposed:

- the impact corridor will be limited to that necessary to complete works
- construction activities will be undertaken in a manner that ensures disturbance-producing activities are completed efficiently to minimise the duration of impacts
- stringent development and implementation of strategies will be undertaken to ensure that water pollution is prevented
- removal and relocation of crocodiles from worksites may be undertaken if required.

Estuarine crocodile

No specific records for the estuarine crocodile (*Crocodylus porosus*) in the study area were found. However, the species is known to inhabit coastal rivers and swamps and visit freshwater rivers. The estuarine crocodile is more likely to inhabit the Victoria River downstream of the study area, although it may migrate upstream as far as the Victoria River Bridge, and has been occasionally observed around the Bridge. It is a mobile species and capable of relocating away from disturbances. Significant habitat for the species is protected elsewhere in the Gregory National Park (PWCNT 2001).

Impacts

The key potential impacts are:

- disturbance owing to construction activities
- reduced water quality owing to construction activities.

The estuarine crocodile is a low risk issue.

Mitigation measures

The following mitigation measures are proposed:

- the impact corridor will be limited to that necessary to complete works
- stringent development and implementation of strategies will be undertaken to ensure that water pollution is prevented
- protective measures and actions may be required to ensure the safety of workers. These will be included in the HSP developed by the contractor. Removal and relocation of crocodiles may be part of these actions.

Freshwater fish and elasmobranch (ray) species

The distribution of the freshwater sawfish (*Pristis microdon*) and dwarf sawfish (*P. clavata*) includes northern gulf rivers, including the Victoria River and others in its catchment. The species inhabit mud bottoms of freshwater areas and upper reaches of estuaries. The sawfish appear to be uncommon in the Victoria River (Stirrat and Larson 2002).

Within Queensland, the sawfish is known to spawn at the start of the wet season (Stirrat and Larson 2002). It is possible that this is also the case within the Northern Territory.

An aquatic fauna survey was carried out by de Lestang and Wedd (2005) in the pool upstream of the proposed gravel source, RG3.

No sawfish species was recorded during the survey. Site investigations revealed that the area includes suitable habitat for both species of sawfish and that they would probably be present in the area at certain times of the year. Traditional owners and anecdotal evidence from the local community indicated that both species are present in the vicinity of the RG3 gravel site at the end of the wet season.

Stirrat and Larson (2002) cite increasing development as a potential threatening process, owing to the resulting water pollution and loss of riverine habitat. Freshwater sawfish is listed as Vulnerable under the EPBC Act and *Territory Parks and Wildlife Conservation Act* and dwarf sawfish is listed under NT legislation, but not under the EPBC Act.

The freshwater whip ray (*Himantura chaophrya*) is present in the Victoria River at the proposed gravel source RG3. This species is recognised as being Data Deficient under the NTPWC Act.

Other threatened species potentially present in the Victoria River include *Glyphis* spp., as *Glyphis* sp. A and *Glyphis* sp. C (spear-toothed sharks). These species are listed as Critically Endangered (sp. A) and Endangered (sp. C) under the EPBC Act, and as Vulnerable under the NTPWC Act. Neither species was recorded during the survey. Both species prefer brackish water. All of the Victoria River in the project area is fresh water. Consequently, neither species is expected to occur in the areas of the Victoria River impacted by this proposal (de Lestang and Webb 2005).

Impacts

The key potential impacts are:

- disruption of breeding owing to construction activities
- direct loss of habitat
- indirect loss of habitat through pollution and temporary changes in the hydrology and river bed.

The potential impacts can be moderately managed through appropriate and timely strategies. The sawfish species are a medium risk issue, reducing to low risk if management actions are established.

Mitigation measures

The following mitigation measures are proposed:

- a follow-up aquatic survey will be undertaken for the Victoria River sites to determine the presence of the species and/or its preferred habitat at the end of the wet season, probably during May to June 2006. If necessary, additional management strategies will be developed based on the outcomes of the survey
- the impact corridor and material extraction areas will be limited to that necessary to complete works
- areas will be rehabilitated to allow the existing flow regime to be maintained and to eliminate depressions and abrupt changes in the contours of the river bed (especially at RG3)
- construction activities within the Victoria River will be undertaken outside the potential spawning season (i.e. beginning of the wet season), where practical
- stringent development and implementation of strategies will be undertaken to ensure that water pollution is prevented

- construction activities within the Victoria River will be restricted to a time of year that minimises additional pressures on individual species, as determined by survey and consultation with experts
- as part of the EMP, a species-specific management plan will be developed that includes contingency requirements if the species is recorded during construction. If necessary, re-location of individuals away from construction areas may be undertaken under an approval permit.

4.4.6 Pest animal species

Many of the pest animal species that are known to occur in the wider area are large, free-ranging species that have large home ranges. The proposed works are unlikely to significantly contribute to the increased abundance and distribution of these species.

Twelve pest animal species have been recorded in the Gregory National Park (PWCNT 2001). Six pest mammal species and one naturalised species (dingo, *Canis lupus*) have been recorded in the study area (DPI 2005, HLA 2005, Horner and Archibald 2005). These species are feral cattle (*Bos taurus*), water buffalo (*Bubalus bubalis*), horse (*Equus caballus*), cat (*Felis catus*), feral pig (*Sus scrofa*) and black rat (*Rattus rattus*). Horner and Archibald (2005) recorded black rat at Lost Creek and RG3, and it is expected that the species is present at other sites in the project area.

Cane toad (*Bufo marinus*) occurs in the region (G. Fischer, Chief District Ranger NTPWS, pers. comm., Feb 2005) and the species was recorded in large numbers at all assessment sites during the recent fauna survey (Horner and Archibald 2005). The cane toad is a threatening agent for many fauna species, primarily owing to its voracious appetite and its ability to poison animals that prey upon it and to out-compete native fauna.

The project has the potential to increase the abundance and accelerate the dispersal of the cane toad (*Bufo marinus*) in and west of the project area. However, as the toad already exists in and to the west of the project area, such acceleration is considered to be minimal.

The proposed works have the potential to encourage breeding and dispersal of exotic animals that compete with and prey on native animals and otherwise adversely impact on the environment, creating unfavourable habitat for those native animals.

The project may assist in the protection of threatened cane grass habitat in the region by various rehabilitation measures including stock-proof fencing.

More detailed impact and management actions are discussed for vermin, namely black rat, house mouse and cane toad.

Black rat and house mouse

Vermin as black rat (*Rattus rattus*) and domestic or house mouse, or 'mice', (*Mus domesticus*) are species that can reach plague proportions in good years in much of Australia. At such abundances, they can severely impact on native wildlife and flora.

House mouse populations tend to fluctuate, and in the project area they are usually associated with areas of human habitation. Black rat populations can be of greater significance in some environments owing to the species' ability to colonise areas of bushland. Even small and medium sized populations of black rat can cause significant impacts on some threatened species by predation and competition for resources. Populations of black rat have been recorded around the Victoria River Inn, and recently in cane grass stands at the Lost Creek and Coolibah Station.

Black rat can be a severe pest and is a declared vermin species in Australia. The occurrence of black rat in cane grass along the Victoria River is unusual. The species is an expert climber and known predator of bird eggs and hatchlings (Major 1991). Its presence raises concerns for the vulnerable purple-crowned fairy-wren and other bird species.

Control of rodent pests, such as black rat, typically relies on poisoning (baits or bait stations) or trapping regimes. In the project area, these methods would be difficult, if not impossible, to apply (Horner and Archibald, 2005; G. Fischer, Chief District Ranger NTPWS, pers. comm., February 2005).

In the project area, black rat occupies a natural environment (cane grass) that is also inhabited by native rodents (tropical short-tailed mouse *Leggadina lakedownensis*, western chestnut mouse *Pseudomys nanus* and pale field rat *Rattus tunneyi*). Any control mechanism that might be applied to black rat would be almost impossible to avoid impacting on these and other non-target native species.

Impacts

The key potential impacts are:

- construction activities encouraging the breeding of vermin, especially black rat, which could contribute to the development of increased populations
- the assisted dispersal of mice and rats through the movement of plant and equipment
- increased competition with native species for some food types and habitat resources
- predation of threatened native species
- damage to infrastructure as a result of nesting and chewing on equipment and service cables.

Black rat is a medium risk issue.

Mitigation measures

The following mitigation measures are proposed:

- construction management for pest animal species will be incorporated into the EMP to minimise the risk of construction activities encouraging or spreading pest animals
- wastes (particularly food) will be appropriately managed. The project can only mitigate the influence of black rat, the population of which pre-dates the proposal.

During all phases of the project, every effort will be made to minimise potential benefits to the black rat populations. Management of domestic hygiene, especially the proper disposal of foodstuffs and other rubbish will be a high priority. Food scraps will not be discarded at construction sites. They will be placed in rubbish bags or bins. Rubbish bins will have vermin-proof, tight-fitting lids and all bins will be regularly cleared and cleaned. Disposal of these wastes will be to an enclosed composting container or to landfill site, which will be covered with earth daily.

- natural predators of rats (e.g. owls, snakes and goannas) will be allowed to remain in the project area. This effort will include not harming, removing or relocating large snakes and lizards that may be found within the project area.

Cane toad

Cane toad was abundant in all habitats along the Victoria Highway (Horner and Archibald 2005). Its current distribution does not extend much further west than the project area, as found during the 2005 survey. However, following each wet season, the species distribution expands and it is predicted to occur in all areas suited to it west of the Victoria River in future years.

Impacts

The key potential impacts are:

- assisted dispersal of the cane toad via movement of plant and equipment
- death of native wildlife that prey on the cane toad species
- reduction in abundance and distribution of native wildlife
- increased pressure on native wildlife species and populations that could result in species becoming threatened.

The cane toad is a high risk issue nationally and for the region, but a low risk issue for the project.

Mitigation measures

The following mitigation measures are proposed:

- construction environmental management will incorporate pre-construction, construction and post-construction hygiene protocols for the prevention of the accelerated spread of cane toads into, and particularly west of, the area
- plant and equipment hygiene will be maintained to prevent the accidental transportation of cane toads
- approved traps and effective disposal will be used.

4.5 AIR QUALITY, NOISE AND VIBRATION

There are few communities or settlements along the route. The closest potentially sensitive noise and vibration receptor is the Victoria River Inn. Consequently, noise and air quality issues are expected to be minimal in the impact area.

Some fauna within the impact area may be adversely affected by noise levels and any decrease in air quality in the short term. Birds are believed to be the main ecological receptor in the vicinity of the construction works. With a few exceptions, these are mobile species and their response will be to leave the impact area.

Impacts

No long-term impacts are expected from changes in noise levels and air quality, and it is not expected that any permanent displacement of bird populations will occur. Fauna species located along the Highway are already accustomed to background noise levels caused by passing traffic and current construction and maintenance works. Construction works would only result in short-term and episodic increases.

There will be some additional noise, vibration and air quality issues during the construction of the bridge foundations. Construction of each individual foundation will probably take one to two days, dependent on the type of foundation constructed. The amount and frequency of the noise and vibration cannot be determined at this stage, as the foundation type will be dependent on the detailed design, which can only occur at a later stage (i.e. to allow it to be informed by the PER requirements). It is expected that the construction period of the bridge foundations would continue intermittently over a period of two to three months.

Vibration may impact on the OFC signal. These impacts will be assessed by monitoring the OFC signal by Telstra

Point sources of dust will be associated with work areas as dust generated by vehicles working at a site and travelling along bare earth surfaces. Other specific examples include the gravel screening and crushing plant and the main gravel stockpile site.

Air quality may be adversely affected by short-term increases in particulate matter. Dust suppression procedures will be required to reduce occupational health and safety risks and also to minimise impacts on fauna populations located within the impact zone.

Fugitive dust could be generated from any bare earth surface during wind, whether the source of this wind is natural or mediated by vehicles.

Greenhouse gas emissions are considered to be those typical of a large construction project. Where possible, the project will comply with the NT Greenhouse Action Strategy (2006); for example, by not burning combustible construction wastes and cleared vegetation. These latter materials will be stockpiled and used during rehabilitation works. Wherever possible, the construction works will use low-energy input materials, such as natural earth fill. The amount of concrete is likely to be relatively small compared with the overall project gas emissions for the project.

Nuisance dust will be an issue for workers and traffic using the Highway. Inhalation of respirable particulates by workers is an occupational health and safety (OH&S) issue for those involved in construction. This will be managed by the contractor as part of the HSP for the project.

Workers and the public travelling on unsealed portions of the works area will require specific protection owing to reduced visibility in dusty conditions and the potential of windscreen and headlight damage owing to rocks being cast up by vehicles.

Mitigation and management

Proposed mitigation and management measures include:

- a complaints register will be kept by the construction contractor. Complaints regarding noise, vibration or dust will be actioned immediately
- vibration impacts on the OFC signal will be monitored by Telstra
- OH&S requirements for working in dusty areas will be enforced by the contractor
- the TMP will establish safe travel requirements for construction workers and general road users in and adjacent to construction precincts.

The following dust suppression procedures will be implemented to ensure that changes in air quality are minimal.

- all complaints related to dust will be recorded and promptly actioned
- excavation works that generate dust will be watered to minimise dust emissions
- during the construction of the areas of the Highway that are to be raised, the earthworks will be watered to ensure compaction. This will be sufficient to control dust generation along those areas
- access roads to borrow pits and other construction sites will be watered at sufficient intervals to ensure adequate suppression of dust
- where close to public roads or other areas accessed by the public, active borrow areas will be sprayed with water to reduce the possibility of dust emissions.

Re-instatement and revegetation works will be undertaken for all areas disturbed by roadworks. Vegetation cleared as part of the roadworks will be used during the revegetation, either whole or mulched.

4.6 WASTE MANAGEMENT

Waste management will include most chemical and mechanical activities being undertaken during construction, such as chemical storage and use, sewage treatment, power generation, fuel storage and use, workshops and infield plant servicing.

The construction camp accommodation and mess area will generate household, packaging and putrescible wastes.

Little hard waste is likely to be generated by the project. Wherever possible, materials such as metals and concrete will be salvaged and re-used.

Specific sources of waste generated by the project include:

- demolition of old bridges and the salvage of the materials. If these materials cannot be recycled, they will be buried in old borrow pits
- concrete batching plant—small amounts of spillage will occur around a job site. Mixer wash-out will only occur at a disposal pit
- domestic waste, which will be buried in a pit and covered daily by an earth layer
- minor servicing of plant and equipment both in the field and at the contractor's depot, including oil changes, changing oil, fuel and air cleaner filters and greasing.

All liquid and hard wastes would be removed from the field and returned to the depot. Spill kits are a component of all in-field service vehicles

- major services and repairs, which would only be undertaken at the depot. Spill kits will be available at all sites in the depot where spills of hazardous materials could occur
- refuelling, which is likely to occur in the field via a vehicle-mounted fuel tank. A spill kit will be deployed with this vehicle. Fuel is too expensive to waste in spills.

4.6.1 Chemicals and hazardous materials, including dangerous goods

All chemicals and hazardous materials, such as petroleum products and fuels, oils and lubricants, acids, paints, thinners, solvents and gases, will be controlled in accordance with NT legislation, Australian Standards, and Material Safety Data Sheet requirements. This includes their transport, storage and use. The contractor will be responsible for this through a combination of its EMP, HSP and ERP, with auditing and review of all plans by the contractor and DPI to ensure compliance with statutory requirements and guidelines.

Bitumen is too expensive too waste and spills of this material will be avoided during construction by use of resurfacing paper, which protects the areas being worked on.

Impacts

Potential impacts include:

- fuel and chemical spills
- disposal of hazardous wastes
- disposal of hard wastes
- management of putrescibles wastes.

Management

A waste management plan will be part of the EMP. Illegal dumping and littering will be prohibited. The plan will define precautions such as Material Safety Data Sheet (MSDS) use and availability, chemical and fuel requirements in accordance with Australian Standards and NT legislation, use of spill kits, and correct disposal of all waste types.

DPI will advise the contractor about any specific requirements for waste disposal.

In the event that a solid waste disposal site is required, the NT Environment Protection Agency's *Guidelines for the Siting, Design & Management of Solid Waste Disposal Sites in the NT*, will be followed. The landfill would be sited above the 100 year flood line. Measures will be implemented to ensure that ground and surface waters are not impacted by leachate. Areas designated as groundwater recharge zones or wetlands will not be used as landfill areas.

On-site sewage and sullage treatment systems will comply with the management of wastewater according to the NT *Code of Practice for Small On-site Sewage and Sullage Treatment Systems and Disposal or Reuse of Sewage Effluent* and the Public Health Act.

4.7 BITING INSECTS

Mosquitoes will be the most likely pest and disease vector species. The potential biting midge species *Culicoides ornatus* is restricted to coastal mangrove areas.

Based on Whelan (1997) the flood plains, levee areas and tributaries of the Victoria River are likely to be a major wet season and early dry season source of mosquitoes. Up to 23 species could occur in the wider region, although four species were recorded at the eastern bank of the Victoria River in February 1984 (Whelan 1997).

A number of potential disease vector species and nuisance mosquito species are likely to be present in the region. However, the two most numerous species are likely to be *Ochlerotatus* (formerly *Aedes*) *normanensis* and *Culex annulirostris*. Both are vectors of viruses that infect people.

The seasonal abundance of all species will vary, with the largest populations occurring over the wet season and early dry season. Details about mosquito species in relation to their potential as vectors of disease in the project area have been provided by the Medical Entomology Branch, NT Department of Health and Community Services (A. Warchot, pers. comm., March 2006).

Ochlerotatus normanensis is likely to be present in pest numbers in the project area. The peak abundance of the species will be during January to April. This species is a potential vector of Ross River virus (RRV) disease, Barmah Forest virus (BFV) disease and Murray Valley encephalitis virus (MVEV) disease. This species bites in the evening and at night.

Culex annulirostris is likely to be a pest species. Peak abundance will be during January to June. This species is a potential vector of RRV disease, BFV disease, MVEV) disease and Kunjin virus (KUNV) disease. This species bites at night.

Anopheles annulipes is likely to be present in pest numbers, and peak abundance will be in the wet season. This species bites at night. This species can potentially transmit malaria; therefore, any worker sourced or returning from overseas countries where malaria is present who suddenly becomes ill with high fever should be considered as possibly having malaria. Immediate referral and treatment by a health care practitioner to determine the cause of the fever will be required.

A. bancroftii could be present in pest numbers. Peak abundance will usually be during February to June. This species bites at night, as well as in shaded areas near their breeding sites during the day. The species is also regarded as a potential malaria vector, but may not pose a significant risk as it does not live as long as other *Anopheles* species.

Other species likely to occur in pest numbers include *A. meraukensis, A. amictus* and *Coquillettidia xanthogaster*. These species will be most abundant during the wet season and early dry season. *A. amictus* could pose a potential malaria risk, while the other two species are irritant pest species.

Impacts

Environmental modifications owing to road and bridge construction activities could lead to increased mosquito populations. In some sites, roadworks could lead to the establishment of new mosquito breeding areas through pooling and ponding of stormwater and the presence of receptacles that store sufficient water to allow for out-of-season breeding of mosquitoes. All of these factors may then result in transmission of diseases.

Transfer of equipment and materials from other locations that contain *Ochlerotatus* (*Aedes*) mosquitoes could occur.

Unless construction works are managed properly there is potential to increase the numbers of biting insects owing to the inadvertent establishment of water ponding areas and breeding sites for these insects. An increase in biting insect populations could also result in an increased prevalence of mosquito-borne viruses such as Ross River, Barmah Forest, Murray Valley and Kunjin encephalitis among residents and workers in the construction zone and the project area and visitors to the region.

There is a low potential to introduce malaria into the region.

Management

The greatest mosquito problems will occur within 3 km of water bodies such as rivers, flood plains, swamps and creek lines.

Proposed management measures include the following:

- borrow pits within 5 km of the Victoria River Inn, Fitzroy Station, Coolibah Station and other human populated areas will be rendered free-draining on completion of construction
- borrow areas, costeans and scrapes will be managed to minimise the risk of ponding and thereby increasing mosquito numbers by providing a breeding site. All sites will be rehabilitated to ensure that they do not hold water for a period of greater than five days. Sites will be free-draining or filled following completion of construction activities
- natural drainage patterns will be maintained where possible. In the event that an alteration to the drainage line is required, culverts or other drainage devices or structures will be installed to prevent retention of water
- culverts will be installed so as to prevent upstream impedance of surface water flows; that is, they will be of sufficient size to prevent upstream flooding for periods that would enable mosquito breeding. They will be constructed and installed flush with the upstream surface level. Erosion prevention structures will be established on the downstream side of culverts and around the headwalls of culverts
- the construction of bridges must not result in the impoundment of water upstream of the structures
- all road machinery and equipment capable of holding or ponding water will be stored under cover, provided with drainage holes and emptied regularly to prevent the establishment of biting insect breeding sites

- no equipment that has been used in Queensland will be brought into the NT unless it has been thoroughly treated to remove the possibility of introducing Ochlerotatus (Aedes) mosquito species
- all open containers or receptacles that could hold sufficient water to provide a breeding site for biting insects will be stored and managed so as to avoid holding water. Regular removal and disposal of these will be undertaken as part of the waste management programme
- the contractor will be provided with copies of the Medical Entomology Branch publications 'Problem mosquito species in the Top End of the NT' and 'Arbovirus disease risk periods in the Northern Territory'
- workers will be advised of the potential risk for mosquito borne disease transmission in the project area. They will be supplied with the Medical Entomology Branch publication 'Personal protection from mosquitoes and biting midges in the NT' and 'Arbovirus disease risk periods in the Northern Territory' during their induction. Personal insect repellent will be supplied to all workers by the contractor
- DPI will require the contractor to establish an OH&S plan for the works, of which management of biting insects will be a component.

4.8 INFRASTRUCTURE AND TRANSPORT

4.8.1 Infrastructure

The Victoria Highway and its associated road infrastructure (including bridges, culverts, signs and similar) and the OFCs are the only infrastructure in this section of the road.

There are no reticulated water, gas or electricity services along the Highway. All distribution systems of these are for local reticulation only and dependent on town or settlement size.

National main trunk OFCs (from Katherine to Kununurra) are located adjacent to the Highway and largely follow the road corridor. In a number of places, the cables' locations are within 5 m of the road. An OFC spur line is also attached to the existing bridge over the Victoria River.

The position of the OFC in some sections of the Victoria Highway is within the works corridor. Any damage to a trunk OFC as a consequence of construction activities would result in the loss of national communication services to a significant area of the Northern Territory, Western Australia and southern Australia. This issue can be managed by careful planning and execution of construction works to avoid damage.

Access to public areas in the Gregory National Park in the project area and to access roads, including those leading to adjacent properties may be impeded; for example, to Joe Creek picnic area and its associated walk and the main access to Fitzroy and Coolibah stations.

The Victoria River Inn could be impacted through reduced or loss of access and disruption of services to the public.

A few fences and stock watering points occur on pastoral land adjacent to the Highway, but not at any of the construction sites.

Impacts

The key potential impacts are:

- loss of communication facilities
- loss and/or disruption of the provision of services to the public.

Impact on infrastructure, apart from the OFC, is a low risk issue. Damage to the OFC is a manageable issue providing that the locations are known to all involved in construction.

Mitigation measures

The following mitigation measures are proposed:

- the alignment and potential to adversely impact on the main trunk OFCs of national telecommunications carriers are to be determined to enable adequate management of any conflicts
- consultation with Telstra will form part of the design component of the project to determine best practice for new works in close proximity to the OFC
- the location of all cable alignments in and adjacent to construction areas will be known and clearly marked in the field and on construction drawings. The construction workforce will be briefed about the importance of the cables
- Telstra will monitor vibration impacts associated with construction on the OFC
- DPI will ensure that the contractor takes account of access to the Victoria Highway Inn in its planning of all works and the construction camp (if it is located in the vicinity of the Inn). Public access to the Inn will remain open and unimpeded
- DPI will ensure that, wherever practicable, the contractor does not impede current access roads from the Highway to Fitzroy and Coolibah stations. If this is not practicable, the contractor will provide acceptable, alternative access to the stations
- appropriate management strategies will be developed and implemented as part of the environmental management plan to manage access issues to Joe Creek picnic area and any other issues identified by the management staff of the Gregory National Park.

4.8.2 Transport

As part of Darwin to Perth corridor, the Victoria Highway is the only sealed, arterial road in the region. It is the major transport route for the region and the major east to west road corridor. Most of the traffic is associated with tourist and freight vehicles 'in transit'; that is, moving between Katherine and Kununurra. Local traffic in this section of the Highway originates from pastoral stations, Aboriginal land and communities, tourism and the community at Timber Creek.

As indicated in Chapter 1, the key objectives for this proposal are to improve flood protection and road safety for this section of the Highway in order to minimise inconvenience and costs to travellers and companies through road closure owing to flooding.

The estimated average annual daily traffic (AADT) volume on the Victoria Highway in the vicinity of the project area was 200 vehicles per day (vpd) in the dry season of 2004. The traffic growth over the past decade from 1994 has been a sustained 3% p.a. (compound), which is consistent with the 'medium growth' scenario of the Bureau of Transport and Communications Economics 1994 report 'Future Transport Demand & Infrastructure Needs—Freight and Passenger Demand'.

This growth is constrained in the wet season by the risks of delays owing to lengthy closures at the Victoria River. This has clearly affected decisions to travel the route in this period each year for both private and commercial traffic. It is estimated that an increase from 30 to 70 vpd (depending on which month of the wet season) to 190 vpd will occur over the wet season months once the flood plain section of the Victoria Highway River is upgraded.

This increase in traffic will equate to an AADT of 240 vpd once the Highway improvements are completed. Based on long-term traffic counts and development of the Northern Territory as a whole, the projected annual traffic growth on the Victoria Highway is 2.5% to 3% per year, which will equate to over 500 vpd in 30 years.

The vehicle classifications from the 2003 traffic counts shows that over 12% of AADT traffic comprises road trains, with a further 4% being articulated trucks; that is, approximately 16% of traffic is heavy or very long and heavy vehicles. As noted earlier, the route also carries a high number of tourists during the peak tourism (dry) season, with caravans and trailers making up 20% of total traffic during this time.

A major road user in the near future will be the Department of Defence (Defence), which has a large field training area and live firing range, Bradshaw Field Training Area (BFTA), north of Timber Creek. BFTA will be primarily used as a training facility by 1st Brigade, which is based at the Brigade Headquarters, Robertson Barracks, near Palmerston (Connell Wagner 1997). Deployment of elements of the Brigade and other users to and from BFTA will occur via road transport convoys, mostly during the dry season. This will include the transport of armoured vehicles (of 1st Armoured Regiment and 2nd Cavalry Regiment) and mechanised infantry training (based on armoured personnel carriers and wheeled vehicles).

In addition to the transport of armoured vehicles by heavy lift transport vehicles, convoys would include heavy and medium trucks and light vehicles used to transport general supplies, fuel, equipment, ordnance and personnel.

Defence management of convoys on public roads is strict. Convoy movements are managed by a regional control office under a Movement Order. A range of other commanders, actions and management controls are also established to control the convoy. Military Police provide support to the convoy, especially its movement through key or critical areas, such as narrow roads or bridges and (if necessary) construction sites along the route

Usually 'packets' of up to six vehicles are formed within the convoy, although this varies according to the type of vehicle and the size of the convoy. All vehicles are driven by professional drivers, travel at a maximum speed of 80 km/h and allow sufficient distance between each other to be overtaken by other road users. Rest stops are mandatory every two hours and five hours of driving. Over-mass and over-size (dimensional) vehicles follow permit conditions while on public roads. Liaison with police, local councils and DPI is undertaken for all large-scale convoy movements.

Impacts

Short-term

Impacts on users of the transport corridor will occur during construction, primarily owing to temporary road closures and access on unfinished sections of passing lanes. Since most of the works will be undertaken adjacent to the existing road, major obstacle and bottlenecks will be avoided. Mandatory safety requirements as per Australian Codes of Practice and Australian Standards will apply, such as the road safety requirements of AS 1742 Part 3.

Of particular interest will be the potential and combined impacts of construction on heavy transport, such as road trains and heavy lift vehicles, and convoys used by Defence in the deployment of personnel, supplies and equipment to and from BFTA, particularly when these are combined with other road users and the construction works.

Dust, both from construction works and from traffic, will have impacts on road users.

As well as the convoys to and from BFTA, the new M1A1 Abrams main battle tank (Abrams) will be shortly introduced into service in Australia by Defence. A new heavy lift tank transporter will also be required. The combination of the increased width and weight of both the Abrams and the tank transporter may impact other road users. While large-scale deployments to and from BFTA are infrequent, particular care will be required to ensure the safety of all road users during and following construction.

Medium and long-term

The medium and long-term impacts of this proposal are positive given the improved flood protection (immunity) of this section of the Victoria Highway. This project will provide a road consistent with National Highway standards and the expectations of road users. Improved road safety for road users will also be an outcome of the project

An increase in the axle and weight limits applicable to heavy transport on the Highway will also be available after all project works have been completed.

Bridge widening will assist in the transport of Defence armoured vehicles from Palmerston to BFTA.

Mitigation

As indicated in Chapter 2 and Appendix B, the TMP is the key document associated with setting out the traffic management regime and actions.

DPI will ensure that the contractor's TMP complies with NT government requirements and that all user groups are informed of the construction programme.

For example, DPI will inform Defence (1st Brigade and the Joint Movement Control Office-Darwin) of the project and, on initiation of the project, of the contractor's work programme; that is, which areas are being worked on. Thereafter, in the field, the contractor will be responsible for maintaining liaison with Defence on this matter.

Defence and DPI will continue to routinely review the safety requirements for deployment of convoys to and from BFTA on the Highway. DPI will ensure that the contractor is made aware of all major deployments and that this matter is considered in the TMP; for example, management of access requirements and traffic flow for all road users during construction. DPI and Defence (probably through the convoy commander, packet commander and Military Police) will be responsible for ensuring safe passage of large convoys using the Highway and of over-size vehicles on narrow areas of roads and bridges.

4.9 FIRE

Fire is a natural and human-induced occurrence in the area, and is particularly common during the early to mid dry season. Fire is an integral component of the Northern Territory's ecosystems, with species and vegetation communities having evolved and adapted to bushfires over millennia.

Bushfires continue to occur throughout the Northern Territory today, as controlled burns for fuel reduction and habitat management, as Aboriginal land management practices, as deliberately lit fires, or as fires started by natural means (e.g. lightning strikes).

Too frequent or infrequent fires have the potential to change the vegetation structure and composition, such as through reduced seed stores and/or seed set.

Fires are a regular occurrence in the Victoria River region, particularly during the late wet/early dry season, when understorey grasses start to dry off and controlled burns are undertaken. Fire frequency in the Victoria River region is typically every three years, although some areas experience more or less frequent fires (G. Fischer, Chief District Ranger NTPWS, pers. comm., 2005).

Impacts

The key potential impacts are:

- serious injury or death of personnel as a result of being caught in a fire
- damage or loss of property and infrastructure
- severe injury or loss of stock and native wildlife
- loss and fragmentation of habitat, which may increase pressure on threatened species.

Natural fires are an unpredictable quantity. Controlled burn-offs have a moderate predictability of size, extent, duration and likelihood. However, even controlled burns can quickly become out of control when weather conditions change quickly and unexpectedly. The manageability of natural and controlled fires is low to moderate, depending on the time of year and weather conditions.

Fire is a medium to high risk issue for all of the Top End, not just this proposal. Fire fuel loads in and around contractor and construction sites must be controlled under legislative, common law and duty of care requirements. This must be balanced with requirements and management of some species.

Mitigation measures

The following mitigation measures are proposed:

- development of a Fire Management Plan as part of the EMP that includes the following measures
  - no fires will be lit by construction personnel, unless a permit has been obtained
  - all plant and equipment will be maintained to minimise the potential for faulty equipment to start fires
  - the use of plant and equipment in and adjacent to dry vegetation, especially grasslands, will be carefully monitored for the start of fire, and fire-fighting equipment located nearby to extinguish any fires that do start
- discussion with adjoining property managers regarding any proposed controlled burns they have planned, and keeping abreast of the timing, location and weather conditions of any burns initiated
- maintaining of regular contact with local fire authorities to determine the risk of fires in construction areas
- developing emergency evacuation and response procedures for fire situations as part of the EMP and the ERP.

4.10 SOCIO-ECONOMIC

The road easement along the section of the Highway affected by this proposal is 100 m wide and is owned by the NT government and managed by DPI. This impact corridor has been used for road construction, maintenance and management actions for over 30 years.

Apart from the RG3 deposit on Coolibah Station, there are no known extractive, exploration or mining leases within the project area. The key stakeholders are users of the Highway and those landowners and managers adjacent to the Highway and its proposed impact sites. A large percentage (71%) of the road reserve is located adjacent to the Gregory National Park (Victoria River Sector), which is administered by the NTPWS. Gregory National Park occupies about 13,016 km^2 and comprises two main areas separated by the Aboriginal land area centred around Stokes Range. The largest of the areas is located west and south of Timber Creek and occupies about 11,571 ha (Gregory Sector). It is not impacted by this proposal. The eastern part of Gregory National Park (Victoria River Sector, 1,445 ha) is the area in which upgrading of the Highway is proposed to occur.

Beyond approximately Ch 210 km, the land tenure adjacent to the Highway varies and includes Aboriginal land, pastoral leases and private freehold.

A summary of the land tenure adjacent to the Highway worksites and potential borrow sites is illustrated in Figure 4.3 and is described as follows:

- Gregory National Park (NT Portion 3651, Victoria River Sector)
- Coolibah Station (NT Portion 2696)
- Coolibah Stockroute (NT Portion 3984)
- Ngaliwarru/Numgali Aboriginal Land Trust (NT Portion 4497)
- Victoria River Inn (NT Portion 4496)
- NTP 3564 owned by Australian Telecommunications Corporation
- NTP 2635 owned by Wildoak Pty Ltd
- NTP 3241 owned by Australian Telecommunications Corporation.

Successful Aboriginal land claims made in the region under the Aboriginal Land Rights (Northern Territory) Act include:

- Claim. No. 107, Stokes Range (NT Portion 2917). Granted on 12 December 1991
- Claim No.140, Beds and Banks of the Victoria River. Granted on 25 November 1994.

Current land claims and Native Title claims under the Native Title Act include:

- Claim No. 167, Gregory National Park/Victoria River
- Claim No.174, Gregory National Park/Victoria River.

4.10.1 Economic benefits

Flooding of the Highway has a significant economic impact, with the loss of connectivity between the east and west of Australia resulting in a direct impact on freight and tourist movements. The Victoria Highway is the only direct sealed road link between the Territory and Western Australia. Travel distance from Perth to Darwin is 1050 km shorter via the Victoria Highway than through Port Augusta and Alice Springs. Any closure of this Highway has major ramfications for interstate traffic and is of even greater importance for more-local traffic.

Closures occur almost every year and may be for an extended duration, such as three weeks in 2003. The current Annual Average Time of Submergence (AATOS) for Victoria River and Lost Creek are 113 and 52 hours respectively (KBR 2004) compared with generally less than 15 hours for the balance of the route and a target standard of 12 hours per year. These delays, and the weight restrictions that may be required for a further period to protect the saturated pavements, cause significant adverse impacts to access and use of the Highway by traffic and additionally create a suppressed demand on this route.

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KBR (2004) identified annual delay costs (direct costs only in the absence of detailed data on indirect costs) ranging from $1.45m/year to $3.56m/year depending on traffic assumptions for wet season changes post-construction and traffic growth generally. The report noted reductions in delay costs for various ARI periods, and concluded that a change from the present flood regime to a five-year ARI would provide an 80% reduction in direct delay costs, with further increases at higher ARI periods to 97% at a 10-year ARI and 99% at ARI 20 years.

These reductions in direct delay costs provide substantial justification for the project, and would be further strengthened by the inclusion of indirect delay costs. However, the data to enable these costs to be assessed is not available, and the extensive research required to obtain such information would not be warranted given the outcome identified above.

Further economic benefits accrue to this project from the widening and strengthening work, with previous evaluations of similar major highway projects identifying a benefit cost ratio (BCR) from such work of 1.7 owing to accident reductions arising from the widened and improved road. A BCR of greater than 1 means that the project must be undertaken in order to fulfil community requirements.

4.10.2 Employment and training opportunities

The contract for the works will be detailed design by DPI followed by letting of a construction contract. The contractor or contractors appointed to undertake the works will be responsible for ensuring that maximum local employment and business opportunities are established. It is likely that the successful company or consortium will be NT-based. A DPI Specification applies to this matter, especially in relation to the employment of a percentage of the labour force from the local community.

Local employment opportunities are emphasised in the Terms and Conditions of the DPI contract that will apply to the work (Appendix B). DPI will encourage and facilitate economic opportunities for all local people as an integral part of this proposal. Owing to the isolation of the area and the lack of large communities, it is expected that the district would be able to provide only limited supplies of resources.

The obvious opportunities for employment and training of local community members are associated with providing materials, equipment and labour for aspects of the construction workforce. For example, specific sub-contracts could be established for matters such as earthmoving and stockpiling, fencing, control of pest species, land management activities and some specialist tasks. 'Locals' could be employed/trained as part of the overall construction workforce.

DPI has undertaken preliminary discussions with the Ngaliwarru-Wali Association at Timber Creek regarding the employment and training opportunities potentially available through the project. Additional discussions have been undertaken with the NTPWS at Timber Creek about flora, fauna and general environmental management matters in the Gregory National Park. These are reflected in the EMP.

Access to potential borrow resources on land areas not controlled by DPI would be subject to negotiation with the landowner. This would include developing a commercial arrangement for use of the area and the resources.

An additional source of employment will be the increased opportunities associated with catering and management of the workforce. This could be associated with the Victoria Highway Inn or the construction camp.

4.10.3 Gregory National Park uses and users (tourism and other uses)

Since about 71% of the area in which the roadwork will be located is adjacent to the Gregory National Park, DPI will ensure that its impacts accord with the Management Plan requirements for this section of the GNP (PWCNT 2001). The Victoria Highway is adjacent to part of the Intensive Use Zone of the Gregory National Park. This zone caters for visitors using the Highway and visiting sites immediately adjacent to the Highway. All potential borrow material sites and other access, impact and use sites are located on privately owned land and are not in the Gregory National Park.

Visitor facilities within the vicinity of the proposed roadworks corridor on the Highway include:

- park entrance sign at the eastern boundary of the Gregory National Park. No impacts would occur at this site
- Sullivan Creek (Sullivan's) campground, which is about 17 km east of the Victoria Highway Bridge. This site would not be impacted by the proposal
- Victoria River Gorge picnic area and boat ramp, about 3 km south of the Highway Bridge. No impact to these sites would be likely
- Escarpment walk, located on the south side of the Highway about 2 km west of the Victoria Highway Inn (Ch 196). The car park area is likely to be raised or relocated. Discussions with the NTPWS will continue to be undertaken to confirm its preference at this site.
- Old Victoria River Crossing, about 500 m to the north of the Highway, west of Escarpment walk. There will not be an impact on this site.
- Joe Creek picnic area, about 10 km west of the Highway Bridge, which is accessed by a 2 km road and includes a defined walk (Nawulbinbin Walk) with interpretive signs up the base of the escarpment. There will be no impact on this site.

Access to each of the last three sites is unlikely to be disrupted**.** Discussions with NTPWS at Timber Creek will be undertaken by DPI to provide for management of access during construction.

The Victoria Highway Inn provides roadside services such as fuel, accommodation and food for road users in transit along the Highway.

Access to launch boats is available at the Victoria River Gorge picnic area. A tourism operator manages boat tours of the River and Gorge area from this area. In addition, flights over the region occasionally operate from the Victoria Highway Inn.

It is unlikely that any of these activities will be adversely impacted by the proposal and proposed work programme. Traffic using the Highway during construction will be required to follow the TMP. It is expected that this will add no more than 10 minutes extra to the three-hour journey between Katherine and Timber Creek.

The other management zone of the Gregory National Park adjacent to the impact areas of the proposal is part of one of the Special Protection Areas, the purple-crowned fairy-wren riverine habitat along the Victoria River. This matter is discussed in detail under Section 4.4.5 and in Appendix D.

The distribution of this species is associated with areas of cane grass and it is estimated that the population of the species is between 7,000 and 12,000 individuals (the former estimate being probably correct). Therefore, it likely that impacts of the project on people visiting the area to specifically view or conduct research of this species will be nil or minimal.

4.10.4 Adjoining properties

The major impacts for adjoining properties will be relatively short-term, with the exception of RG3, if it is used as a source of gravel. Consultation with adjoining property owners and managers will be required to ensure any disruptions and road closures do not significantly impact on their activities. In particular, ongoing consultation with the NTPWS will be undertaken to identify and establish ongoing management requirements, especially species and area specific management actions and monitoring, during construction.

4.10.5 Road users and communities

The proposed works are consistent with the ongoing programme of asset enhancement to upgrade the existing highway road network, including the proposed increase in Austroads vehicle live loading and the National Transport Commission (NTC) initiatives to increase vehicle axle loads. Both Lost Creek and Victoria River bridges are 'strength and width deficient', with substandard guard rails.

The regional implications of the route are clear, with interstate trade and road communications a key function. This latter component includes maintenance of the main trunk OFC, which is the key carrier of north–south telecommunications and associated data links. Tourism is also a significant component of use, especially in the dry season, when vehicles towing caravans approach 20% of the total road volume. In addition, the Territory tourism authorities and private operators are seeking to attract more visitors during the wet season. Many potential visitors travelling by road are discouraged from visiting during the wet season owing to the potential for road closures because of flooding.

Defence is also a key road user owing to the establishment of the largest training area in the NT north of Timber Creek. BFTA is about 80 km west of the project area and it will be the main training area for 1st Brigade, which is based in Darwin.

In summary, the Victoria Highway is the primary route for tourist, freight and defence transport in this region. The upgrading of the bridges and pavement in this section of the Highway will provide much higher flood protection for the Highway and transport using the road. In turn, this will benefit the local region (an important cattle-producing region of the Territory), the communities of Katherine to the east and Timber Creek to the west, BFTA, and the broader communities including Kununurra and the Ord region. The Ord region in particular is seeking enhanced access to road and rail at Katherine as the horticultural developments there expand to meet the needs of the markets in eastern and southern Australia.

Impacts

The key potential impacts are:

- construction activities occurring outside of the road reserve
- adjoining land users being unable to gain access to their properties
- activities that are in conflict with the provisions of the Territory Parks and Wildlife Conservation Act
- activities that conflict with management practices being undertaken by adjoining landowners.

Impacts on land uses and land users are likely to be relatively small, primarily owing to the small population in the region. Access to properties by contractors will only be undertaken under agreement and to agreed, specific sites. Access to properties during roadworks will not be jeopardised and access tracks will remain open at all times

In addition, the purpose of the project is to provide enhanced access during the wet season. This will be a significant future advantage.

Impacts on road users will not differ greatly to those from roadworks along any other section of road. Over the past five years numerous roadworks programmes have been completed along major highways involving construction of new bridges, new routes and passing lanes throughout Australia. At most, the impacts will be an inconvenience to road users by adding no more than 10 minutes to the trip between Kununurra and Katherine.

Road users will be required to follow the road safety requirements of the TMP.

Adequate advertisement of all works programmes, including location and restrictions, mandatory speed limits, traffic controls and adequate signage are components of the TMP and these will be in place at all times.

Improving access via flood protection will allow for enhanced regular heavy truck movements, truck and tourist access during the wet season, and will relieve the pressure on the Victoria Highway Inn when road users are stranded at the Inn.

Minimising the risk to adjoining land management can readily be achieved through appropriate consultation and remediation of any issues that are raised during consultation. Disruption and conflicts with adjoining properties is a medium risk issue.

Mitigation measures

The following mitigation measures are proposed:

- DPI and the contractor will consult and maintain consultation links with all adjoining property owners/managers regarding potential issues, in particular with staff of the NTPWS at Timber Creek
- appropriate management strategies to rectify and adequately manage conflict issues that are raised during consultation are to be developed and included in the environmental management plan
- a TMP for the project will be established (see Appendix B for its required contents)
- tourism web sites and authorities will be contacted and updated regarding the works programmes. Adequate warning signage is part of the TMP.

4.11 ABORIGINAL, HISTORIC AND CULTURAL HERITAGE VALUES

People of seven Aboriginal language groups have traditional links to the region. Within the vicinity of the project area, there are two groups with ties to the land, namely the:

- Ngaliwurru, who are associated with country south of the Victoria River from Timber Creek to the Victoria Highway Inn. and to the southern side of the Stakes Range. The Stokes Land Claim was granted to the Ngaliwarru. Most of these Traditional Owners live in the vicinity of Gilwi, an Aboriginal living area on the Fitzroy Pastoral Lease.
- Wardaman people, who are linked to the country east of the Victoria River, both north and south of the Victoria River Inn.

The Gregory National Park provides for local Aboriginal people to maintain their affiliation with and traditional practices within their country.

The proposal for the roadworks along the Highway does not seek to interfere with any of these values. Consequently there has been ongoing and effective consultation with all Traditional Owner groups and field investigations to identify sites of significance. Details of this process and the findings of investigations are outlined in this section.

Employment and training opportunities for local Aboriginal people associated with the PER are discussed in Section 4.10.

4.11.1 Aboriginal heritage (archaeology)

Aboriginal archaeological sites are known to occur adjacent to sections of the Victoria Highway, with some sites recorded in the study area. The proposed works have the potential to disturb and destroy unregistered sites of archaeological significance. All Aboriginal sites are protected under the Heritage Conservation Act.

Earth Sea Heritage Surveys (ESHS, 2005) undertook a literature review of the archaeological surveys conducted in the Victoria River area in the past. This area has been extensively surveyed in the past on behalf of a number of Commonwealth and NT agencies. The reports of some of these surveys were not generally in the public domain and some have been difficult to access. The aim of the literature review was to determine which parts of the road alignment should be subject to archaeological survey.

ESHS (2005a) then conducted archaeological surveys of the four bridge crossing sites in January and June 2005. These surveys did not find Aboriginal archaeological sites in these areas. Further archaeological investigations in the study area in July and August 2005 were undertaken and directed at archaeological survey of the gravel and fill borrow areas proposed at that time.

ESHS (2006) completed a reconnaissance archaeological survey of potential gravel and fill extraction areas in the Victoria River Region as part of wider preliminary environmental reporting for the project as per the Environmental Assessment Act.

The survey located seven archaeological sites and four background scatters of isolated artefacts in and near the areas proposed for gravel extraction. Seven archaeological sites were recorded within the survey areas. The sites consist of artefact scatters, stone artefact quarries, historic carved boab trees, historic burial site, and scatters of historic artefacts. Site size ranged from 400 m^2 to 6750 m^2. Archaeological sites were found in close proximity to major freshwater sources. The majority of sites are located on the levee banks of the Victoria River. Average artefact densities ranged from 0.01/m^2 to 10/m^2 with a maximum artefact density of +50/m^2 noted at Skull Creek.

The archaeological site assemblages are represented mostly by flaked artefacts, with ground artefacts present on some sites including sandstone and quartzite grinding stones and basalt edge ground axes. Raw materials present on archaeological sites include silcrete, quartzite, chert, fine-grained sedimentary, and basalt. Most of these raw materials occurred as cobbles in the Victoria River bed, especially silcrete, quartzite, and chert nodules.

The historic sites recorded in this survey appear to date from the post-World War II period. A carved boab tree was inscribed with the date '1952'. The burials are inferred to be modern owing to the presence of deteriorated plastic flower fragments. Diagnostic features from the scatter of historic artefacts appeared to date this material from the 1930s to the 1950s.

Archaeological sites RG7 AS02 to RG7 AS06 are assessed as having a high level of archaeological and cultural heritage significance. These sites consisted of features such as two historic graves, a carved boab, and extensive open stone artefact scatters. The areas surrounding RG7 is considered to have high archaeological potential. Another artefact scatter was located in the river gravel of Area RG3. This site is potentially rare in the NT, being one of the few recorded stone artefact scatters located in a river bed in the Top End. The background scatters are considered to have a low level of archaeological significance.

The review of the known archaeological record and this survey found that the banks of the Victoria River are an archaeologically significant zone. The Victoria River has been a focal point and resource for Indigenous people over millennia. Since European settlement, early explorers and the pastoral industry have used the Victoria River for a number of activities, further contributing to this rich archaeological resource. Therefore the levee bank zone along either side of the Victoria River tends to have a high archaeological potential. This includes a high sub-surface potential in this area. Despite this, the survey found that there tended to be areas away from the river where the archaeological potential diminished significantly. Some of the gravel search areas are located in these zones.

The indigenous archaeological places recorded in this survey are considered significant within the terms of the NT Heritage Conservation Act. These sites are afforded protection under Section 39 of the Act and should be avoided by the proposed exploration works.

Archaeological Risk Management Model

An archaeological risk assessment model has been developed based on the archaeological data obtained during field assessments and review of the literature. It is known that distance to potable water and raw material sources are major factors in influencing the detection of archaeological materials in the Victoria River region. Therefore, the archaeological risk assessment model is based on topographic features that occur within the project area along the Victoria Highway. Table 4.4 provides the predicted frequency of archaeological materials for high, moderate, and low rankings. Table 4.5 provides an analysis of major archaeological site types in the region according to geomorphology land unit.

Table 4.4 Frequency of archaeological sites and isolated artefacts for each ranking

Frequency	Sites per km ^{2}	Isolated Artefact Density per m ^{2}
High	0.5–1	0.0005–0.001
Moderate	0.1–0.5	0.0001–0.0005
Low	0.01–0.1	0.00001–0.0001

Table 4.5 Predicted archaeological sensitivity for each geomorphological zone

Geomorphic units	Stone Quarry	Artefact Scatter	Rockshelter & Rock Art	Stone Arrangements	Isolated Artefacts	Overall Archaeological Sensitivity
Victoria River banks and terraces	Low	High	Low	Low	High	High
Victoria River bed	Moderate	Moderate	Low	Low	Moderate	Low–Moderate
Major drainage systems	Low–Moderate	High	Low	Low	Moderate–High	Moderate
Steep rises on sandstone & quartzite	Moderate	Low–Moderate	High	Moderate	Moderate	Moderate
Mesa Plateau on sandstone & quartzite	Low	Low–Moderate	Low	Moderate	Moderate	Low–Moderate
Dissected plateau on sandstone & quartzite	Moderate-High	Moderate–High	High	Low	Moderate	Moderate–High
Level to gentle lowland plains on deeply weathered Quaternary sediments and colluvium	Low	Low	Low	Low	Low	Low

Figure 4.6 illustrates the predictive model according to the topographic areas along the Victoria River. This map is designed to act as a guide to illustrate zones of high archaeological potential. It should be used as a planning tool for the project managers in assessing potential risk to archaeological resources. High-risk areas will require a high level of archaeological survey, whereas low-risk areas probably require less intensive review.

Integrated Resource Assessment

It is recommended that an integrated resource assessment approach is taken with regards to future development of potential gravel source areas.

Currently the areas identified as potential sources for gravel are large and some have high levels of archaeological potential, which in turn warrants a high level of archaeological inspection. High levels of archaeological survey are time-consuming and costly, since they must cover large areas when only a small portion will ultimately be used for gravel extraction. As the project involves the ongoing identification of gravel extraction areas that may be excluded for a range of economic, environmental, and cultural reasons, it is recommended that the project adopts a strategy of integrating the archaeological assessment in the ongoing development of gravel extraction areas.

Future Gravel Extraction Areas

It is recommended that the proposed gravel extraction area should be specifically identified to allow for an effective archaeological survey of the potential extraction area. This could be undertaken during the geotechnical assessment phase of the project and would reduce the need to survey large areas that will not ultimately be used for gravel extraction. Recommendations for gravel search areas and archaeological sites are provided in Tables 4.6 and 4.7 respectively.

Another factor is the likely presence of sub-surface archaeological deposits in accumulated soils along the Victoria River. It is likely that there will be buried deposits of archaeological materials along this river corridor. Open archaeological deposits (other than shell middens) are generally rare in the Northern Territory, usually owing to difficulties in detection. Therefore an integrated resource assessment would allow for the inspection of sub-surface deposits during geotechnical operations when test pits are excavated.

Victoria Highway Chainage 185 km to 220 km

ESHS (2006) recommended that no further archaeological surveys were required within a 50 m zone from the centreline of the Victoria Highway from chainage 185 km to 220 km. However, if works are required outside the 50 m zone from the centreline along the Victoria Highway, then further archaeological inspections are required in the high archaeological risk areas.

DPI will continue its consultation programme with Aboriginal Traditional Owners and Custodians to assess the social significance of the archaeological materials (should any archaeological sites require permission to disturb or destroy).

Table 4.6 Recommendations for Victoria Highway gravel search areas

Gravel Area	Location	Archaeological Assessment	Recommendation
RG3	Located in the Victoria River bed (MAP 2)	Artefacts were found in a discrete area. Estimated that the site contains approximately +600 stone artefacts. It is likely that there are sub-surface artefacts in the levee bank.	Avoid the use of RG3 if possible. However, should this gravel source be required then a permit to disturb may be required from the Minister (NRETA) with further documentation of the affected site
Area 21	Skull Creek runs parallel along the western side of the ridge	Recorded one open archaeological site (Skull Creek AS01) on the north side of Skull Creek Major. Adjacent to the site on the other side of the creek is a registered Sacred Site with carved Boabs. The area has significant archaeological potential and Indigenous cultural significance	Area would require greater than 10% archaeological survey

Table 4.7 Recommendations for archaeological sites identified during the survey of Victoria Highway gravel search areas

Site Name	Major Site Type	Significance Assessment	Recommendations
Skull Creek	Artefact Scatter, Quarry, Carved Boabs, Registered Sacred Site	The complex of sites in this area, including the Registered Sacred Site (carved boab trees) across Skull Creek, demonstrates many layers of occupation through time. Extensive chert quarries in the Top End are not common, therefore this site has high archaeological potential. The area has a high level of Indigenous cultural significance owing to the presence of the registered Sacred Site. The carved Boabs also represent local historical significance from the pastoral history of the region.	It is recommended that this site and area is not disturbed.
RG3	Artefact Scatter	Few sites have been recorded in the beds of the major northern river systems. Although the site has a high level of disturbance, the site is of archaeological interest in terms of further investigation of the underlying causes of site formation.	It is recommended that this site is not disturbed. It is recommended that an exclusion zone is enforced around the site. However, should this source be required then a permit to disturb must be sought from the Minister NRETA with further documentation of the affected site

Impacts

The key potential impacts are:

- loss and desecration of Aboriginal heritage and sites protected under legislation
- delays or abortion of construction activities as a result of finding items/sites of significance during construction.

Providing that all important sites are not impacted, then Aboriginal archaeological heritage sites are a low to medium risk issue depending on the area involved.

Mitigation measures

The following mitigation measures are proposed:

- potential new impact areas will be assessed by a qualified archaeologist
- the recommendations and mitigation measures proposed by the archaeologist for new and existing sites will be implemented by DPI
- all significant sites will be delineated in the field and treated as No Go areas
- the EMP will detail areas to be avoided and proposed contingency measures in the instance of potential artefacts being unearthed during construction, including for all construction to halt if Aboriginal artefacts are unearthed. No work is to commence until the significance of the artefacts has been determined and remediation measures developed and implemented
- where necessary, local Aboriginal community members are to be employed during construction, to ensure that significant sites are not impacted on.

4.11.2 Aboriginal heritage (Sacred Sites)

The AAP) has undertaken and is undertaking Sacred Site clearance investigations of the project area. This includes the works proposed to be undertaken along the Highway and the potential borrow sites that were not assessed as part of the NOI (DPI 2005). A summary of its comments and actions to date according to each potential borrow area is included in this section.

The initial AAPA map of sites investigated is included as Figure 4.5.

Victoria Highway Certificate Upgrade (AAPA Document 50575)

The AAPA will issue a Certificate for the road and bridge works along the Highway. The only outstanding issue is the Joe Creek Bridge area. It will not issue a Certificate for these works until receiving additional information from DPI.

Extraction Certificate Application (AAPA Document 49644): Victoria Highway Upgrade

Comments from the AAPA on specific matters of this Document are as follows:

- the Authority will issue a Certificate in regard to areas RG3: Restricted Works (i.e. works excluding trees in area) and Site 25. Works are allowed at these sites.
- Site 24 and Fill Pit area 26: Works refused
- RG2: Works refused.

The Clearance Certificate does not include the following areas in the Application:

- RG7 and Site 21. The location and extent of both these areas have been varied and will need to be consulted on once more.
- Site 20 and 22 plus access tracks. These areas cannot be consulted on at this time.

AAPA has indicated that it will continue to liaise with the NLC, indicating that the Authority is prepared to issue Certificates to DPI on Aboriginal Land based on NLC research and findings, thus avoiding duplication.

Future AAPA clearance of potential borrow areas (gravel and fill)

After further discussions and investigations of localised alternative gravel and fill sources, DPI has identified potential borrow sources and has provided AAPA with the location of the areas. It has applied to AAPA for a further Clearance Certificate(s).

Consultation on these potential borrow sites will continue to be undertaken by DPI through AAPA and the NLC with the Traditional Owners. The aim of these investigations will be to determine the significance of known, registered sites of significance and other sites, such as specific areas or trees that may be removed or impacted by construction activities

4.11.3 Native Title

Current land claims in region are only associated with the Gregory National Park. It is unlikely that this proposal will impact the determination of claimants and Native Title on this land area.

4.11.4 European heritage

No significant sites of European heritage are recorded in the impact areas. Two sites with carved boab trees at RG7 and AS4 are of local significance. The Old Victoria River Crossing site is also of local interest.

Impacts

Sites are localised and documented. The key potential impact would be deliberate or inadvertent damage to known sites during construction. European heritage is a low risk issue. As a consequence no adverse impacts have been identified.

Management and mitigation measures

The sites at RG7 and AS4 will be avoided by construction works. These sites will be marked on the ground and on construction maps as No Go areas. No additional specific mitigation measures are proposed for these sites.

However, if any sites are uncovered during construction, the contractor will notify DPI. Construction work will halt at the site until further instruction.

4.12 COMBINED AND CUMULATIVE IMPACTS

Seventy-one per cent of the construction will be undertaken along the Victoria Highway easement adjacent to the Gregory National Park. Most of the other construction impact sites are on or adjacent to Aboriginal land and pastoral land. The region is sparsely populated and the most obvious impacts in the region are associated with pastoral management, tourism and populations of pest plants and animals. There are no other proposals for major projects in the section of the region that would add to the impact of the proposed works.

Use of BFTA by Defence is discussed in Section 4.8.

There are no other DPI proposals to undertake major improvements or construction programmes in this section of the Victoria Highway for the foreseeable future. However, pavement strengthening and rehabilitation works are part of this proposal and road maintenance works are ongoing on this road. These are routine actions including management of accelerated erosion, repair of the road seal and surface, and replacing roadside 'furniture' such as signs.

Impacts

Approval to undertake construction for this proposal is to be obtained from all relevant sections of the NT Government and the Commonwealth for matters of national significance, which is undertaken through the bilateral agreement between the two governments.

Ongoing works requires consultation with the NTPWS.

Potential impacts from these activities are:

- the spread of pest plants and animals.
- reduced access to pastoral stations
- management and mitigation actions not undertaken.

Mitigation

As noted in Appendix B, DPI has stringent management requirements applicable to all of its construction activities. An EMP will apply to the construction works so as to avoid or minimise these impacts.

4.13 SUSTAINABILITY

The NT Government is a signatory to the National Strategy on Ecologically Sustainable Development (NSESD) 1992 which provides a framework for:

- cooperative decision-making within Government
- promoting ESD throughout Australia.

Sustainable transportation and best practice environmental management in road development and road use in the NT is implemented through the use of an environmental management system (EMS). The EMS:

- establishes an environmental policy and strategy
- sets objectives and targets
- develops monitoring and reporting procedures and guidelines
- evaluates environmental performance.

Through the strategy and EMS the NT government aims to deliver, sustainably, an advanced and efficient road transport system for the Territory, with the essential elements of an EMS guiding day-to-day service delivery and long-term planning.

The strategy is based on the following principles:

- demonstrating duty of care in environmental protection as a good corporate citizen
- implementing relevant policy and legislation on environmental protection relating to the provision of road transport
- applying environmental management and ecologically sustainable development principles.

These principles establish the policy framework for sustainable and integrated road development and road use.

The strategy aims to integrate important environmental issues such as air pollution, biodiversity and water pollution into the planning and operational stages of developing road infrastructure and managing road use.

All of these strategies and commitments apply to the current proposal.