

Purple-crowned Fairy-wren Habitat Survey 185 - 220 km, Victoria Highway

24 June 2005

Prepared for:

Road Projects Division

Department of Infrastructure, Planning and Environment

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24 June 2005

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By


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EXECUTIVE SUMMARY

1. A proposed upgrade of the Victoria Highway, 185 to 220 km west of Katherine has the potential to disturb the habitat and populations of the threatened Purple-crowned Fairy-wren (*Malurus coronatus*);
2. To assess the likelihood and significance of disturbance, a survey was carried out, 16-20 April, 2005, inclusive;
3. 44 culverts, Escarpment, Joe, Sandy and Lost Creeks and the Victoria River were specified for assessment. The location of each was recorded at the road centre-line using a GPS and where Purple-crowned Fairy-wren habitat, Cane Grass (*Chionachne cyathopoda*), was present, transects 85 m upstream and 155 m downstream were surveyed. The dimension of Cane Grass patches was measured and the numbers of individuals and groups of Purple-crowned Fairy-wren were recorded. Habitat characteristics, such as dominant vegetation, weeds, feral animal activity and other disturbance were also recorded;
4. In the immediate-term, road works have the potential to impact on the Purple-crowned Fairy-wrens and their habitat at Lost and Escarpment Creeks, Victoria River and culverts 7 and 8, 14 and 19. The habitat of at least 19 groups of fairy-wrens and 52 individuals will be severely impacted during the proposed road works;
5. In the long-term, the impact of the proposed road works is considered significant in that the construction activities are proposed to be undertaken during the breeding season of the Purple-crowned Fairy-wren, potentially resulting in disrupted breeding and a resultant long-term reduction in the population size. Further, the fragmentation of existing Cane Grass habitat has the potential to impact on dispersion of young into new areas of habitat, further impacting population size in the long-term;
6. In order to minimise the impacts on fairy-wrens, the following recommendations are made:

Site with Cane Grass Present	Recommendation	Justification
Victoria River (Figure 13)	Use Cane Grass to be removed for transplanting downstream in bare patches of existing Cane Grass community, to create good quality habitat in a continuous band to the Victoria River, as well as for rehabilitation post construction. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.	It is recognised that to implement any realignment at this site would be difficult. There will be a significant impact on downstream Cane Grass habitat and Purple-crowned Fairy-wrens. The post construction rehabilitation of the disturbed area and transplanting to other areas downstream and upstream of the site should be considered as an appropriate offset to disturbance.
Culvert 7 (Figure 13)	Unavoidable impact – rehabilitate post construction.	Recommend that Cane Grass present and cleared is used as a source for transplants elsewhere and later rehabilitation of the site.
Culvert 8 (Figure 13)	Insignificant impact – rehabilitate post construction.	Only a small area of Cane Grass present - recommend that Cane Grass present and cleared is used as a source for transplants

Site with Cane Grass Present	Recommendation	Justification
		elsewhere and later rehabilitation of the site.
Escarpment Creek (Figure 14)	Use Cane Grass to be removed for transplanting downstream in bare patches of existing Cane Grass community, to create good quality habitat in a continuous band to the Victoria River, as well as for rehabilitation post construction. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.	It is recognised that to implement any realignment at this site would be difficult. There will be a significant impact on both upstream and downstream Cane Grass habitat and Purple-crowned Fairy-wrens. The post construction rehabilitation of the disturbed area and transplanting to other areas downstream of the site should be considered as an appropriate offset to disturbance.
Culvert 14 (Figure 14)	Use Cane Grass to be removed for transplanting downstream in bare patches of existing Cane Grass community, to create good quality habitat in a continuous band to the Victoria River, as well as for rehabilitation post construction. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.	It is recognised that to implement any realignment at this site would be difficult. There will be a significant impact on both upstream and downstream Cane Grass habitat and Purple-crowned Fairy-wrens. The post construction rehabilitation of the disturbed area and transplanting to other areas downstream of the site should be considered as an appropriate offset to disturbance.
Culverts 15, 16, 17, 18, 19 (Figure 15)	The only site that will be directly impacted is Culvert 19. As an off-set, it is recommended that the existing narrow strip of Cane Grass along the Victoria River is rehabilitated through use of Cane Grass transplants, erosion and weed control. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.	This area, although very small, provides a corridor for dispersion of young Purple-crowned Fairy-wrens into new habitat areas. It is currently degraded and could benefit from rehabilitation.
Lost Creek (Figure 16)	Strongly preferred option. Realign proposed alignment to move road south (upstream).	The current alignment will severely damage a significant area of habitat and result in the loss of 18 Purple-crowned Fairy-wrens. It is acknowledged that realignment will result in further encroachment into

Site with Cane Grass Present	Recommendation	Justification
	<p>Alternative option: Use Cane Grass to be removed for transplanting downstream in bare patches of existing Cane Grass community, to create good quality habitat in a continuous band to the Victoria River, as well as for rehabilitation post construction. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.</p>	<p>the Avoidance Area, but this area would be disturbed by the proposed alignment and clearance would need to be obtained anyway.</p> <p>As an alternative, this site could be treated in the same manner as Escarpment Creek, with post-construction rehabilitation at the disturbed areas and transplanting downstream to improve existing habitat quality.</p>
Culvert 13	No impact	<p>Outside of proposed area for construction. This culvert is on the edge of the construction site however, so it is important that the boundaries for clearing are clearly delineated in the field.</p>
Culvert 37	Insignificant impact	Only two clumps of Cane Grass present

7. Other mitigative measures include the following:

- Wash down all plant and machinery before moving away from weed-infested sites to non weed-infested sites. It would also be prudent to wash down all machinery before moving from site to site, in order to not exacerbate existing weed problems, even if weeds are present at each site;
- Work with staff at Gregory National Park to encourage continued feral animal control (especially buffalo and feral cattle) and weed control. There may be opportunities for Road Projects Division to work with the Park rangers for a common goal of reducing feral animal impact and spread of weeds;
- Remove weeds that occur between Cane Grass patches and rehabilitate where Cane Grass is absent along the Victoria River, for one kilometre upstream and one kilometre downstream of the Victoria River bridge, to create a continuous belt of Cane Grass. Although weed reintroductions from upstream are likely, if Cane Grass patches are not disturbed, by feral animals for example, weeds are less likely to re-establish;
- Monitor populations of Purple-crowned Fairy-wrens within the study area at least annually during April-May, for a period of at least three years post construction. An assessment of Cane Grass transplant and rehabilitation success, weeds and feral animal activity could be undertaken at the same time;
- Work with Greening Australia to undertake rehabilitation and transplanting of Cane Grass, as they have the greatest amount of expertise in this area; and

- Educate pastoralists, tourists and local people on the importance of preserving Cane Grass habitat and how to observe birds, if desired, without having a negative impact on them or their habitat.

In addition to the above, the issue of feral animal and weed control in the region needs to be addressed. It may be unrealistic to expect removal of feral species from the study area, as any such activity undertaken in isolation will merely create a vacuum for feral animals in surrounding areas to move into. This needs to occur on a regional basis, with the greatest opportunity for this to occur being within Gregory National Park. Ongoing control of feral animals would assist in long-term maintenance of Purple-crowned Fairy-wren by reducing impacts from grazing, soil erosion and weed establishment. Similarly, weed control is an ongoing task and the likelihood of weed seeds being distributed along drainage lines (and therefore re-establishing) in the study area during the wet season is high. Weed control should occur for at least three years post construction, to maximise the re-establishment of high quality Cane Grass habitat.



Purple-crowned Fairy-wren in Cane Grass (Source: A. Van Doorn)

1 INTRODUCTION

1.1 Background to Project

The Road Projects Division of the NT Department of Infrastructure, Planning and Environment (DIPE) proposes to undertake road improvement works along the Victoria Highway. Specifically, it is proposed to:

- Widen, raise and realign as required a 35 km length of the Highway (from 185 to 220 km);
- Rebuild bridges at the Victoria River and the Sandy, Joe and Last Creeks, 20 m downstream from the current crossing positions; and
- Improve the existing bridge at Escarpment Creek¹, requiring a traveller bypass road downstream of the existing crossing during road works.

Many of the larger drainage lines in the 185 to 220 km section of the Victoria Highway contain Cane Grass (*Chionachne cyathopoda*), habitat upon which the threatened Purple-crowned Fairy-wren (*Malurus coronatus coronatus*) is dependent. In order to assess the significance of disturbance to this habitat and existing Purple-crowned Fairy-wren populations, the Road Projects Division commissioned HLA-Envirosciences (HLA) on 11 April, 2005 (Client Ref: CD2314/05) to undertake a survey and provide recommendations to minimise or mitigate impacts. The DIPE Project Requirements are provided in Appendix 1.

1.2 Study Area

The study area is a 35 km length of the Victoria Highway from 185 to 220 km west of Katherine (Figure 1). A tourist complex exists at the Victoria River crossing and there is an optic fibre cable running from Katherine to Kununurra. Apart from these, there are no other settlements or infrastructure elsewhere within the study area. Escarpments are a major feature of this part of the highway and most of it is contained within Gregory National Park. Because of the landforms, the highway crosses numerous drainage lines, some small enough to utilise culverts, the largest of which is the Victoria River. Other major creeks are Lost, Sandy, Joe and Escarpment.

1.3 Project Aims and Scope of Works

The survey objective was to quantify the presence and/or populations of the Purple-crowned Fairy-wren, particularly in its normal habitat in association with Cane Grass communities along stream banks. This would allow the government to comply with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), particularly Parts 1.3 and 1.3A.

The scope of works was as follows:

- Survey of habitat of the Purple-crowned Fairy-wren at 44 culverts along the Victoria Highway from 185 km 220 km, including the Lost, Joe, Sandy and Escarpment Creeks and the Victoria River²;

¹ Escarpment Creek was considered by HLA to be located at the existing culvert at chainage 196 km. During receipt of comments on the draft report, HLA was notified that Road Projects Division considered Escarpment Creek to be located at chainage 188 km, which is a culvert. This location is the same as HLA Culvert 4. Throughout this report, Escarpment Creek refers to the culvert at chainage 188 km. Culvert 4 did not have either Cane Grass or Purple-crowned Fairy-wrens present.

² Initially all rivers, creeks, crossings, watercourses and culverts were to be surveyed. As this was not achievable within the project timeframe and budget, Road Projects Division provided a list of 44 culverts likely to be disturbed, on which the survey was focussed.

- Quantify the number of Wrens (and Wren territories) in the nominated survey area;
- Assess the significance of possible loss of these individuals (and suitable habitat) relative to the total population of the species and subspecies;
- Estimate the extent to which disturbance works will further fragment the population in the Victoria River crossing area, and the possible consequences of this further fragmentation;
- Assess whether the population at this site may be further affected beyond the existing development works (e.g. by change in traffic mortality patterns);
- Provide advice on adjacent Cane Grass populations within and in proximity of the road reserve and optimal use of Cane Grass in revegetation of disturbed areas;
- Provide advice on other mitigation or offset activities (e.g. cattle exclosure fencing elsewhere that may result in net benefit to this population);
- Assess the risks of weed spread associated with disturbance activities, and provide protocols that ensure that there is no increased spread of weeds;
- Provide conservation advice in relation to short-term and long-term disturbance associated with the development proposal; and
- Provide recommendations for consideration during the road improvement works on the Victoria Highway.

1.4 Report Structure

The report provides the results of the survey and is structured as follows:

- Section 2 – Description of Environment, including physical, natural and cultural environment;
- Section 3 – Previous Research, providing a summary of the biology of the Purple-crowned Fairy Wren and current knowledge of populations in the project area;
- Section 4 – Methods, describing the manner in which the survey was undertaken and the data collected;
- Section 5 – Results, summarising the survey data collected;
- Section 6 – Discussion, providing an analysis of the results with respect to the project aims and scope of work;
- Section 7 – Summary and Recommendations, providing an overview of the results and recommendations;
- Section 8 – References; and
- Appendices, providing additional supporting information.

1.5 Project Team

Survey work was undertaken by Annamaria Van Doorn and James Brown. Data collation and entry was undertaken by James Brown. This consultancy report was prepared by Dr Sonia Tidemann, Annamaria Van Doorn. Dr Sandy Griffin edited and peer reviewed the report.

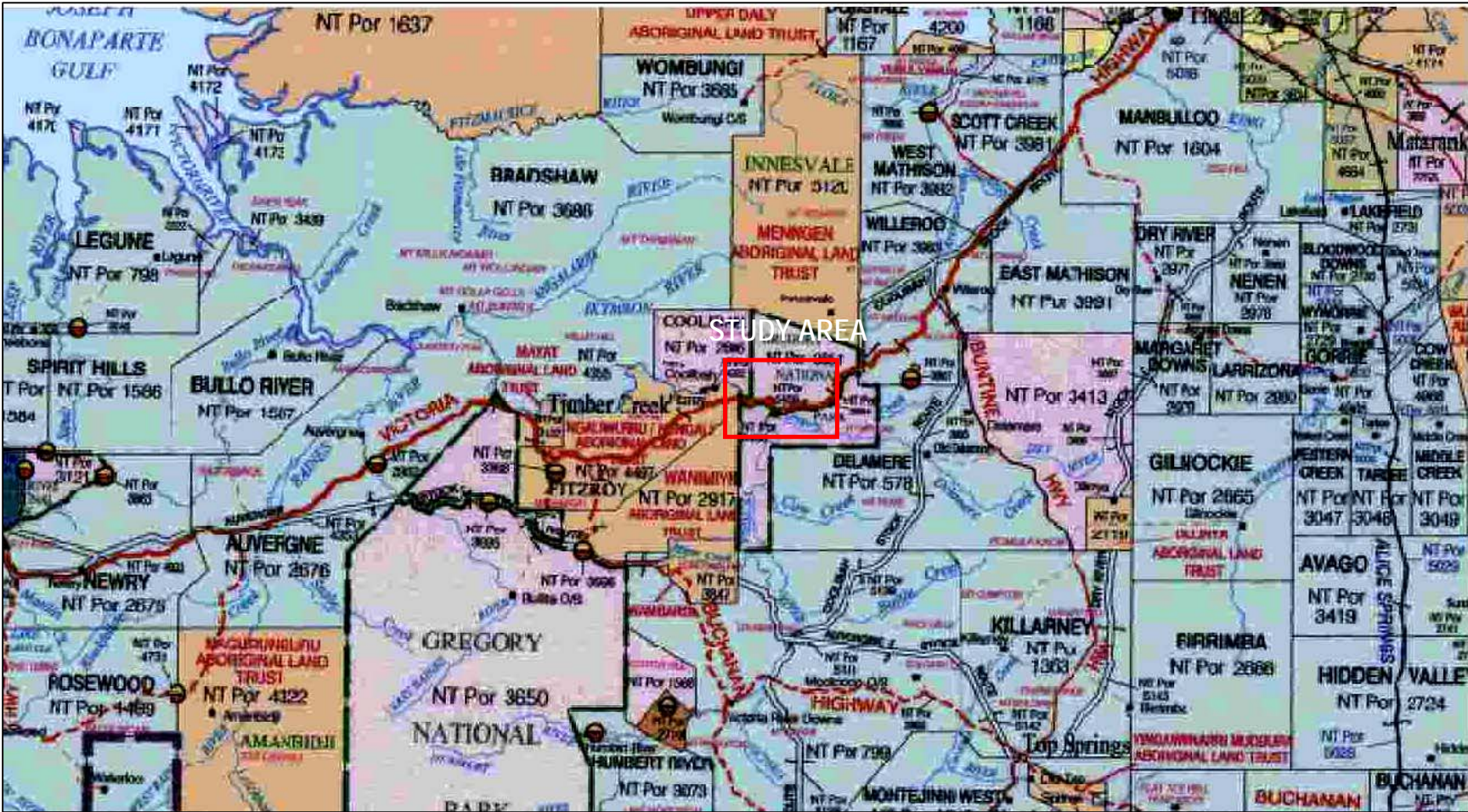


Figure 1: Location of Study Area

2 DESCRIPTION OF ENVIRONMENT

2.1 Climate

Two distinct seasons exist within tropical Australia, the wet season (October to April) and the dry season (May to September). The Victoria River District (VRD) records between 800 and 1000 mm of rain each year. It maintains an average minimum temperature of 18°C and an average maximum temperature of 33°C (Bureau of Meteorology, 2004). The hottest month of the year is January whilst the coldest is July (Connell Wagner, 1997).

2.2 Physiography

The study area is characterised by rocky escarpments intersected by drainage systems and associated floodplains. Erosion has deeply cut through what was once a vast plain, to reveal large rocky escarpments and sheer cliffs (Nasca, 1981). Elevation in the VRD ranges from 0 m at the coastline to 498 m AMSL³ (Power and Water Authority, 1994), whereas the study site itself lies within 65 to 150 m AMSL. Drainage lines extend from the escarpment bases to the creek channels (Kraatz, 2000). Tidal influences extend 100 kilometres upstream from the Joseph Bonaparte Gulf, affecting the study site, and extending past Timber Creek (Connell Wagner, 1997).

2.3 Land Systems

The study area includes three land systems, defined in Table 1 (Connell Wagner, 1997).

Table 1: Land Systems of the Study Area

Land System	Description	Geology	Geomorphology
Pinkerton	Rugged and stony country lying on sedimentary rocks	Sandstone, shale and some dolomite	Ridges and structural plateaux
Ivanhoe	Almost flat plains	Quaternary alluvia	Fine textured alluvial plain
Dinnabung	Small areas of gently undulating limestone country	Granite, gabbro, rhyolite and metamorphic rocks	Erosional plain

Pinkerton appears to follow the edge of the Victoria River covering the majority of the study site, including the eastern edge. Dinnabung appears as a small patch toward the western most edge of the study site. One small patch of Ivanhoe is situated between the Dinnabung and Pinkerton systems. Soil systems within the study site are closely related to the land systems. Soils related to the Pinkerton system include alluvial soils towards the river channel and flood plain, with rock outcrops and skeletal soils appearing on plateaux. Soils related to the Ivanhoe system include grey and brown cracking clays along the flood plain, and sandier alluvial soils within the channels. The Dinnabung system is characterised by light powdery loam along drainage channels, and sandy clay soils on the crests and low rises (Connell Wagner, 1997).

³ AMSL = Above Mean Sea Level

2.4 Geology

Previous surveys conducted throughout the VRD class the geology as strongly folded, metamorphic basement rock, with underlying sedimentary rock (Tropical Savannas CRC, 2005). This sedimentary rock is known as the Sturt Block and is characterised by unmetamorphosed sedimentary layers and forms part of the North Australian Platform Cover. Dolostone, sandstone, limestone and shale comprise a majority of the sedimentary layer. Ancient drainage systems have now eroded a lot of the VRD, exposing older, more resistant rocks as plateau low hills. Alluvial deposition along major streams has occurred over more recent times (DIPE, 2004). Older alluvium deposits, mainly silt, dominate the Victoria River flood plain. Other geological layers present at the study site include gravel, sand and silt alluvium, and interbedded dolomitic sandstone and dolomite (DBIRD, 2004).

2.5 Hydrology

The study site is located within the Victoria River Basin (VRB), which extends over an area of 78,146 km² (Australian Government, 2002). The Victoria River has a mean annual run-off of 4,540,000 ML and flows throughout the year. The five major tributaries originate from rocky escarpments. They then travel through low hilly areas, across the floodplains and into the river channel (Australian Government, 2002). Many of the smaller creek systems are ephemeral, only flowing during the wet season. The basins major aquifer, named 'Jasper George Sandstone', yields between 0.5 and 5.0 L of fresh water per second, through fractured rock (DIPE, 2004). Another minor aquifer occurs closer to the coast, the 'Angellan Siltstone' aquifer, which produces 0.05- 0.5 L.s⁻¹ (Power and Water Authority, 1994). Study sites situated close to the escarpments and steep hill areas are prone to flash flooding. Study sites west of the Victoria River, including Lost and Sandy Creeks, are situated on the river's flood plain and have drainage characterised by deep meandering channels (Connell Wagner, 1997).

2.6 Vegetation

Tropical Savannas CRC (2005) identified three vegetation units along the Victoria Highway in the survey area. Woodland I (closely related to the Pinkerton land system) dominates the surveyed area, lying within the Victoria River's flood plain. Woodland II (closely related to the Dinnabung land system) appears only at the western most edge of the study site, while Woodland III (closely related to the Ivanhoe land system) appears at the eastern most edge. Table 2 defines each vegetation unit and provides a comparison of the Tropical Savannas CRC (2005) definition and the Connell Wagner (1997) definition.

Table 2: Vegetation Descriptions

Vegetation Unit	Description by Tropical Savannas CRC	Description by Connell Wagner
Woodland I	Eucalyptus overstorey with perennial grasses	Northern Box-Bloodwood woodland with Tippera tall grass
Woodland II	Woodland dominated by <i>Terminalia</i> and <i>Lysiphyllum</i>	Tall grass with fringing forest
Woodland III	Eucalyptus on hummock grass understorey	Stringybark-Bloodwood woodland with upland tall grasses

2.7 Current Land Use and Integrity

Most of the study area occurs within Gregory National Park. Outside the Park, the land is used for grazing cattle except for the tourist complex situated at Victoria River. Activities at the tourist complex do not impinge on the habitat of the Purple-crowned Fairy-wren but its proximity to the River make the habitat and environs more susceptible to human disturbance because people stop there to take advantage of the facilities. Because the Cane Grass at Victoria River is dense, it is not subject to physical disturbance but is susceptible to fire.

Over the past few years, the number of Water Buffalo *Bubalis bubalis* in the area has increased suggesting that they are not being actively controlled within Gregory National Park. Feral cattle also occur in low numbers. These animals have can have an impact on the Cane Grass (see historic descriptions below and photographic evidence).

Away from the drainage lines, there is little grazing because numbers of cattle are controlled within the Park. There are small numbers of feral donkeys and feral horses but these do not appear to have an impact on the parts of the river, or other drainage lines, containing Cane Grass.

Lewis (2002) reports that compared with the distribution of Cane Grass reported by early explorers, it is now restricted to 'relict patches' but in areas such as Gregory National Park, where stock numbers have been controlled and reduced in number, the area of Cane Grass present is increasing.

2.8 Adjacent Land Uses

Cane Grass has been recorded along the banks of the Victoria River since 1846 when Stokes made several mentions of it as being tall and thickly growing (Stokes, 1846) and again by Gregory in 1855 who described the banks of the Victoria River as being 'densely covered with reeds' (Gregory, 1981). The steep banks that were also recorded in early journals have been eroded (Lewis, 2002) because of the impact of stock. Lewis (2002) reports that within six years of the station being stocked, at a rate of about 15,000 head, degradation of the river banks had begun. On VRD station alone, stock numbers increased to around 145,000 by 1921 (Lewis, 2002) and, in 1945, Maze (1945, cited in Lewis, 2002) stated that the plant association was not able to withstand the close and continuous grazing to which the river frontage country was subjected.

Currently, adjacent areas outside Gregory National Park are occupied by pastoralists, the Australian Defence Force at Bradshaw Field Training Area and Coolibah Crocodile Farm. While it is not possible to reverse all of the impacts of erosion described above, stretches of Cane Grass in the Park and on Bradshaw are the best locations to be managed to protect existing populations of the Purple-crowned Fairy-wren. Because of the changed drainage patterns within the region (Lewis, 2002), it is better to increase the quality and extent of known patches of Cane Grass rather than try to re-establish the species in areas that it may have been in the past, or in drainage lines within the study area where it is absent.

3 PREVIOUS RESEARCH

The most extensive research on the Purple-crowned Fairy-wren has been done by Rowley and Russell (Rowley, 1993; Rowley and Russell, 1993; 1997). Their study was to the west of the current study area and the Purple-crowned Fairy-wrens frequented *Pandanus aquaticus* in fringed riverine habitat, with the result that the territories were much more long and thin compared with those in Cane Grass habitats (Annamaria van Doorn, unpublished data; Sonia Tidemann, unpublished data). Rowley and Russell (1993; 1997) found that the territories of the Purple-crowned Fairy-wren are '*strung out in linear succession along the rivers they frequent. Each territory usually has only two neighbours and is 200-300 m long, including both banks of the river, but where two rivers join, or a river has islands and a number of channels, territories may form a more complex mosaic*'. Territories in Cane Grass can be much more rounded, particularly in areas of Cane Grass that are wide (Annamaria van Doorn, unpublished data; Sonia Tidemann, unpublished data). Territorial boundaries can be determined from the locations in which birds sing because territorial song is well co-ordinated in this species; a male and its mate fly to a conspicuous perch and sing together a loud duet in response to a neighbour's song (Rowley and Russell, 1997) or a play-back of a recorded song (see also in methods). Groups can be simple pairs or up to four adults and this may depend on the extent of the Cane Grass patches as well as the quality of Cane Grass (height, width and length of the patch) (Annamaria van Doorn, unpublished data; Sonia Tidemann, unpublished data).

Rowley and Russell (1993) reported finding 70 clutches, recording nesting in July to September and January to May, with most clutches (about 75%) found in the former period and birds raising 2 to 3 clutches per season with 2 to 3 eggs in each clutch. Although they found nests in only *Pandanus* sites, the heights of nests (mean 880 mm: range 250-2900 mm), it suggests that habitat suitable for nesting needs to be around 2-3 m. Like other fairy-wrens, the breeding period of the Purple-crowned Fairy-wren is dependent on climatic conditions, in particular the length of the wet season, local flooding and so on (Tidemann and Marples, 1987; Annamaria van Doorn, unpublished data). At the end of the breeding season, groups can swell to more than 10 before the young of the year disperse. At this time of the year, as in other fairy-wrens, territory size expands (Tidemann, 1990; Annamaria van Doorn, unpublished data).

Rowley (1993) lists all the places searched for the Purple-crowned Fairy-wren and locations where they were found. These data, as well as historic data, are held in the database of the *Atlas of Australian Birds* (Blakers *et al.*, 1984) and *New Atlas of Australian birds* (Barrett *et al.*, 2003). The species was listed as threatened because of the decline of the subspecies compared with historic data (Rowley, 1988; Garnett 1992). Information held at the Biodiversity Conservation, Parks and Wildlife, Darwin, NT, is sufficient to indicate that there may be some impact of the proposed road and bridge works along the Victoria Highway (185 to 220 km east of Katherine) on the species (John Woinarski, Parks and Wildlife Service, email 25.2.05).

The current distribution of the Purple-crowned Fairy-wren has been greatly reduced (Rowley, 1993) and estimated at less than 7,000 birds in seven sub-populations (Rowley, 1993). More recent surveys along the Victoria River suggested that the population size was larger than previously thought and so the population estimate revised to 12,000. However, aerial survey of available habitat in the region has shown a great degree of fragmentation and so this number is thought to be an over-estimate and the original estimate of Rowley (1993) is more likely (Annamaria Van Doorn, unpublished data).

4 METHOD

Aerial photographs and data identifying sites where the Victoria Highway is to be widened, raised or re-aligned were obtained from the Road Projects Division. These data were used to prepare field maps, showing the location of each of the identified survey sites, including their distance from Katherine (chainage) and distance between sites, to facilitate easier relocation in the field.

Detailed technical drawings showing the aerial extent of impact were not provided but an indication of the proposed construction works was provided in the Tender documents. Therefore, it was assumed that all habitat from the up-stream side of the existing bridge to 50 m from the downstream side of the existing bridge, will be impacted during road works.⁴

Field surveys were undertaken between 16 and 20 April, 2005, inclusive. Work commenced at dawn and continued until dusk, focussing assessment work on sites with Cane Grass present in the early morning and late afternoon, to maximise the potential for recording Purple-crowned Fairy-wrens. During the middle of the day, sites without Cane Grass present were surveyed. Annamaria van Doorn and James Brown travelled to the site and surveyed for three and a half full days (dawn to dusk). Specifically, the following tasks were performed:

Field assessment included:

- A visual assessment from the road at nominated sites to determine whether Cane Grass was present within 150 m on either side of the road;
- For all sites, irrespective of whether Cane Grass was present or absent, the following information was collected:
 - Photos both upstream and downstream of the road, unless the drainage line was so small that one photo was sufficient to show site features;
 - GPS co-ordinates, from centre-line of road;
 - Brief physical description of the site, including whether it was a river, creek, crossing, watercourse or culvert; and
 - Weed cover (classified as low, medium or high);
- For sites with Cane Grass present, transects were surveyed to determine the extent of Cane Grass present and Purple-crowned Fairy-wren activity. Upstream transects covered a distance of 85 m perpendicular from the road. Downstream transects were extended to a distance of 150 m perpendicular from the road, because it was understood that any proposed realignment would occur on the downstream side of the existing alignment. At these sites, the following additional information was collected:
 - Photos at the commencement of each transect;
 - The dominant weed species present, particularly between Cane Grass patches;
 - Feral animal activity such as tracks, droppings and rootings (classified as low, medium or high) and the name of these species, if able to be ascertained;
 - The presence of erosion and a brief description;
 - Dominant flora species;

⁴ Late in the project HLA was provided with aerial photographs showing the actual areas to be cleared. In some cases the area to be cleared is up to 80 m wide, so subsequent assessments of impact on habitat have been revised to reflect the new information provided. These new aerial photographs, showing proposed areas for realignment and clearing are provided in Appendix 2. It should be noted that these do not include Culverts 1, 6, 12, 21, 22 and 40-44.

- Measurements of length, width and height of the Cane Grass, if one continuous patch, or the lengths, widths and height of Cane Grass patches and the distance between patches, if multiple patches were present. Where the Cane Grass was continuous, three spaced measurements for width (to calculate an average width) and 10 random height measurements (to calculate an average height) were obtained;
- The number of groups, numbers of individuals within each group, core areas of use by each group and the range of each group of Purple-crowned Fairy-wrens. Data on the Fairy-wrens was collected by listening, watching, squeaking up and play-back of the species' calls; and
- Other bird species present, opportunistically seen or heard.

The data collected were recorded on data sheets and sketches of the Cane Grass patches were drawn.

One day was spent with Greening Australia (NT) personnel, collecting Cane Grass seed and plant cuttings. This plant material was provided to Greening Australia for germination (seeds) and strike rate (cuttings) trials.

5 RESULTS

Table 3 shows the culverts recommended for survey, their characteristics and their location on the Victoria Highway. Added to these are Lost, Joe, Sandy and Escarpment Creeks and the Victoria River.

Table 3: Culverts Recommended for Survey

Culvert No	Chainage (kms from Katherine)	Distance to next culvert (km)	Distance to previous culvert (km)	Culvert Type
1	185.08	1.49		RCP
2	186.57	1.17	1.49	RCBC
3	187.74	0.25	1.17	RCBC
4	187.99	0.30	0.25	CAST INSITU
5	188.29	3.99	0.30	ARMCO PIPES
6	192.28	0.76	3.99	RCP
7	193.04	0.12	0.76	ARMCO PIPES
8	193.16	0.99	0.12	RCP
9	194.15	0.33	0.99	RCP
10	194.48	0.35	0.33	RCBC
11	194.83	0.25	0.35	CAST INSITU
12	195.08	0.36	0.25	RCBC
13	195.44	0.38	0.36	RCP
14	195.82	6.17	0.38	RCP
15	201.99	0.17	6.17	RCBC
16	202.16	0.12	0.17	RCP
17	202.28	0.04	0.12	RCP
18	202.32	0.09	0.04	RCP
19	202.41	0.75	0.09	RCP
20	203.16	0.11	0.75	RCP
21	203.27	0.13	0.11	RCP
22	203.40	0.11	0.13	RCP
23	203.51	0.17	0.11	RCBC
24	203.68	0.49	0.17	RCP
25	204.17	0.26	0.49	RCP
26	204.43	0.24	0.26	CAST INSITU
27	204.67	0.22	0.24	RCP
28	204.89	1.53	0.22	RCP
29	206.42	0.08	1.53	RCBC
30	206.50	0.14	0.08	RCBC
31	206.64	0.10	0.14	RCP

Culvert No	Chainage (kms from Katherine)	Distance to next culvert (km)	Distance to previous culvert (km)	Culvert Type
32	206.74	0.05	0.10	RCP
33	206.79	0.10	0.05	RCBC
34	206.89	0.10	0.10	RCBC
35	206.99	0.63	0.10	RCBC
36	207.62	0.36	0.63	RCBC
37	207.98	2.43	0.36	RCBC
38	210.41	3.47	2.43	RCP
39	213.88	1.45	3.47	CAST INSITU
40	215.33	0.23	1.45	RCBC
41	215.56	0.46	0.23	RCBC
42	216.02	0.24	0.46	RCBC
43	216.26	0.80	0.24	RCBC
44	217.06		0.80	RCBC

In total, 49 sites were surveyed. Appendix 3 provides a summary for each of these sites, including site features, GPS co-ordinates and site photos.

Of the sites surveyed, 10 had Cane Grass present and six contained populations of Purple-crowned Fairy-wrens. Figures 2 to 12 show the location of each site surveyed and those sites which had Cane Grass present, in relation to the proposed road realignments. Sketches for each site with substantially sized Cane Grass patches present are provided in Appendix 4. These sketches also show the territorial areas of the Purple-crowned Fairy-wrens present and the number of birds recorded within these.

The length, width and volume (where able to be calculated) for each substantially sized Cane Grass patch is provided in Table 4. The presence of Purple-crowned Fairy-wrens within these patches is also indicated.

Table 4: Cane Grass Patch Dimensions and Volume and Purple-crowned Fairy Wren Presence

Site No	Site Name	Patch Length (m)	Average Width (m)	Area (m2)	Area (ha)	Average Height (m)	Volume (m3)	Fairy Wrens Present
7	Culvert 7 – Upstream	150	63	9402	0.94	2.3	21624.4	Yes
7	Culvert 7 – Downstream	26	49	1279	0.13	2.07	2647.3	No
8	Culvert 8 – Upstream	5	5	25	0.0025	2.26	56.5	No
13	Culvert 13	30	40	1200	0.12	2.2	2640.0	No
14	Culvert 14 – Upstream	82	44	3617	0.36	2.4	8681.3	Yes



Site No	Site Name	Patch Length (m)	Average Width (m)	Area (m ²)	Area (ha)	Average Height (m)	Volume (m ³)	Fairy Wrens Present
14	Culvert 14 – Downstream	Continuous	Continuous	n/a	n/a	2.44	n/a	Yes
15	Culvert 15 – Downstream	46	Continuous	n/a	n/a	2.44	n/a	Yes
16	Culvert 16 – Downstream	16	Continuous	n/a	n/a	2.48	n/a	Yes
17	Culvert 17 – Downstream	24	Continuous	n/a	n/a	2.44	n/a	No
18	Culvert 18 – Downstream	27	Continuous	n/a	n/a	2.52	n/a	No
19	Culvert 19 – Downstream	16	Continuous	n/a	n/a	2.55	n/a	No
37	Culvert 37	n/a	n/a	n/a	n/a	n/a	n/a	No
45	Victoria River East – Upstream 1	80	278	22,330	2.23	2.41	53,814.4	Yes
45	Victoria River East – Upstream 2	198	111	21,940	2.19	2.55	55,946.9	Yes
45	Victoria River East – Downstream 1	180	126	22,668	2.27	2.47	55,990.0	Yes
45	Victoria River East – Downstream 2	137	199	27,219	2.72	2.47	67,229.7	Yes
46	Escarpment Creek – Upstream	106	157	16,766	1.68	2.45	41,077.0	Yes
46	Escarpment Creek – Downstream	155	Continuous	n/a	n/a	2.29	n/a	Yes
47	Lost Creek – Downstream 1	121	199	24,130	2.41	2.76	66,598.1	Yes
47	Lost Creek – Downstream 2	137	66	8,981	0.90	2.36	21,196.2	Yes
47	Lost Creek – Upstream 1	55	23	1,255	0.13	2.28	2,860.6	Yes
47	Lost Creek – Upstream 2	25	91	2,276	0.23	2.28	5,188.5	Yes
47	Lost Creek – Upstream 3	2	2	4	0.0004	2.2	8.8	No
47	Lost Creek – Upstream 4	2	2	4	0.0004	2.2	8.8	No

Cane Grass is distributed along the wetter drainage lines in the study area. Maintenance of cane patches is essential to stabilise river banks and creek lines and so minimise erosion. Open areas along creek lines are more susceptible to invasion by weeds and dense, continuous patches of Cane Grass assist in preventing weed invasion. Based on the results of the current survey, it appears that there is a threshold volume (about 3,000 m³) of Cane Grass if it is an isolated patch, below which, it is not utilised by Purple-crowned Fairy-wrens.

Of critical importance to long-term survival of Purple-crowned Fairy-wrens in the project area and wider region is the loss and continued fragmentation of existing habitat. The existing Cane Grass areas between Lost Creek and the Victoria River access road have been identified as a core breeding area for the Purple-crowned Fairy-wren. This area provides the best condition and most interconnected area of Cane Grass in the region, when considering previous survey work undertaken between Timber Creek and the Dashwood Crossing on Victoria River Downs.

6.1.3 Impacts on Habitat Quality

Disturbance to soil in the study area and clearing of vegetation can greatly enhance the ability of weed species to become established, through reduced competition for resources such as light and nutrients. Further exacerbating this problem is the potential for weed seeds to be transported onto construction sites on machinery.

6.2 Impact Mitigation Measures

Currently it is proposed to:

- Widen, raise and/or realign sections of the highway from 185 km to 220 km;
- Rebuild bridges at the Victoria River and Sandy, Joe and Lost Creeks, 20 m downstream of the current crossings; and
- Build a by-pass crossing at Escarpment Creek, downstream of the existing crossing.

In order to minimise the impact on Cane Grass habitat and Purple-crowned Fairy-wren populations, the following mitigation options were examined:

- Reassessment of the proposed alignment;
- Rehabilitation of areas of Cane Grass habitat to be disturbed by road works, once road works have been completed;
- Transplanting of Cane Grass clumps to other Cane Grass habitat areas to improve existing habitat quality;
- Erosion control;
- Weed control;
- Stock exclusion; and
- Control of feral animals such as buffalo, cattle and pigs.

Impact mitigation has not just focussed on the road reserve for which Road Projects Division has responsibility for. This is because the opportunities to offset the impacts created by the proposed activity are limited within the road reserve alone. Therefore, areas outside of the road reserve, within Gregory National Park have been identified as suitable areas to offset impacts.

6.2.1 Stock Exclusion

Stock exclusion through fencing of Cane Grass habitat areas was initially considered as an option for off-setting impacts resulting from the proposed road works. However, stock exclusion fencing presents a number of issues, as follows:

- Ability to fence to the water line – river height varies seasonally and flood waters have the potential to damage fencing, thus requiring long-term maintenance;
- Risk of feral animals becoming trapped within a fenced area of Cane Grass habitat – this could result in a high level of damage to Cane Grass habitat; and
- Fencing within a National Park is not desirable.

It was concluded that ongoing feral animal control within Gregory National Park is a better option for reducing impacts on Cane Grass from feral animals, such as buffalo, feral cattle and pigs.

6.2.2 Feral Animal Control

The increase of feral water buffalo over the last few years is of concern because of their impact on the Cane Grass habitat by grazing and wallowing. The impacts of the buffalo and feral cattle are more detrimental than the impacts of feral pigs.

A concerted effort by the Gregory National Park rangers would be desirable during the proposed road works to shoot feral buffalo, cattle and, opportunistically, pigs, without disrupting Cane Grass habitat. Control efforts by Park rangers should continue after road works are completed. It is recognised that feral animal control needs to occur on a regional scale and that it is an issue beyond the scope of this project alone.

6.2.3 Erosion Control

A factor that influences Cane Grass habitat quality is erosion of stream banks. Conversely, Cane Grass can assist in prevention of erosion of stream banks. Therefore, it is recommended that, erosion control works be undertaken at completion of the construction phase, to maximise stability of stream banks and therefore increase the chances of Cane Grass becoming re-established.

In areas recommended for transplant of Cane Grass clumps (refer to Sections 6.2.5 and 6.2.6 below), some erosion control works may also be required to assist in maximising survival of Cane Grass transplants, particularly after wet season flooding.

6.2.4 Weed Control

Weed control at sites directly impacted by the road works should occur post construction (after the first wet season) and should continue after the road works and rehabilitation efforts are completed for at least three years. Particular emphasis should be placed on control of Noogoora Burr.

There is a high level of risk of transporting of weeds from one part of the construction area to another, especially Noogoora Burr as it is widely established in disturbed areas in the region. It is critical that Noogoora Burr is not spread by machinery and plant during the road works. Machinery must be washed down before leaving a site where Noogoora Burr has been

recorded. This will require access to a portable high pressure hose and water source and suitable method of collecting seed and other vegetative material washed from the vehicles.

Weed control should also be undertaken at transplant sites between patches of Cane Grass and before the transplanting is commenced. This will require ongoing control for at least three years after transplanting.

6.2.5 Revegetation/Rehabilitation of Sites Disturbed by Road Works

The construction sites and cleared areas should be rehabilitated post-construction, as indicated in Figures 14 to 16. Rehabilitation should include:

- Planting of clumps of Cane Grass in disturbed areas. Advice received from Greening Australia indicates that 1 clump per 2 m² would be a sufficient density. These clumps (including root-balls) could be retained during the clearing process and would need to be cut-back, divided into smaller clumps and maintained in a shaded and irrigated area until the site is ready for replanting after construction has been completed (and prior to wet season rainfall);
- Erosion control; and
- Weed control.

Revegetation, erosion control and weed management is important for maintenance of a habitat and dispersion corridors for Purple-crowned Fairy-wren dispersal.

Because of its volume and density, the Cane Grass along the Victoria River is of the highest quality of any other sites surveyed. For this reason it is important to restore it to its historical pre-grazing quality as far as possible, within its current distribution. This will provide the greatest opportunity for sub-populations of the Purple-crowned Fairy-wrens along the Victoria River to become re-established following the disruption to the habitat that will occur through constructing another bridge.

Any patches of Noogoora Burr, and any other weeds, within 1 km of either side of the Victoria River bridge should be removed and replaced with Cane Grass plants propagated by seed or cuttings, prior to planting out. These should be planted at a time that will optimise the chances of the Cane Grass becoming established. Information from Greening Australia has indicated that the greatest success can be obtained from cuttings, as much of the Cane Grass seed collected has proven to be non-viable or not yet ripe. If replanting *Mnesithea rottboellioides*, as an additional perennial species known to be used by Purple-crowned Fairy-wrens, this should be undertaken using locally collected seed, as growth from cuttings is generally not successful. Greening Australia have advised that *Mnesithea rottboellioides* seed may be available in the future, pending the results of planned seed viability testing. The seed of this species can be difficult to obtain and the appropriate sowing rate is unknown (Greening Australia, *pers. comm.*).

Other dominant flora species, such as *Eucalyptus microtheca*, *E. camaldulensis*, *Barringtonia acutangula* and *Ficus coronulata* should also be considered for re-establishment in Cane Grass habitat where they have been lost. This assists in maintenance of soil stability during flood events.

Areas rehabilitated with Cane Grass should be monitored annually, for at least three years, to determine whether replantings need to be carried out, which may be necessary following flooding.

6.2.6 Transplant Sites

In order to off-set loss of Cane Grass habitat, it is recommended that, in addition to rehabilitation of disturbed sites, the Cane Grass that is to be cleared should be used for transplanting to other locations, to enhance existing habitat areas. Figures 14 to 16 show the proposed sites for transplanting. These transplant sites should be considered as an off-set for the areas of high quality Cane Grass habitat that will be removed during road works. Although it is also recommended to rehabilitate disturbed sites post construction, it will take several years for these rehabilitated sites to regain the current habitat quality. Enhancement of other areas of Cane Grass habitat through transplants will provide an immediate benefit to Purple-crowned Fairy-wrens, thereby minimise population impacts.

As outlined above, the material for transplanting would need to be removed from the site, divided, cut back and kept under shade and irrigation until such time the transplant sites were ready for the transplants to be installed.

Any patches of Noogoora Burr in these areas should be controlled and ongoing monitoring and further control works undertaken for at least three years after transplanting. In some areas indicated, erosion control may also be required to maximise the chance of transplant survival.

Within the study area, the only site outside Gregory National Park that requires management for Purple-crowned Fairy-wren habitat is Lost Creek. This belongs to either Fitzroy Station, managed by Ngaliwurru/Nungali Aboriginal Land Trust (Telephone: 08 8975 0710) or Coolibah Station, owned by Milton Jones (Telephone: 08 8975 0764).



Figure 13: Proposed rehabilitation and transplanting at Victoria River and Culverts 7 and 8.

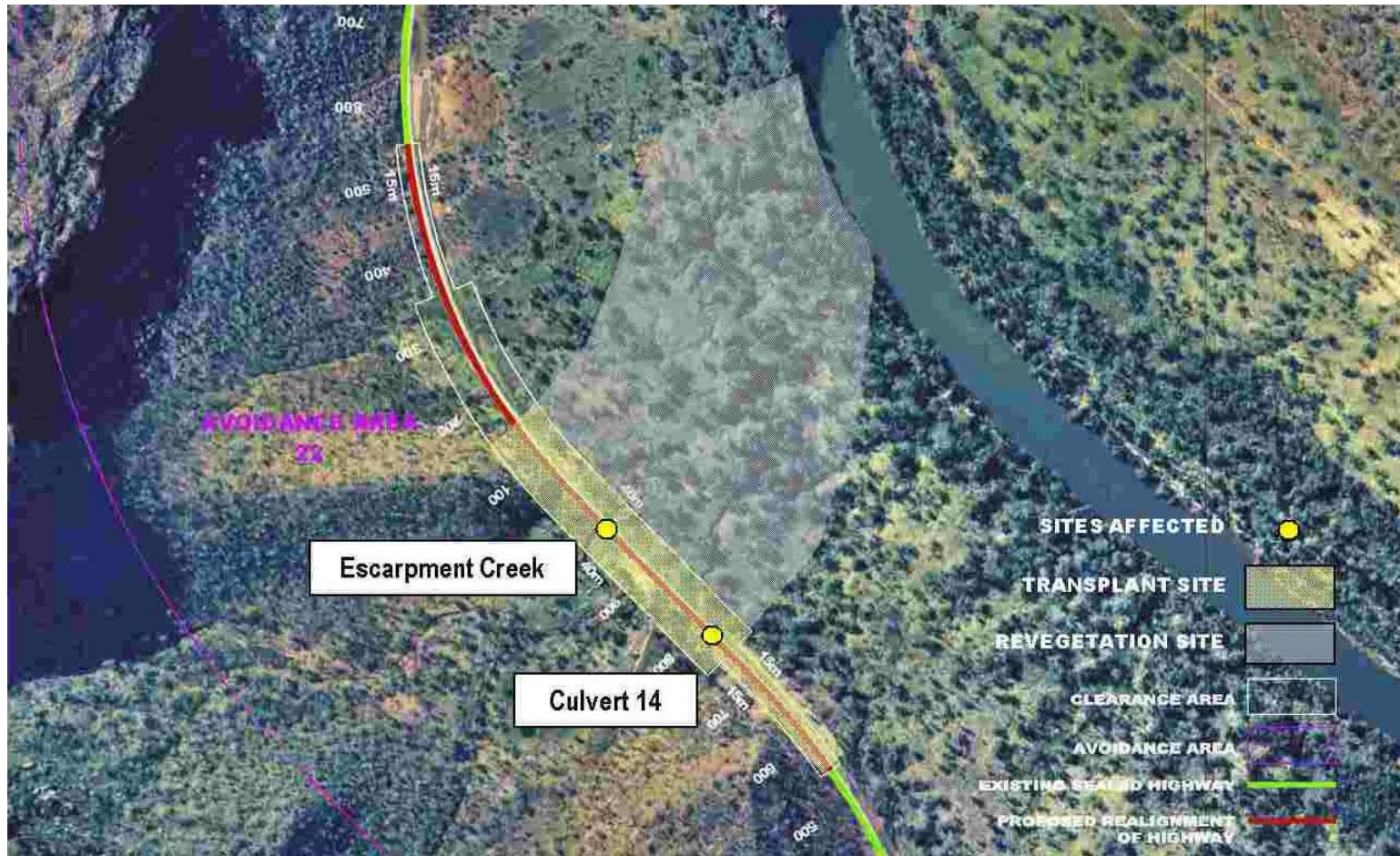


Figure 14: Proposed rehabilitation and transplanting at Escarpment Creek and Culvert 14.

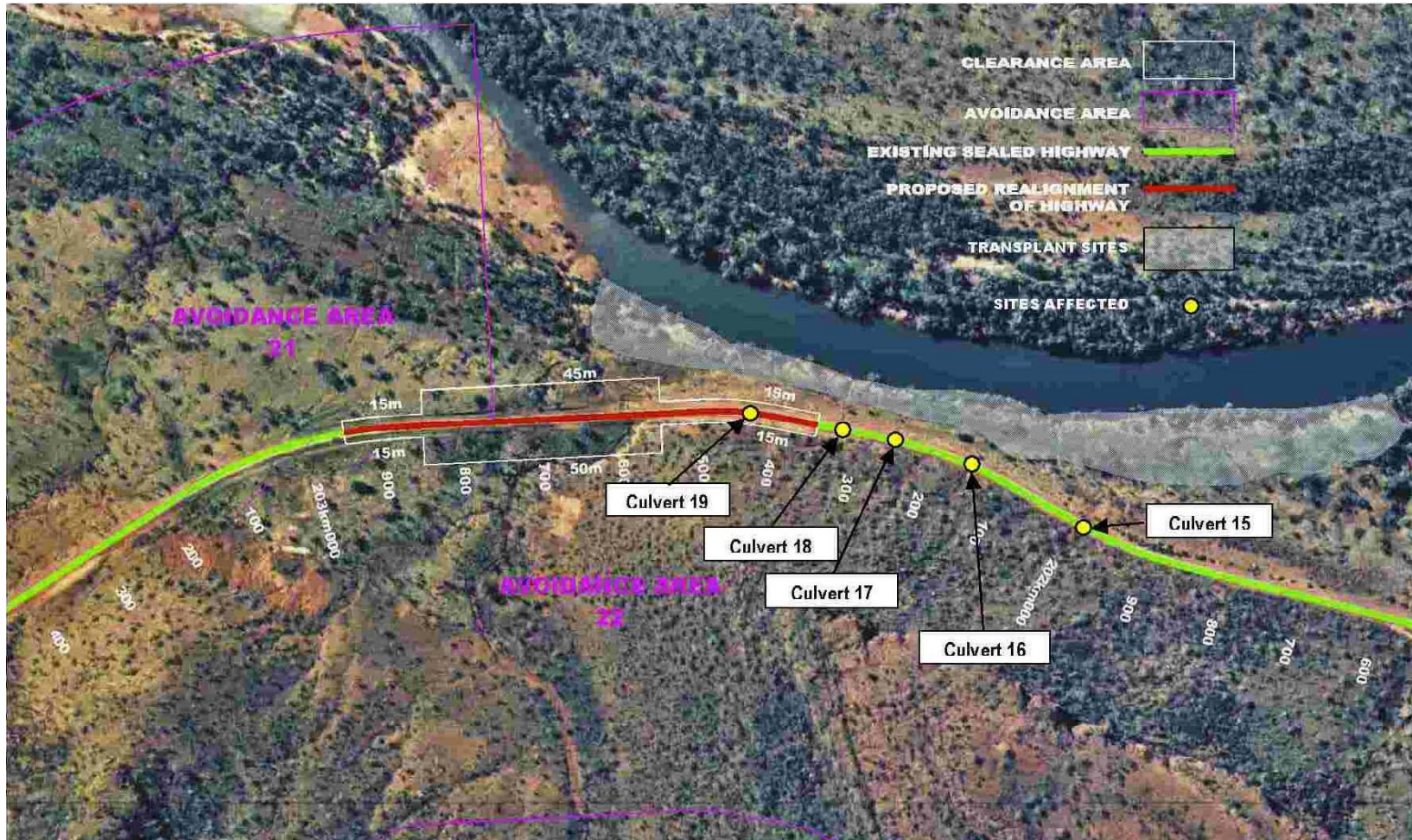


Figure 15: Proposed rehabilitation and transplanting at Culverts 15, 16, 17, 18 and 19.

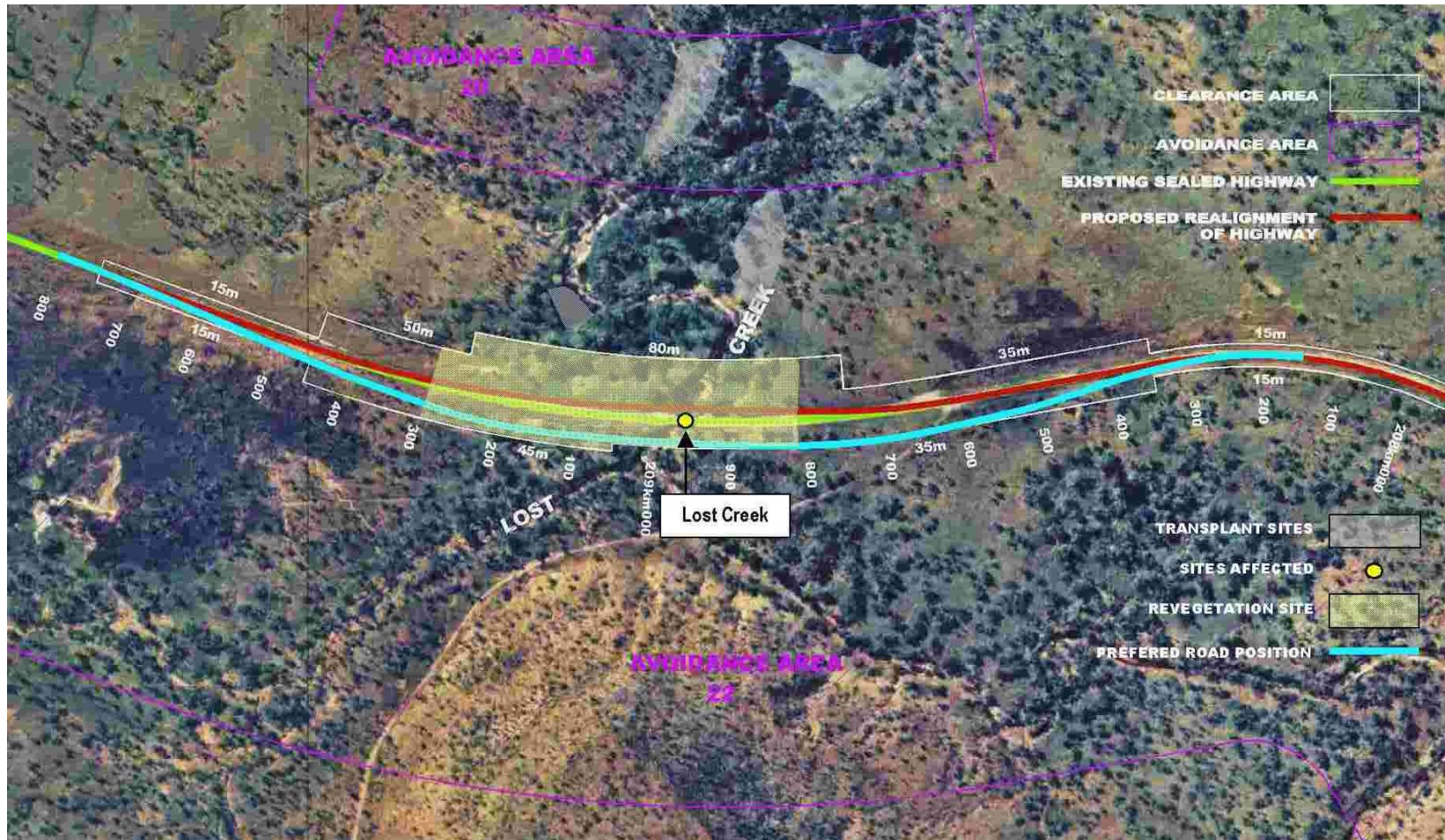


Figure 16: Proposed rehabilitation and transplanting at Lost Creek.

6.2.7 Summary of Recommended Mitigation Measures

The recommended measures for mitigating against the disturbance to Cane Grass habitat (and therefore Purple-crowned Fairy-wrens) or off-set measures required are provided in Table 7.

Table 7: Recommendations for Mitigation Against Disturbance from Proposed Construction Activities at all Sites with Cane Grass Present.

Site with Cane Grass Present	Recommendation	Justification
Victoria River (Figure 13)	Use Cane Grass to be removed for transplanting downstream in bare patches of existing Cane Grass community, to create good quality habitat in a continuous band to the Victoria River, as well as for rehabilitation post construction. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.	It is recognised that to implement any realignment at this site would be difficult. There will be a significant impact on downstream Cane Grass habitat and Purple-crowned Fairy-wrens. The post construction rehabilitation of the disturbed area and transplanting to other areas downstream and upstream of the site should be considered as an appropriate offset to disturbance.
Culvert 7 (Figure 13)	Unavoidable impact – rehabilitate post construction.	Recommend that Cane Grass present and cleared is used as a source for transplants elsewhere and later rehabilitation of the site.
Culvert 8 (Figure 13)	Insignificant impact – rehabilitate post construction.	Only a small area of Cane Grass present - recommend that Cane Grass present and cleared is used as a source for transplants elsewhere and later rehabilitation of the site.
Escarpment Creek (Figure 14)	Use Cane Grass to be removed for transplanting downstream in bare patches of existing Cane Grass community, to create good quality habitat in a continuous band to the Victoria River, as well as for rehabilitation post construction. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.	It is recognised that to implement any realignment at this site would be difficult. There will be a significant impact on both upstream and downstream Cane Grass habitat and Purple-crowned Fairy-wrens. The post construction rehabilitation of the disturbed area and transplanting to other areas downstream of the site should be considered as an appropriate offset to disturbance.
Culvert 14 (Figure 14)	Use Cane Grass to be removed for transplanting downstream in bare patches of existing Cane Grass community, to create good quality	It is recognised that to implement any realignment at this site would be difficult. There will be a significant impact on both upstream and

Site with Cane Grass Present	Recommendation	Justification
	<p>habitat in a continuous band to the Victoria River, as well as for rehabilitation post construction. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.</p>	<p>downstream Cane Grass habitat and Purple-crowned Fairy-wrens. The post construction rehabilitation of the disturbed area and transplanting to other areas downstream of the site should be considered as an appropriate offset to disturbance.</p>
<p>Culverts 15, 16, 17, 18, 19 (Figure 15)</p>	<p>The only site that will be directly impacted is Culvert 19. As an off-set, it is recommended that the existing narrow strip of Cane Grass along the Victoria River is rehabilitated through use of Cane Grass transplants, erosion and weed control. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.</p>	<p>This area, although very small, provides a corridor for dispersion of young Purple-crowned Fairy-wrens into new habitat areas. It is currently degraded and could benefit from rehabilitation.</p>
<p>Lost Creek (Figure 16)</p>	<p>Strongly preferred option. Realign proposed alignment to move road south (upstream).</p> <p>Alternative option: Use Cane Grass to be removed for transplanting downstream in bare patches of existing Cane Grass community, to create good quality habitat in a continuous band to the Victoria River, as well as for rehabilitation post construction. Prior to transplanting or rehabilitation, weed control and erosion control works would need to be undertaken to enhance survival rate of transplants. Monitoring or transplant and rehabilitation success and weed and erosion control would be required for at least three years post construction.</p>	<p>The current alignment will severely damage a significant area of habitat and result in the loss of 18 Purple-crowned Fairy-wrens. It is acknowledged that realignment will result in further encroachment into the Avoidance Area, but this area would be disturbed by the proposed alignment and clearance would need to be obtained anyway.</p> <p>As an alternative, this site could be treated in the same manner as Escarpment Creek, with post-construction rehabilitation at the disturbed areas and transplanting downstream to improve existing habitat quality.</p>
<p>Culvert 13</p>	<p>No impact</p>	<p>Outside of proposed area for</p>

Site with Cane Grass Present	Recommendation	Justification
		construction. This culvert is on the edge of the construction site however, so it is important that the boundaries for clearing are clearly delineated in the field.
Culvert 37	Insignificant impact	Only two clumps of Cane Grass present

6.3 Monitoring

The data collected during this survey provide a valuable base line and the opportunity to monitor these populations, habitat rehabilitation, weed and feral animal control over future years should not be lost. Monitoring the presence of weeds, and weed control, should occur at least annually for at least three years and feral animal control, particularly of grazing animals, should be on-going, particularly within Gregory National Park. Cane grass distribution and Purple-crowned Fairy-wren groups and total numbers should be monitored annually during April-May, for at least the first three years post construction. If it is found to be necessary, a management plan for the population between 185 and 220 km west of Katherine should be developed and implemented.

6.4 Contractor Management

The area to be cleared should be clearly delineated to ensure additional areas are not inadvertently cleared. The construction supervisor should be responsible for ensuring this does not occur and should be written into contractual documents. This is considered necessary to ensure that only the area that must be cleared is impacted.

6.5 Public Education

Public education to protect Cane Grass patches and, consequently, Purple-crowned Fairy-wrens should be initiated in a variety of ways, particularly at ranger stations in Gregory National Park and at the Victoria River Roadhouse. Information boards at the Old Victoria River Crossing camp site should be established, interpreting the importance of the Cane Grass at that site and suggesting ways that the fairy-wrens can be viewed without destroying the habitat – for example, describing the calls for people to hear and hence locate individual birds, how to ‘squeak birds up’, describing diurnal foraging behaviour and the best time of the day to observe them and so on.

The proposed road works along the Victoria River Highway should be regarded as an obligatory opportunity to enhance the habitat of the Purple-crowned Fairy-wren rather than focusing on it as a potentially destructive process.

6.6 Responsibility

While it is understood that the Road Projects Division has certain areas of responsibility, the proposed road works have the potential to create disturbance which will require ongoing remediation and monitoring, including in areas outside of the road reserve. It may be possible for Road Projects Division to negotiate with Gregory National Park to assist in weed control,



erosion control and monitoring, so as to best utilise resources in the area. However, there may also be a requirement for financial support for this to occur. These negotiations are beyond the scope of this study; however, our recommendations can be used as a basis for negotiation.

7 SUMMARY AND RECOMMENDATIONS

Road works along the Victoria Highway, between 185 and 220 km, have the potential to impact on the Purple-crowned Fairy-wrens and their habitat at Lost and Escarpment Creeks, Victoria River and culverts 7 and 8, 14 and 19. The habitat of at least 19 groups of fairy-wrens and 52 individuals will be impacted during the proposed road works (as shown on Figures 13 to 16). The proposed areas to be cleared will remove all habitat and therefore lead to the death of individual birds in those territories, as Purple-crowned Fairy-wren are territorial and existing habitat is already used to capacity, leaving little opportunity for relocation to new habitat areas.

Mapping the distribution of Cane Grass and Purple-crowned Fairy-wren territories enabled recommendations to be compiled. The recommendations are aimed at off-setting impacts through enhancement of existing habitat and then re-creation of habitat at the disturbed sites. This two-pronged approach provides a short-term opportunity to increase available habitat for displaced birds (through transplanting Cane Grass into bare patches in existing habitat) and a longer-term remediation of the impacts created (through re-establishment of Cane Grass in areas cleared). It is believed that this approach will reduce the long-term impacts of the proposed construction works.

Mitigation measures include the following:

- Use Cane Grass cleared from construction sites for transplanting to bare patches within other existing Cane Grass habitat areas to improve their quality;
- Use Cane Grass cleared from construction sites for rehabilitation of construction sites once work has been completed;
- Clean down all plant and machinery before moving away from weed-infested sites to non weed-infested sites;
- Remove weeds that occur between Cane Grass patches and rehabilitate where Cane Grass is absent along the Victoria River, for one kilometre upstream and one kilometre downstream of the Victoria River bridge, to create a continuous belt of Cane Grass. Although weed reintroductions from upstream are likely, if Cane Grass patches are not disturbed, by feral animals for example, weeds are less likely to re-establish;
- Undertake control of weeds in transplant and rehabilitation sites for at least three years post construction;
- Monitor populations of Purple-crowned Fairy-wrens within the study area at least annually during April-May, for a period of at least three years post construction. An assessment of weeds and feral animal activity could be undertaken at the same time; and
- Educate pastoralists, tourists and local people on the importance of preserving Cane Grass habitat and how to observe birds, if desired, without having a negative impact on them or their habitat.

In addition to the above, the issue of feral animal and weed control in the region needs to be addressed. It may be unrealistic to expect removal of feral species from the study area, as any such activity undertaken in isolation will merely create a vacuum for feral animals in surrounding areas to move into. This needs to occur on a regional basis, with the greatest opportunity within Gregory National Park. Similarly, weed control is an ongoing task and the likelihood of weed seeds being distributed along drainage lines (and therefore re-establishing) in the study area during the wet season is high. However, exclusion of feral animals (through fencing) from Cane Grass habitat areas would assist in long-term maintenance of Purple-crowned Fairy-wren by reducing impacts from grazing, soil erosion and weed establishment.

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