Mahogany Glider Management Plan for Ingham – Tully Transmission Line Upgrade

Addendum Report

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1.0 Background

Powerlink Queensland (Powerlink) has identified the need to replace the 132kV transmission line between its existing Ingham and Tully substations. In order to maintain electrical supply reliability, it is proposed to construct a dual voltage 275/132kV double circuit transmission line within a designated corridor between the localities of Ingham and Tully (RPS 2010). The upgraded transmission line will require a wider corridor to maintain the necessary safety zones; a standard corridor width for the higher voltage transmission line is 60m as compared to 30m for the existing transmission line.

An Environmental Impact Statement (EIS) was prepared by RPS in 2010 to assess the potential impacts of the corridor to safely accommodate the higher voltage conductors. This report also recommended mitigation measures for the corridor that will mitigate or preclude potential impacts on a range of flora and fauna species. One of the key mitigation features was to increase the height of some of the transmission towers to allow the conductors to be strung above the canopy of the surrounding vegetation. This has minimised the amount of vegetation clearing to be undertaken as a result of the transmission line upgrade. Other mitigation measures include the retention of low growing species beneath the transmission lines to prevent the full clearing of a 60m wide corridor.

Within the EIS it is recognised that the transmission line runs through a large amount of habitat that is mapped as essential habitat for the mahogany glider (*Petaurus gracilis)* which is listed as endangered under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and Queensland's *Nature Conservation Act* 1992 (NCA). In the absence of mitigation, the widening of the corridor could have a significant impact on this species. Under the EPBC Act, actions that have, or are likely to have, a significant impact on a Matter of National Environmental Significance (MNES) such as the mahogany glider, require approval from the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC).

A Mahogany Glider Management Plan was prepared by Conics (now RPS) in 2010 which addressed issues associated with potential impacts of the corridor widening on the mahogany glider. This report, together with the EIS was submitted to DSEWPaC in 2010.

Concurrently, Powerlink commissioned a scientific research study in conjunction with the University of Queensland to investigate some of the key issues that may potentially affect mahogany gliders as a result of the transmission line upgrade. The research brief can be found in Appendix 1. Results of this research can also be used to assist with the mitigation of impacts. The main aims of this research are to understand mahogany glider habitat use around and under the transmission line to:

- Determine the value of regenerating easement vegetation; and
- Provide information to assist in the design and location of glider poles

Several months of field work has been undertaken. Obtaining sufficient data on a nocturnal, cryptic, arboreal species is very labour intensive (Brady, 2011). The data is being processed at the time of this report and where appropriate, findings will be incorporated into the Environmental Work Plans (EWP) being prepared for the project.

The Minister has proposed to approve the upgrade of the transmission line subject to a number of conditions (Decision Notice 2010/5346), including the submission of an updated Mahogany Glider Management Plan. This addendum report will draw together the key points included in the original Mahogany Glider Management Plan (Conics, 2010) and the knowledge accumulated as a result of the scientific research that has been commissioned by Powerlink Queensland.

2.0 Mahogany Glider Habitat

2.1 Range and Populations

The range and distribution of mahogany glider populations is discussed in the original Mahogany Glider Management Plan (included as Appendix 2)

> Mahogany gliders use lowland sclerophyll forest, the main canopy and sub-canopy trees are eucalypts, bloodwoods and paperbarks and less commonly swamp Mahogany and turpentine with an open mid-stratum of smaller trees and shrubs (e.g. wattles, forest siris, black she-oak, pandanus) and a grassy ground stratum in which grass trees may be present. The Mahogany glider requires a relatively open forest structure for efficient gliding and tends to avoid dense vegetation such as rainforest (DERM, 2009);

(Source: Conics, 2010)

The distribution of mahogany glider habitat has been identified and mapped by the Queensland Environment Protection Agency (EPA), and is based on Regional Ecosystem (RE) v 5.0 mapping. Therefore this mapping is indicative of potential mahogany glider habitat rather than actual mahogany glider habitat (Conics, 2010).

Figure 1 shows this mapped mahogany glider habitat in relation to the Ingham – Tully transmission line. transmission line traverses the essential habitat for the mahogany glider. Studies by Kanowski (2009) and Brady (2011a,b) using radio-tracking on individual mahogany gliders have shown gliders to be present on both sides of this transmission line.

However, the essential habitat mapping for this species is based on Regional Ecosystem mapping and is only indicative of potential habitat. Mahogany gliders have relatively specific habitat requirements.

> The geographic range of the Mahogany glider is limited to an area of coastal lowland forest between Ollera Creek and the Hull River, a north-south range of about 120km (Jackson and Claridge 1999). The 100km east-west range extends from the coast to the lower Herbert Gorge and foothills of the Mt Fox section of Girringun National Park in the Wet Tropics Bioregion (Parsons and Latch, 2007). Over 98% of Mahogany glider sightings have been recorded at altitudes below 120 metres elevation (DERM, 2009).

(Source: Conics, 2010)

Some areas adjacent to the transmission line that are marked as essential habitat for the mahogany glider have been invaded by rainforest species or have a woody thickening in the sub-canopy that makes them suboptimal for mahogany gliders.

A detailed environmental assessment of the segments of the transmission line that are within the Wet Tropics World Heritage Area (WTWHA) has been undertaken specifically in relation to mahogany glider habitat features (Biotropica, 2011) (refer Appendix 3). This assessment included the recognition and recording of mahogany glider habitat features such as food plants and nest hollows that may potentially be affected by the upgrade of the transmission alignment. Thirteen trees with potential nest hollows were identified to species level, GPS recorded, photographed and flagged, and labelled with a numbered aluminium tag. Of these, eight required pruning and for these, detailed specific pruning requirements were documented.

Figure 1: Distribution of Mahogany Glider Habitat in relation to Ingham - Tully Transmission Line

3.0 Design Detail for Glider Poles

3.1 Location of glider pole arrays

The key mitigation strategy for minimising the impact of the widened corridor on mahogany gliders is the raising of transmission towers to enable the conductors to be strung over the canopy, allowing habitat beneath to remain relatively intact. Because there are likely to be some residual impacts on mahogany gliders it has been recommended that glider poles be installed in order to better connect fragmented habitats (Conics, 2010).

The use of glide poles to encourage mahogany gliders to cross gaps in the canopy, and connect fragments of habitat, is a recognised mitigation strategy in the Recovery Plan for the Mahogany Glider (Parsons and Latch, 2007).

In the original Mahogany Glider Management Plan (Conics 2010), it is recommended that arrays of glider poles are placed in three key locations (Towers IT79-80, IT91 and IT106-108) under the elevated conductors of the proposed new line (refer Appendix 4). Powerlink will initially establish one array across the existing easement. The first pole array will be a pilot which will be monitored before the design and location of the subsequent pole arrays is decided on.

A “glider pole array”, in comparison to a single “glider pole”, refers to a group of poles that together form a movement pathway across the cleared easement. The philosophy behind a glider pole *array* is that it maximises movement choices for gliders, reducing predation potential while the gliders are moving through open areas. This knowledge comes from unpublished data gathered by glider experts over hundreds of hours of observation (M.Brady unpub. data, B. Kanowski, unpub. data, M.Parsons unpub. data).

The location selected for the pilot pole array (Tower IT76) exhibits surrounding habitat characteristics that ensure frequent use by the mahogany glider (refer Appendix 4). Furthermore, easement crossings by mahogany gliders were observed in this location and this importantly includes crossings by female gliders. The location of the pilot pole array was decided upon through extensive research and monitoring by both Powerlink employees (Kanowski, 2009) and externally contracted researchers at the University of Queensland (Brady, 2011a), plus consultation with other experts (Mark Parsons, QPWS). Research has included extensive observational data of male, female and juvenile mahogany gliders across the broad range of different vegetation types (Eucalypt woodland, Melaleuca woodland and Riparian forest) that occur through the mahogany gliders range. Animals were radio-tracked and observations were made of habitat use and movement paths through both remnant habitat and across the powerline easement. Initial research showed a reluctance of female mahogany gliders to cross the easement (Kanowski, 2009), therefore subsequent research conducted by the University of Queensland included translocating female mahogany gliders to the opposite side of the easement to their home range to observe their crossing behaviour and location (Brady, 2011a). Easement crossing points were examined for surrounding habitat attributes (including species and size of launching and landing trees) and location of crossing points in relation to home range movement paths.

Monitoring of this pilot pole array is fundamental research that will help ensure the effectiveness of the glider poles in reconnecting fragmented habitat for the mahogany glider. Use of such pole structures has in the past been implemented by agencies before research has developed the design elements needed for their effectiveness (Goldingay et al. 2011). This has the potential to result in ineffective structures with no, or very few, positive outcomes for species of concern. Powerlink will be ensuring this does not happen in the case of the mahogany glider through implementing this first critical stage of construction and monitoring the pilot pole array.

Monitoring efforts will be concentrated on the initial pilot array to determine whether these poles are an effective mitigation measure. Results from these studies will be incorporated into the final design and location of the proposed glider array.

3.2 Current status of glider pole array

Powerlink Queensland is currently awaiting finalised costing for the installation of the glider pole array from Ergon Energy. Construction will commence as soon as possible after receipt of this quote. Powerlink Queensland expects the glider pole installation to be complete by end of September 2011.

3.3 Technical design of glider pole array

The original Mahogany Glider Management Plan provides some technical details as to the arrangement of the glider poles in each array. Further details have since been finalised for the pilot pole array described above.

> It is important that the ecology of the Mahogany glider is taken into consideration when placing the glider poles. The spacing and height of the poles are an important issue that must be considered if planning to install poles for gliding mammals. Glide distance is directly proportional to launch height (Ball & Goldingay, 2008). Jackson (2000c) estimated a mean glide distance of about 29.71m +/- 2.38m with an average launch height of 19.75m +/- 1.01m and an average landing height of 4.48m+/- 0.31m. The mean glide ratio for the Mahogany glider is 1.91 (1.91m horizontal distance to 1m vertical fall) or a glide angle of 28.26 degrees (Jackson, 1999).

(Source Conics, 2010)

Basic design elements of the 5 pole array include poles in an approximate rectangular shaped layout with a central pole and 4 surrounding poles, each pole being approximately 10m apart. This is to provide linkage across the current 30m cleared easement. Pole height for the pilot pole array is to be the maximum allowable within electrical safety clearances. For the pilot location, this is estimated to be 6.4m. Each pole will have two cross-arms running perpendicular to each other to assist in glider launch. Each pole will have a refuge on the bottom cross-arm constructed with PVC piping to allow gliders to retreat should they encounter a predation threat. Launching cross-arms are to be located at 500mm and 1m from the top of each pole to allow maximum choice of glides between individual poles and surrounding habitat. The landing zone is anticipated to be approximately 1.9m from the ground resulting in a glide angle of approximately 28 degrees.

Design elements were formulated based on current knowledge of mahogany glider movements including glide distances, glide angles, heights of launch and landings, as well as extensive observational data of glider manoeuvres during different movement behaviours. Information was used from previous research on the species (Jackson 1998, 2000a,b, 2001), as well as recent research (Brady unpub. data, Kanowski 2009; referred to above in point (i)) conducted in the same habitat area of the pilot pole array. Importantly, this has ensured relevancy of research data to the target habitat and gliders, as well as maximum use of available knowledge.

4.0 Performance Indicators

The performance indicators for the implementation of the Mahogany Glider Management Plan are being formulated in detail in conjunction with the team of experts from QPWS and the University of Queensland.

Performance indicators for the phase of the pilot pole array will include:

- Observations of safe use of the poles by mahogany gliders, including
  - female and
  - juvenile individuals,
- resulting in
  - successful easement crossings by multiple individuals including
  - movements in both directions across the easement.

Safe use of the poles refers to observations of ease of use with no signs of distress. Results will be used to design additional pole arrays. Details of performance indicators in relation to the full set of glider pole arrays will be determined following the research and monitoring of the pilot pole array and subsequent design of further pole arrays.

In addition to safe use of poles, performance indicators will address issues such as:

- Patterns of individual gliders movements relative to the easement
- Use of regrowth vegetation by mahogany gliders

5.0 Monitoring

Monitoring of the pilot pole array will include both direct observational data and the use of motion-sensitive cameras. Subject to ethics approval, research methods may again include translocation of individuals to the opposite side of the powerline easement from their home range. Monitoring will begin as soon as possible after installation of the pilot pole array and will continue on a nightly basis until sufficient data has been gained to make a decision on their effectiveness. It must be noted that this is highly innovative research and no established methodology exists to date. Therefore this research will be conducted by UQ researchers or other suitably qualified experts in ecological research to ensure both appropriate methodology and scientifically correct application of the data.

Details of monitoring of the full set of glider pole arrays will be established when design and location details are finalised, following monitoring of the pilot pole array. It will include more extensive observations than those conducted for the pilot pole array, including observations throughout different seasons. Information gained from monitoring both the pilot pole array and the full set of pole arrays represents an important contribution to scientific knowledge that can also be applied in other situations.

The remaining three glider pole arrays will be established following completion of the new transmission line scheduled for 2012-2013.

6.0 Corrective Actions

In considering research outcomes regarding the performance of pilot glider pole arrays, it is likely that the initial design may require some refinements. Direct observational data during monitoring will identify what corrective actions would be appropriate should monitoring show that safe use of the poles is not occurring. This may include changes to design and direction of launching cross-arms, spacing of the individual poles, heights of the poles and/or design of the predator refuge devices at the top of the poles. Sufficient work will be undertaken to inform further decision making and ensure the most effective design and locations.

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Appendix 1 – University of Queensland Research Brief

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Research brief for work conducted by The University of Qld for Powerlink Qld.
The value and implementation of measures to reduce impacts of powerline works on the Mahogany Glider. June 16, 2011.

Background:
Powerlink's Ingham – Tully and sections of Townsville GT – Ingham high voltage transmission lines currently traverse areas of high quality habitat for the endangered Mahogany Glider (*Petaurus gracilis*). To minimise the impacts of the planned upgrade of this line on this species two main measures are being implemented: 1) vegetation is being allowed to regenerate within the easement corridor and 2) 'glider poles' will be installed to assist movement of individuals (especially females and juveniles) across the easement.

Research aims:
The University of Queensland is currently conducting research, funded by Powerlink Qld, to assist with the mitigation of impacts of the powerline upgrade on the mahogany glider. The main aims of the research are to understand mahogany glider habitat use around and under the powerline to 1) determine the value of the regenerating easement vegetation and 2) provide information to assist with the location and design of the glider poles.

The specific questions being addressed in this work include:
How does vegetation composition and structure regenerating under the powerline compare to surrounding remnant vegetation that the mahogany glider uses and does not use?
What management actions would help ensure this regenerating vegetation has maximum benefit and minimum detriment (e.g. restrict movement) to mahogany gliders?
What activities do the mahogany gliders engage in within different proximities of the powerline with different values of regenerating easement vegetation and remnant vegetation?
What tree species do mahogany gliders use for these activities around powerlines (denning, foraging and gap crossing)?
What vegetation characteristics typify easement crossing locations by the mahogany glider (especially female mahogany gliders translocated to the opposite side of the powerline to their home range)?
Are there any patterns with where the gliders cross the easement, in terms of fine scale of both the surrounding and easement vegetation (e.g. tree species, tree height, tree DBH, canopy cover) and the landscape scale (e.g. RE, landforms)?
Where may the best location for 'glider pole' arrays be and why?

Progress to date:
Several months of extensive fieldwork have been completed to date. To obtain adequate information on a cryptic, nocturnal, arboreal species is extremely labour and resource intensive. This data is currently being processed.
In order to address the above questions, information that has been gained includes:

- Easement crossing points during natural movements of male gliders
- Easement crossing points of translocated gliders (both male, and very importantly, female)
- Patterns of individuals movements in relation to easement and characteristics of both easement and surrounding vegetation
- Nature of regenerating easement vegetation and surrounding remnant vegetation within Melaleuca woodland, Eucalypt woodland and riparian rainforest vegetation types. This includes information on both the floristics and structure of vegetation, such as vegetation density at mid and upper canopy levels and tree diameter of all trees observed being used by the gliders (over 200 observations).

Continuing work:
Data analysis will investigate patterns of habitat usage within the remnant vegetation and will correlate these with the nature of the regenerating easement vegetation. This body of work will provide an understanding of the trajectory of the regrowth vegetation and its potential to serve as a link across or along the powerline easement, but will be thorough enough to also investigate any potential negative effects. A greater understanding of the nature of the associated edge effects (or mitigation of these due to the regrowth) and the likely impacts on the species will also be gained. Information on the use of remnant vegetation and the easement crossing locations will be used to assist in design elements of the 'glider pole' arrays such as pole height, diameter, spacing and positioning.

Reports will also include recommendations for management for the easement vegetation and future monitoring of the species through these areas, including their use of the pole arrays.

Until then, further research briefs will be provided.

Appendix 2 – Original Mahogany Glider Management Plan

MAHOGANY GLIDER MANAGEMENT PLAN

"Ingham to Tully Powerline"

"Powerlink Queensland"

Date: January 2010
Ref: 10150 (R66499)

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1.0 INTRODUCTION

1.1 OBJECTIVES

The Environment Protection and Biodiversity Conservation Act (EPBC Act) is the Australian Government's key piece of environmental legislation which commenced in July 2000. One of the stated objectives of the EPBC Act is to provide for the protection of the environment, especially Matters of National Environmental Significance (MNES). This report is specifically to address issues associated with potential impacts to the Mahogany glider which is one of the MNES identified in the vicinity of the proposed action and will potentially be impacted.

The Mahogany glider is deemed to be a (MNES) as it is a threatened species which is listed as 'endangered' under the EPBC Act 1999 and the Queensland Nature Conservation Act 1992. Under the EPBC Act, actions that have, or are likely to have, a significant impact on an MNES requires approval from the Australian Government Minister of the Environment, Heritage and the Arts (DEWHA). The Minister must make a decision on whether assessment and approval is required under the EPBC Act. The objective of this report is to determine the potential impacts of the proposed works using the guidance established in the EPBC Act Policy Statement 1.1 "Significant Impact Guidelines; Matters of Environmental Significance" and develop appropriate mitigation measures to ensure there is no significant impact on an MNES.

1.2 DESCRIPTION OF PROJECT

Powerlink Queensland (Powerlink) has identified the need to replace the aged 132kV transmission line between the Tully substation and the Ingham substation. In order to maintain a reliable electricity supply, it is proposed to construct a replacement dual voltage 275/132kV double circuit transmission line between Tully and Ingham (refer Figure 1).

The upgrading of the Ingham – Tully transmission line includes an allowance for the inclusion of a 275kV transmission circuit as well as a 132kV transmission circuit. For reasons of electrical safety, the replacement of the current line necessitates a wider easement for the transmission corridor due to the higher voltage (refer Electrical Safety Regulation 2002). The current cleared corridor between Ingham and Tully has a width of approximately 30m. In the absence of mitigation, the line upgrade would result in the clearing of an additional 30 metres of vegetation along the length of the line (approximately 95km) a width of 60 metres wide. Therefore a range of mitigation measures have been instigated to preclude any potentially significant impacts on the Mahogany glider.

1.3 BACKGROUND

Conics (Cairns) (previously known as Natural Solutions) were commissioned by Powerlink to undertake an Environmental Impact Assessment (EIA) of the proposed replacement of the transmission line between Ingham and Tully. This work was undertaken in a number of stages as discussed below.

Firstly a range of alternative routes for the transmission alignment were determined by undertaking a Minor Route Study Alignment (MRSA) investigation. This culminated in a report that outlined prudent and feasible alignment alternatives minimise potential impacts upon any areas of high ecological significance, as well as social factors such as residential development.

The environment was considered by way of a detailed analysis and investigation of impacts that are likely to occur over the short, medium and long term. These investigations reviewed matters such as rare and threatened plants and animals, the ecological values and qualities of watercourses and sensitive habitats, soils and erosion, as well as Acid Sulfate soils, bushfires and other natural hazards. During the initial analysis of these matters, it became apparent that there was the potential for impacts to the Mahogany glider (*Petaurus gracilis*) to occur.

The impacts that could occur to the Mahogany glider were identified by a combination of methods including assessment of existing and background data. This enabled an initial referral under the EPBC Act to be compiled. A pre-lodgment meeting was undertaken in Canberra which was attended by representatives from Conics, Powerlink and DEWHA in order to discuss the initial EPBC referral. Following this meeting, it was identified that more detailed information was needed to determine the significance of potential impacts of the project and appropriate mitigation measures. This report has been written to address this requirement and will be an addendum to the final referral under the EPBC Act to be considered by DEWHA.

A series of actions were undertaken in order to obtain a more detailed analysis of the potential impacts of the proposed work in the Mahogany glider area. These include:

- A detailed analysis undertaken by Powerlink using ground and vegetation profiles sourced by aerial laser survey (LiDAR) in order to identify the exact extent of the vegetation on both sides of the current easement. This information was then used in conjunction with information on wind, temperature and load conditions in order to show which vegetation (to the level of which individual trees) would need to be removed or impacted (e.g. lopped) for the safe operation of the higher voltage dual line;

- Two round table discussion meetings were attended by representatives of Powerlink, Conics and Queensland Parks and Wildlife Service (QPWS) on 11 August 2009 and 4 September 2009 in order to discuss the areas of vegetation to be impacted according to the revised mapping as discussed above. This resulted in a number of amendments to the planned tower locations and heights in order to remove the most significant potential impacts. A number of areas were identified as requiring field based investigations to confirm the potential impact and most suitable mitigation measures;

- A thorough literature review was conducted and meetings and correspondence held with Ben Kanowski in relation to the results of his unpublished research regarding the behaviour of the Mahogany glider in the vicinity of transmission line easements; and

- Two field research trips were undertaken over 4 days in September and October 2009 in order to clarify the potential impact of the replacement transmission line in the locations that had been identified during the desk based research. These field trips were attended by representatives of Conics, Powerlink and QPWS.

Using the above techniques, a range of management measures, techniques and work principles were developed that are designed to mitigate or preclude significant negative impacts to the Mahogany gliders from occurring. An assessment of the potential impacts and mitigation measures are outlined within this report. These mitigation measures will also act to minimise any potential impacts to other MNES including rare and threatened species that are of significance under the EPBC Act such as the Southern Cassowary (*Casuarius casuarius johnsonii*) and the Apollo jewel butterfly (*Hypochrysops apollo apollo*) which are likely to inhabit the southern Wet Tropics coastal lowland forests along with the Mahogany glider.

2.0 RELEVANT BIOLOGY AND ECOLOGY OF MAHOGANY GLIDERS

- Size: Fully grown Mahogany gliders are around 600mm long from head to tail-tip and weigh 300 – 450g. (Queensland Department of Environment and Resource Management (DERM), 2009);
- Appearance: The Mahogany glider receives its name from its buff-coloured belly. The top of the head is pale and as with all *Petaurus* gliders, a dark to black stripe extends from the eyes to the rump (refer Plate 1). The Mahogany glider, in common with other gliders, has a fold of skin which stretches between the front and rear legs. This acts as a parachute enabling individuals to glide between tree trunks. The long tail is used for stabilisation especially when coming in to land on tree trunks. (DERM 2009; Van Dyck 1993);

Plate 1: Mahogany Glider. Photograph © DERM, 2009

- Identification: The Mahogany glider can be distinguished from the much smaller sugar glider as the Mahogany glider typically has a white tail tip, with the lower half of the Mahogany glider's tail being black (Van Dyck, 1993);
- Abundance: Although various surveys have been conducted within representative sites, population numbers are currently unknown;
- Distribution: The geographic range of the Mahogany glider is limited to an area of coastal lowland forest between Ollera Creek and the Hull River, a north-south range of about 120km (Jackson and Claridge 1999). The 100km east-west range extends from the coast to the lower Herbert Gorge and foothills of the Mt Fox section of Girringun National Park in the Wet Tropics Bioregion (Parsons and Latch, 2007). Over 98% of Mahogany glider sightings have been recorded at altitudes below 120 metres elevation (DERM, 2009). Plate 2 shows the distribution of habitat that has been identified and mapped by the Queensland Environment Protection Agency (EPA), and is based on Regional Ecosystem (RE) v 5.0 mapping. Therefore this mapping is indicative of potential Mahogany glider habitat rather than actual Mahogany glider habitat;

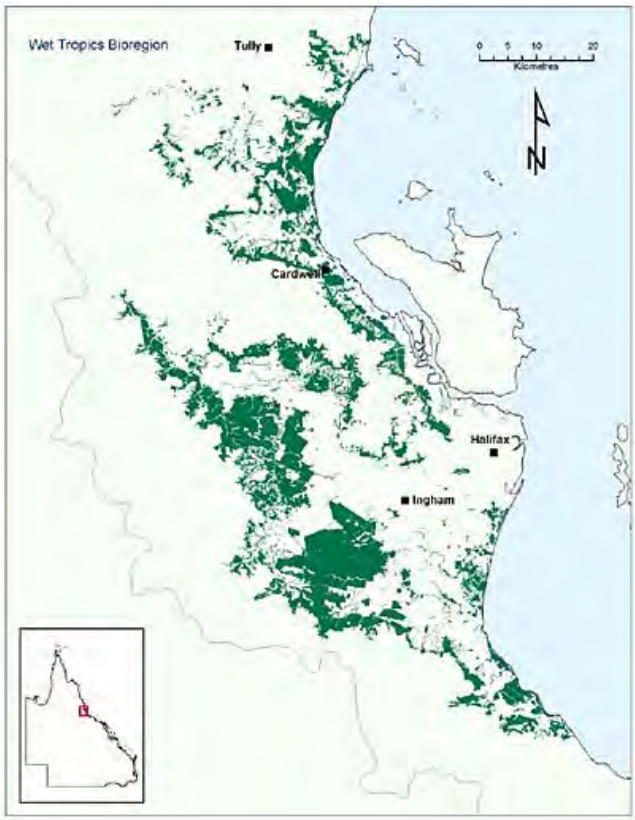


Plate 2: The distribution of Mahogany glider habitat. Image: © DERM

- Current Populations: There are five large habitat areas and three smaller habitat fragments currently recognised within the distribution of the Mahogany glider from a conservation planning perspective (Parsons and Latch, 2007) (refer Table 1);

Table 1: Current Populations of Mahogany gliders (Parsons and Latch, 2007)

Area Name	Location
Large Habitat Areas	
1. Wharps Holding – Paluma Range	South of Stone River including Bambaroo Hills and Paluma Range
2. Lannercost – Henrietta	South of the Herbert River west to foothills of Seaview Range
3. Yamanie – Cardwell Range west	North of the Herbert River east to Cardwell Gap
4. Cardwell Range east	Cardwell Gap north to the Kennedy Valley
5. Cardwell coastal region	Meunga Creek to the Tully River *
Small, Isolated and Highly Fragmented Areas	
6. Halifax Bay	Coastal complex east of the Bruce Hwy from Crystal Creek north to Lucinda
7. Hull Heads	North of the Hull River
8. Murray Floodplains	West of the Bruce Highway, north of Bilyana to Euromo

* Location of Ingham – Tully Transmission line upgrade

- Habitat: Mahogany gliders use lowland sclerophyll forest, the main canopy and sub-canopy trees are eucalypts, bloodwoods and paperbarks and less commonly swamp Mahogany and turpentine with an open mid-stratum of smaller trees and shrubs (e.g. wattles, forest siris, black she-oak, pandanus) and a grassy ground stratum in which grass trees may be present. The Mahogany glider requires a relatively open forest structure for efficient gliding and tends to avoid dense vegetation such as rainforest (DERM, 2009);
- Diet and Foraging: Although principally nectarivorous, the Mahogany glider relies on many food sources such as nectar, pollen, mistletoe, insects, wattle exudates and honeydew (Jackson, 2001). More than 20 tree and shrub species including; eucalypts, bloodwoods, melaleucas, acacia, *Albizia procera*, and *Xanthorrhoea* flower spikes provide nectar, pollen and spa that the Mahogany glider eats (Van Dyck, 1993; Jackson, 2001). However it appears that individuals may generally exploit a single food resource during a night's activity and that individuals appear to show a preference for a certain food resource when a number of resources are available within their range (Kanowski, 2009);
- Reproduction and Mating: Mahogany gliders use hollows in trees as dens for sleeping and rearing their young (Van Dyck, 1993). Den-tree species generally include *Eucalyptus platyphylla, E. tereticornis, E. globulus, Corymbia intermedia, C. clarksoniana*, *Lophostemon suaveolens*, *Melaleuca quinquenervia*, and *Poplar sp*., (Jackson, 2000b, Kanowski, 2009);
- The entrance hole to the den is generally of minimal dimensions to allow the Mahogany glider to access the den and the den itself is often 2-3 metres down inside the hollow tree or branch (Kanowski, 2009). Mahogany gliders den either alone or in pairs (Jackson, 2000b). Up to 10 dens may be used during a single season by one individual (Van Dyck, 1993; Jackson, 2000b) and pairs may use up to 13 dens, sharing them with offspring of the previous breeding season (Jackson, 2000b). Individuals appear to prefer certain dens but regularly use widely separated dens (including those separated by a linear feature such as a cleared easement) throughout their home range (Van Dyck, 1993; Kanowski, 2009); and

- Conservation status: The Mahogany glider is listed as 'endangered' under both the Queensland Nature Conservation Act 1992 and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 due to habitat loss, restricted distribution and small amount of habitat protected within National Parks (Jackson, 1998).

3.0 POTENTIAL IMPACTS OF PROPOSED POWERLINE

3.1 LIKELIHOOD OF SIGNIFICANT IMPACTS AS DEFINED BY THE EPBC ACT

The proposed Ingham – Tully Transmission circuit will run from the current Powerlink substation at Ingham through to the current Powerlink Substation at Tully. The proposed alignment runs through a large amount of habitat that is mapped as 'essential habitat' by DERM (refer Figure 2). Essential habitat is vegetation in which a species that is endangered, vulnerable, rare or near threatened has been known to occur. Much of the essential habitat mapped within the study area is likely to be mapped as being suitable for use by Mahogany gliders.

The outcome of this report is to decide whether 'the action' (which is the upgrade to the transmission line) will have or is likely to have a significant impact on the Mahogany glider population and thus require referral as a controlled action under the EPBC Act. In order to do this, the phrases 'significant impact' and 'will have, or is likely to have' in the previous sentence warrant further definition.

- Significant Impact: In this context, a 'significant impact' is an impact which is important, notable or of consequence, having regard to its context or intensity (DEH, 2006). Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity duration, magnitude and geographic extent of the impacts (DEH, 2006); and

- When is a significant impact likely? To be likely, it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility (DEH, 2006). If there is scientific uncertainty about the impacts of the action and potential impacts are serious or irreversible, the precautionary principle is applicable (DEH, 2006).

In considering whether the upgrading of the transmission line is likely to have a significant impact on the Mahogany glider, the following points will be considered:

1. Are Mahogany gliders present within the area of the proposed action?
2. Considering the action at its broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), is there the potential for impacts, including indirect impacts, on Mahogany gliders?
3. Are there any proposed measures to avoid or reduce impacts on Mahogany gliders (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?

4. Are any impacts of the proposed action on matters of Mahogany gliders likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?

(DEH, 2006)

It is known that the Mahogany glider currently inhabits the area through which the current and proposed future upgraded transmission line is located (refer Section 2). The remaining three points to be considered will be addressed below.

3.2 POTENTIAL IMPACTS AND PROPOSED MITIGATION FOR MAHOGANY GLIDERS

When considering whether the proposed upgrade of the transmission line will potentially impact on Mahogany gliders, the EPBC sets out that an action is likely to have a significant impact on an endangered species (in this case the Mahogany glider) if there is a real chance or possibility that it will:

1. Lead to a long-term decrease in the size of a population;
2. reduce the area of occupancy of the species;
3. fragment an existing population into two or more populations;
4. adversely affect habitat critical to the survival of a species;
5. disrupt the breeding cycle of a population;
6. modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
7. result in invasive species that are harmful to an endangered species becoming established in the endangered species habitat;
8. introduce disease that may cause the species to decline; or
9. interfere with the recovery of the species.

Each of these will be discussed in relation to the proposed transmission line.

3.2.1 Habitat Loss and Fragmentation (Points 1 – 3)

Clearing is one of the most serious threats to the long-term viability of Mahogany glider populations (Parsons and Latch, 2007). In an area where habitat is already severely fragmented, small incremental losses over time may eventually lead to a landscape matrix not able to support local Mahogany glider populations (Parsons and Latch, 2007). The effects of habitat loss and fragmentation are two fold. Firstly the loss of habitat will decrease the viability of populations by reducing the size of the population that can be supported in that area (van der Ree *et al*, 2008). Secondly the connectivity of populations in fragmented habitats is a major influence on their probability of persistence (Stacey & Taper (1992, cited in Kanowski, 2009)). Fragmentation disrupts the movement paths of Mahogany gliders, may segregate feeding and breeding sections

of an individual's range and may predispose the species to genetic isolation and local extinctions (Parsons and Latch, 2007).

It is possible that the proposed transmission line could, in the absence of mitigation, cause both habitat loss and habitat fragmentation if construction methods are not modified. Therefore a range of mitigation measures will be undertaken in order to reduce this potential impact as identified in Section 3.2.2).

The habitat which is essential for the survival of the Mahogany gliders within the area between Ingham and Tully is essentially bisected by the current 132kV transmission line. It has been shown by radio tracking studies undertaken by Kanowski (2009) that the current transmission line (consisting of a cleared corridor of approximately 25-30m in width) does not present a significant barrier to male Mahogany gliders. This was shown by several verified crossings of the easement by male Mahogany gliders during Kanowski's study. Home ranges of male Mahogany gliders often encompassed vegetation and den trees on both sides of the easement, showing that the easement did not present a barrier to movement (Kanowski, 2009) although females were shown to less readily cross these corridors. The females that were tracked all had home ranges that were restricted to one side or the other of the transmission corridor (Kanowski, 2009). The effect of the 30m linear clearings on the spatial arrangement of female home ranges is further demonstrated by den locations for these animals which were consistently located on one side of the easement (Kanowski, 2009). This represents a significant behavioural difference between male and female Mahogany gliders. The vegetation gap of 30 metres does not, however, present an absolute physical constraint as Kanowski's study did record three crossing events by female Mahogany gliders across a 30m width easement (Kanowski, 2009). The unwillingness of the females to cross the 30m vegetation clearings may be due to a behavioural adaptation of the species to fragmentation of habitat areas (Van Dyke, 1993, Kanowski, 2009).

Studies have been undertaken of Mahogany glider gliding ability and therefore the width of linear corridor that is likely to have an impact on Mahogany gliders. These studies by Jackson (1998), Asari (2008) and Kanowski (2009) have suggested that gaps in habitat should not exceed 20m, 30-35m and approximately 40m respectively in order to minimise fragmenting impacts on the species. Maximum glide distances recorded by Jackson (1999) and Kanowski (2009) found the maximum glide distances of male Mahogany gliders to be 60m and 47m respectively. The results of these studies have been used as a basis for a range of mitigation measures to ensure that Mahogany gliders can still cross the easement that is necessary for the safe working of the proposed upgraded transmission line.

3.2.2 Mitigation for habitat loss and fragmentation

To minimise the amount of vegetation impacted by the line upgrade, a detailed analysis was undertaken using ground and vegetation profiles sourced by aerial laser survey techniques (LiDAR). This identifies the exact extent and height of the vegetation on both sides of the current easement and the requirement for its clearing to maintain operational safe clearance distances. This information was then used in conjunction with information on wind, temperature and load conditions in order to show which vegetation (to the level of which individual trees) would need to be removed or impacted (e.g. lopped) due to the widened easement in order for the safe operation of the higher voltage dual line.

3.2.2.1 Habitat Connectivity

The LiDAR information was used in a desk based consultation exercise undertaken with representatives of Powerlink, Conics Ecologists and Queensland Parks and Wildlife Service (QPWS) in order to identify and quantify areas of habitat loss within key Mahogany glider areas. Each of these key locations was considered individually in order to decide the most appropriate mitigation measure at the site. In some instances the requirement for raising towers was identified in order to over string the existing canopy to maintain key vestiges of habitat or crossing locations (with the possible exception of occasional emergent trees which may need to be lopped or pruned in order to maintain the safety zone).

A design that facilitates over stringing (no clearing) of Mahogany Glider habitat completely removes many of the potential impacts of the proposed action. Much of the alignment within critical Mahogany glider habitat is now proposed to be strung above the main vegetation canopy height.

In addition, some areas of the current cleared corridor have been identified where the new increased tower heights allow for natural regeneration of vegetation (again excepting some lopping of emergents) underneath the proposed transmission line without affecting the safety buffer zone or distance from the powerlines that vegetation can safely grow to without potential for electrical arcing.

The combination of the total overcanopy areas and the areas where it has been identified that vegetation can grow up underneath the transmission line gives a significant proportion of the Mahogany Glider habitat within the corridor where there is habitat connectivity across the corridor. These areas are shown on the maps in Figures 3 to 13, the Plan and Profiles in Figure 14 and the table in Annexure 1.

It can be seen from Annexure 1 that a total of 14km of line will have habitat providing connectivity underneath the transmission line. Assuming that the current easement consists of a 30m wide cleared corridor with no or limited connectivity, this represents an increase in habitat of 420,000m^2. The majority of these areas are concentrated within the known Mahogany glider habitat range. Areas of mahogany Glider habitat were analysed through review of available habitat mapping supported by site investigations to confirm qualitative features of the areas. Glider survey work including radio tracking has been undertaken along the alignment (Kanowski, 2009) and the results of these studies have been used to conservatively indicate ranges and requirements of habitat to maintain connectivity and foraging home ranges. In some instances vegetation mapping included areas that are unlikely to be suitable for Mahogany gliders and as such a conservative figure for potential habitat is provided. When identifying the type of vegetation that may regrow across the currently cleared easement, if there was a variety of RE types surrounding the current alignment, not all of which are suitable for Mahogany gliders, the precautionary principle was applied and it was deemed unsuitable for use by the gliders. Therefore the amount of connective habitat that may be used by Mahogany gliders is likely to be underestimated in the calculations. When summed, it can be seen that 12.5km of the 14km of connective habitat is likely to be suitable for Mahogany gliders. Using the same assumption as above, this represents an increase in habitat suitable for Mahogany gliders of 375,000m^2. This habitat will provide connectivity across the easement thus preventing habitat fragmentation and its associated negative impacts on the Mahogany glider population.

3.2.2.2 Regeneration Areas

Three alignment deviations have been proposed due to construction difficulties and potential environmental impacts. These deviations have been designed to go over canopy such that no clearing of vegetation is required or in some isolated instances emergents are lopped. At these locations, during the construction of the new line, the existing transmission line will be dismantled and the vegetation allowed to regenerate. This regenerated vegetation will be left to grow to its natural climax community and will not be subject to further disturbance.

The total length of easement that will be allowed to regenerate is 5,115m, which, assuming a cleared corridor of 30m, presents an additional 153,450m^2 of potential Mahogany Glider habitat.

3.2.2.3 Clearing of Vegetation

Due to the introduction of a dual voltage 275/132kV double circuit transmission line between Tully and Ingham, the width of the cleared corridor needs to be increased for reasons of electrical safety. The clearing required to maintain electrical safety has been calculated along the length of the easement as shown in the profiles provided in Annexure 3. In many areas, the clearing of vegetation has been avoided by raising the transmission line over the height of the trees or allowing habitat connectivity beneath the line. However some clearing will be required for the safe operation

of the dual voltage transmission line where topography restrictions limit the ability to effectively over string vegetation. The areas that will be impacted by this clearing are shown in Figures 3 – 13 , the Plan and Profiles in Figure 14 and summarised in tabular form in Annexure 2. The vegetation that is currently mapped in each of these areas was analysed in a desk based exercise to determine whether it may currently be used by Mahogany gliders.

Annexure 2 identifies 6km of the alignment that requires some clearing. Assuming that 100% of the easement is vegetated, this would equate to 180,000m2 of clearing. Of this 6km (180,000m2), 3.2km (96,000m2) of the cleared habitat was suitable for utilisation by Mahogany gliders. However this is typically an overestimation of the clearing required as this calculation is based on the full width of the corridor and assumes that the corridor is vegetated. From site investigations many of these areas include only a limited number of individual trees that meet the height criteria required for removal due to safe clearances to operating transmission infrastructure. As such it is expected that the figures identified in Table 2 are conservative estimates of the clearing required. In these instances mitigation measures including provision of glider poles or connectivity corridors have been proposed for mitigating potential impacts.

A summary of the required vegetation changes along the route can be seen in Table 2

Table 2: Summary of Vegetation Changes

Impacts on Vegetation	Distance (km)	Area
Under line connectivity provided	14	420,000m^2
Areas of complete regeneration	5	150,000m^2
Sub total	19	570,000m^2
New clearing required	6	180,000m^2
Total net gain of vegetation	13	390,000m^2
No change in vegetation / land use	75	2,250,000m^2

Table 2 identifies that a net gain of 39 hectares of habitat will be realised following development of the transmission line to offset any potential impacts to Mahogany Gliders and their habitat.

3.2.2.4 Glider Poles

The use of high towers in order to provide over-canopying of significant habitat, corridors or 'pinch points' as discussed above, together with allowing natural regeneration of vegetation in selected areas is considered sufficient to mitigate against the potential impacts of the proposed widened corridor or to provide a temporary corridor whilst vegetation is regrowing. Monitoring will be undertaken in the areas where the glider poles will be erected in order to observe the use of the poles by the gliders.

However in taking a precautionary approach, and to ensure a net benefit in terms of habitat restoration and biodiversity conservation, a number of areas have been identified where it is recommended that glider poles area installed in order to connect currently fragmented habitat.

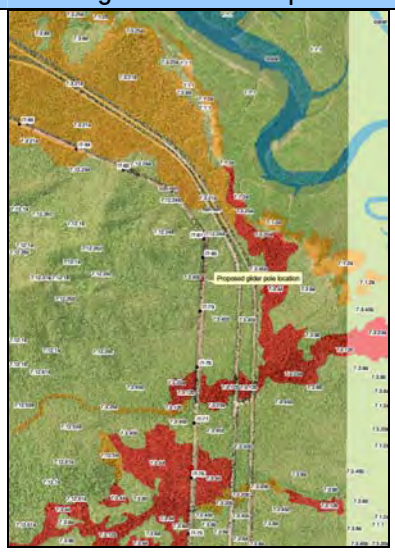
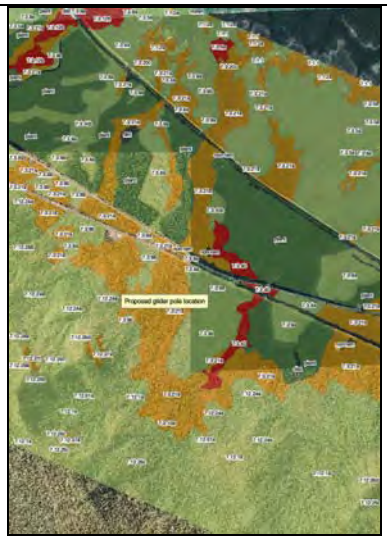
The use of glider poles for the reconnection of severed habitats for gliding mammals has been previously investigated. A study by Ball and Goldingay (2008) confirmed that gliding mammals (squirrel gliders (*Petaurus norfolcensis*) were used in their study) were able to successfully glide pole-to-pole and that they utilised the glide poles to traverse between patches of habitat. A further study by Asari (2008) recorded an observation of a male Mahogany glider using a treated hardwood low voltage electricity pole as an aid to crossing a highway cleared habitat gap. This proves that male Mahogany gliders can use artificial poles to supplement the natural habitat.

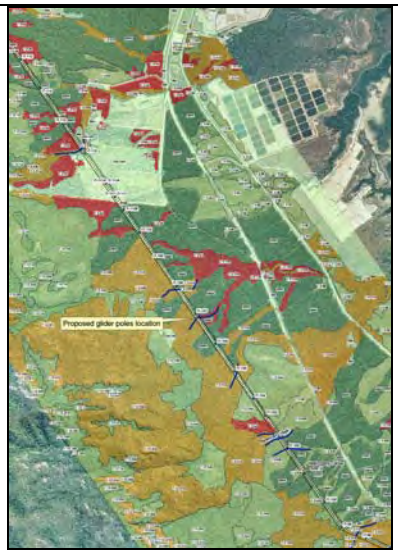
The re-establishment of connectivity areas will benefit gene exchange and increase foraging ranges and dispersal areas for juvenile gliders. This is seen as a significant benefit resulting from the project.

Location of Proposed Glider Poles

The purpose of the proposed glider poles is to link habitat fragments across the transmission line easement to effectively increase the size of areas of suitable habitat. This should increase the size of the population that are able to exist in the area and increase the resilience of the population to further environmental changes. Landscape scale habitat connectivity is also important to allow dispersal opportunities for juvenile individuals within the population (Kanowski, 2009). It has been identified that with exclusive home ranges of approximately 300m in any direction, that positioning of poles is required within a distance of 300m along the alignment in areas that are likely to be impacted. The locations of the proposed glider poles is based on the landscape scale view of habitats and connectivity across the easement as discussed in Table 3 below:

Table 3: Location of Glider Poles

Location	Diagram at Landscape Scale	Comment
IT79-IT80		This point is identified as a likely intersection of a number of home ranges (pers comms. Mark Parsons) and significant feeding area. Some likely corridor crossing trees will be removed during construction to maintain electrical safety clearances. The gliding poles are required to maintain corridor crossing ability at this site in order to preserve the connectivity across the easement in this key Mahogany glider habitat.
IT91		There is an extensive pine forest plantation adjacent to the Bruce Highway in this area which stretches for approximately 5.5km. There are a number of narrow corridors of remnant vegetation in this area that provide connectivity between areas of suitable Mahogany glider habitat to the east and west. The glider poles are required to provide connectivity for dispersing juveniles through this landscape

IT106-IT108		There is an extensive pine forest plantation in this area which stretches for approximately 2.5km. There are a number of narrow corridors of remnant vegetation in this area that provide connectivity between areas of suitable Mahogany glider habitat to the east and west. The glider poles are required to provide connectivity for dispersing juveniles through this landscape.

Placement of Glider Poles

It is important that the ecology of the Mahogany glider is taken into consideration when placing the glider poles. The spacing and height of the poles are an important issue that must be considered if planning to install poles for gliding mammals. Glide distance is directly proportional to launch height (Ball & Goldengay, 2008). Jackson (2000c) estimated a mean glide distance of about 29.71m +/- 2.38m with an average launch height of 19.75m +/- 1.01m and an average landing height of 4.48m +/- 0.31m. The mean glide ratio for the Mahogany glider is 1.91 (1.91m horizontal distance to 1m vertical fall) or a glide angle of 28.26 degrees (Jackson, 1999). It is therefore recommended that the glider poles should be placed approximately 25m apart.

Kanowski (2009) identified that the gliders that crossed the 30m cleared corridor did not do so just at one set crossing point, rather a variety of points are used for crossing the cleared habitat gaps potentially as a predator avoidance behaviour. Thus it is recommended that the glider poles are set out in an array at the four proposed locations so that the Mahogany glider has a variety of routes from which to choose and this will allow variation in usage patterns that will facilitate the species natural predator avoidance techniques (Kanowski, 2009). Although the spacing and placement will be determined on a site specific basis, the following specifications will be taken into consideration.

It is recommended that four poles are provided in an array at each location. Each pole will have 2 cross arms running perpendicular to each other to enable both launching mechanisms. Each pole will have a refuge on the bottom cross arm (design of refuge to be finalised but likely to be a section of PVC piping). The maximum height of the poles will be determined by the required electrical safety distance between the pole and the conductor at each specific location. As discussed above, the poles will be placed at spacing sufficient to allow for a glide angle of 1.9:1 or 28.26 degrees with a landing height two thirds of the height of the pole. It is important that the poles are located in an area that has suitable land and launching trees available at the edge of the

cleared corridor within reach of the first and last pole provided in the array. It may also be necessary to control low growing or dense vegetation around and between the poles and the launch and land trees to enable a clear glide path.

3.2.3 Habitat Degradation and Alteration (Points 4 & 6)

Altered fire regimes, weed invasion and intensive grazing, individually or collectively threaten the structure and ecological integrity of habitat fragments. Over time these changes decrease the ability of fragments to support glider populations (Parsons and Latch, 2007).

The proposed widening of the transmission line is unlikely to significantly alter or degrade the Mahogany glider habitat. The only potential issue is the thickening and in filling of the habitat at the edge of the easement. The increased light penetration and clearing of canopy species may allow the growth of a more significant sub canopy. This creates a more closed mid storey dominated by rainforest species and may restrict the use of the area by Mahogany gliders which preferentially utilise more open woodland (Parsons and Latch, 2007). Although this phenomenon is currently occurring, the widening of the corridor will cause this edge effect to penetrate further into any areas of suitable Mahogany glider vegetation which are adjacent to the current alignment. Due to the insignificant area of habitat that may potentially be affected by this process, it is considered unlikely to threaten the ecological integrity of the habitat or have an impact on glider populations.

It is therefore considered unlikely that the proposed transmission line upgrade will cause a significant adverse affect on habitat critical to the survival of a species or will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Habitat degradation and alteration is unlikely to be a significant impact of the proposed transmission line upgrade.

3.2.4 Breeding Cycle (Point 5)

In the absence of mitigation, the widening of the transmission line cleared corridor from 30m to 60m is likely to have an effect disrupting the breeding cycle of the Mahogany Glider population as it is likely to limit the likelihood of male and female gliders from crossing the alignment. However, with the implementation of mitigation measures as discussed in Section 3.2.2, the connectivity of habitat across the transmission line easement will not be impacted, in fact a net benefit may be realised in that previously fragmented populations are linked. Therefore it is likely that there will be no impacts on the breeding cycle of the Mahogany gliders in the vicinity of the proposed transmission line.

3.2.5 Invasive Species (Point 7)

The upgrading of the transmission line and the corresponding increased width of the cleared corridor is unlikely to result in conditions unlike the existing situation where invasive species are potentially introduced that may be harmful to Mahogany gliders.

3.2.6 Introduction of disease (Point 8)

As with invasive species, the upgrading of the transmission line and the corresponding increased width of the cleared corridor is unlikely to increase the risk of introduction of diseases that are harmful to Mahogany gliders.

3.2.7 Species Recovery (Point 9)

As discussed in Section 3.2.2, as a result of the mitigation measures that will be undertaken as part of the construction of the upgraded transmission line, there is likely to be a net benefit for the Mahogany gliders as there will be increased connectivity and habitat provided for this species. As such, opportunities are available to improve the existing situation for the conservation of Mahogany Gliders.

3.2.8 Fencing

Although not mentioned in the significant impact guidelines, it is documented that the use of barbed-wire fences is detrimental to Mahogany gliders as entanglement in these fences has resulted in recorded deaths (eleven barbed-wire entanglements, five of which were fatal, were recorded between May 1994 and October 2007) with dehydration and/or starvation being a likely consequence (Parsons and Latch, 2007). Barbed wire fences that are located at the edge of habitat clearings pose a risk to Mahogany gliders as they are more likely to come into contact with the wire when reaching the extent of their glide distance when crossing a habitat clearing.

In order to mitigate against the potential impacts of entanglement the following measures will be implemented including;

- ,all anti-climb barriers on the tower structures will consist of smooth wire or non barbed climb prevention structures rather than barbed wire,
- assuming landowners consent, barbed wire will be replaced by smooth wire in the vicinity of the glide pole structures.

4.0 CONCLUSION

There is an identified need for the transmission line between Ingham and Tully to be upgraded by Powerlink Queensland in order to provide a reliable electricity supply and to allow for the forecast population growth in this area. A range of alternative routes were considered however utilizing the current alignment for the vast majority (95%) of the route was deemed to have the least potential impacts to the environment. However the upgrading of the transmission line requires the allowance of a 275kV circuit as well as a 132kV circuit. In order to maintain electrical safety standards, the current cleared corridor requires widening in some areas. As the transmission line passes through some known Mahogany glider habitat, this report has detailed the potential impacts of the proposed works and the mitigation measures that will be undertaken.

Section 4 discusses methods by which mitigation of potentially significant impacts for the upgrading of the Ingham to Tully transmission line will be achieved. In summary, the mitigation methods include:

- Raising of tower heights to a sufficient height that allows sufficient electrical safety clearance above the natural forest canopy. This allows complete canopy connectivity beneath the transmission line and negates any potential impacts on connectivity for arboreal species such as the Mahogany glider;
- Natural regeneration of vegetation communities across the current easement. This will provide for connectivity across previously fragmented areas; and
- Provision of easement crossing structures (glider poles) in selected key locations. In some locations this replaces trees that may have to be removed due to the widening of the easement, however above and beyond this, some crossing structures are being located in areas that are not being impacted by the proposed easement widening. These crossing structures are being provided to provide habitat connectivity in previously fragmented areas which will result in a net benefit to the Mahogany glider population. This will essentially provide habitat reconnection and corridors for dispersing juveniles.

Table 2 shows that a net benefit will result from establishing connectivity of habitats resulting in a net increase in potential glider habitat of 390,000m^2. Therefore it is concluded that there will be no significant impacts to the Mahogany glider its habitat and lifecycle as a result of the proposed upgrade to the Ingham – Tully transmission line. It is concluded that the Mahogany glider is likely to in time marginally benefit from the increase in suitable habitat although increased connectivity across the easement is likely to be of high significance for conservation of the species.

5.0 REFERENCES

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Appendix 3 - Ingham – Tully 275/132kV upgrade: Impacts on vegetation within Wet Tropics World Heritage Area

275kV /132kV Ingham Tully Upgrade
Wet Tropics World Heritage Area section:
Detailed study of ecological values

May 2011

Report No: pow10.9.01

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Prepared by: BIOTROPICA Australia Pty Ltd

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1.0 General Overview

The 132kV transmission line between Ingham and Tully is being upgraded by Powerlink Queensland. This new project involves demolition of the existing asset and replacing this asset with a 275kV transmission line. The project traverses environmentally sensitive areas which include National Parks, State forests, the Wet Tropics World Heritage Area (WTWHA), and essential habitat for endangered flora and fauna. The objective of this report is to provide a detailed ecological survey to mitigate potential impacts on the area's environmental values. A detailed environmental assessment of those portions of the WTWHA affected by the proposed 275kV transmission line (IT 55 to IT 87 and areas adjacent to Dallachy Creek) has therefore been undertaken.

The WTWHA section of the proposed Ingham-Tully 275kV transmission corridor, between the Cardwell Range and Cardwell town-ship, lies within a diverse and complex ecological setting. This area is a habitat mosaic which includes sclerophyll woodlands of the coastal flats and uplands often with a partial understorey of rainforest, mesophyll and notophyll vine forest taxa, including rain forest, mangroves and associated halophytic communities, riparian zone forests, and *Melaleuca* dominated freshwater wetlands. These myriad of habitats support a concomitant faunal diversity which includes some of Australia's most endangered species and species that are endemic to the Wet Tropics. This section of the project area is flanked by both the Wet Tropics World Heritage Area (WTWHA) and the Great Barrier Reef Marine Park. Both world heritage sites exhibit very high levels of biodiversity and endemism, and the protection of these values is reflected in Commonwealth and Sate legislation. Overall the project traverses 37.4km of WTWHA.

Habitats within the WTWHA sections are suitable for both the Southern Cassowary (*Casuarius casuarius*) and the Mahogany Glider (*Petaurus gracilis*). The forest mosaic represents high quality cassowary habitat and the availability of freshwater increases this value. Riparian zones are also likely to be used as linkage habitat, allowing birds to move between forests of the uplands and lowlands. Woodland habitats on both sides of the power-line represent high quality habitat for the Mahogany Glider. Mahogany Glider food plants and nesting sites are common through this section. The area was severely disturbed by Tropical Cyclone Yasi, affecting virtually all of the core habitat of the Mahogany Glider (Wet Tropics Management Authority 2011). Vine forest habitats utilised by Cassowaries have been similarly affected. Although this report specifically concentrates on the environmental impacts within the WTWHA, it was deemed necessary by Powerlink to include other areas adjacent to the WTWHA that are regarded as essential habitat for the Mahogany Glider (Parsons and Latch 2008), and general habitat for Cassowaries (Kutt et al 2004).

Because the project will involve construction of over-the-canopy towers, a significant proportion of the area formerly cleared will be abandoned and allowed to naturally regenerate.

2.0 Methodology

Two Biotropica botanists were commissioned to assess the environmental impacts of the 275kV upgrade within potentially affected sections of the WTWHA.. A field survey was undertaken within the WTWHA to document (a) all areas proposed for clearing of native habitats and, (b) areas available for the natural regeneration of native habitats. The areas surveyed were:

1. The construction footprint of the proposed 275kV upgrade including new tower sites, new access tracks, and the management of very tall stems in mid-span areas.

2. Sections of the current easement that will not be modified by the upgrade and will be available for natural regeneration of native habitats into the future.

Specifically, surveys involved identifying;

- habitats and ecosystems;

- clearance areas for both access tracks and tower pads;
- Mahogany Glider habitat features e.g., food plants, nest hollows, that may be affected.

All trees with nest hollows that may be impacted upon were identified to species, GPS recorded, photographed, flagged and labeled with a numbered aluminium tag. These trees were labeled as stems that need to be pruned or cleared, or not disturbed. Furthermore, trees that require pruning were assessed and detailed specific pruning requirements were documented.

A Garmin 60CSX GPS was used to generate waypoints and this data was transformed using the Arcview 9.3 GIS platform. An accuracy of 5m should be assumed.

Mid-span trees to be removed were identified using vegetation profiles determined from LIDAR survey data.

The total area to be cleared was calculated using GPS data and known dimensions of tower pads and easement widths. Aerial photography, GPS co-ordinates, and known dimensions of access tracks and easement widths were used to calculate the total area of native habitats that may regenerate.

3.0 Results

Clearing Effects

The total area within the WTWHA to be cleared was calculated to be 23 625m^2 (Table1). This includes 3200m^2 for the construction of new towers, and 20 425m^2 for the construction of new access tracks and mid-span clearing. The total area of Mahogany Glider habitat that may be cleared outside the WTWHA is 3140m^2.

Table 1: Total area of native habitats to be cleared, and total area available for regeneration, within WTWHA, and essential Mahogany Glider habitat

Location	Wet Tropics	Mahogany glider habitat outside WTWHA
Area to be cleared	23 625m^2	3140m^2
Area available for regeneration	145 290m^2	690m^2

Endangered, Vulnerable and Near Threatened (EVNT) Species

No Endangered, Vulnerable or Near Threatened flora listed under the *Nature Conservation Act 1992* (NCA) (Qld) or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) (Commonwealth) were identified. Survey conditions were suitable for the identification of all EVNT species potentially occurring, including ground orchids, but none were located during ground traverse.

Habitat Trees

Within the WTWHA 13 trees with potential nest hollows were identified (Table 2). Of these, eight will require pruning and the remaining five trees are to be retained. Pruning advice for each stem to be retained can be found in Appendix 2. No trees containing nest hollows require total removal. Ground survey revealed that most hollows were on lower portions of the stem and would not be affected by the removal of uppermost limbs.

Greater attention may be required for pruning activities on stem #312. At present this tree contains an artificial nest box erected by Ergon Energy in 2006 for Mahogany Gliders. At the time of the survey it was not known whether the nest box or tree hollows were occupied, however the tree is located in core Mahogany Glider habitat and any pruning activities may affect species utilizing hollows.

Outside the WTWHA (but within essential Mahogany Glider habitat), four trees were identified with potential nest hollows along a proposed access track deviation to IT 134. These four trees are to be retained as the proposed access track will be constructed 5m to the east of their current location (pers. comm. John Peeters – Powerlink Qld). Stem #320 (at proposed tower IT167 also contains potential nest hollows. This tree may require greater attention as it not known if the upper dead limb protruding towards the tower contains hollows and/or is in use.

Table 2: Trees identified with potential nest hollows that may be impacted by the construction of new tower sites, access tracks and/or mid-span clearing, within the WTWA and essential Mahogany Glider habitat

Stem Number	Species	Location	Treatment
#301	Dead Tree	Bordering IT 59	To be Retained
#302	Yellow Stringybark (*Eucalyptus portuensis*)	Bordering IT 60	Upper limbs to be pruned only
#303	Pink Bloodwood (*Corymbia intermedia*)	Bordering IT 61	Upper limbs to be pruned only
#304	Weeping Paperbark. (*Melaleuca leucadendra*)	South of IT 61	Upper limbs to be pruned only
#305	Yellow Stringybark	Bordering IT 62	Upper limbs to be pruned only
#306	Pink Bloodwood	Bordering IT 64	Upper limbs along the eastern side of the tree to be pruned
#307	Yellow Stringybark	Bordering IT 80	Upper limbs to be pruned only
#308	Poplar Gum (*Eucalyptus platyphylla*)	Proposed access track from IT 80 to IT 81	To be Retained
#309	Yellow Stringybark	Proposed access track from IT 80 to IT 81	To be Retained
#311	Molloy Box (*Eucalyptus leptophleba*)	Mid-span between proposed IT 82 and IT 83.	Limbs on the western side of the tree and upper branches to be pruned only.
#312	Pink Bloodwood	Bordering IT 86.	Upper branches to be pruned avoiding all hollows
#314	Narrow-leaved Ironbark* (*Eucalyptus crebra*)	Along proposed access track deviation adjacent to quarry site	To be Retained
#315	Molloy Box*	Along proposed access track deviation adjacent to quarry site	To be Retained
#316	Clarkson's Bloodwood * (*Corymbia clarksoniana*)	Along proposed access track deviation adjacent to quarry site	To be Retained
#317	Molloy Box*	Along proposed access track deviation adjacent to quarry site	To be Retained
#318	Pink Bloodwood	Proposed access track to IT 166 (option A)	To be Retained
#319	Pink Bloodwood	Proposed access track to IT 166 (option A)	To be Retained
#320	Molloy Box*	Bordering proposed IT 167	Avoid all potential nest hollows if pruning is required

** Trees identified outside the Wet Tropics World Heritage Area*

4.0 Natural Regeneration Areas

The total area within the WTWHA that may be regenerated is approximately 145 290m^2 (see Table 1). The greatest proportion of land to be regenerated will be along the current easement between IT 59 and IT 54 (26 400m^2). This easement bisects seven Regional ecosystems, of which two are Of Concern (7.12.60b and 7.3.20c).

The proposed line replacement within the WTWHA includes the potential for natural regeneration of plant communities along the current 132KV easement, and the retention of most vegetation underneath the proposed 275kV easement. Enabling plant regeneration along disturbed easements will increase habitat connectivity for endangered fauna.

Natural regeneration of native habitats is more likely to occur in areas where drainage is poor and the adjacent vegetation community is dominated by *Melaleuca dealbata* and *M. viridiflora*. In these areas, *Melaleuca* stems are already established within disturbed areas along the existing 132kV line, having been retained during vegetation maintenance due to their low growing habit. Competition with introduced grass species may restrict their regeneration over shorter temporal periods. However, over time it would be expected that similar vegetation communities to those neighboring these sites would be restored.

Natural regeneration is less likely to occur in areas where introduced grass species e.g., Guinea grass (*Megathyrsus maximus* var. *maximus*), Para grass (*Urochloa mutica*) Molasses Grass (*Melinis minutiflora*), Signal Grass (*Urochloa decumbens)* and Creeping Signal Grass (*Urochloa humidicola*)) are already established. These grasses have a tendency to suppress natural regeneration by outcompeting native grasses and altering fuel loads, often increasing the severity of planned and/or unplanned fire. Specific management may need to be implemented to ensure natural regeneration occurs in areas where introduced grasses are established.

5.0 Managing Regeneration

There are a combination of factors that will influence the type of vegetation community that will naturally regenerate along abandoned sections of the corridor, and their associated access tracks and tower pads. Weed colonisation, woodland invasion by rain forest species (woody thickening) and altered fire regimes, are the key factors which will potentially influence the species composition and physical structure of future vegetation communities.

Weed species are generally the initial colonisers of disturbed areas, often outcompeting native plant species and altering community composition. At present there is greater chance of weed invasion along the corridor because the surrounding landscape has been severely disturbed by Tropical Cyclone Yasi, and there is a range of weeds already present within the corridor (Biotropica 2010). At the time of the survey it was evident that weed outbreaks had occurred along access tracks and were spreading to/from vegetation along the easement as a result of this disturbance. The control of most weeds, but especially exotic grasses, will be required to promote natural regeneration along some sections of the corridor.

Natural regeneration within areas that are in close proximity to riparian vegetation and rain forest margins may not reflect the species composition of the in-situ regional ecosystem. Many rainforest pioneer species have significantly greater growth rates when compared with species within the genera *Corymbia* and *Eucalyptus* (Williams 2000), and in the absence of fire they are common invaders of adjacent woodland systems. The invasion of rain forest (woody thickening) species is a threat to essential Mahogany Glider habitats (Parsons and Latch 2007). Promoting an open forest structure through the regeneration of *Eucalyptus* and *Corymbia* is of high priority in the management of Mahogany Glider habitat (Parsons and Latch 2007).

Fire frequency and intensity influence forest structure and species composition. A fire regime that is too early in the fire season will not maintain an overall open forest structure essential for Mahogany

Gliders, whereas a fire regime that is too frequent will gradually simplify the plant structure and promote a grassy understory, also detrimental to Mahogany Glider habitat (Parsons and Latch 2007). Medium to low intensity fires are not capable of removing rainforest pioneer species from the soil seed bank (Williams 2000). Rainforest pioneer species tend to out-compete woodland species. Promoting a "hot burn" has a greater chance of destroying seeds from rainforest pioneers whilst promoting the recruitment of *Eucalyptus* and *Corymbia* species. Exotic grasses often increase fuel loads resulting in a fire of higher intensity. Controlled hot burns within the easement may not only eradicate exotic grasses and weeds, but may also promote the recruitment of *Eucalyptus* and *Corymbia* species and destroy seeds from rainforest pioneers.

As noted in the Environmental Impact Statement for this project (RPS 2010), revegetation of disturbed areas may also require direct planting of tube stock. *Eucalyptus* and *Corymbia* species are a key canopy component of most Regional Ecosystems within this area. Their ability to become established and integrated within the restored vegetation community is a key requirement for rehabilitating Mahogany Glider habitat (Parsons and Latch 2007). The planting of *Eucalyptus* and *Corymbia* species will promote faunal connectivity across disturbed areas, potentially benefitting all fauna including the Mahogany Glider.

6.0 Monitoring Regeneration

Natural regeneration of the former corridor, disused access tracks and tower sites will depend on a range of factors including;

- weed invasion
- woody thickening (by rain forest pioneer species)
- frequency and intensity of fire

Identification of these processes through monitoring will enable the creation of site specific management plans for future regeneration.

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Appendix 1. Site specific impacts associated with the 275kV Upgrade

Access deviation to IT 44 (outside WTWHA)

Access to the proposed tower IT 44 will require modifications to allow crane and machinery access during construction and also in the event of an emergency. The proposed new access track will deviate slightly to the north of the existing track. Approximately 150m^2 will be cleared for construction of the track. The Regional Ecosystem is 7.12.5a (Endangered). Vegetation north of the track is primarily Acacia dominated woodland and rainforest regrowth with Golden Wattle (*Acacia flavescens*), Brown Macaranga (*Macaranga involucrata*), Glossy Tamarind (*Guioa lasioneura*) and Ivory Basswood (*Polyscias australiana*) being conspicuous. The mid canopy and ground layer are comprised of a similar suite of species with the inclusion of the Palm Cycad (*Cycas media ssp media*).

An alternative deviation to the south was also investigated. This area contains a high number of mature stems of Qld Blue Gum (*Eucalyptus tereticornis*), Red Mahogany (*Eucalyptus pellita*) and Pink Bloodwood (*Corymbia intermedia*) with a high proportion of these containing nest hollows. Due to the high number of habitat trees that would require clearing, the southern deviation has been deemed inappropriate by Powerlink (pers. comm. John Peeters).

Regeneration of the existing access track

The proposed area to be regenerated is approximately 120m^2. The close proximity to the existing (disturbed) corridor is likely to make the area prone to weed invasion. In the longer term rain forest species are likely to colonise this area due to floristics along the southern side of the access track. The natural regeneration of *Eucalyptus* and *Corymbia* species is less likely to occur due to the invasive nature of adjacent weeds and rain forest pioneers.

Access deviation to IT 44A (outside WTWHA)

A new access track will be constructed to the proposed tower IT 44A. The total area of the proposed track is 390m^2. The route follows a disused track approximately 5m wide. The Regional Ecosystem is 7.12.5a (Endangered). The current vegetation within the disused track is predominately Guinea Grass with Red Ash (*Alphitonia incana*) and a single Clarkson's Bloodwood (*Corymbia clarksoniana*).

Proposed Access to IT 54 (outside WTWHA)

A new access track will be constructed to proposed tower IT 54. The width of the access track is 6m and the length is 335m. The total area to be cleared for the access track is 2010m^2 and for the proposed tower site 1600m^2. The Regional Ecosystem is predominately 7.3.20c (Of Concern with 7.12.24a (Least Concern). The vegetation consists of Pink Bloodwood, Moreton Bay ash (*Corymbia tessellaris*), and Poplar Gum (*Eucalyptus platyphylla*) within the canopy. The mid layer is dominated by Golden Wattle and She Oak (*Casuarina torulosa*) with a ground layer of Blady Grass (*Imperata cylindrica*).

Proposed Access to IT 55

A new access track will be constructed to proposed tower IT 55. The width of the access track is 6m and the length is 180m. The total area to be cleared for the access track is 1080m^2 and for the proposed tower site 1600m^2.

The vegetation consists of a canopy with Poplar Gum (*Eucalyptus platyphylla*) and Pink Bloodwood with a mid-storey consisting of Yellow wattle, Broadleaf Salwood (*Acacia mangium*), and Red Ash with rainforest regrowth. The ground layer is dominated by Blady Grass (*Imperata cylindrica*) and weeds including Lantana (*Lantana camara*), Horehound (*Hyptis suaveolens*) and Urena Burr (*Urena lobata*). The Regional Ecosystems is predominately 7.12.60b (Of Concern) with 7.12.23a (Least Concern). No

trees with potential nest hollows were identified within the construction footprint, or within adjacent vegetation communities.

Proposed Access to IT 62 – IT 63

A new access track will be constructed between proposed IT 62 and IT 63. The total area to be cleared is 630m^2. This forest is comprised of Yellow Stringybark and Pink Bloodwood with a mid-storey of She-oak (*Casuarina torulosa*), Sersalisia (*Sersalisia unmackiana*), and Woody Pear (*Xylomelum scottianum*). The ground layer is predominately Kangaroo Grass (*Themeda triandra*) with Giant Spear (*Heteropogon triticeus*) and Grass trees (*Xanthorrhoea johnsonii*). The Regional Ecosystem is 7.12.24a (Least Concern) with 7.3.21a (Least Concern). No large trees with potential nest hollows will be affected by clearing operations in this area.

Mid-span clearing between IT 64 and IT 65

Clearing of vegetation will be required between the proposed IT 64 and 65 where transmission lines may come into contact with vegetation. The area to be cleared was estimated to be 5m wide and 15m long, an area of 75m^2. Vegetation to be cleared includes Yellow Stringybark, Pink Bloodwood, She-oak and Yellow wattle. The Regional Ecosystem is 7.12.24a (Least Concern). There are no mature trees that contain nesting hollows that will be disturbed in this area.

Proposed Access to IT 80 – IT 81

A new access track will be constructed between the proposed IT 80 and IT 81. This new track will use some of the existing easement before veering west. The width of the track varies. In sections that require a bend in the track for heavy vehicles, the proposed width is 9m. The same width is proposed on steeper slopes, and this will require the construction of batters. It is estimated that 50% of the proposed track requires a width of 6m and the remaining 50% requires a width of 9m. The length from the deviation of the existing track to the tower is 180m. The approximate area of vegetation to be removed is 1350m^2.

Vegetation along the proposed track includes a mixed canopy of Poplar Gum, Yellow Stringybark, Narrow-leaved Ironbark (*Eucalyptus crebra*) and Molloy Box (*Eucalyptus leptophleba*). The mid-storey consists of Sandpaper Fig (*Ficus opposita*), Cocky Apple (*Planchonia careya*) and rainforest regrowth within a seasonal gully. The ground layer consists of Kangaroo Grass, Giant Spear Grass and Grass Trees. Two large trees with potential nesting hollows were identified, #308 – Poplar Gum and #309 – Yellow Stringybark. These trees have been flagged and labelled. Scratches on the main stem of #308, close to a tree hollow suggests the tree may be habitually used by arboreal fauna. The access track is to deviate further to the west avoiding both individuals. The Regional Ecosystem is 7.3.45b (Least Concern)

Mid-span clearing between the proposed IT 82 and IT 83

Clearing of vegetation will be required between the proposed IT 82 and IT 83 as transmission lines may come into contact with vegetation. The area to be cleared was estimated to be 5m wide and 20m long, an area of 100m^2. Vegetation to be cleared includes Yellow Stringybark, Pink Bloodwood, She-oak and Yellow wattle. One tree (Tree #311) with potential nest hollows was identified along the western side of the current easement. Pruning may be required for this tree. The Regional Ecosystem is 7.3.45b with 7.3.21a. There are no other mature trees that contain nesting hollows that occur within this area.

Access deviation to the proposed IT 84 *via* IT 83

A deviation of the present access track to IT 84 has been proposed. This new access track is 5m wide and 72m in length. The total area to be cleared is 360m^2. The proposed access track skirts the current easement to the east resulting in a reduced clearing footprint. Vegetation in this area is predominately Acacia regrowth (i.e. Yellow Wattle and *Acacia crassicarpa*) with juvenile Red Mahogany. The

Regional Ecosystem is 7.3.21a (Of Concern). There were no trees with potential nesting hollows identified within this area.

Area available for natural regeneration

The benefit of the proposed access deviation is a large proportion of the access track to the proposed IT 84 can be abandoned and allowed to naturally regenerate. At present 50% of the access track is 6m wide and the remaining 50% is 9m wide. The length of track is 235m. The total area available for regeneration is 1762.5m^2.

Access Deviation *to* IT 134 (outside WTWHA)

A deviation of the access track to IT 134 has been proposed to avoid washouts along the Attie Creek crossing. The total area of clearing is approximately 1110m^2 and the area for regeneration is 570m^2. The area of remnant vegetation is small, being bordered by the quarry site to the north and west and the access track to IT134 to the south and east. This forest fragment was comprised of a mixture of mature rainforest pioneer species (i.e. Broadleaf Salwood, Glossy Tamarind, and Red Ash (*Alphitonia excelsa*)), along with mature Molloy Box, Narrow-leaved Ironbark and Clarkson's Bloodwood. The area has been severely disturbed by Tropical Cyclone Yasi with all mature *Eucalyptus* and *Corymbia* losing multiple limbs and most mature rainforest vegetation being heavily disturbed.

The mid canopy and ground cover is predominately rainforest regrowth with weed incursions along the edges (i.e. Lantana (*Lantana camara*) and Guinea Grass (*Megathyrsus maximus* var *maximus*)). The Regional Ecosystem is 7.3.8b (Least Concern). Adjacent to the proposed access track, four trees have been identified with potential nest hollows; a Narrow-leaved Ironbark (Tree #314), 2 × Molloy Box (Tree #315 and #317) and a Clarkson's Bloodwood (Tree #316). The four trees are to be retained as the proposed track will deviate to the east of their present location (pers. comm. John Peeters).

Regeneration of the existing access track

Regeneration of the existing access track is unlikely to occur through natural processes alone. In part this is due to the access track being well worn with a highly compacted substrate which will restrict natural recruitment. Most natural recruitment will potentially be those weeds that presently border the access track along the eastern side prior to the creek crossing. The present creek crossing is bordered by a thin strip of riparian vegetation approximately 5m wide on both sides of the creek. The northern and southern approaches to the crossing are highly eroded and stabilisation of these banks may be necessary to avoid gully and rill formation and sediment run-off.

Proposed access to IT 165

The construction of an access track deviating from the present alignment has been proposed to IT 165. The deviation is necessary due to the steep incline from the centre of the access track to IT 165. The existing access track is to be abandoned and allowed to naturally regenerate. The deviation has been assessed and the potential impacts on vegetation and Mahogany Glider habitat are outlined below. The proposed access track deviates north 5m from the base of the existing access. The width of the track varies. In sections that require a bend in the track the proposed width is 9m. The same width is proposed on steeper slopes which will require the construction of batters. It is estimated that 50% of the proposed track requires a width of 6m and the remaining 50% requires a width of 9m. The length from the deviation of the existing track to the tower is 240m. The approximate area of vegetation to be removed is 1800m^2.

Vegetation along the proposed track includes canopy trees of Pink Bloodwood, Swamp Mahogany, Red Mahogany and Golden Bouquet (*Deplanchea tetraphylla*). The mid-storey contains; Forest Oak, Yellow Wattle and rainforest regrowth including Hard Milkwood (*Alstonia muelleriana*), Coffee Bush (*Breynia oblongifolia*), Brown Macaranga (*Macaranga mallotoides*) and Chain Fruit (*Alyxia spicata*). The ground layer is dominated by Bracken Fern (*Pteridium esculentum*) with Kangaroo Grass, Blady Grass and rainforest seedlings. The Regional Ecosystem is 7.12.5c (Of Concern). Within this area the

vegetation is represented by a mixed stage of succession with mature rainforest trees (i.e. Golden Bouquet Tree) and scattered mature Pink Bloodwood and Swamp Mahogany. The area to be cleared for the access track avoids all mature Pink Bloodwood and Swamp Mahogany; however some juvenile stems will be cleared.

Regeneration of the existing access track to IT 165

The total area that will be abandoned and allowed to naturally regenerate is 456m^2. Regeneration of the steep incline through natural processes is unlikely to restore similar canopy tree species occupying this area. Rainforest species in the surrounding area are more likely to colonise the access track and suppress the natural regeneration of the canopy flora, and some intervention may be required.

Proposed Access to IT166

The construction of an access track deviating from the existing alignment has been proposed to IT 166. The deviation is necessary due to the steep incline from the centre of the access track to IT 166. The steep incline of the existing access track is to be regenerated. The Regional Ecosystem is 7.12.5c (Of Concern). Two options have been assessed and the potential impacts on vegetation and Mahogany Glider habitat are outlined below.

Option A

The proposed access track deviates north from the middle of the existing access. The width of the track varies. In sections that require a bend in the track the proposed width is 9m. The same width is proposed on steeper slopes which will require the construction of batters. It is estimated that 50% of the proposed track requires a width of 6m and the remaining 50% requires a width of 9m. The length from the deviation of the existing track to the tower is 204m. The approximate area of vegetation to be removed is 1530m^2.

Vegetation along the proposed track includes canopy trees of Pink Bloodwood, Swamp Mahogany and Red Mahogany, with a mid storey layer of She-oak, Red Ash and rainforest regrowth including Brown Kurrajong (*Commersonia bartramia*) Coffee Bush and Chain Fruit. The ground layer is dominated with Bracken Fern and Kangaroo Grass with emerging rainforest seedlings. Within this area, individuals of Pink Bloodwood, Swamp Mahogany and Forest She-oak will potentially be cleared for track construction. The plant community in this area is at an early stage of succession with few mature individuals. All trees along the proposed track were screened for potential nest hollows. Two mature Pink Bloodwood (#318 and #319) with visible tree hollows were identified within 5m of the proposed track boundary. Both individuals can be retained and both have been numbered and flagged.

Option B

The proposed access track deviates south from the middle of the existing access and enters the easement from the south west. The width of the track varies. In sections that require a bend in the track the proposed width is 9m. The same width is proposed on steeper slopes which will require the construction of batters. It is estimated that 50% of the proposed track requires a width of 6m and the remaining 50% requires a width of 9m. The length from the deviation of the existing track to the tower is 256m. The approximate area of vegetation to be removed is 1920m^2.

Vegetation along the proposed track is similar in composition to Option A. However, the community is at a much later stage of succession, with a higher number of mature Pink Bloodwood, Swamp Mahogany and Red Mahogany containing hollows. In addition to the high number of hollows, the majority of mature trees contain orchids.

Regeneration of the existing access track

Regeneration of steeper sections is unlikely to occur in this area. Rainforest species surrounding the site are more likely to colonise the access track and suppress the natural regeneration of the local canopy flora. Some management intervention may be required.
Proposed new site for IT 167 (outside WTWHA)

The location of the proposed IT 167 is approximately 1m east of the current access track. The surrounding area has been severely disturbed by TC Yasi with many large trees uprooted. The vegetation within this community is primarily comprised of Pink Bloodwood, Red Mahogany and Molloy Box in the upper canopy with a mid storey of Forest Oak and Yellow Wattle. The ground layer is comprised of Bracken Fern with Blady Grass and Kangaroo Grass. The Regional Ecosystem is 7 12.5c (Of Concern). Within the construction footprint (40m × 40m) juvenile Pink Bloodwood and Red Mahogany will be removed. A visual inspection of these trees found no evidence of tree hollows. One Molloy Box (#320) was located 30m to the south west of the proposed tower which contained nest hollows. This tree may require pruning to avoid contact with the tower in the event of a tree fall. It was not possible to identify hollows. If dead limbs are to be trimmed or removed a faunal spotter may be required to supervise removal.

Appendix 2. Stems with nest hollows

Figure 1: Stem #301 bordering proposed IT #59. Dead tree with potential nest hollows at ends of both limbs. To be retained

Figure 2: Stem #302 bordering proposed IT 60. Yellow Stringybark with two nest hollows located along mid-limbs. Upper limbs to be pruned

Figure 3: Stem #303 bordering proposed IT 61. Pink Bloodwood with nest hollows located midway along the main trunk. Upper limbs to be pruned

Figure 4: Stem #304 south of proposed IT 61. Weeping Paperbark with nest hollows located midway along the main trunk and limbs. Upper limbs to be pruned

Figure 5: Stem #305 bordering proposed tower #62. Yellow Stringybark with nest hollows located on the lower limbs. Upper limbs to be pruned

Figure 6: Stem #306 bordering proposed tower #64. Pink Bloodwood with nest hollows located on the lower limbs. Upper limbs along the eastern side of the tree to be pruned.

Figure 7: Stem #307 bordering proposed tower #80. Yellow Stringybark with nest hollows located midway along the main trunk. Upper limbs to be pruned.

Figure 8: Stem #308 along proposed access track from IT 80 to IT 81. Poplar Gum with multiple nest hollows and evidence of animal habitation. Access track to avoid marked individual.

Figure 9: Stem #309 along proposed access track from IT 80 to IT 81. Yellow Stringybark with multiple potential nest hollows. Access track to avoid marked individual.

Figure 10: Stem #311 mid-span between IT 82 and IT 83. Molloy Box with nest hollows along limbs facing north. Limbs on the western side, and upper branches to be pruned.

Figure 11: Stem #312 bordering IT 86. Pink Bloodwood with nest hollows and breeding box. Upper branches to be pruned

Figure 12: Stem #314 along proposed access track deviation adjacent to quarry site. Narrow-leaved Ironbark with nest hollow along lower limb. Access track to avoid marked individual.

Figure 13: Stem #315 along proposed access track deviation adjacent to quarry site. Molloy Box with nest hollows along lower limbs. Access track to avoid marked individual.

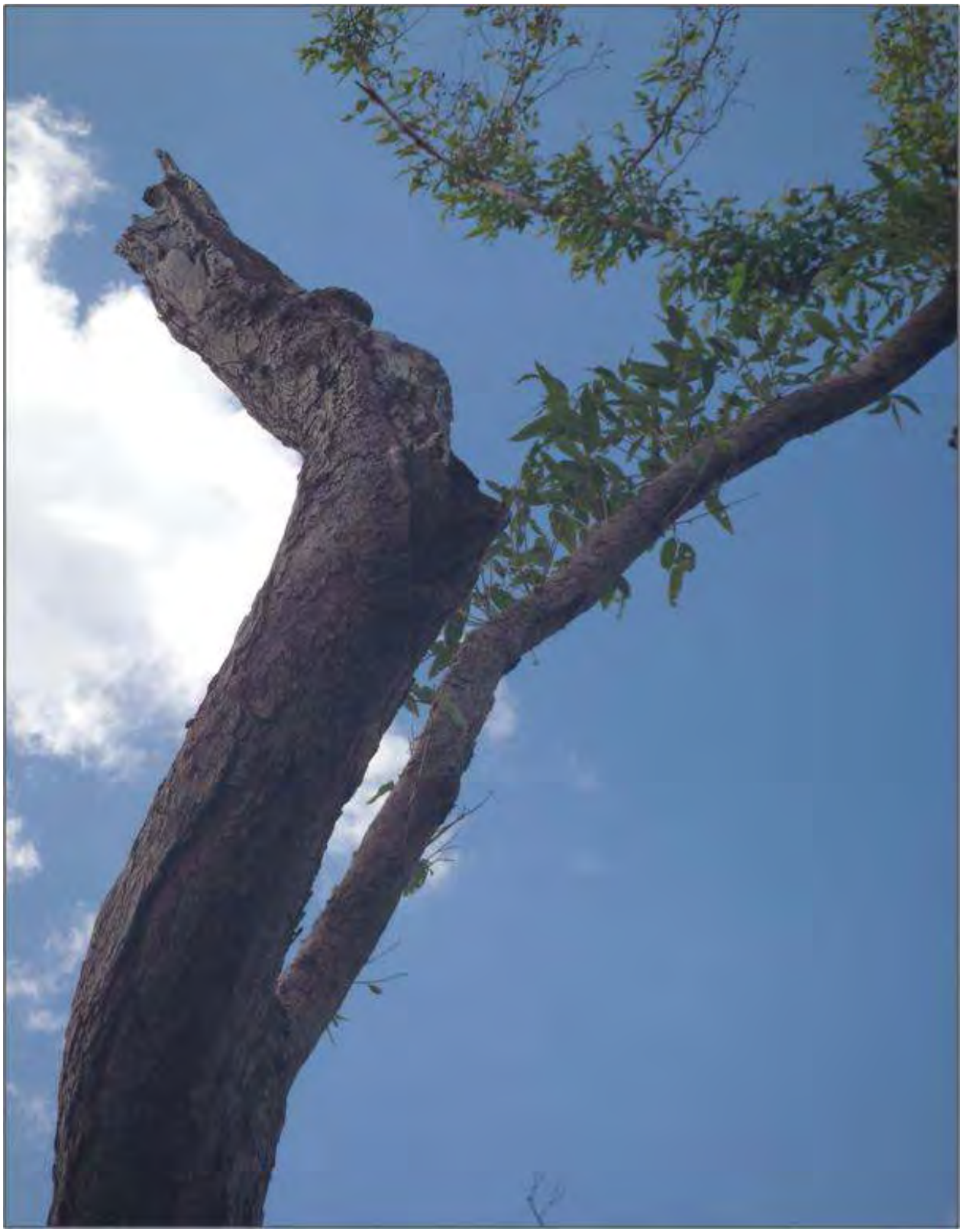


Figure 14: Stem #316 along proposed access track deviation adjacent to quarry site. Clarkson's Bloodwood with nest hollows along main stem. Access track to avoid marked individual.

Figure 15: Stem #317 along proposed access track deviation adjacent to quarry site. Molloy Box with nest hollow along lower limb. Access track to avoid marked individual.

Figure 16: Tree #318 along proposed access track to IT 166 (option A). Pink Bloodwood with nest hollows mid stem. Access track to avoid marked individuals by deviating access track north.

Figure 17: Stem #319 near proposed access track to IT 166 (option A). Pink Bloodwood with nest hollows mid stem, and orchids. Access track to avoid marked individuals by deviating access track north of tree.

Figure 18: Stem #320 bordering proposed IT167. Molloy Box with nest hollows along the main stem and potentially along the upper limbs facing east. Avoid all nest hollows if pruning is required.

Appendix 3 - Ingham Tully 275kV Line – Wet Tropics World Heritage Area Vegetation Descriptions

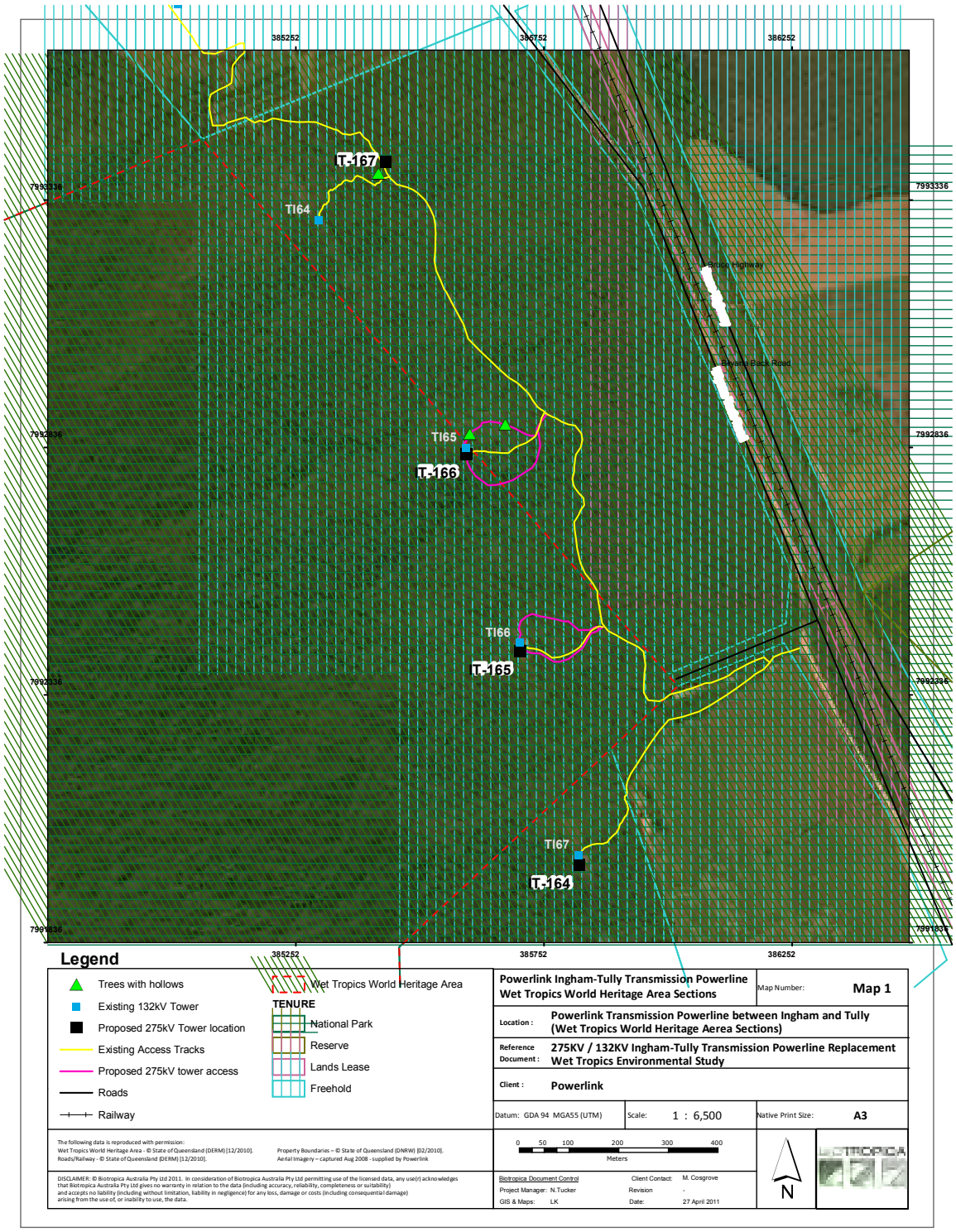
Tower Number	Vegetation description	Animal breeding places	Notes
*New access to IT 44	Canopy: *Eucalyptus pellita, E. tereticornis, C. intermedia* to 25m Sub-canopy: *Polyscias australiana*, *Macaranga mallotoides, Guioa acutifolia, Acacia flavescens* Ground: Rainforest seedlings, *Cycas media* RE: 7.12.5a (Endangered)	Present in nearly all mature trees south of the proposed access track	Rain forest invasion underway Significant invasion of Guinea grass (*Megathyrsus maximus*) along easement
*New access to IT 44A	Canopy: *Corymbia clarksoniana* Sub-canopy: *Alphitonia excelsa* Ground: *Megathyrsus maximus* RE: 7.12.5a (Endangered)	Not present	New access is along a disused track.
IT 54	Canopy: *Corymbia intermedia, C. tessellaris, Eucalyptus platyphylla* to 28m Sub-canopy: *Acacia flavescens, Casuarina torulosa* Ground: *Imperata cylindrica* RE: 7.3.20c (Of Concern) and 7.3.8b (Least Concern)	Not present	Rain forest invasion underway, many broad-leaf weeds also invading Cattle grazing evident 1 x mature *E. platyphylla* to be removed
IT 55	Canopy: *C. intermedia, Syncarpia glomulifera* to 18m Sub-canopy: Very sparse, occasional *C. torulosa* Ground: *Themeda triandra*, *I. cylindrica* RE: 7.12.60b (Of Concern) and 7.12.23a (Least Concern)	1 very small hollow present	Tower sited on boulder ridge Vegetation more open
IT 57	Canopy: *C. intermedia* Sub-canopy: *Acacia flavescens, Planchonia careya, C. torulosa* Ground: *T. triandra, Xanthorrhoea johnsonii, Heteropogon triticeus*, *I. Cylindrica* RE: 7.12.23a (Least Concern) and 7.12.24a (Least Concern)	Not present	Intact site, no weeds present
IT 58	Canopy: *C. intermedia, Eucalyptus leptophleba* to 15m Sub-canopy: Sparse, occasional *P. careya* Ground: *T. triandra, H. triticeus*, *I. cylindrica* RE: 7.12.23a (Least Concern) and 7.12.37a (Least Concern)	Not present	Tall stems uncommon High quality habitat with diverse ground storey vegetation
IT 59	Canopy: *Eucalyptus portuensis, C. intermedia, S. glomulifera* to 25m Sub-canopy: *P. careya, C. torulosa* Ground: *T. triandra, H. triticeus*, *Lomandra multiflora* RE: 7.12.24a (Least Concern)	Small hollows only present in live stems 3 x hollows in dead stag Stag tagged #301	Numerous tall stems at this site, only minor weeds present
IT 60	Canopy: *E. portuensis, C. intermedia, S. glomulifera* to 30m Sub-canopy: *P. careya, C. torulosa, Clerodendrum floribundum* Ground: *T. triandra, H. triticeus*, *I. cylindrica, Pteridium esculentum* RE: 7.12.24a (Least Concern)	2 hollows present in *E. portuensis* Stem tagged #302	Numerous tall stems at this site. High quality habitat with very few weeds

Tower Number	Vegetation description	Animal breeding places	Notes
IT 61	*C. intermedia, E. leptophleba, Eucalyptus tereticornis* to 30m Sub-canopy: *P. careya, A. flavescens* Ground: *T. triandra, H. triticeus*, *I. cylindrica, L. Multiflora* RE: 7.3.21a (Of Concern)	1 X *C. intermedia* with hollows Stem tagged #303 1 x *Melaleuca leucadendra* with hollows Stem tagged #304	Poorly drained site, potential *Myrmecodia beccarii* habitat but none recorded
IT 62	Canopy: *E. portuensis, C. intermedia, S. glomulifera* to 28m Sub-canopy: *P. careya, C. torulosa, Pandanus cookii* Ground: *T. triandra, H. triticeus* RE: 7.3.21a (Of Concern) and 7.12.24a (Least Concern)	Hollows (at least 2) present in *E. portuensis* Stem tagged #305	Tower within existing clearing but many tall trees adjacent
IT 63	Canopy: *E. portuensis* to 15m Sub-canopy: *P. careya, C. torulosa,A. flavescens* Ground: *T. triandra, X. johnsonii* RE: 7.12.24a (Least Concern)	Not present	New 70m tower to be erected within existing clearing
IT 64	Canopy: *C. intermedia* to 25m Sub-canopy: *P. careya, C. torulosa, Acacia crassicarpa* Ground: *T. triandra, H. triticeus, X. johnsonii* RE: 7.12.24a (Least Concern)	1 x *C. intermedia* – marginal tree with no hollows present Stem tagged #306	Many tall stems adjacent
IT 65	Canopy: *E. tereticornis, C. tessellaris* to 25m Sub-canopy: *Lophostemon suaveolens*, *P. careya* Ground: *T. triandra, I. cylindrica, H. triticeus* RE: 7.12.24a (Least Concern)	Not present	Tower within existing clearing but many tall trees adjacent
IT 76	Canopy: *E. platyphylla* to 25m Sub-canopy: *P. careya, A. crassicarpa, Melaleuca quinquenervia, Albizia procera* Ground: *I. cylindrica, T. triandra, Bothriochloa bladhii ssp bladhii* RE: 7.3.44 (Endangered) and 7.3.45b (Least Concern)	Not present	Re-planted Mahogany glider habitat adjacent
IT 77	Canopy: *E. platyphylla* to 25m Sub-canopy: *P. careya, A. crassicarpa, Melaleuca quinquenervia, Albizia procera* Ground: *I. cylindrica, T. triandra, Bothriochloa bladhii ssp bladhii* RE: 7.3.12b (Endangered) and 7.3.23a (Endangered)	Not present	Significant invasion of Guinea grass (*Megathyrsus maximus*) at the site
IT 78	Canopy: *E. platyphylla, C. tessellaris, E. tereticornis* to 25m Sub-canopy: *A. crassicarpa, A. flavescens, Acacia mangium* Ground: *Melinis minutiflora, Urochloa decumbens, U. humidicola, Lantana camara, Stylosanthes humilis* RE: 7.3.21a (Least Concern)	Not present	Ground storey almost completely dominated by exotic species

Tower Number	Vegetation description	Animal breeding places	Notes
IT 79	Canopy: *E. portuensis, C. intermedia* to 25m Sub-canopy: *P. careya, A. crassicarpa, A. flavescens, Canarium vitiense* Ground: *M. minutiflora, U. decumbens, S. humilis, I. cylindrica* RE: 7.3.21a (Least Concern)	Not present	Significant weed invasion of ground storey
IT 80	Canopy: *Corymbia clarksoniana, E. leptophleba* to 25m Sub-canopy: *Persoonia falcata, Grevillea parallela, A. flavescens* Ground: *X. johnsonii, H. triticeus, Hibbertia scandens* RE: 7.3.45b (Least Concern)	1 x *E. portuensis* with hollow Stem tagged #307	Tower sited on boulder ridge Well established glider connection corridor at base of slope (south side)
Access track IT 80 – IT 81	Canopy: *Eucalyptus platyphylla*, *E. portuensis* to 20m Sub-canopy: *A. flavescens, C. torulosa, P. falcata* Ground: *T. triandra, H. Triticeus* RE: 7.3.45b (Least Concern)	1 × *E. platyphylla* with hollows Stem tagged #308 1 × *E. portuensis* with hollows Stem tagged #309	Access track along boulder gully with Vine thickets and large trees
IT 81	Canopy: *E. portuensis, E. leptophleba* to 18m Sub-canopy: *P. careya, A. flavescens, C. vitiense, Ficus opposita* Ground: *M. minutiflora, L. multiflora, H. triticeus, T. triandra, Aristida calycina* RE: 7.12.24a (Least Concern)	Not present	Significant canopy damage caused by TC Yasi
IT 82	Canopy: *E. portuensis, C. intermedia* to 20m Sub-Canopy: *A. flavescens, P. falcata, G. parallela* Ground: *T. triandra, H. triticeus*, *X. johnsonii* RE: 7.3.45b (Least Concern)	1 × *E. leptophleba* with hollows (midspan) Stem tagged #311	Significant canopy damage caused by TC Yasi
IT 83	Canopy: *Eucalyptus crebra, Eucalyptus pellita, C. intermedia* to 17m Sub-Canopy: *A. flavescens, P. falcata* Ground: *T. triandra, H. triticeus, Cycas media* RE: 7.3.21a (Of Concern)	Not present	*C. tessellaris* regrowth along easement. Juvenile *E. pellita* to be removed along access track deviation
IT 84	Canopy: *E. pellita*, *C. intermedia* to 17m Sub-canopy: *A. flavescens, C. torulosa, G. parallela* Ground: *T. triandra, H. triticeus*, *X. johnsonii* RE: 7.3.21a (Of Concern)	Not present	*Eucalyptus* regrowth along easement
IT 85	Canopy: *E. pellita*, *C. intermedia* to 20m Sub-canopy: *C. torulosa, P. careya, A. flavescens* Ground: *H. Triticeus, T. Triandra, M. minutiflora* RE: 7.3.21a (Of Concern)	Not present	Significant weed invasion of ground storey
IT 86	Canopy: *E. pellita*, *C. intermedia* to 25m Sub-canopy: *C. torulosa, A. flavescens* Ground: *T. triandra, H. triticeus*, *X. johnsonii* RE: 7.3.21a (Of Concern)	1 × *C. intermedia* with hollows and artificial nesting box. Stem tagged #312	High quality Mahogany Glider habitat Potential for Riparian vegetation along waterway

Tower Number	Vegetation description	Animal breeding places	Notes
New access to IT 165	Canopy: *E. pellita*, *C. intermedia*, *Lophostemon suaveolens* to 20m Sub-canopy: *A. flavescens, C. torulosa*, rainforest regrowth Ground: *P. esculentum*, *T. triandra*, *I. cylindrica* RE: 7.12.5c (Of Concern)	Hollows present in *C. intermedia* and *L. suaveolens*. Track to avoid these individuals	High quality Mahogany Glider habitat Significant canopy damage caused by TC Yasi
New access to IT 166	Canopy: *E. pellita*, *C. intermedia*, *L. suaveolens* to 20m Sub-canopy: *C. torulosa*, *A. excelsa*, rainforest regrowth Ground: *P. esculentum*, *T. triandra*, *I. cylindrica* RE: 7.12.5c (Of Concern)	2 × *C. intermedia* with hollows. Stems tagged #318 & #319	High quality Mahogany Glider habitat Significant canopy damage caused by TC Yasi
IT 167	Canopy: *E. pellita*, *C. intermedia*, *E. leptophleba* to 25m Sub-canopy: *C. torulosa* Ground: *P. esculentum*, *T. triandra*, *I. Cylindrica* RE: 7.12.5c (Of Concern)	1 × *E. leptophleba* with hollows Stem tagged #320	Significant canopy damage caused by TC Yasi

Appendix 4. Maps



Legend

- Trees with hollows
- Existing 132kV Tower
- Proposed 275kV Tower location
- Existing Access Tracks
- Proposed 275kV tower access
- Roads
- Railway
- Wet Tropics World Heritage Area

TENURE

- State Forest
- State Land
- Freehold

Powerlink Ingham-Tully Transmission Powerline Wet Tropics World Heritage Area Sections		Map Number:	**Map 2**
Location :	**Powerlink Transmission Powerline between Ingham and Tully (Wet Tropics World Heritage Aerea Sections)**		
Reference Document :	**275KV / 132KV Ingham-Tully Transmission Powerline Replacement Wet Tropics Environmental Study**		
Client :	**Powerlink**		
Datum: GDA 94 MGA55 (UTM)	Scale: 1 : 3,000	Native Print Size:	**A3**

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Project Manager:	N.Tucker	Revision	-
GIS & Maps:	LK	Date:	20 April 2011

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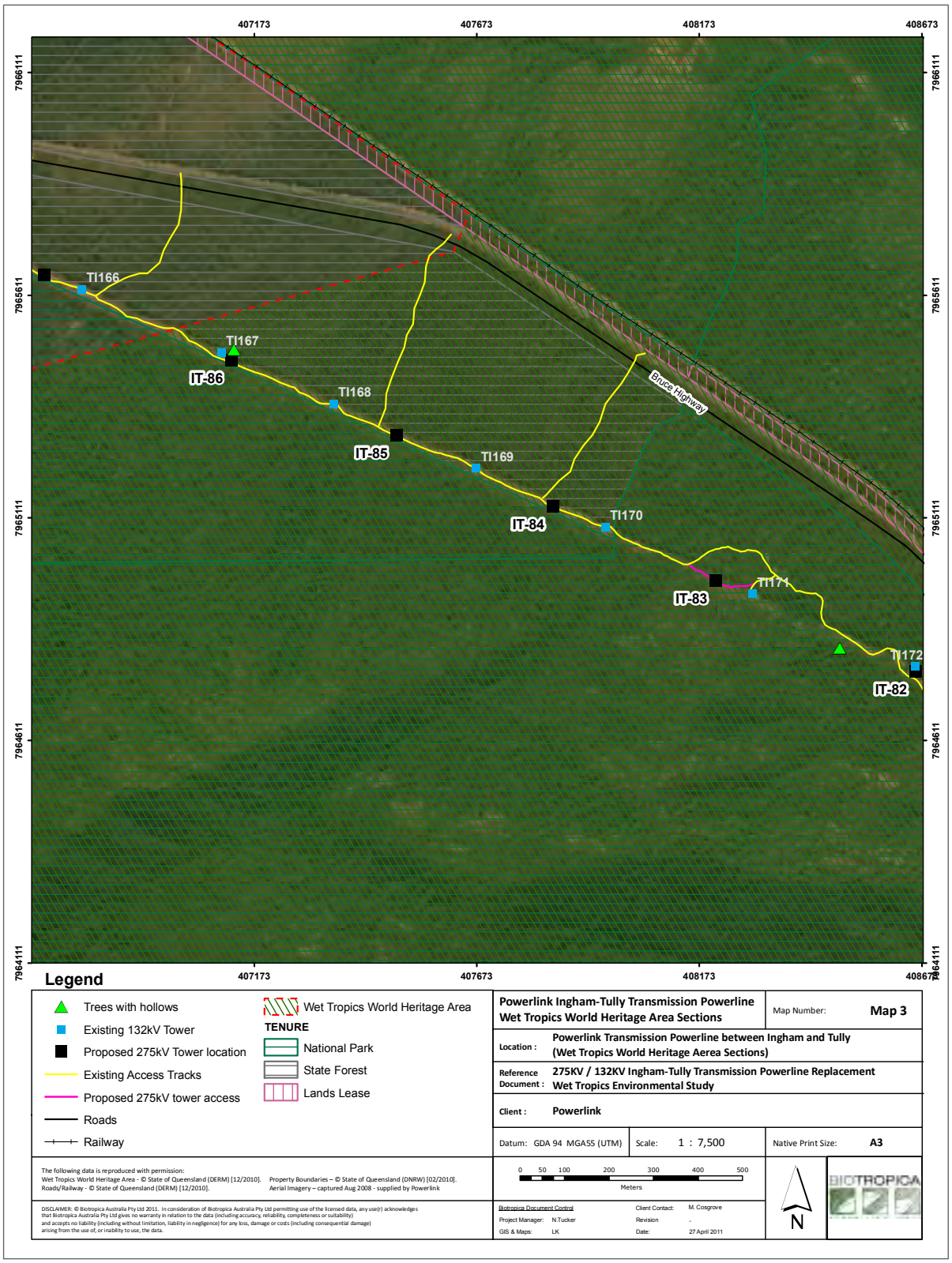
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Bruce Highway
Legend
Trees with hollows
Existing 132kV Tower
Proposed 275kV Tower location
Existing Access Tracks
Proposed 275kV tower access
Roads
Railway
Wet Tropics World Heritage Area
TENURE
National Park
State Forest
Lands Lease
Powerlink Ingham-Tully Transmission Powerline
Wet Tropics World Heritage Area Sections
Map Number: Map 3
Location : Powerlink Transmission Powerline between Ingham and Tully (Wet Tropics World Heritage Aerea Sections)
Reference Document : 275KV / 132KV Ingham-Tully Transmission Powerline Replacement Wet Tropics Environmental Study
Client : Powerlink
Datum: GDA 94 MGA55 (UTM)
Scale: 1 : 7,500
Native Print Size: A3
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Project Manager: N.Tucker
GIS & Maps: LK
Client Contact: M. Cosgrove
Revision -
Date: 27 April 2011
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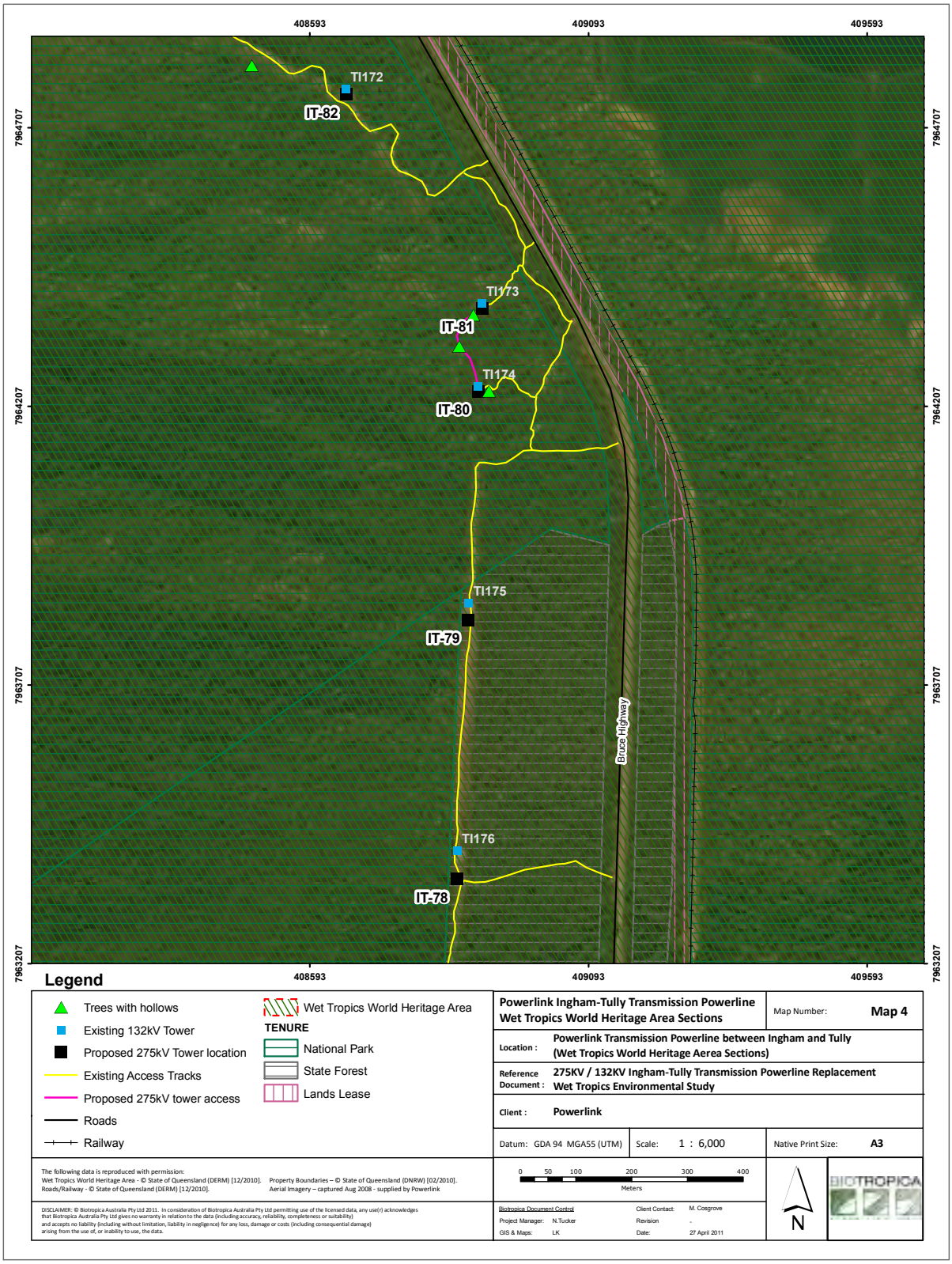
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Wet Tropics World Heritage Area
TENURE
National Park
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Lands Lease
Powerlink Ingham-Tully Transmission Powerline
Wet Tropics World Heritage Area Sections
Map Number: Map 4
Location : Powerlink Transmission Powerline between Ingham and Tully (Wet Tropics World Heritage Aerea Sections)
Reference Document : 275KV / 132KV Ingham-Tully Transmission Powerline Replacement Wet Tropics Environmental Study
Client : Powerlink
Datum: GDA 94 MGA55 (UTM)
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Project Manager: N.Tucker
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Date: 27 April 2011
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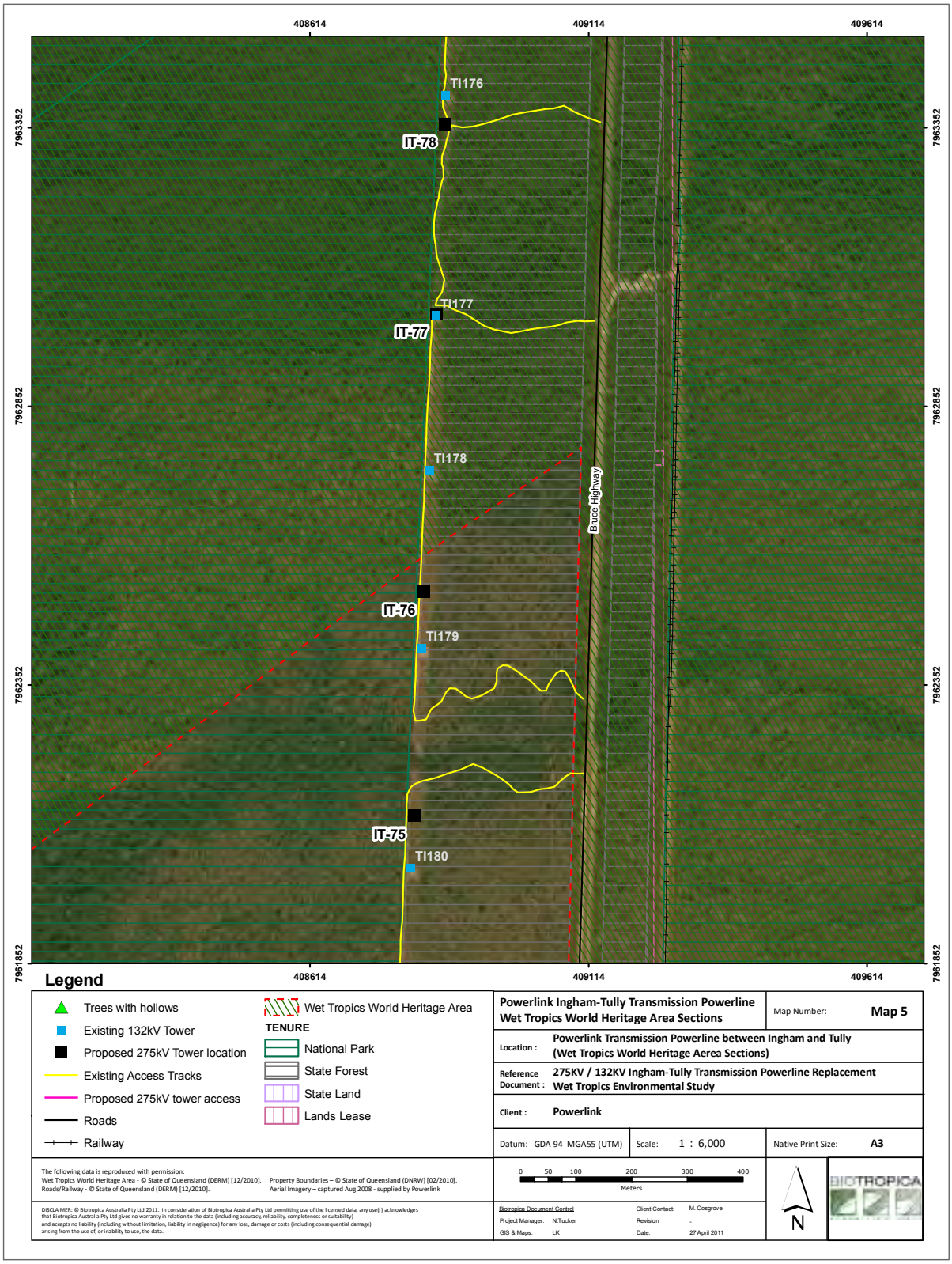
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Wet Tropics World Heritage Area
TENURE
National Park
State Forest
State Land
Lands Lease
Powerlink Ingham-Tully Transmission Powerline
Wet Tropics World Heritage Area Sections
Map Number: Map 5
Location : Powerlink Transmission Powerline between Ingham and Tully (Wet Tropics World Heritage Aerea Sections)
Reference Document : 275KV / 132KV Ingham-Tully Transmission Powerline Replacement Wet Tropics Environmental Study
Client : Powerlink
Datum: GDA 94 MGA55 (UTM)
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Project Manager: N.Tucker
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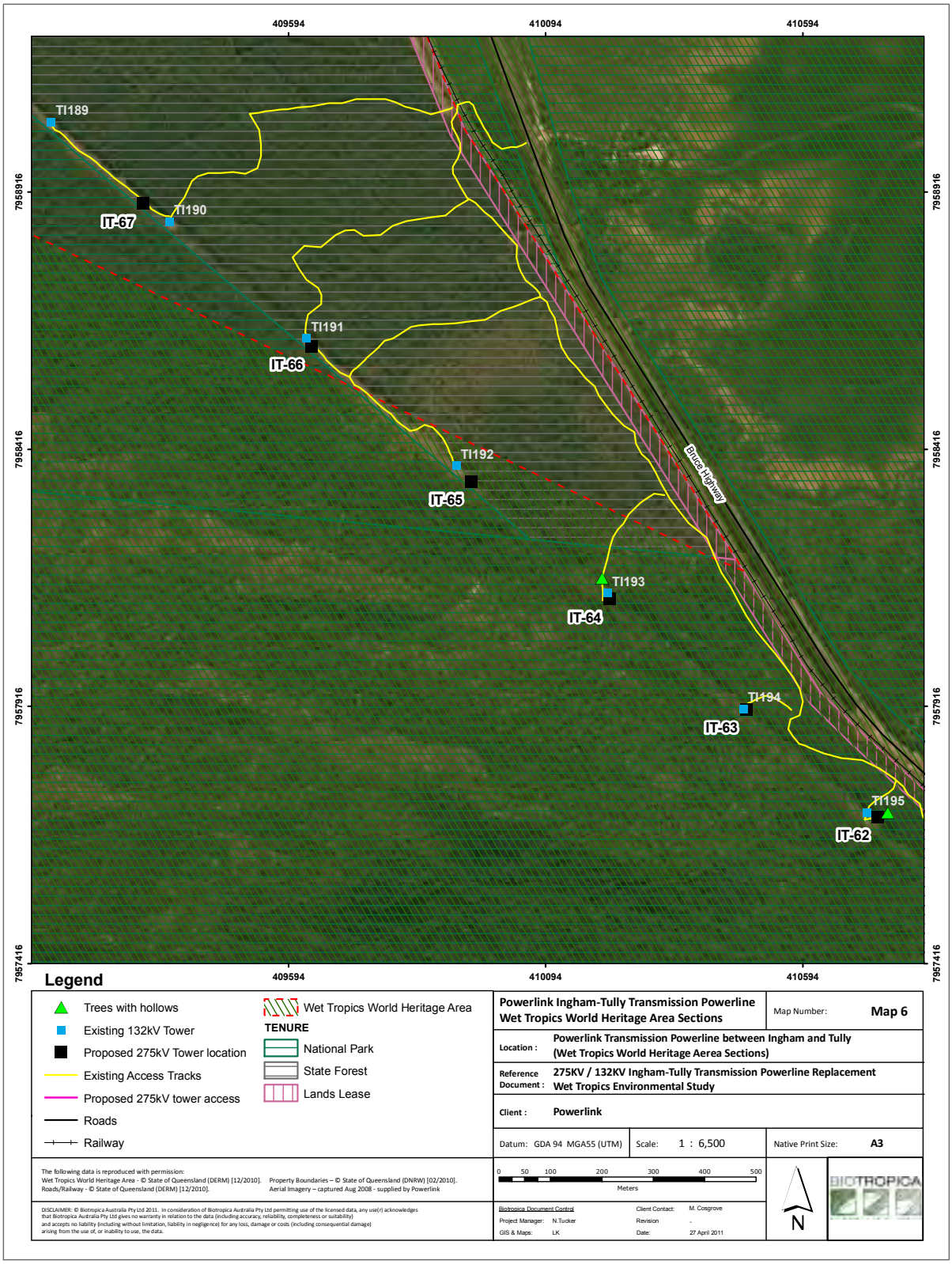
Revision -
Date: 27 April 2011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Wet Tropics World Heritage Area Sections
Map Number: Map 6
Location : Powerlink Transmission Powerline between Ingham and Tully (Wet Tropics World Heritage Aerea Sections)
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GIS & Maps: LK
Client Contact: M. Cosgrove
Revision: -
Date: 27 April 2011
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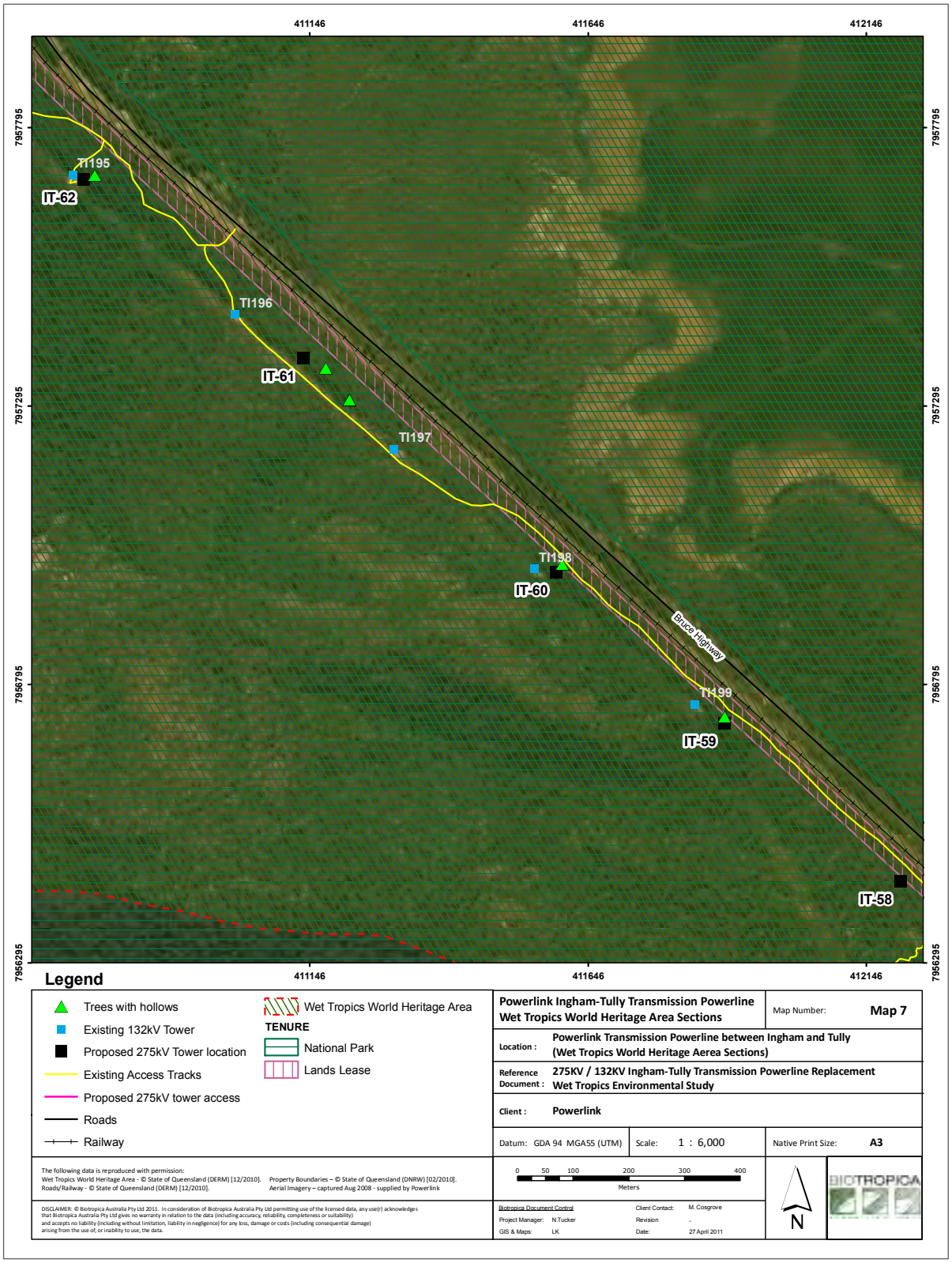
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TI195
IT-62
TI196
IT-61
TI197
TI198
IT-60
Bruce Highway
TI199
IT-59
IT-58
Legend
Trees with hollows
Existing 132kV Tower
Proposed 275kV Tower location
Existing Access Tracks
Proposed 275kV tower access
Roads
Railway
Wet Tropics World Heritage Area
TENURE
National Park
Lands Lease
Powerlink Ingham-Tully Transmission Powerline
Wet Tropics World Heritage Area Sections
Map Number: Map 7
Location : Powerlink Transmission Powerline between Ingham and Tully (Wet Tropics World Heritage Aerea Sections)
Reference Document : 275KV / 132KV Ingham-Tully Transmission Powerline Replacement Wet Tropics Environmental Study
Client : Powerlink
Datum: GDA 94 MGA55 (UTM)
Scale: 1 : 6,000
Native Print Size: A3
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Aerial Imagery – captured Aug 2008 - supplied by Powerlink
0 50 100 200 300 400
Meters
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GIS & Maps: LK
Client Contact: M. Cosgrove
Revision -
Date: 27 April 2011
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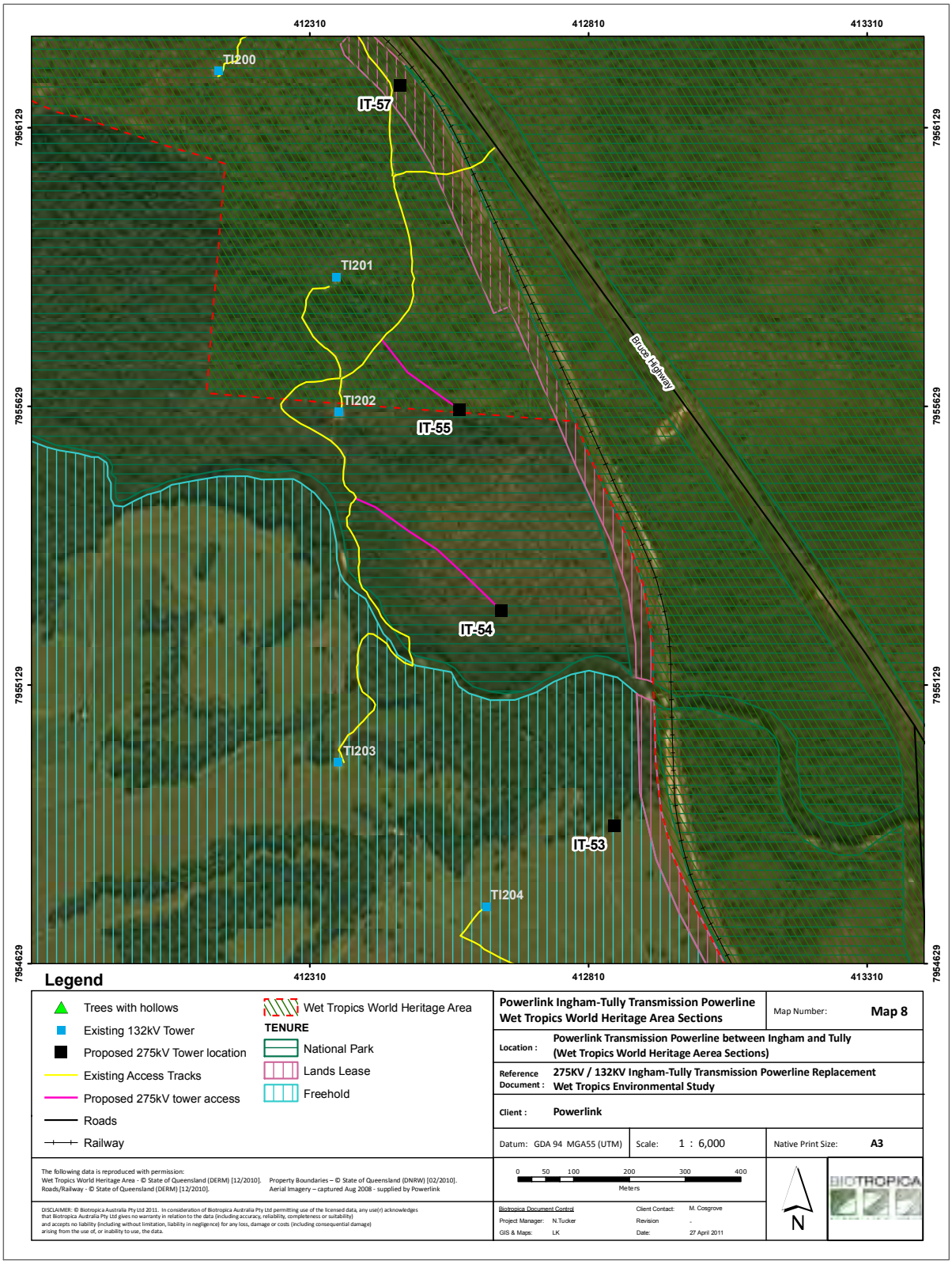
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TI200
IT-57
TI201
TI202
IT-55
IT-54
TI203
IT-53
TI204
Bruce Highway
Legend
Trees with hollows
Existing 132kV Tower
Proposed 275kV Tower location
Existing Access Tracks
Proposed 275kV tower access
Roads
Railway
Wet Tropics World Heritage Area
TENURE
National Park
Lands Lease
Freehold
Powerlink Ingham-Tully Transmission Powerline
Wet Tropics World Heritage Area Sections
Map Number: Map 8
Location : Powerlink Transmission Powerline between Ingham and Tully (Wet Tropics World Heritage Aerea Sections)
Reference Document : 275KV / 132KV Ingham-Tully Transmission Powerline Replacement Wet Tropics Environmental Study
Client : Powerlink
Datum: GDA 94 MGA55 (UTM)
Scale: 1 : 6,000
Native Print Size: A3
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0 50 100 200 300 400
Meters
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GIS & Maps: LK
Client Contact: M. Cosgrove
Revision: -
Date: 27 April 2011
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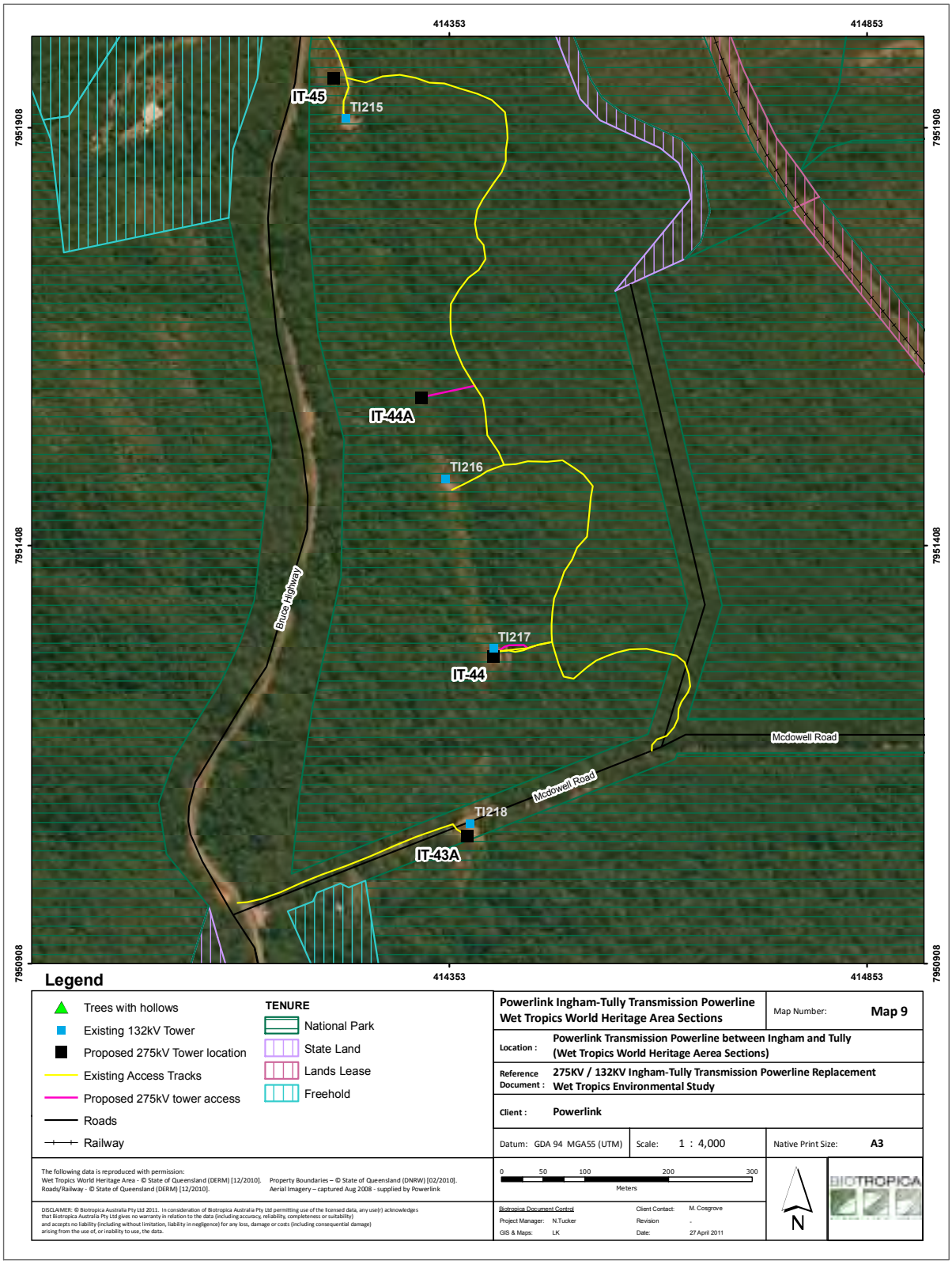
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IT-45
TI215
IT-44A
TI216
Bruce Highway
TI217
IT-44
Mcdowell Road
Mcdowell Road
TI218
IT-43A
Legend
Trees with hollows
Existing 132kV Tower
Proposed 275kV Tower location
Existing Access Tracks
Proposed 275kV tower access
Roads
Railway
TENURE
National Park
State Land
Lands Lease
Freehold
Powerlink Ingham-Tully Transmission Powerline
Wet Tropics World Heritage Area Sections
Map Number: Map 9
Location : Powerlink Transmission Powerline between Ingham and Tully (Wet Tropics World Heritage Aerea Sections)
Reference Document : 275KV / 132KV Ingham-Tully Transmission Powerline Replacement Wet Tropics Environmental Study
Client : Powerlink
Datum: GDA 94 MGA55 (UTM)
Scale: 1 : 4,000
Native Print Size: A3
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Aerial Imagery – captured Aug 2008 - supplied by Powerlink
0 50 100 200 300
Meters
N
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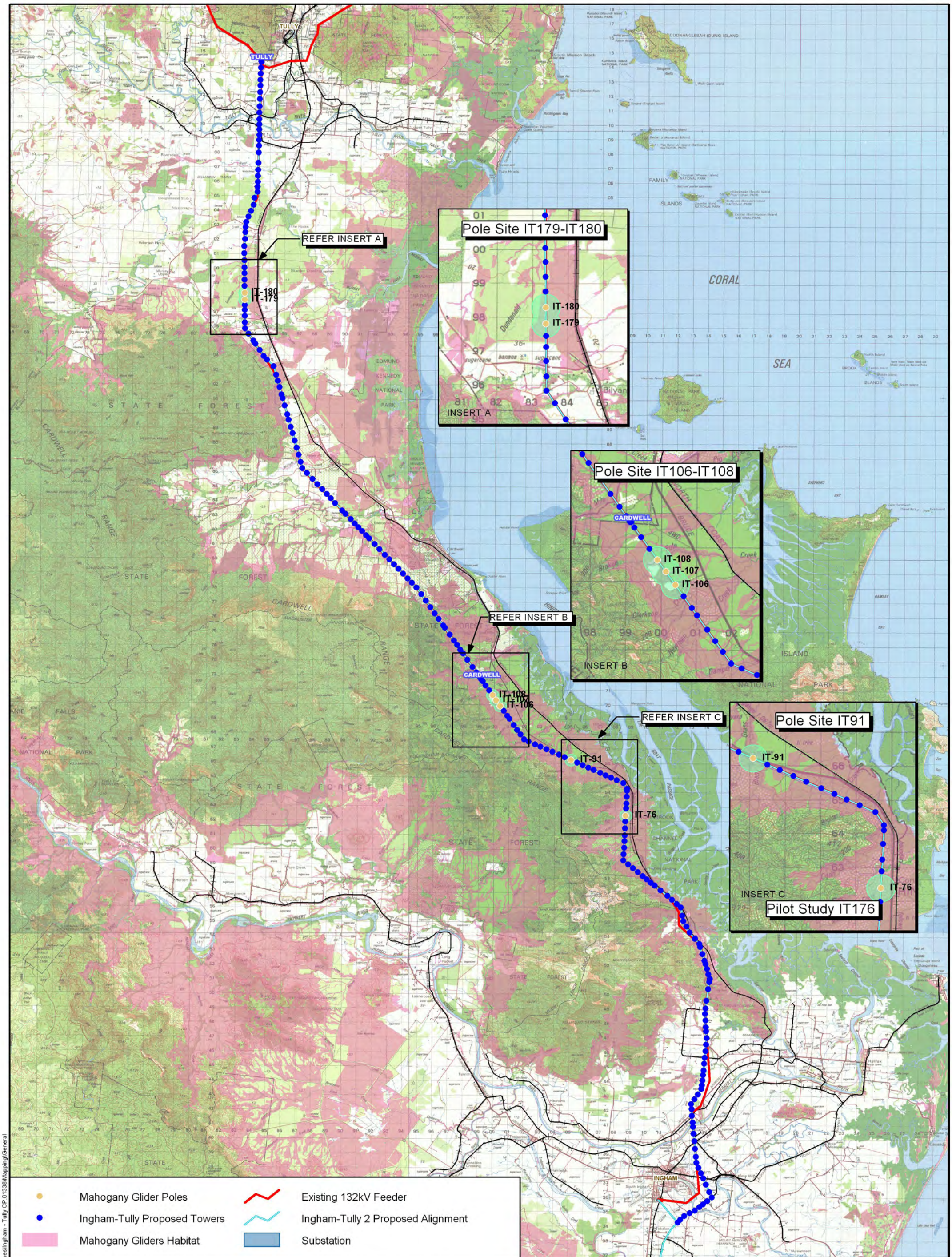
Project Manager: N.Tucker
GIS & Maps: LK
Client Contact: M. Cosgrove
Revision -
Date: 27 April 2011

Appendix 4 – Proposed Glider Pole Array Locations

Ingham - Tully Transmission Line Replacement - Mahogany Glider Pole Locations



Powerlink Queensland makes every effort that the information contained on this map is up to date and correct but accepts no responsibility for this information. The information is provided as a guide only. For up to date and specific information you should contact our Virginia office on (07) 3860 2111.

N

Coordinate System
Horizontal: MGA Zone 55, GDA 94

2nd July 2011

0.0 2.5 5.0 7.5 10.0 12.5
Kilometers

L:\LIS-GIS_Work\GIS\Lines\Ingham - Tully CP 01338\Mapping\General