A New South Wales Government Initiative

RTA

Newcastle inner city bypass

Sandgate to Shortland

REVIEW OF ENVIRONMENTAL FACTORS
APPENDICES VOLUME 1
JUNE 2006

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Appendix A

Photographs of Study Area

Figure 3 - View south from Maitland Road along proposal corridor.

Figure 4 - View north along corridor from low-lying area south of Deepbridge Creek.

Figure 1 - View north from fill embankment south of Main Northern Railway line.

Figure 2 - View northwest along Maitland Road (Pacific Highway) - proposed site of northern intersection.

Figure 5 - View south along existing fill embankment south of Main Northern Railway.

Figure 6 - View south from proposed location of H23 overpass (Shortland Road/Sandgate Road). Southern end of route where Proposal would tie into existing section of H23.

Appendix B

Concept Design

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Roads and Traffic Authority

State Highway 23 – Shortland to Sandgate Route Selection Study

Revised Concept Design

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1. Introduction

Connell Wagner was initially engaged by the Hunter Region of the Roads and Traffic Authority (RTA) in June 1998 to undertake a Route Selection Study for a connection between State Highway 23 (SH23) at Shortland and the Pacific Highway (SH10) at Sandgate. This culminated in the recommendation for the retention of the existing route corridor for SH23, forming a northern extension of the existing section of SH23 from Jesmond to Shortland.

As part of the Route Selection Study, preliminary road design concepts were developed within the route corridor. These concepts included a proposal for a full interchange with SH10 at the northern end of SH23 at Sandgate. The concept designs had been prepared in sufficient detail to establish engineering feasibility and to provide preliminary construction quantities for cost estimates.

Subsequent to the completion of the Route Selection Study and a Public Display of the Preferred Option, the RTA engaged Connell Wagner to review the interchange design and to undertake additional investigations to consider the possibility future strategic connections to / from SH23 in this vicinity. The proposed interchange was successfully modified to include these potential future connections as compatible additions that may or may not eventuate. As such these potential future connections are not further referenced in this report.

More recently the RTA further engaged Connell Wagner to undertake additional investigations and concept design based on a staged construction of the modified interchange, a revised vertical alignment to reflect new clearance constraints and the potential replacement of the full interchange proposal with a signalised intersection between SH23 and SH10.

This report provides an account of the rationale behind the concept design modifications, outlines the changes in the scope of the project in relation to the various design elements and provides revised cost estimates for the two principal options as most recently developed.

2. Description of Site

The existing section of SH23 from Jesmond to Shortland terminates at its northern end at Sandgate Road, near the entry to the Shortland Wetlands Centre. From that point traffic accesses SH10 at Sandgate via Sandgate Road and Wallsend Road. Photograph 1 provides an aerial view of the site, showing the circuitous nature of the existing connection south of Sandgate Cemetery and the proposed corridor to the west of the cemetery.

North of Sandgate Road, the SH23 corridor proceeds across low lying undeveloped land and a drainage/creek line known as Deepbridge Creek. This creek links the Shortland Wetlands and the Ironbark Creek catchment, which is a key part of the Hunter River floodplain in this area.

After Deepbridge Creek the route corridor crosses an access road to the former Newcastle Council landfill site, now used as a golf driving range. Immediately north of this access road, a 250m long section of embankment has already been constructed (using excess material from the Shortland to Sandgate section) for the southern approach to the Main Northern Railway Line.

After crossing the Main Northern Railway the route corridor runs along more low lying land between the cemetery on the eastern side and an industrial area and an isolated wetland on the western side. The SH23 corridor joins SH10 between the cemetery and Old Maitland Road, which provides access to a large trucking terminal in the industrial area and the St Josephs Aged Care facility. At this location SH10 is located on the high ground forming the southern bank of the south channel of the Hunter River and features a very wide grassed median from historical planning for an interchange at this location.

Photograph 1. Site of SH23 – Shortland to Sandgate

3. Concept Design Modifications

The ongoing development of the Shortland to Sandgate section of SH23 has necessitated a number of concept design modifications as a result of changing project circumstances and consultations with various community groups.

The original concept design has been revised in a number of areas and the proposed interchange for the SH23 / SH10 junction has been modified and given detailed consideration for a staged approach to its implementation. Finally, an earlier concept of providing an intersection only at the main highway connection at the northern end of the project has been reinvestigated in relation to providing a lower cost option for funding deliberations.

3.1 Original Concept Design

The original concept design for the SH23 and its associated interchange with SH10 involved south facing ramps to a new road crossing of SH23 approximately 150m south of SH10. This road would connect the existing highway with a southerly deviation of Old Maitland Road and provide for four way access between SH23 and the existing SH10 and full access to both highways from the Old Maitland Road area.

In this original arrangement the northbound carriageway of SH23 would merge on the outside (or western side) of the existing highway lanes in front of St Josephs and would necessitate relocation of the existing Old Maitland Road intersection and closure of the secondary access to the aged care facility. A feature of the original interchange proposal was that there was a long skewed structure to be built to carry the existing SH10 northbound carriageway over the southbound lanes of SH23.

The horizontal and vertical alignments for the majority of the route were generally in accordance with a preliminary design prepared by the RTA in the early 1990's. This preliminary design was used as the basis for embankment construction on a 250m section of the route immediately south of the Main Northern Railway. This existing embankment is clearly evident on the aerial photograph of the site. The concept design in the Route Selection Report adopted the bridge structures and sizes developed by the RTA for the Sandgate Road overpass, Deepbridge Creek and the Main Northern Railway.

3.2 Revised Concept Design and Modified Interchange

Following a public display of the original concept design and after representations from community groups, the RTA engaged Connell Wagner to review the concept design and to undertake additional investigations into the possibility of modifying the SH23 / SH10 interchange to simplify its layout.

One of the main areas of concern from a community perspective was the location of the southbound unloading ramp to Sandgate Road at the southern end of the project. This was previously proposed though RTA owned land close to the SH23 corridor but the concept design was modified to position the intersection with Sandgate Road well clear of the majority of existing residences in this vicinity.

Other concept design revisions have involved vertical alignment changes to the main carriageways either side of the Main Northern Railway as follows:

- Raising the vertical alignment by up to 1.5m south of the railway (over the existing embankment construction) due to the need for increased clearance requirements associated with future freight of double stacked containers by the Australian Rail Track Corporation (ARTC).
- The increased vertical clearance would also impact on the bridge structure previously nominated by the RTA. This was for a 52.5m clear span bridge using a steel box girder section. In order to avoid major increases to approach embankment heights it is appropriate to revert to

a more slender structure (maximum span of 35m) using PSC Super T girders. This in turn would require a central pier for the bridge with appropriate railway impact protection.

- Lowering the vertical alignment by approximately 1m north of the railway to reduce the amount of imported fill material and to generally match existing levels on SH10 at Ironbark Creek, approximately 1.5km to the north, the notional flood control for the road network in the Sandgate / Hexham area.

On commencing the investigations for a modified interchange it was apparent that a full access facility was not absolutely necessary and that the carriageway alignments offered limited flexibility in providing for a possible future fourth leg to the interchange. To provide this the south facing ramps would be eliminated and the cross connection between the existing highway and Old Maitland Road would be relocated back to the existing wide median. This in turn meant that it was more appropriate to merge the northbound carriageway of SH23 on the inside of the existing highway to limit the scope of bridge and retaining wall structures now required.

The new interchange would continue to provide access to Old Maitland Road via a partially relocated northbound carriageway of SH10 but there would be no direct access off SH23 – this access would be available via Sandgate Road and SH10 as currently provided.

The key changes resulting from the development of the modifications to the proposed interchange were as follows:

- Removal of south facing ramps as previously proposed for the interchange.
- Elimination of a dedicated bridge and access road to connect the existing SH10 with Old Maitland Road.
- Removal of the previously necessary southern extension of Old Maitland Road to meet this highway connection.
- Construction of a new northbound carriageway for SH10, clear of the existing for traffic management during construction.
- Inclusion of a shorter, more perpendicular bridge structure for the northbound carriageway of SH10 over both carriageways of SH23
- Inclusion of longitudinal retaining walls either side of SH23 to facilitate bridge crossings for SH10 northbound and the cross connection between SH10 southbound and Old Maitland Road.

A schematic plan layout on aerial photo base and a longitudinal section for the revised concept design and modified interchange are provided in Appendix A. The plan layout features the revised ramp arrangement and intersection for southbound unloading at Sandgate Road and the modified interchange for SH23/SH10. The longitudinal section shows the relativities between the original and revised vertical alignment profile, including where SH23 embankments are already in position from construction in the early 1990's.

There are a number of options for the Old Maitland Road access. Under each of these options the fundamental operation of the interchange between SH23 and SH10 does not alter but the intersection connections and extent of bridging does differ. The three potential options are shown in Appendix B. The interchange layout in Appendix A incorporates Option 3 for the Old Maitland Road access. This is the free flow option that involves the least bridging and earthworks off the SH10 carriageway. Detailed consideration should be given to these options during the final development of the project, in conjunction with consultations with land and property owners.

In addition to the interchange modifications and the alternative options for access to Old Maitland Road, there are a number of alternatives for the merging treatment of the two highways. Each

northbound carriageway would have two lanes but these four lanes need to merge into three lanes and then into two immediately north of the project. A definitive treatment has not been nominated pending further traffic analysis at the detailed design phase of the project.

At this point it has been assumed that a merge to one lane on SH23 followed by a short length of three lanes is one alternative, the other being a mutual merge from both highways into the central lane of three lanes on SH10 north of St Josephs. Under both scenarios it is necessary to revert back to two lanes before the bridge over Ironbark Creek.

3.3 Development of Intersection Treatment

The potential for an intersection only treatment at the junction of SH23 and SH10 was canvassed as an option in the Route Selection Report. It was identified as a lower cost option that would deliver the travel time savings and network efficiencies that the new route between Shortland and Sandgate would provide, but with some intersection inefficiencies and potential delays, particularly for southbound right turning movements from SH10 to SH23 at Sandgate.

Significant delays are currently experienced at the existing SH10 / Wallsend Road intersection, where heavy southbound right turning movements toward Shortland impinge on major east / west traffic flows on SH10. The intersection efficiency at this location is further impaired by eastbound right turning movements out of Wallsend Road.

Separation of the majority of these turning movements into two signalised intersections approximately 1km apart would allow them to be coordinated and improve overall traffic flows on SH10, although not to the full extent of a grade separated interchange. Nonetheless, an intersection only treatment would provide an opportunity to provide the key Shortland to Sandgate link of SH23 in its most rudimentary form. It would require dual turning lanes for movements to / from SH23 and would ideally eliminate right turns from SH23 to the east on SH10, so that SH10 southbound would be free flow.

A schematic plan layout on aerial photo base and a longitudinal section for the revised concept design with an intersection only treatment at the junction of SH23 and SH10 are provided in Appendix C. The plan layout features the revised concept design as in Appendix A but with a notably shortened overall project length. The longitudinal section again shows the relativities between the original and revised vertical alignment profile, including existing embankments, but also highlights the additional fill requirements and the steeper than desirable approach (4%) to meet the existing highway at grade.

The issues surrounding the relative merits of providing an intersection instead of an interchange are further outlined in relation to staged construction options.

3.4 Staged Construction Options

The majority of construction on the Shortland to Sandgate section of SH23 would be free from interference with existing traffic. The location of the overpass at Sandgate Road at the southern end of the project has already been bypassed with a sidetrack and the remainder of the route is in a green field site with good access both north and south of the railway. The exception to this would be where the proposed connection to SH10 is to be constructed and this would be adjacent heavy traffic flows on the existing highway.

The construction of an intersection only treatment for the longer term operation of SH23 would be relatively simple, with the new leg of intersection off the existing road and the right turn lanes for southbound access to SH23 adjacent the existing southbound carriageway. This could be achieved with minimal impact on existing traffic. Intersection capacity and delay issues aside, the intersection only treatment would allow the Shortland to Sandgate section of SH23 to be operational in the shortest possible timeframe.

A key decision in the development of a staging strategy for the interchange was whether or not to provide an intersection in the short to medium term and what impact that intersection would have on the ultimate construction approach.

If the interchange was constructed immediately, the staging would entail a side track for northbound traffic so that the majority of the work could be built free of existing traffic flows, with some substantial benefit to earthworks operations from a cut to fill operation through the existing northbound carriageway. The staging arrangements for this construction scenario are provided in Appendix D.

Complications would arise if a temporary intersection were to be constructed as part of the interchange. It is apparent that if the intersection is provided as an initial part of the interchange it would substantially alter the staging strategy and would be very costly because of the additional earthworks and pavement associated with the temporary ramp required to meet the existing highway at grade.

A series of staging drawings for the interchange, inclusive of a temporary intersection, are provided in Appendix E. These diagrams show the complexity of building a temporary facility in conjunction with the interchange. In this regard it would be preferable to leave existing traffic flows on Sandgate Road and Wallsend Road during the initial construction.

The relative simplicity of the intersection only and the full interchange alternative lead to the conclusion that the initial construction should be one intersection type or the other. It also follows that any future conversion from an intersection to an interchange would be difficult.

4. Cost Estimates

The cost estimates for each of the potential routes comprise linked Excel spreadsheets that have been prepared in accordance with RTA *Project Management Guidelines – Scope and Cost Control for Development Projects* (February 2000). This document specifies the procedure and format that the RTA requires to be used for the preparation and presentation of project cost estimates.

The RTA Estimating Guidelines require that a risk-based approach be adopted in the preparation of project cost estimates. The base cost of any project element is increased by an appropriate contingency cost to allow for risk factors including variations to the quantities / rates used to calculate the base cost.

For the strategic or preliminary concept stage of a project's development, RTA's contingency allowance as a proportion of the total project base cost should be in the range from 35% to 50% as specified in RTA *Project Management Notes PMN-004* (March 2000). However, the contingency allowance for individual project elements may vary, depending on the level of information available and the assessed risks. Given that the concept design for the section of SH23 between Shortland and Sandgate is relatively well defined it is believed that lower contingencies (25% – 30%) are sustainable at this point.

4.1 Scope Definition

To provide a direct comparison of the original concept design and the revised concept design, with the modified interchange and intersection only treatment, the key scope elements of pavement area, bridge and retaining structures and earthworks are summarised as follows.

4.1.1 Project Length and Pavement Area

The length of works for each option is shown in Table 4.1. The table also lists the pavement areas for each option.

It has been assumed that the SH23 carriageways of SH23 would consist of dual carriageway concrete pavements separated by a narrow median. All other pavements (ramps, deviation of existing highway, local roads) have been assumed to have a flexible pavement. There are also areas where the existing highway will require AC overlay for either shape correction or tie-ins to the new SH23 pavement.

A comparison of the total pavement areas associated with the original and revised concept designs is also provided in Table 4.1. The original and modified interchanges have similar areas but the intersection only proposal reduces total pavement area from 70,000 m^2 to 52,000 m^2.

Table 4.1 Project Length and Pavement Areas

Option	Length (km)	Pavement Area (m^2)	
		SH23 Concrete Pavement	Other Flexible or Overlay
Original Concept Design	2.6	46,600	20,000
Revised Concept with Modified Interchange	2.6	45,100	25,500
Revised Concept with Intersection	2.2	36,500	15,000

4.1.2 Bridges and Retaining Walls

A significant proportion of the length of the Shortland to Sandgate section of SH23 is to be bridged and structures represent a large percentage of the overall construction estimate for the work. Bridges proposed for the project are as follows:

- Sandgate Road overpass
- Bridge over Deepbridge Creek and Access Road
- Bridge over Main Northern Railway
- SH10 Northbound carriageway overpass
- SH10 Southbound carriageway – Old Maitland Road connection

The location and indicative size of these structures has not varied for the first three bridges. The modified interchange bridge structures have lesser areas but they now incorporate longitudinal retaining walls to reduce the extent of earthworks in this area. In addition, lifting of the vertical alignment south of the railway line would require some edge of pavement walls to avoid widening the existing embankment.

A summary of the respective bridge deck and retaining wall areas for the various structures is provided in Table 4.2 overleaf.

Table 4.2 Bridge and Structure Details

Bridge / Retaining Wall Locations	Original Concept Design	Revised Concept Modified Interchange	Revised Concept with Intersection	Structure Dimensions (m)
Sandgate Road over SH23	1,120	1,120	1,120	60m x 16m
Deepbridge Ck and Access Road	5,520	5,520	5,520	2 x 240m x 11.5m
Main Northern Railway	1,210	1,210	1,210	2 x 52.5m x 11.5m
SH10 (N/B) over SH23 (S/B)	970		-	
SH10 over SH23 (S/B & N/B)		520	-	32m x 16m
Access Road over SH23	700		-	
SH10 over SH23 (S/B)		288	-	24m x 12m
Bridge Deck Areas	**9,520 m²**	**8,658 m²**	**7,850 m²**	
Precast Wall on railway approach		600	600	2 x 200m x 1.5m
Piled wall through interchange area		2,000		2 x 250m x 4m
Retaining Wall Areas		**2,600 m²**	**600 m²**	

4.1.3 Earthworks

The earthworks volumes for the various concept designs are provided in Table 4.3. These quantities have been calculated by adjusting the raw earthworks volumes computed from road design models of the route options to allow for unsuitable cut materials and unsuitable below embankment foundations, allowances for bridging layers over poor subgrades, select fill materials and pavement volumes.

It should be noted that all scenarios for SH23 have a shortfall of material available from cut to fill earthworks operations. This shortfall would be compounded by the expectation of poor embankment foundations and the need to remove unsuitable material in low lying areas. As such there would be a requirement to import substantial amounts of fill material from off-site, with the minimum amount expected in the order of 200,000m^3.

Table 4.3 Earthworks Volumes

Option	Cut to Fill (m^3)	Unsuitable Material (m^3)	Imported Fill incl. SMZ (m^3)
Original Concept Design	36,100	47,800	204,000
Revised Concept with Modified Interchange	73,000	49,000	192,000
Revised Concept with Intersection	25,000	46,000	247,000

The figures in Table 4.3 show that construction of a signalised intersection at the junction of SH23 and SH10, as opposed to a full interchange, would further reduce the quantity of cut material available for embankment construction and the volume of imported material would increase to approximately 250,000m^3.

4.2 Cost Estimates

The cost estimates prepared for each option are provided as detailed spreadsheets in Appendix F of this report. The cost estimates comprises a combination of available construction quantities and lump sum items where appropriate to define the scope of work, including all project development, investigation and design, land acquisition, infrastructure construction and anticipated environmental requirements for each option.

The cost estimate for the original concept design was prepared in 2001 and subsequently approved by the RTA Project Management Office (PMO) at Blacktown, in an amount of $51M. This estimate is included in Appendix F and an updated version is also provided, with rates and contingency adjustments to reflect more recent project costs, to allow direct comparison with the more recent estimates for the revised concept design.

A summary of the cost estimates for the original and revised concept design is provided in Table 4.4. This includes the modified interchange and the intersection only alternatives for the revised concept.

Table 4.4 Cost Estimates and Contingency Allocations

Concept Design	Base Cost	Contingency Allocation		Total Cost
	$M	%	$M	$M
Original Concept Design (PMO Approved 2001)	$40.8	25%	$10.0	$50.8
Original Concept Design (2003)	$44.1	28%	$12.2	$56.3
Revised Concept with Modified Interchange (2004)	$45.8	28%	$12.7	$58.5
Revised Concept with Intersection (2004)	$37.6	28%	$10.4	$48.0

The estimate summaries show that the expected cost of the revised concept design with the modified interchange is comparable ($2M difference) with the updated estimate for the original concept design. This is not unexpected because the scope of the major work elements is similar.

With respect to providing the revised concept design with a signalised intersection for the SH23 / SH10 junction there are savings in bridge and structure costs and reduced pavement areas but these are partially off-set by the increased earthworks costs associated with the need to import more embankment material. The potential savings of providing the intersection only treatment is estimated at $10.5M.

The marginal cost of converting the project from an intersection junction to a full grade separation would be well in excess of the difference between the two concept estimates. The initial difference of $10.5M between the stand alone estimates would be amplified by a number of construction practicalities and difficulties as follows:

- additional design and investigation costs associated with two treatments for SH10/SH23 junction
- additional contractor site establishment and start up costs
- substantial increases in control of traffic adjacent an operational, high volume intersection
- additional work significantly more piecemeal – more difficult staging arrangements
- inefficient earthworks to create the grade separation through existing Pacific Highway – material to be spoiled off site
- removal of intersection works and traffic signals after conversion
- need to remove and spoil earthworks material from ramp required for at grade intersection

It is estimated that these difficulties and inefficiencies would result in a marginal or add on cost in the order of $15 - $18M, making any future conversion a project of significance in its own right. As outlined in Section 3.4 and as shown in the relative staging diagrams in Appendices D and E, the most efficient delivery of the interchange, particularly from control of traffic, road safety and earthworks perspectives is to construct it as part of the initial project.

Consideration of early works packages for bridges and imported fill would assist with better definition of cost estimates and more control of construction cash flow requirements.

5. Summary

The concept design for the proposed section of SH23 from Shortland to Sandgate has been modified in response to community input and other project development constraints and opportunities. It has been demonstrated that modifications to the proposed interchange layout provide more flexibility for staging of the project and better long term options for possible additional connections to SH23.

The need or otherwise for a full interchange or an at grade (signalised) intersection is to be determined by further traffic analysis in the detailed design phase of the project. The detailed design phase should also determine the most appropriate option for access to Old Maitland Road and seek to optimise the merging of the two highways at the northern extremity of the project.

The estimates for construction of the project have been updated for the changed scope of the revised concept design. The cost estimate associated with the full interchange option for the SH23 / SH10 junction is $58.5M, whereas the estimate for the intersection only treatment is $48M. These estimates are inclusive of contingencies in a range of $10M - $13M.

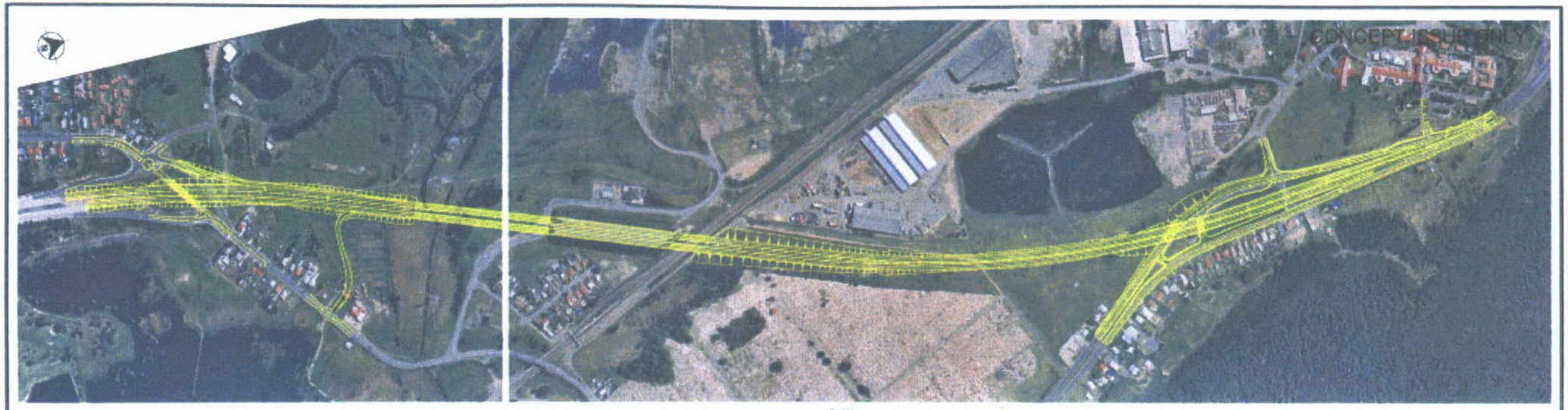
Structures are a major component of the work (~40%) and the estimates are very sensitive to these cost elements. The other key aspect of the work is earthworks where there would be an imported fill requirement of approximately 200,000m^3. This would be increased by a further 50,000m^3 if the intersection only treatment is adopted because of the additional fill required and the loss of the only substantive on-site source of material.

As such more detailed cost estimating of these elements (structures and earthworks) may allow a reduction in contingencies and a clearer understanding of the marginal costs of the full interchange option. Consideration of early works packages for bridges and imported fill would assist with better definition of cost estimates and a more informed decision on the interchange deliberations.

In relation to an overall construction strategy, it is apparent that construction of the interchange can be simplified if the SH23 traffic flows remain on Sandgate Road / Wallsend Road route until the project is complete. However, adoption of an interim intersection would complicate initial construction efforts and provide difficulties with any future conversion to a full interchange.

Appendix A

Revised Concept Design and Modified Interchange



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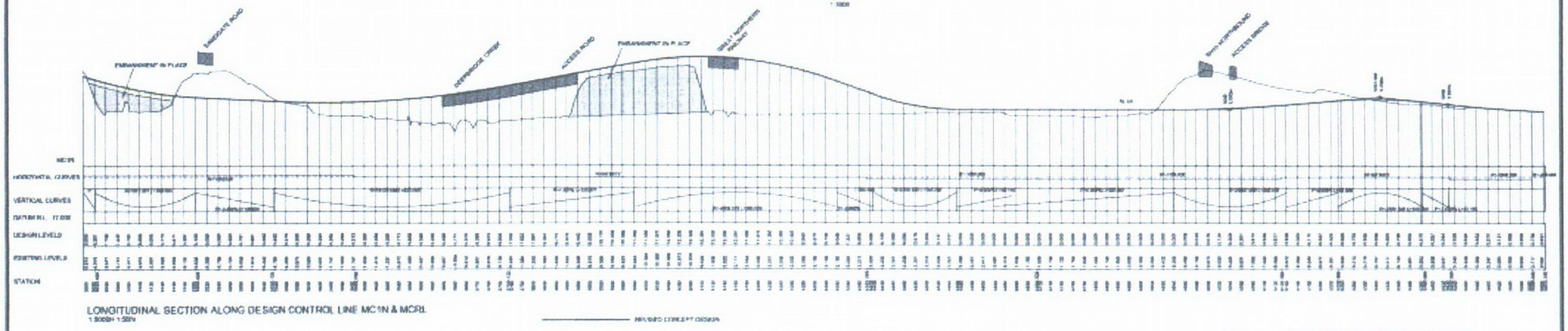

LONGITUDINAL SECTION ALONG DESIGN CONTROL LINE MC1N & MCRL

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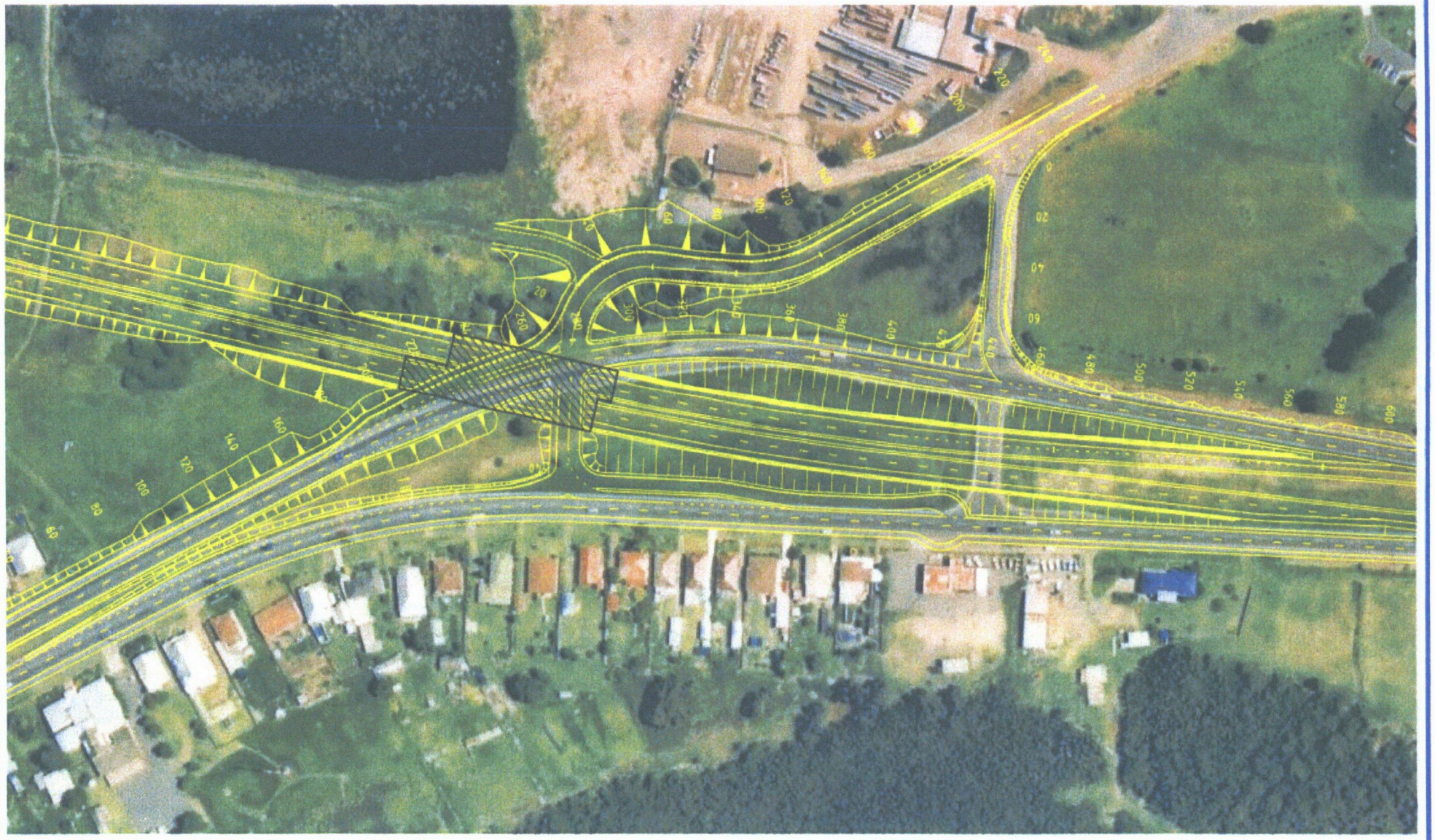
JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
REVISED INTERCHANGE

Appendix B

Options for Access to Old Maitland Road



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OLD MAITLAND ROAD
ACCESS OPTION 1
SCALE 1:2000

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23

REVISION 9
Job No. N501 11.CH
Date 15.12.2004
Dwg No. OLD_MAIT

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OLD MAITLAND ROAD
ACCESS OPTION 3
SCALE 1:2000

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JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23

REVISION 9
Job No N901 11 CH
Date 15.12.2004
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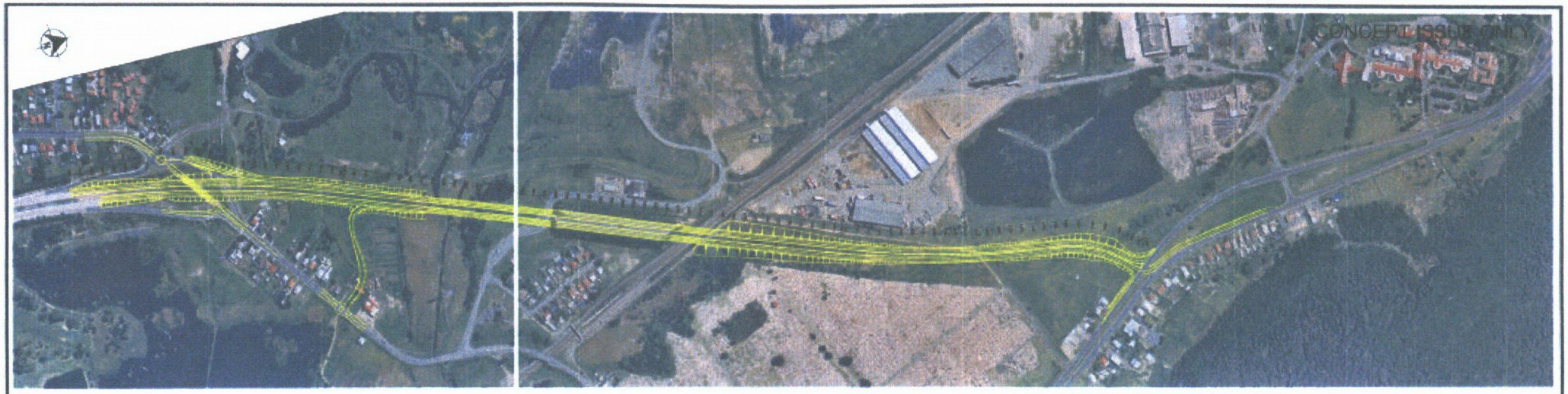
Appendix C

Revised Concept Design – Intersection Only



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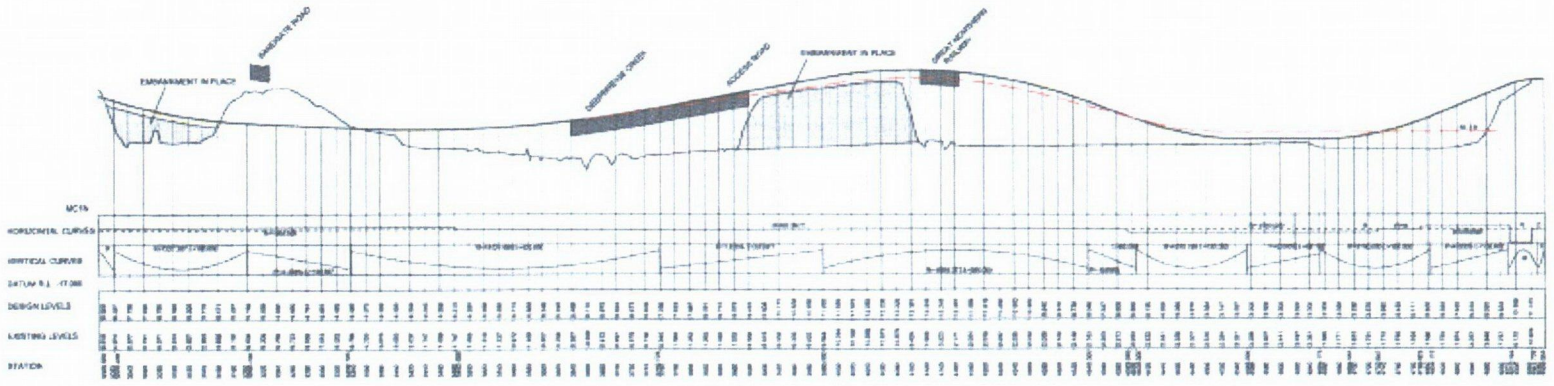

LONGITUDINAL SECTION ALONG DESIGN CONTROL LINE MCIN & MCIR
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ORIGINAL CONCEPT DESIGN
REVISED CONCEPT DESIGN

Connell Wagner

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
REVISED CONCEPT DESIGN - AT GRADE
INTERSECTION

REVISION 10
DATE 15.12.2004

Appendix D

Staged Construction of Interchange – without intersection

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LEGEND

- EXISTING
- CONSTRUCTION COMPLETE
- TEMPORARY WORK TO BE REMOVED
- WORKS UNDER CONSTRUCTION
- TRAVEL LANES

STAGE 1

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERCHANGE CONSTRUCTION
SEQUENCING WITHOUT INTERSECTION

REVISION 8
N501 11 CH
18 08 2004
STAGE 1

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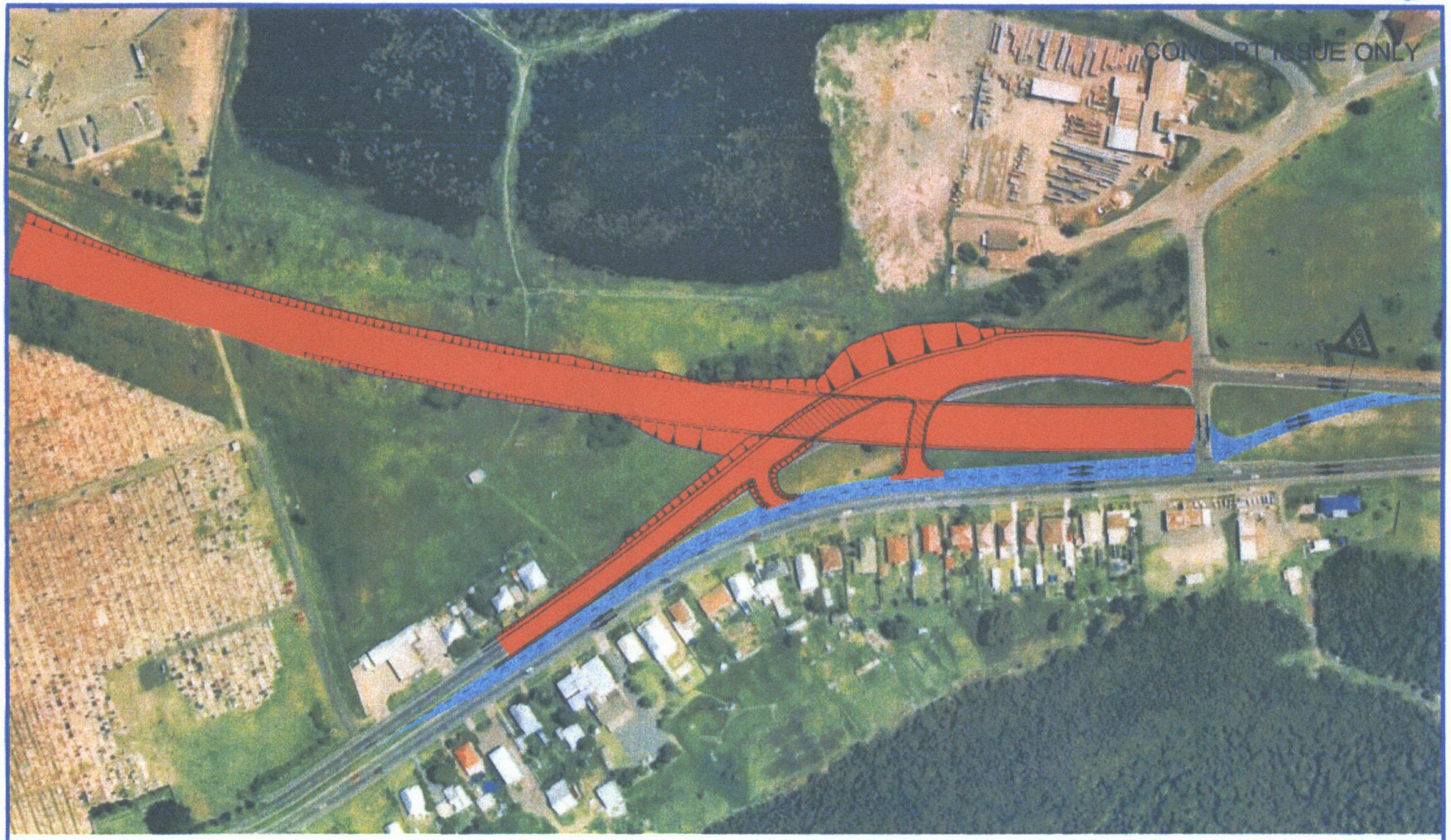

LEGEND

- EXISTING
- CONSTRUCTION COMPLETE
- TEMPORARY WORK TO BE REMOVED
- WORKS UNDER CONSTRUCTION
- TRAVEL LANES

STAGE 2

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RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERCHANGE CONSTRUCTION
SEQUENCING WITHOUT INTERSECTION

REVISION B
JOB No N501 11 CH
DATE 18 08 2004
DWG No STAGE 2

Connell Wagner

LEGEND

- EXISTING
- CONSTRUCTION COMPLETE
- TEMPORARY WORK TO BE REMOVED
- WORKS UNDER CONSTRUCTION
- TRAVEL LANES

STAGE 3

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERCHANGE CONSTRUCTION
SEQUENCING WITHOUT INTERSECTION

REVISION 8
JOB No. N501 11 CH
DATE 18 08 2004
DWG No. STAGE 3

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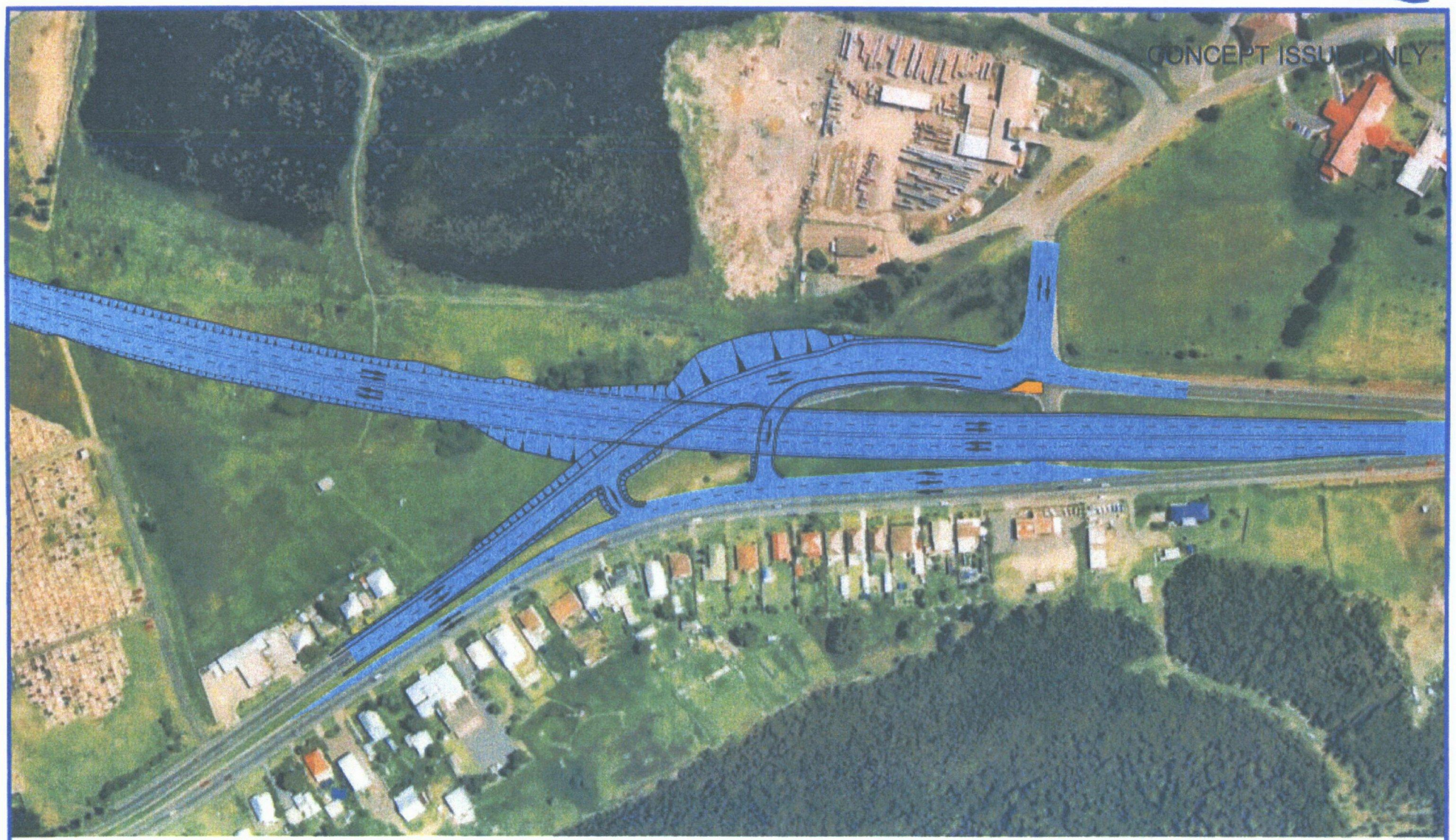

LEGEND

- EXISTING
- CONSTRUCTION COMPLETE
- TEMPORARY WORK TO BE REMOVED
- WORKS UNDER CONSTRUCTION
- TRAVEL LANES

Connell Wagner

STAGE 4

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERCHANGE CONSTRUCTION
SEQUENCING WITHOUT INTERSECTION

REVISION B
Job No. N501 11 CH
DATE 18.08.2004
DWG No. STAGE 4

Appendix E

Staged Construction of Interchange – with intersection

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LEGEND

- CONSTRUCTION COMPLETE & OPERATIONAL
- PAVEMENT COMPLETE
- EARTHWORKS COMPLETE
- WORKS UNDER CONSTRUCTION
- LEVEL CORRECTIONS UNDER TRAFFIC
- TEMPORARY WORK TO BE REMOVED
- INTERSECTION RAMP TO BE RESHAPED

STAGE 1

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERSECTION CONSTRUCTION
AND FUTURE CONVERSION
TO INTERCHANGE

REVISION 10
JOB No. N501 11 CH
DATE 22.03.2005
DWG No. STAGE 1

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CONCEPT ISSUE ONLY

LEGEND

- CONSTRUCTION COMPLETE & OPERATIONAL
- PAVEMENT COMPLETE
- EARTHWORKS COMPLETE
- WORKS UNDER CONSTRUCTION
- LEVEL CORRECTIONS UNDER TRAFFIC
- TEMPORARY WORK TO BE REMOVED
- INTERSECTION RAMP TO BE RESHAPED

STAGE 2

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERSECTION CONSTRUCTION
AND FUTURE CONVERSION
TO INTERCHANGE

REVISION 10
JOB No. N501 11.CH
DATE 22.03.2005
DWG No. STAGE 2

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LEGEND

- CONSTRUCTION COMPLETE & OPERATIONAL
- PAVEMENT COMPLETE
- EARTHWORKS COMPLETE
- WORKS UNDER CONSTRUCTION
- LEVEL CORRECTIONS UNDER TRAFFIC
- TEMPORARY WORK TO BE REMOVED
- INTERSECTION RAMP TO BE RESHAPED

STAGE 3

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERSECTION CONSTRUCTION
AND FUTURE CONVERSION
TO INTERCHANGE

REVISION 10
JOB No N561.11.CH
DATE 22.03.2005
DWG No STAGE 3

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Connell Wagner

LEGEND

- CONSTRUCTION COMPLETE & OPERATIONAL
- PAVEMENT COMPLETE
- EARTHWORKS COMPLETE
- WORKS UNDER CONSTRUCTION
- LEVEL CORRECTIONS UNDER TRAFFIC
- TEMPORARY WORK TO BE REMOVED
- INTERSECTION RAMP TO BE RESHAPED

STAGE 4

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERSECTION CONSTRUCTION
AND FUTURE CONVERSION
TO INTERCHANGE

REVISION 10
JOB No. N501.11.CH
DATE 22.03.2005
DWG No. STAGE 4

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CONCEPT ISSUE ONLY

LEGEND

- CONSTRUCTION COMPLETE & OPERATIONAL
- PAVEMENT COMPLETE
- EARTHWORKS COMPLETE
- WORKS UNDER CONSTRUCTION
- LEVEL CORRECTIONS UNDER TRAFFIC
- TEMPORARY WORK TO BE REMOVED
- INTERSECTION RAMP TO BE RESHAPED

STAGE 5

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERSECTION CONSTRUCTION
AND FUTURE CONVERSION
TO INTERCHANGE

REVISION 10
JOB No. N501.11.CH
DATE 22.03.2005
DWG No. STAGE 5

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LEGEND

- CONSTRUCTION COMPLETE & OPERATIONAL
- PAVEMENT COMPLETE
- EARTHWORKS COMPLETE
- WORKS UNDER CONSTRUCTION
- LEVEL CORRECTIONS UNDER TRAFFIC
- TEMPORARY WORK TO BE REMOVED
- INTERSECTION RAMP TO BE RESHAPED

STAGE 6

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERSECTION CONSTRUCTION
AND FUTURE CONVERSION
TO INTERCHANGE

REVISION 10
N501 11 CH
22.03.2005
STAGE 6

Connell Wagner

Connell Wagner

LEGEND

- CONSTRUCTION COMPLETE & OPERATIONAL
- PAVEMENT COMPLETE
- EARTHWORKS COMPLETE
- WORKS UNDER CONSTRUCTION
- LEVEL CORRECTIONS UNDER TRAFFIC
- TEMPORARY WORK TO BE REMOVED
- INTERSECTION RAMP TO BE RESHAPED

STAGE 7

RTA

JUNCTION OF STATE HIGHWAY No.10
&
STATE HIGHWAY No.23
INTERSECTION CONSTRUCTION
AND FUTURE CONVERSION
TO INTERCHANGE

REVISION 10
N501.11.CH
22.03.2005
STAGE 7

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Appendix F

Cost Estimate Spreadsheets

Original Interchange - Concept Estimate (2001) - Summary Sheet

Project: SH23 - Shortland to Sangate - Original Concept Design (2001) **Prepared by:** Connell Wagner
Project No: 5040 **Date:** 2001 **Estimate Type:** Concept

Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments/Assumptions
1. Project Development						
1.1 Route / Concept / EIS	558,000	25	139,500	697,500		
1.2 Project Management Services	40,000	25	10,000	50,000		
1.3 Client Representation	5,000	25	1,250	6,250		
Sub total	603,000	25	150,750	753,750	1%	
2. Investigation and Design						
2.1 Detail Design and Documentation	546,000	25	136,500	682,500		
2.2 Project Management Services	50,000	25	12,500	62,500		
2.3 Client Representation	5,000	25	1,250	6,250		
Sub total	601,000	25	150,250	751,250	1%	
3. Property Acquisitions						
3.1 Professional Services for Acquisitions	10,000	25	2,500	12,500		
3.2 Property Acquisition Costs	1,000,000	25	250,000	1,250,000		To be confirmed by RTA
3.3 Project Management Services	4,000	25	1,000	5,000		
3.4 Client Representation	1,000	25	250	1,250		
Sub total	1,015,000	25	253,750	1,268,750	2%	
4. Public Utility Adjustments						
4.1 Public Utility Adjustments	600,000	50	300,000	900,000		To be confirmed by relevant authority
4.2 Project Management Services	6,000	25	1,500	7,500		
4.3 Client Representation	1,000	25	250	1,250		
Sub total	607,000	50	301,750	908,750	2%	
5. Construction						
5.1 Infrastructure - Environmental Works	442,000	25	110,500	552,500	1%	Refer to Subsidiary Sheet for details
5.2 Infrastructure - Noise Mitigation	379,000	25	94,750	473,750	1%	Refer to Subsidiary Sheet for details
5.3 Infrastructure - Earthworks	6,178,000	25	1,564,500	7,742,500	15%	Refer to Subsidiary Sheet for details
5.4 Infrastructure - Drainage	1,725,000	30	517,500	2,242,500	4%	Refer to Subsidiary Sheet for details
5.5 Infrastructure - Pavement	5,312,400	16	876,000	6,188,400	12%	Refer to Subsidiary Sheet for details
5.6 Infrastructure - Structures	17,855,000	25	4,463,750	22,318,750	44%	Refer to Subsidiary Sheet for details
5.7 Infrastructure - Local Roads	1,900,000	25	475,000	2,375,000	5%	Refer to Subsidiary Sheet for details
5.8 Infrastructure - Miscellaneous	710,000	25	177,500	887,500	2%	Refer to Subsidiary Sheet for details
5.9 Infrastructure - General Activities	500,000	30	150,000	650,000	1%	Refer to Subsidiary Sheet for details
5.10 Infrastructure - Site Management	1,400,000	25	350,000	1,750,000	3%	
5.11 Project Management Services	950,000	25	237,500	1,187,500	2%	
5.12 Client Representation	130,000	25	32,500	162,500	0%	
Sub total	37,481,400	24	9,049,500	46,530,900	92%	
6. Handover						
6.1 Rehabilitate Existing Roadway	293,000	25	73,250	366,250		
6.2 Allwance for Specific Works	100,000	25	25,000	125,000		
6.3 Project Data and Performance	20,000	10	2,000	22,000		
6.4 Project Management Services	30,000	25	7,500	37,500		
6.5 Client Representation	10,000	10	1,000	11,000		
Sub total	453,000	24	108,750	561,750	1%	
TOTAL CONCEPT ESTIMATE	40,760,400	25	10,014,750	50,775,150	100%	**$51M (rounded)**

	Total Amount	% of Total Estimate
Project Management	1,334,500	2.63%
Client Representation	215,000	0.42%
Site Management	1,750,000	3.45%

Reality Checks (including contingency)

1. Cost $M/ km	$	16.93	3.0 km 2 lanes	
2. Cost $M/lane km	$	8.46	6 lane km	
3. Earthworks Cost/m3	$	26	0.23	M m3 - imported fill and unsuitable only
4. Structures Cost/m2	$	2,310	9,660	m2 - road bridges
5. Pavement Cost/m2	$	53	99,380	m2

Original Interchange - Concept Estimate (Updated 2003) - Summary Sheet

Project: SH23 - Shortland to Sangate - Original Concept Design (2003) **Prepared by:** Connell Wagner
Project No: N501.11.CH **Date:** Oct 2003 **Estimate Type:** Concept

Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments/Assumptions
1. Project Development						
1.1 Route / Concept / EIS	700,000	25	175,000	875,000		
1.2 Project Management Services	200,000	25	50,000	250,000		
1.3 Client Representation	20,000	25	5,000	25,000		
Sub total	920,000	25	230,000	1,150,000	2%	
2. Investigation and Design						
2.1 Detail Design and Documentation	1,000,000	25	250,000	1,250,000		
2.2 Project Management Services	200,000	25	50,000	250,000		
2.3 Client Representation	20,000	25	5,000	25,000		
Sub total	1,220,000	25	305,000	1,525,000	3%	
3. Property Acquisitions						
3.1 Professional Services for Acquisitions	50,000	25	12,500	62,500		
3.2 Property Acquisition Costs	2,000,000	25	500,000	2,500,000		To be confirmed by RTA
3.3 Project Management Services	5,000	25	1,250	6,250		
3.4 Client Representation	1,000	25	250	1,250		
Sub total	2,056,000	25	514,000	2,570,000	5%	
4. Public Utility Adjustments						
4.1 Public Utility Adjustments	600,000	50	300,000	900,000		To be confirmed by relevant authority
4.2 Project Management Services	6,000	30	1,800	7,800		
4.3 Client Representation	1,000	30	300	1,300		
Sub total	607,000	50	302,100	909,100	2%	
5. Construction						
5.1 Infrastructure - Environmental Works	865,000	40	346,000	1,211,000	2%	Refer to Subsidiary Sheet for details
5.2 Infrastructure - Noise Mitigation	379,000	30	113,700	492,700	1%	Refer to Subsidiary Sheet for details
5.3 Infrastructure - Earthworks	6,178,000	30	1,852,325	8,030,325	14%	Refer to Subsidiary Sheet for details
5.4 Infrastructure - Drainage	1,725,000	40	690,000	2,415,000	4%	Refer to Subsidiary Sheet for details
5.5 Infrastructure - Pavement	6,306,200	25	1,576,550	7,882,750	14%	Refer to Subsidiary Sheet for details
5.6 Infrastructure - Structures	17,855,000	25	4,463,750	22,318,750	40%	Refer to Subsidiary Sheet for details
5.7 Infrastructure - Local Roads	1,900,000	30	570,000	2,470,000	4%	Refer to Subsidiary Sheet for details
5.8 Infrastructure - Miscellaneous	710,000	30	213,000	923,000	2%	Refer to Subsidiary Sheet for details
5.9 Infrastructure - General Activities	500,000	30	150,000	650,000	1%	Refer to Subsidiary Sheet for details
5.10 Infrastructure - Site Management	1,400,000	30	420,000	1,820,000	3%	
5.11 Project Management Services	950,000	30	285,000	1,235,000	2%	
5.12 Client Representation	130,000	30	39,000	169,000	0%	
Sub total	38,898,200	28	10,719,325	49,617,525	88%	
6. Handover						
6.1 Rehabilitate Existing Roadway	293,000	25	73,250	366,250		
6.2 Allwance for Specific Works	100,000	25	25,000	125,000		
6.3 Project Data and Performance	20,000	25	5,000	25,000		
6.4 Project Management Services	30,000	25	7,500	37,500		
6.5 Client Representation	10,000	25	2,500	12,500		
Sub total	453,000	25	113,250	566,250	1%	
TOTAL CONCEPT ESTIMATE	44,154,200	28	12,183,675	56,337,875	100%	**$56M (rounded)**

	Total Amount	% of Total Estimate
Project Management	1,774,050	3.15%
Client Representation	259,050	0.46%
Site Management	1,820,000	3.23%

Reality Checks (including contingency)

1. Cost $M/ km	$	18.78	3.0 km 2 lanes	
2. Cost $M/lane km	$	9.39	6 lane km	
3. Earthworks Cost/m3	$	27	0.23 M m3	imported fill and unsuitable only
4. Structures Cost/m2	$	2,310	9,660 m2	road bridges and retaining walls
5. Pavement Cost/m2	$	79	99,380 m2	

Revised Scope - Intersection (June 2005) - Concept Estimate - Supplementary Sheet - Earthworks Costs

Project: SH23 - Shortland to Sangate - Revised Concept with Intersection (2004)	**Prepared by: Connell Wagner**
Project No: N501.11.CH **Date:** June 2005	**Estimate Type: Concept**

Item	Quantity	Unit	Rate ($)	Amount ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	Comments and Assumptions
Clearing	3.5	Ha	2,400	8,400	25	2,100	10,500	
Remove & Stockpile Topsoil	3,000	m^3	5	15,000	25	3,750	18,750	Refer Note 3
Cut to Fill	25,000	m^3	16	400,000	30	120,000	520,000	Refer Note 2
Imported Fill for embankments	212,000	m^3	18	3,816,000	30	1,144,800	4,960,800	Refer Note 1
Unsuitable Material	46,200	m^3	12	554,400	30	166,320	720,720	Assumed 1m depth removal and disposal from low embankments
Subtotal	286,200	m^3		4,793,800	30	1,436,970	6,230,770	
Imported Select Material Zone	21,000	m^3	24	504,000	30	151,200	655,200	Refer Note 1
Imported Bridging Layer	11,000	m^3	30	330,000	30	99,000	429,000	Refer Note 1
Wick Drains	4,000	m2	20	80,000	30	24,000	104,000	
Geotextile	16,000	m^2	10	160,000	25	40,000	200,000	
				-		-	-	
Earthworks Items Total	1	Item		5,867,800	30	1,751,170	7,618,970	

Notes.

1. Based on supply from local quarry sources plus allowance for placement
2. Assumes 5% of cut is unsuitable
3. Assumes Topsoil is 120mm thick

Revised Scope - Intersection (June 2005) - Concept Estimate - Subsidiary Sheet

Project: SH23 - Shortland to Sangate - Revised Concept with Intersection (2004)
Project No: N501.11.CH **Date:** June 2005 **Prepared by: Connell Wagner**
Estimate Type: Concept

Item	Qty	Unit	Rate ($)	Amount ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments and Assumptions
5.6 Infrastructure - Structures									
Sandgate Road Over SH23	1,120	m2	2,000	2,240,000	25	560,000	2,800,000		
SH23 over Deepbridge Creek and Access Road	5,520	m2	2,200	12,144,000	25	3,036,000	15,180,000		
SH23 over Main Northern Railway	1,210	m2	2,200	2,662,000	25	665,500	3,327,500		Requires intermediate pier
Retaining Walls									
- railway approach	600	m^2	250	150,000	25	37,500	187,500		
Structures Sub total	8,450	Item		17,196,000	25	4,299,000	21,495,000	44.7%	
5.7 Infrastructure - Local Roads									
Reinstate Sandgate Rd	1.00	Item	300,000	300,000	30	90,000	390,000		Assumes flexible pavement to Council Standard
Reinstate Old Maitland Road	1	Item	300,000	300,000	30	90,000	390,000		Nominal allowance only
Local Roads Sub total		Item		600,000	30	180,000	780,000	1.6%	
5.8 Infrastructure - Miscellaneous									
Medians & Footpath	3,000	m^2	40	120,000	30	36,000	156,000		1.8m Chainwire Mesh (Manproof) assumed
Linemarking & Signposting	0.7	Item	250,000	175,000	30	52,500	227,500		Includes allowance for pavement markers
Traffic Barrier Safety works	1,600	m	140	224,000	30	67,200	291,200		Assumes lighting at Intersections only
Allowance for traffic signal installation	1	m	160,000	160,000	25	40,000	200,000		Nominal allowance only
Miscellaneous Sub total	1	Item		679,000	29	195,700	874,700	1.8%	
5.9 Infrastructure - General Activities									
Control of Traffic	0.7	Item	600,000	420,000	30	126,000	546,000		
Track Possession	3	Item	200,000	600,000	30	180,000	780,000		
General Activities Sub total	1	Item		1,020,000	30	306,000	1,326,000	2.8%	
5.10 Infrastructure - Site Management	0.7	Item	2,000,000	1,400,000	30	420,000	1,820,000		
Site Management Sub total	1	Item		1,400,000	30	420,000	1,820,000	3.8%	
5.11 Project Management Services	0.7	Item	600,000	420,000	30	126,000	546,000		
Project Management Services Sub total	1	Item		420,000	30	126,000	546,000	1.1%	
5.12 Client Representation	0.7	Item	60,000	42,000	30	12,600	54,600		
Client Representation Sub total	1	Item		42,000	30	12,600	54,600	0.1%	
5.13 Principal Arranged Insurance	1	Item	693,418	693,418	30	208,025	901,444		1.7% of construction costs
Principal Arranged Insurance total	1	Item		693,418	30	208,025	901,444	1.9%	
6. Project Handover									
6.1 Allowance for Specific Works	0.7	Item	100,000	70,000	25	17,500	87,500		
6.2 Project Data and Performance	1	Item	20,000	20,000	25	5,000	25,000		
6.3 Project Management Services	1	Item	30,000	30,000	25	7,500	37,500		
6.4 Client Representation	1	Item	10,000	10,000	25	2,500	12,500		
Sub Total				130,000	25	32,500	162,500	0.3%	
TOTAL				36,317,336	27	10,418,875	46,042,594	100.0%	$46.0M (rounded)

Notes:

1. Estimate allowance only. To be confirmed by the relevant authorities.
2. Quantity based on preliminary noise study recommendations. Acoustic barriers are not practical in some locations.
3. Culvert oversized and heavily reinforced to allow for the expected settlement after installation.

Revised Scope - Intersection (June 2005) - Concept Estimate - Subsidiary Sheet

Project: SH23 - Shortland to Sangate - Revised Concept with Intersection (2004) — **Prepared by: Connell Wagner**
Project No: N501.11.CH — **Date:** June 2005 — **Estimate Type: Concept**

Item	Qty	Unit	Rate ($)	Amount ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments and Assumptions
5. Construction									
5.1 Infrastructure - Environmental Works									
Temporary Erosion and Sedimentation Control Measures	2.2	km	50,000	110,000	40	44,000	154,000		
Permanent Wetland & Water Quality Controls	0.75	Item	200,000	150,000	40	60,000	210,000		Nominal Allowance only. No details to date
Landscaping & Revegetation	0.75	Item	400,000	300,000	40	120,000	420,000		
Environmental Works Sub total		Item		560,000	40	224,000	784,000	1.6%	
5.2 Infrastructure - Noise Mitigation									
Noise Attenuation Measures - Area 1	500	m2	250	125,000	30	37,500	162,500		Refer to Note 2
Noise Attenuation Measures - Area 2	600	m2	250	150,000	30	45,000	195,000		Refer to Note 2
Noise Attenuation Measures - Area 3	-	m2	250	0	30	0	0		Refer to Note 2
Noise Mitigation Sub total	1,100	Item		275,000	30	82,500	357,500	0.7%	
5.3 Infrastructure - Earthworks	1	Item	5,867,800	5,867,800	30	1,761,170	7,616,970	15.9%	Refer to Supplementary Sheet attached
5.4 Infrastructure - Drainage									
1200W x 600H Box Culvert	71	m	1,200	85,200	40	34,080	119,280		
3600W x 600H Box Culvert	29	m	2,500	57,500	40	23,000	80,500		
2400W x 1500H Box Culvert	56	m	3,000	168,000	40	67,200	235,200		Refer to Note 3
300 dia Pipe Culverts	4,500	m	200	900,000	40	360,000	1,260,000		
600 dia Pipe Culverts	375	m	400	150,000	40	60,000	210,000		
Drainage Structures	0.70	Item	50,000	35,000	40	14,000	49,000		
Subsurface Drainage	0.70	Item	120,000	84,000	40	33,600	117,600		
Kerbs and Gutters	2,000	m	80	160,000	40	64,000	224,000		
Drainage Sub total			750,000	1,939,700	40	655,880	2,295,580	4.8%	
5.5 Infrastructure - Pavement									
Total SH23 Concrete Pavement	35,500	m^2	80	2,840,000	25	710,000	3,550,000		Assumes 250 over 150 Subbase
Total Flexible Pavement	5,200	m^2	60	312,000	25	78,000	390,000		Assumes 350 Base
Total Pavement strengthening and AC overlay	1,120	m^2	36	40,320	25	10,080	50,400		
Total AC on Bridge Decks	8,820	m^2	24	211,680	25	52,920	264,600		50mm AC for bridges
Sectional Components									
Section 1 (CH 3000 to 3838)									
SH23 Concrete Pavement	14,700	m^2							
Flexible Pavement Flexible	2,600	m^2							
Pavement Strengthening and AC Overlay	-	m^2							
Wearing Surface Bridges	1,120	m^2							
Section 2 (CH 3838 to 4185)									
SH23 Concrete Pavement	4,900	m^2							
Flexible Pavement Flexible		m^2							
Pavement Strengthening and AC Overlay		m^2							
Wearing Surface Bridges	7,700	m^2							
Section 3 (CH 4157 to 4620)									
SH23 Concrete Pavement	10,000	m^2							
Flexible Pavement Flexible		m^2							
Pavement Strengthening and AC Overlay		m^2							
Wearing Surface Bridges		m^2							
Section 4 (CH 4620 to 4958)									
SH23 Concrete Pavement	5,900	m^2							
Flexible Pavement Flexible	2,600	m^2							
Pavement Strengthening and AC Overlay	1,120	m^2							
Wearing Surface Bridges	-	m^2							
Pavement Sub total	50,640	m^2	67	3,404,000	25	851,000	4,255,000	8.9%	

Revised Scope - Intersection (June 2005) - Concept Estimate - Subsidiary Sheet

Project: SH23 - Shortland to Sangate - Revised Concept with Intersection (2004)
Project No: N501.11.CH
Date: June 2005
Prepared by: Connell Wagner
Estimate Type: Concept

Item	Qty	Unit	Rate ($)	Amount ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments and Assumptions
1. Project Development									
1.1 Project Development Contract (Route / Concept / EIS)	1	Item	600,000	600,000	25	150,000	750,000		
1.4 Project Management Services	1	Item	300,000	300,000	25	75,000	375,000		
1.5 Client Representation	1	Item	20,000	20,000	25	5,000	25,000		
Sub total	1	Item		920,000	25	230,000	1,150,000	2.4%	
2. Investigation and Design									
2.1 Detail Design and Documentation	0.7	Item	1,200,000	840,000	25	210,000	1,050,000		
2.4 Project Management Services	0.7	Item	200,000	140,000	25	35,000	175,000		
2.5 Client Representation	0.7	Item	20,000	14,000	25	3,500	17,500		
Sub total	1	Item		994,000	25	248,500	1,242,500	2.6%	
3. Property Acquisitions									
3.1 Professional Services for Acquisitions	1	Item	50,000	50,000	25	12,500	62,500		
3.2 Property Acquisition Costs	0.8	Item	1,400,000	1,120,000	25	280,000	1,400,000		Advised by RTA's Valuer
3.3 Project Management Services	1	Item	5,000	5,000	25	1,250	6,250		
3.4 Client Representation	1	Item	1,000	1,000	25	250	1,250		
Sub total	1	Item		1,176,000	25	294,000	1,470,000	3.1%	
4. Public Utility Adjustments									Refer to Note 1
4.1 Gas Reticulation	0.6	Item	150,000	75,000	50	37,500	112,500		
4.2 Electricity Plant	0.9	Item	200,000	175,000	50	87,500	262,500		
4.3 Water / Sewer Mains	0.9	Item	200,000	175,000	50	87,500	262,500		
4.4 Concrete Encase Sewer Main	1	Item	100,000	100,000	50	50,000	150,000		
4.6 Telecommunications Plant	0.8	Item	100,000	75,000	50	37,500	112,500		
4.7 Project Management services	1	Item	6,000	6,000	30	1,800	7,800		
4.8 Client Reptresentation	1	Item	1,000	1,000	30	300	1,300		
Sub total	1	Item		607,000	50	302,100	909,100	1.9%	

Revised Scope - Intersection (June 2005) - Concept Estimate - Summary Sheet

Project: SH23 - Shortland to Sangate - Revised Concept with Intersection (2004) **Prepared by:** Connell Wagner
Project No: N501.11.CH **Date:** June 2005 **Estimate Type:** Concept

Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments/Assumptions
1. Project Development						
1.1 Route / Concept / EIS	600,000	25	150,000	750,000		
1.2 Project Management Services	300,000	25	75,000	375,000		
1.3 Client Representation	20,000	25	5,000	25,000		
Sub total	920,000	25	230,000	1,150,000	2%	
2. Investigation and Design						
2.1 Detail Design and Documentation	840,000	25	210,000	1,050,000		
2.2 Project Management Services	140,000	25	35,000	175,000		
2.3 Client Representation	14,000	25	3,500	17,500		
Sub total	994,000	25	248,500	1,242,500	3%	
3. Property Acquisitions						
3.1 Professional Services for Acquisitions	50,000	25	12,500	62,500		
3.2 Property Acquisition Costs	1,120,000	25	280,000	1,400,000		To be confirmed by RTA
3.3 Project Management Services	5,000	25	1,250	6,250		
3.4 Client Representation	1,000	25	250	1,250		
Sub total	1,176,000	25	294,000	1,470,000	3%	
4. Public Utility Adjustments						
4.1 Public Utility Adjustments	600,000	50	300,000	900,000		To be confirmed by relevant authority
4.2 Project Management Services	6,000	30	1,800	7,800		
4.3 Client Representation	1,000	30	300	1,300		
Sub total	607,000	50	302,100	909,100	2%	
5. Construction						
5.1 Infrastructure - Environmental Works	560,000	40	224,000	784,000	2%	Refer to Subsidiary Sheet for details
5.2 Infrastructure - Noise Mitigation	275,000	30	82,500	357,500	1%	Refer to Subsidiary Sheet for details
5.3 Infrastructure - Earthworks	5,867,800	30	1,751,170	7,618,970	16%	Refer to Subsidiary Sheet for details
5.4 Infrastructure - Drainage	1,639,700	40	655,880	2,295,580	5%	Refer to Subsidiary Sheet for details
5.5 Infrastructure - Pavement	3,404,000	25	851,000	4,255,000	9%	Refer to Subsidiary Sheet for details
5.6 Infrastructure - Structures	17,196,000	25	4,299,000	21,495,000	45%	Refer to Subsidiary Sheet for details
5.7 Infrastructure - Local Roads	600,000	30	180,000	780,000	2%	Refer to Subsidiary Sheet for details
5.8 Infrastructure - Miscellaneous	679,000	29	195,700	874,700	2%	Refer to Subsidiary Sheet for details
5.9 Infrastructure - General Activities	1,020,000	30	306,000	1,326,000	3%	Refer to Subsidiary Sheet for details
5.10 Infrastructure - Site Management	1,400,000	30	420,000	1,820,000	4%	
5.11 Project Management Services	420,000	30	126,000	546,000	1%	
5.12 Client Representation	42,000	30	12,600	54,600	0%	
5.13 Principal Arranged Insurance	693,418	30	208,025	901,444	2%	
Sub total	33,796,918	28	9,311,875	43,108,794	90%	
6. Handover						
6.2 Allwance for Specific Works	70,000	25	17,500	87,500		
6.3 Project Data and Performance	20,000	25	5,000	25,000		
6.4 Project Management Services	30,000	25	7,500	37,500		
6.5 Client Representation	10,000	25	2,500	12,500		
Sub total	130,000	25	32,500	162,500	0%	
TOTAL CONCEPT ESTIMATE	37,623,918	28	10,418,975	48,042,894	100%	**$48.0M (rounded)**

	Total Amount	% of Total Estimate
Project Management	1,135,050	2.36%
Client Representation	137,150	0.29%
Site Management	1,820,000	3.79%

Reality Checks (including contingency)

1. Cost $M/ km	$	21.84	2.2 km 4 lanes	
2. Cost $M/lane km	$	5.46	8.8 lane km	
3. Earthworks Cost/m3	$	27	283,200.00	m3 - Cut to fill, imported fill and unsuitable
4. Structures Cost/m2	$	2,544	8,450	m2 - road bridges & retaining wall
5. Pavement Cost/m2	$	84	50,640	m2

Revised Scope - Interchange (June 2005) - Concept Estimate - Supplementary Sheet - Earthworks Costs

Project: SH23 - Shortland to Sangate - Revised Concept Modified Interchange (2004) — **Prepared by: Connell Wagner**
Project No: N501.11.CH — **Date:** June 2005 — **Estimate Type: Concept**

Item	Quantity	Unit	Rate ($)	Amount ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	Comments and Assumptions
Clearing	5	Ha	2,400	10,800	25	2,700	13,500	
Remove & Stockpile Topsoil	4,000	m^3	5	20,000	25	5,000	25,000	Refer Note 3
Cut to Fill	73,000	m^3	16	1,168,000	30	350,400	1,518,400	Refer Note 2
Imported Fill for embankments	150,000	m^3	18	2,700,000	30	810,000	3,510,000	Refer Note 1
Unsuitable Material	49,000	m^3	12	588,000	30	176,400	764,400	Assumed 1m depth removal and disposal from low embankments
Subtotal	276,000	m^3		4,486,800	30	1,344,500	5,831,300	
Imported Select Material Zone	28,000	m^3	24	672,000	30	201,600	873,600	Refer Note 1
Imported Bridging Layer	13,500	m^3	30	405,000	30	121,500	526,500	Refer Note 1
Wick Drains	5,000	m^2	20	100,000	30	30,000	130,000	
Geotextile	20,000	m^2	10	200,000	25	50,000	250,000	
Earthworks Items Total	1	Item		5,863,800	30	1,747,600	7,611,400	

Notes.

1. Based on supply from local quarry sources plus allowance for placement
2. Assumes 5% of cut is unsuitable
3. Assumes Topsoil is 120mm thick

Revised Scope - Interchange (June 2005) - Concept Estimate - Subsidiary Sheet

Project: SH23 - Shortland to Sangate - Revised Concept Modified Interchange (2004) | **Prepared by: Connell Wagner**
Project No: N501.11.CH | **Date: November 2004** | **Estimate Type: Concept**

Item	Qty	Unit	Rate ($)	Amount ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments and Assumptions
5.6 Infrastructure - Structures									
Sandgate Road Over SH23	1,120	m^2	2,000	2,240,000	25	560,000	2,800,000		
SH23 over Deepbridge Creek and Access Road	5,520	m^2	2,200	12,144,000	25	3,036,000	15,180,000		
SH23 over Main Northern Railway	1,210	m^2	2,200	2,662,000	25	665,500	3,327,500		
SH10 over SH23 (S/B & N/B))	520	m^2	1,600	832,000	25	208,000	1,040,000		
SH10 over SH23 (S/B)	288	m^2	1,600	460,800	25	115,200	576,000		
Retaining Walls									
- railway approach	600	m^2	250	150,000	25	37,500	187,500		
- interchange	2,000	m^2	1,250	2,500,000	25	625,000	3,125,000		
Structures Sub total	11,258	Item		20,988,800	25	5,247,200	26,236,000	44.9%	
5.7 Infrastructure - Local Roads									
Reinstate Sandgate Rd	1	Item	300,000	300,000	30	90,000	390,000		Assumes flexible pavement to Council Standard
Reinstate Old Maitland Road	1	Item	300,000	300,000	30	90,000	390,000		Nominal allowance only
Local Roads Sub total		Item		600,000	30	180,000	780,000	1.3%	
5.8 Infrastructure - Miscellaneous									
Medians & Footpath	3,400	m^2	40	136,000	30	40,800	176,800		1.8m Chainwire Mesh (Manproof) assumed
Linemarking & Signposting	1	Item	250,000	250,000	30	75,000	325,000		Includes allowance for pavement markers
Traffic Barrier Safety works	2,600	m	140	364,000	30	109,200	473,200		Assumes lighting at Intersections only
Miscellaneous Sub total	1	Item		750,000	30	225,000	975,000	1.7%	
5.9 Infrastructure - General Activities									
Control of Traffic	1	Item	600,000	600,000	30	180,000	780,000		
Track Possession	3	Item	200,000	600,000	30	180,000	780,000		
General Activities Sub total	1	Item		1,200,000	30	360,000	1,560,000	2.7%	
5.10 Infrastructure - Site Management	1	Item	2,000,000	2,000,000	30	600,000	2,600,000		
Site Management Sub total	1	Item		2,000,000	30	600,000	2,600,000	4.4%	
5.11 Project Management Services	1	Item	600,000	600,000	30	180,000	780,000		
Project Management Services Sub total	1	Item		600,000	30	180,000	780,000	1.3%	
5.12 Client Representation	1	Item	60,000	60,000	30	18,000	78,000		
Client Representation Sub total	1	Item		60,000	30	18,000	78,000	0.1%	
5.13 Principal Arranged Insurance	1	Item	842,277	842,277	30	252,683	1,094,960		1.7% of construction costs
Principal Arranged Insurance total	1	Item		842,277	30	252,683	1,094,960	1.9%	
6. Project Handover									
6.1 Allowance for Specific Works	1	Item	100,000	100,000	25	25,000	125,000		
6.2 Project Data and Performance	1	Item	20,000	20,000	25	5,000	25,000		
6.3 Project Management Services	1	Item	30,000	30,000	25	7,500	37,500		
6.4 Client Representation	1	Item	10,000	10,000	25	2,500	12,500		
Sub Total				160,000	25	40,000	200,000	0.3%	
TOTAL				45,820,749	28	12,674,951	58,495,700	100.0%	$58.5M (rounded)

Notes:

1. Estimate allowance only. To be confirmed by the relevant authorities.
2. Quantity based on preliminary noise study recommendations. Acoustic barriers are not practical in some locations.
3. Culvert oversized and heavily reinforced to allow for the expected settlement after installation.

Revised Scope - Interchange (June 2005) - Concept Estimate - Subsidiary Sheet

Project: SH23 - Shortland to Sangate - Revised Concept Modified Interchange (2004) — **Prepared by: Connell Wagner**
Project No: N501.11.CH — **Date:** November 2004 — **Estimate Type: Concept**

Item	Qty	Unit	Rate ($)	Amount ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments and Assumptions
6. Construction									
6.1 Infrastructure - Environmental Works									
Temporary Erosion and Sedimentation Control Measures	3	km	50,000	130,000	40	52,000	182,000		
Permanent Wetland & Water Quality Controls	1.00	Item	200,000	200,000	40	80,000	280,000		Nominal Allowance only. No details to date
Landscaping & Revegetation	1.00	Item	400,000	400,000	40	160,000	560,000		
Environmental Works Sub total		Item		730,000	40	292,000	1,022,000	1.7%	
6.2 Infrastructure - Noise Mitigation									
Noise Attenuation Measures - Area 1	500	m2	250	125,000	30	37,500	162,500		Refer to Note 2
Noise Attenuation Measures - Area 2	600	m2	250	150,000	30	45,000	195,000		Refer to Note 2
Noise Attenuation Measures - Area 3	600	m2	250	150,000	30	45,000	195,000		Refer to Note 2
Noise Mitigation Sub total		Item		425,000	30	127,500	552,500	0.9%	
6.3 Infrastructure - Earthworks	1	Item	5,883,800	5,883,800	30	1,747,600	7,611,400	13.0%	Refer to Supplementary Sheet attached
6.4 Infrastructure - Drainage									
1200W x 600H Box Culvert	95	m	1,200	114,000	40	45,600	159,600		
3600W x 600H Box Culvert	30	m	2,500	75,000	40	30,000	105,000		
2400W x 1500H Box Culvert	75	m	3,000	225,000	40	90,000	315,000		Refer to Note 3
300 dia Pipe Culverts	6,000	m	200	1,200,000	40	480,000	1,680,000		
600 dia Pipe Culverts	500	m	400	200,000	40	80,000	280,000		
Drainage Structures	1	Item	50,000	50,000	40	20,000	70,000		
Subsurface Drainage	1	Item	120,000	120,000	40	48,000	168,000		
Kerbs and Gutters	2,650	m	80	212,000	40	84,800	296,800		
Drainage Sub total	2.3	km	750,000	2,196,000	40	878,400	3,074,400	5.3%	
6.5 Infrastructure - Pavement									
Total SH23 Concrete Pavement	46,340	m^2	80	3,707,200	25	926,800	4,634,000		Assumes 250 over 150 Subbase
Total Flexible Pavement	10,300	m^2	60	618,000	25	154,500	772,500		Assumes 350 Base
Total Pavement strengthening and AC overlay	9,600	m^2	36	345,600	25	86,400	432,000		
Total AC on Bridge Decks	9,628	m^2	24	231,072	25	57,768	288,840		50mm AC for bridges
Sectional Components									
Section 1 (CH 3000 to 3838)									
SH23 Concrete Pavement	14,700	m^2							
Flexible Pavement Flexible	2,800	m^2							
Pavement Strengthening and AC Overlay	-	m^2							
Wearing Surface Bridges	1,120	m^2							
Section 2 (CH 3838 to 4166)									
SH23 Concrete Pavement	4,900	m^2							
Flexible Pavement Flexible		m^2							
Pavement Strengthening and AC Overlay		m^2							
Wearing Surface Bridges	7,700	m^2							
Section 3 (CH 4157 to 4620)									
SH23 Concrete Pavement	10,000	m^2							
Flexible Pavement Flexible		m^2							
Pavement Strengthening and AC Overlay		m^2							
Wearing Surface Bridges		m^2							
Section 4 (CH 4620 to 5600)									
SH23 Concrete Pavement	18,740	m^2							
Flexible Pavement Flexible	7,700	m^2							
Pavement Strengthening and AC Overlay	9,600	m^2							
Wearing Surface Bridges	808	m^2							
Pavement Sub total	75,868	m^2	65	4,801,872	25	1,225,468	6,127,340	10.5%	

Revised Scope - Interchange (June 2005) - Concept Estimate - Subsidiary Sheet

Project: SH23 - Shortland to Sangate - Revised Concept Modified Interchange (2004) | **Prepared by: Connell Wagner**
Project No: N501.11.CH | **Date:** November 2004 | **Estimate Type: Concept**

Item	Qty	Unit	Rate ($)	Amount ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments and Assumptions
1. Project Development									
1.1 Project Development Contract (Route / Concept / EIS)	1	Item	600,000	600,000	25	150,000	750,000		
1.4 Project Management Services	1	Item	300,000	300,000	25	75,000	375,000		
1.5 Client Representation	1	Item	20,000	20,000	25	5,000	25,000		
Sub total	1	Item		920,000	25	230,000	1,150,000	2.0%	
2. Investigation and Design									
2.1 Detail Design and Documentation	1	Item	1,200,000	1,200,000	25	300,000	1,500,000		
2.4 Project Management Services	1	Item	200,000	200,000	25	50,000	250,000		
2.5 Client Representation	1	Item	20,000	20,000	25	5,000	25,000		
Sub total	1	Item		1,420,000	25	355,000	1,775,000	3.0%	
3. Property Acquisitions									
3.1 Professional Services for Acquisitions	1	Item	50,000	50,000	25	12,500	62,500		
3.2 Property Acquisition Costs	1	Item	1,400,000	1,400,000	25	350,000	1,750,000		Advised by RTA's Valuer
3.3 Project Management Services	1	Item	5,000	5,000	25	1,250	6,250		
3.4 Client Representation	1	Item	1,000	1,000	25	250	1,250		
Sub total	1	Item		1,456,000	25	364,000	1,820,000	3.1%	
4. Public Utility Adjustments									Refer to Note 1
4.1 Gas Reticulation	1	Item	100,000	100,000	50	50,000	150,000		Relocate 180m of 150mm dia. Main
4.2 Electricity Plant	1	Item	200,000	200,000	50	100,000	300,000		Relocate 550m of Overhead Powerlines
4.3 Water / Sewer Mains	1	Item	200,000	200,000	50	100,000	300,000		Relocate 600m of 150mm dia. Main
4.4 Concrete Encase Sewer Main	1	Item	100,000	100,000	50	50,000	150,000		
4.6 Telecommunications Plant	1	Item	100,000	100,000	50	50,000	150,000		Relocate 500m of copper Riser Cable
4.7 Project Management services	1	Item	6,000	6,000	30	1,800	7,800		
4.8 Client Reptresentation	1	Item	1,000	1,000	30	300	1,300		
Sub total	1	Item		707,000	50	352,100	1,059,100	1.8%	

Revised Scope - Interchange (June 2005) - Concept Estimate - Summary Sheet

Project: SH23 - Shortland to Sangate - Revised Concept Modified Interchange (2004) **Prepared by:** Connell Wagner
Project No: N501.11.CH **Date:** June 2005 **Estimate Type:** Concept

Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate	Comments/Assumptions
1. Project Development						
1.1 Route / Concept / EIS	600,000	25	150,000	750,000		
1.2 Project Management Services	300,000	25	75,000	375,000		
1.3 Client Representation	20,000	25	5,000	25,000		
Sub total	920,000	25	230,000	1,150,000	2%	
2. Investigation and Design						
2.1 Detail Design and Documentation	1,200,000	25	300,000	1,500,000		
2.2 Project Management Services	200,000	25	50,000	250,000		
2.3 Client Representation	20,000	25	5,000	25,000		
Sub total	1,420,000	25	355,000	1,775,000	3%	
3. Property Acquisitions						
3.1 Professional Services for Acquisitions	50,000	25	12,500	62,500		
3.2 Property Acquisition Costs	1,400,000	25	350,000	1,750,000		To be confirmed by RTA
3.3 Project Management Services	5,000	25	1,250	6,250		
3.4 Client Representation	1,000	25	250	1,250		
Sub total	1,456,000	25	364,000	1,820,000	3%	
4. Public Utility Adjustments						
4.1 Public Utility Adjustments	700,000	50	350,000	1,050,000		To be confirmed by relevant authority
4.2 Project Management Services	6,000	30	1,800	7,800		
4.3 Client Representation	1,000	30	300	1,300		
Sub total	707,000	50	352,100	1,059,100	2%	
5. Construction						
5.1 Infrastructure - Environmental Works	730,000	40	292,000	1,022,000	2%	Refer to Subsidiary Sheet for details
5.2 Infrastructure - Noise Mitigation	425,000	30	127,500	552,500	1%	Refer to Subsidiary Sheet for details
5.3 Infrastructure - Earthworks	5,863,800	30	1,747,600	7,611,400	13%	Refer to Subsidiary Sheet for details
5.4 Infrastructure - Drainage	2,196,000	40	878,400	3,074,400	5%	Refer to Subsidiary Sheet for details
5.5 Infrastructure - Pavement	4,901,872	25	1,225,468	6,127,340	10%	Refer to Subsidiary Sheet for details
5.6 Infrastructure - Structures	20,988,800	25	5,247,200	26,236,000	45%	Refer to Subsidiary Sheet for details
5.7 Infrastructure - Local Roads	600,000	30	180,000	780,000	1%	Refer to Subsidiary Sheet for details
5.8 Infrastructure - Miscellaneous	750,000	30	225,000	975,000	2%	Refer to Subsidiary Sheet for details
5.9 Infrastructure - General Activities	1,200,000	30	360,000	1,560,000	3%	Refer to Subsidiary Sheet for details
5.10 Infrastructure - Site Management	2,000,000	30	600,000	2,600,000	4%	
5.11 Project Management Services	600,000	30	180,000	780,000	1%	
5.12 Client Representation	60,000	30	18,000	78,000	0%	
5.13 Principal Arranged Insurance	842,277	30	252,683	1,094,960	2%	
Sub total	41,157,749	28	11,333,851	52,491,600	90%	
6. Handover						
6.2 Allwance for Specific Works	100,000	25	25,000	125,000		
6.3 Project Data and Performance	20,000	25	5,000	25,000		
6.4 Project Management Services	30,000	25	7,500	37,500		
6.5 Client Representation	10,000	25	2,500	12,500		
Sub total	160,000	25	40,000	200,000	0%	
TOTAL CONCEPT ESTIMATE	45,820,749	28	12,674,951	58,496,700	100%	**$58.5M (rounded)**

	Total Amount	% of Total Estimate
Project Management	1,444,050	2.47%
Client Representation	168,050	0.29%
Site Management	2,600,000	4.44%

Reality Checks (including contingency)

1.	Cost $M/ km	$	22.50	2.6 km 4 lanes
2.	Cost $M/lane km	$	5.62	10.4 lane km
3.	Earthworks Cost/m3	$	28	272,000.00 m3 - Cut to fill, imported fill and unsuitable
4.	Structures Cost/m2	$	2,330	11,258 m2 - road bridges and retaining wall
5.	Pavement Cost/m2	$	81	75,868 m2

Appendix C

Consultation

GRAINGER Andrew

From: Wright, Kevin D [Kevin.D.Wright@team telstra.com]
Sent: Tuesday, 10 January 2006 11:22 AM
To: GRAINGER Andrew
Subject: Extension of State Highway No 23

Andrew,
I am responding to your letter addressed to Peter Sumner dated 4th January 2006. Peter no longer is employed by Telstra so I have taken over his projects.

I have looked at your proposal and have found four possible sites where there will be some conflict between the proposed road works and existing Telstra network. I do not believe we have any major cable conflicts to solve, but there will be some relocation works required. These conflicts you probably are aware of by the normal acquisition of DBUD plans. When final designs have been completed, with Telstra network shown at the relevant sites, please contact me so we can arrange for suitable resolution to conflicts.

Regards,
Kevin Wright
Damage Minimisation Project Officer
02-4904 4165
Fax 02-4904 4122
Mobile 0428 265 137
Kevin.D.Wright@team.telstra.com

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Metro Core Services
Network Integrity Services, Working with the construction industry to provide Network Integrity Solutions and preventing damage to All underground assets.

Keeping your network "ALIVE"

Department of
Environment and Conservation (NSW)

Your reference : WBS D/00169/C/D1/04
Our reference : NEF 18485, 270140A7
Contact : Jim Clarence 49086814
Date : 12 Jan 2006

RECEIVED
18 JAN 2006
BY:.....

RTA
Environmental Technology
Level 5, Pod D, 99 Phillips St
PARRAMATTA NSW 0000

13 JAN 2006

Attn: Andrew Grainger

Dear Sir

Proposed continuation of State Highway No.23 between Shortland and Sandgate

I refer to your letter dated 9 January 2006 requesting comments from the Department of Environment and Conservation (DEC) on issues to be addressed in the preparation of a Review of Environmental Factors for the above proposal.

A brief review of the information provided suggests that the interests of the DEC are likely to be affected by the proposal.

The REF must demonstrate that:

- The proposal is not likely to cause impacts on areas of native vegetation, with special reference to threatened or regionally significant flora and fauna species, populations and ecological communities..
- The proposed development is consistent with relevant provisions of the Threatened Species Conservation Act 1995, State Environmental Planning Policy (SEPP) 44 - Koala Habitat Protection, SEPP 71 - Coastal Protection and the Native Vegetation Conservation Act 1997.
- An appropriate level of archaeological assessment has been undertaken, and that the proposal is not likely to impact on areas of cultural significance to the Aboriginal community.
- Potential direct and indirect impacts on DEC estate, wilderness areas and recognised areas of high conservation value have been adequately considered.
- The requirements of the Commonwealth legislation, the Environment Protection and Biodiversity Conservation Act 1999, have been met. If the proposal affects any species requiring consideration under this legislation then approval may be required from the Department of Environment and Heritage (formerly Environment Australia).

PO Box 488G, Newcastle NSW 2300
117 Bull Street, Newcastle West NSW 2302
Telephone (02) 4908 6800
Facsimile (02) 4908 6810
ABN 30 841 387 271
www.environment.nsw.gov.au

Please note that the Department of Environment and Conservation exercises certain statutory functions and powers in the name of the Environment Protection Authority

- The requirements of the NSW Protection of the Environment Operations Act (1997) have been adequately considered. Based on the information provided, the proposal will require an Environment Protection Licence (EPL). The REF should contain all information required to accompany an application for an EPL.

- All issues relating to the following have been addressed:

  - Water pollution
  - Noise pollution
  - Land contamination
  - Waste Management

The enclosed attachments provide information which will assist you in determining the required information in more detail.

The enclosed attachments provide information which will assist you in determining the required information in more detail.

If you have any questions concerning the overall project or pollution control issues please contact Jim Clarence on (02) 49086814. For any questions concerning flora and fauna contact Andrew McIntyre on 02 6659 8232 and for Aboriginal cultural heritage matters Brendon Diacono on 02 6659 8220.

Yours sincerely

TREVOR HENDERSON
A/Head Regional Operations Unit
North East Branch
Environment Protection and Regulation Division

enclosure:

1. National Parks and Wildlife Act 1974 and the Threatened Species Conservation Act 1995 requirements
2. Protection of the Environment Operations Act (1997) and Associated Legislation requirements

Attachment 1

DEPARTMENT OF ENVIRONMENT AND CONSERVATION
ENVIRONMENT PROTECTION AND REGULATION DIVISION – NORTH EAST
ENVIRONMENTAL ISSUES TO BE ADDRESSED
National Parks and Wildlife Act 1974 and the *Threatened Species Conservation Act 1995*

INTRODUCTION

The following list is provided to assist in the preparation of environmental impact assessment reports. The list details the type of information that is recommended by the Department of Environment and Conservation's (DEC) Environment Protection and Regulation Division (EPRD) - NorthEast for inclusion in such assessments.

Please note that the provision of information in accordance with this list does not negate the applicant's obligations under any legislative or planning instruments and deals with those components of DEC's responsibilities relating to the *National Parks and Wildlife Act 1974* and the *Threatened Species Conservation Act 1995* only. EPRD suggests that the applicant contact the relevant local council and the Department of Infrastructure Planning and Natural Resources to ascertain these obligations.

GENERAL

1. Map(s) showing the locality of the proposed development in a regional and local context. Local context maps should be based on 1:25 000 topographic plans. Photographs of the site's key attributes may provide useful documentation.

2. A description of the existing environment on the subject land and surrounding land, the proposed development and ancillary works, and the manner in which the environment will be modified by the proposal (particularly with regard to the clearing of native vegetation and impacts on fauna habitat).

3. The area subject to development should be clearly identified on an appropriately scaled plan. This includes all ancillary works such as buildings and other structures, parking areas, loading/processing/treatment areas, access roads, and material stockpiling areas.

4. The applicability or otherwise of Local Environment Plans (LEP), Regional Environment Plans (REP) and State Environmental Planning Policies (SEPP) and Regional Vegetation Management Plans (RVMPs) to the site should be determined and detailed. In particular, your attention is drawn to SEPP No. 14 - Coastal Wetlands, SEPP No. 26 - Littoral Rainforest, SEPP No. 44 - Koala Habitat Protection and the *Native Vegetation Conservation Act 1997*.

5. Your attention is also drawn to the new Commonwealth legislation, the *Environment Protection and Biodiversity Conservation Act* 2000. The Act specifically focuses on matters of national environmental significance (NES matters) which include listed threatened species and ecological communities, World Heritage properties, Ramsar wetlands of international importance, internationally protected migratory species and Commonwealth Marine Areas. If any NES matters under this legislation may be affected by the proposal, approval for the development may also be required from Environment Australia.

FLORA

1. A comprehensive description of the vegetation on the site. This will include an assessment of the condition of the plant communities present, including the designation of conservation significance at a local, regional and State level, and an assessment of the likely occurrence of any threatened species, populations or ecological communities listed under Schedules 1 or 2 of the *Threatened Species Conservation Act 1995* and any Rare or Threatened Australian Plant (ROTAP) species.

2. A plan showing the distribution of any threatened or ROTAP species and the vegetation communities on the site, and the extent of vegetation proposed to be cleared. This plan should be at the same scale as the plan of the area subject to development in order to assist in the assessment the impact of the proposal on the existing vegetation.

3. Where the assessment concludes that threatened species, populations or ecological communities, or their habitats, exist on or in proximity to the subject land, the effect of the proposed development should be determined in accordance with the eight point test described in Section 5A of the *Environmental Planning and Assessment Act* 1979. An assessment of the impact of the development on the plant communities and/or ROTAP species should also be provided.

4. A description of the measures proposed to mitigate and/or ameliorate the impact of the development on the plant communities, threatened and ROTAP species.

FAUNA

1. A fauna survey to identify the distribution and abundance of fauna species known or likely to utilise the site, including a description of available fauna habitats and an assessment of the conservation status of each of the faunal components at a local, regional and State level.

2. A plan showing the results of the above survey. This plan should be at the same scale as the plan of the area subject to development to assist in the assessment of the impact of the proposal on fauna.

3. An assessment of the impact of the development on the identified fauna.

4. An assessment of the existence or likely occurrence of threatened species, populations or ecological communities, or their habitats on the subject land. Where the assessment concludes that threatened species, populations or ecological communities, or their habitats exist on or in proximity to the subject land, the effect of the proposed development should be determined in accordance with the eight point test described in Section 5A of the *Environmental Planning and Assessment Act* 1979.

5. A description of the measures proposed to mitigate and/or ameliorate the impact of the development on fauna.

CULTURAL

1. The presence or absence of Aboriginal objects should be identified and the significance of the area to the local Aboriginal community must be determined. Accordingly, a search of the DEC Aboriginal Heirtage Information Management System (AHIMS) should be made and the local Aboriginal community should also be consulted with regard to any Aboriginal heritage issues associated with the proposed development.

2. Aboriginal objects and places of significance to the Aboriginal community are to be detailed on a plan. This plan should be at the same scale as the plan of the area subject to development to assist in the assessment of the impact of the proposal on the identified cultural components.

3. An assessment of the impact of the development on the identified cultural sites.

4. A description of the measures proposed to mitigate and/or ameliorate the impact of the development on the identified cultural sites.

5. A contingency plan that details the measures to be taken in the event that archaeological sites are discovered during the course of operations must be prepared.

DEPARTMENT OF ENVIRONMENT AND CONSERVATION ESTATE

1. **Where the proposal may result in impacts on DEC estate or is on land adjacent to DEC estate, an assessment of the impact of the development on DEC estate.**

2. A description of the measures proposed to mitigate and/or ameliorate the impact of the development on the DEC estate.

SURVEYS AND ASSESSMENTS

1. Fauna, flora and cultural surveys and assessments should be undertaken by suitably qualified persons and the qualifications and experience of the persons undertaking the work detailed.

2. Dates, site locations, design, methodology, analysis techniques, and weather conditions at the time of the assessments and surveys must be described. The limitations of surveys should be identified and the results interpreted accordingly.

3. **Conclusions drawn in surveys and assessments should be substantiated by evidence resulting from those surveys and assessments. The document being supported by the surveys and assessments should reflect these conclusions and clearly state where recommendations of the survey and assessments have been incorporated in the proposal.**

DEC DATABASES

1. The DEC can provide records of flora and fauna held in the Wildlife Atlas and / or Rare or Threatened Australian Plants (ROTAP) databases. In addition searches of the DEC AHIMS database can be made. These services generally attract a fee. It should be noted that these databases are not comprehensive, should only be used as a guide and do not negate the need for specific site investigations. Enquires should be made to DEC Hurstville office, telephone (02) 9585 6444.

Attachment 2

DEPARTMENT OF ENVIRONMENT AND CONSERVATION
ENVIRONMENT PROTECTION AND REGULATION DIVISION – NORTH EAST
ENVIRONMENTAL ISSUES TO BE ADDRESSED
Protection of the Environment Operations Act (1997) and Associated Legislation

INTRODUCTION

The following list is provided to assist in the preparation of environmental impact assessment reports. The list details the type of information that is recommended by the Department of Environment and Conservation's (DEC) Environment Protection and Regulation Division (EPRD) - Northeast for inclusion in such assessments.

Please note that the provision of information in accordance with this list does not negate the applicant's obligations under any legislative or planning instruments and deals with those components of DEC's responsibilities relating to the *Protection of the Environment Operations Act (1997)*and its associated legislation only. EPRD suggests that the applicant contact the relevant local council and the Department of Infrastructure Planning and Natural Resources to ascertain these obligations.

GENERAL

1. Map(s) showing the locality of the proposed development in a regional and local context. Local context maps should be based on 1:25 000 topographic plans. Photographs of the site's key attributes may provide useful documentation.

2. A description of the existing environment on the subject land and surrounding land, the proposed development and ancillary works, and the manner in which the environment will be modified by the proposal.

3. The area subject to development should be clearly identified on an appropriately scaled plan. This includes all ancillary works such as buildings and other structures, parking areas, loading/processing/treatment areas, access roads, and material stockpiling areas.

4. The activity will be scheduled and require a licence issued by the EPA if the work comprises the construction of new, re-route or additional carriageways, that as a result will have:

    1. physically separated carriageways for traffic moving in different directions, and
    2. at least 4 lanes (other than lanes used for entry or exit), and
    3. no access for traffic between interchanges for at least 1 kilometre of their length in a metropolitan area.

Water Pollution

The REF should detail the planning and pollution control measures to be implemented to prevent adverse impacts on water quality in permanent or ephemeral water courses both during construction and after the construction works are completed. The issues to be considered should include but need not be limited to erosion and sediment transport from disturbed areas and pollution from plant and machinery operation and maintenance areas, mobile equipment, fuel storage and staff amenities established for the project.

The information provided in the REF should be suitable for incorporation into an appropriate 'Erosion and Sediment Control Plan'.

The following publications may be useful guides in the preparation of an Erosion and Sediment Control Plan:

- NSW Department of Housing guidelines, *Managing Urban Stormwater: Soils and Construction, 1998 may be a useful guide, and*

- *Australian & New Zealand Environment Council's - Guidelines for Fresh and Marine Water Quality (2000).*

Noise Pollution

The work should not cause offensive levels of noise at neighbouring residences or other sensitive noise receptors. Chapter 171 of the Environmental Noise Control Manual provides guidance on the assessment of noise impacts associated with construction works.

The REF should contain:

- Quantitative information on noise levels for fixed and mobile equipment to be used;
- An assessment of the existing acoustic environment and the predicted noise levels at residences or other sensitive noise receptors likely to be affected by the works proposed;
- Details of any noise control measures to be implemented; and
- Hours of operation.

Noise impacts during the construction and operating phases of the project should be outlined and discussed in the REF. Reference should also be made to the EPA's *NSW Industrial Noise Policy* and *Environmental Noise Management: Environmental Criteria for Road Traffic Noise* documents where necessary.

Air Pollution

The REF should identify activities with the potential to produce air pollution including dust, and propose measures that will be implemented to control emissions to within acceptable goals. Work areas, vehicle manoeuvring areas and equipment storage areas should be included in the assessment.

Contaminated Land

The REF must determine whether contaminated soils are present, and if the proposed works are likely to disturb these soils. If contaminated soils are likely to be disturbed, the LES should fully investigate the cost of treatment and disposal in accordance with the 1998 Department of Urban Affairs and Planning/EPA document *Managing Land Contamination: Planning Guidelines*. I also refer you to the following guidelines, which can be obtained by contacting the EPA's Pollution Line on 131555.

- *Contaminated Sites - Guidelines for Consultants Reporting on Contaminated Sites* (EPA 1997)
- *Contaminated Sites - Guidelines for the NSW Site Auditor Scheme* (EPA 1998)
- Contaminated Sites - Sampling Design Guidelines (EPA 1995)

Waste

The REF should identify sources of waste material that may be generated during the project and proposed suitable treatment or disposal options for the material based on a waste management hierarchy of waste avoidance, followed by reuse and recycling/reprocessing with disposal as a last resource.

The Department of Urban Affairs and Planning (DUAP) EIS Guideline titled "*Roads and Related Facilities – Specific requirements for an EIS*" (September 1996) may also be a useful reference. I note that some of the documents referred to in the DUAP guideline have been superseded. A copy of a revised guideline index titled "*Appendix: A – List of Relevant EIS / REF Guidance Documents*" is attached for your information.

APPENDIX: A - List of Relevant EIS / REF Guidance Documents

The following (and other) relevant EPA publications may be referenced on the EPA's web site at www.epa.nsw.gov.au, with copies available by telephoning the EPA's Pollution Line on 131555.

Table: 1 – List of Guidance documents

SOIL & WATER	· *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC, 2000 "In Publication") · *Water Quality and River Flow Interim Environmental Objectives: Guidelines for River, Groundwater and Water Management Committees* (EPA, 1999) · *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (EPA, 1998) · *Managing Urban Stormwater: Soils and Construction* (Dept of Housing, August 1998) *("The Blue Book")* · *Soil Landscape Maps* (Dept Land & Water Conservation) · *Construction* Sites (EPA Manual for Authorised Officers, 1995) · *The Utilisation of Treated Effluent by Irrigation* (EPA, Draft, August, 2000) · *Wetlands for Treating Wastewater* (EPA Manual for Authorised Officers ,1995) · *Environment Matters Series: Using Herbicides Near Water* (EPA's Draft, April, 2000)
ACID SULFATE SOILS	· *Acid Sulphate Soils Manual* (Acid Sulphate Soil Management & Advisory Committee, 1998) · *Acid Sulfate Soils Risk Maps* (Soil Conservation Service of NSW, 1995)

Locked Bag 914
Federation House Level 7, 24 Moonee St Coffs Harbour NSW 2450
Telephone (02) 6651 5946
Facsimile (02) 6651 6187
ABN 30 841 387 271
www.environment.nsw.gov.au

Table: 1 – List of Guidance documents (Cont'd)

AIR	· *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (EPA, 2000)
NOISE	· *Environmental Noise Management: Environmental Criteria for Road Traffic Noise* (EPA, 1999) · *NSW Industrial Noise Policy* (EPA, 2000) · *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure & Ground Vibration* (ANZECC) · *Environmental Noise Control Manual* (EPA,1994)
FUEL & CHEMICAL STORAGE	· *Bunding and Spill Management* (EPA Manual for Authorised Officers, 1997)
WASTE AND LITTER	· Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes" (EPA, 1999) · *Concrete Wastes* (EPA Manual for Authorised Officers, 1995) · *Not Too Hard: Minimising Waste. An information and training package for construction workers* (EPA, The Aust. Centre for Construction Innovation, Uni. Of NSW)
CONTAMINATED SITES	· *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (ANZECC, 1992) · *Guidelines for Consultants Reporting on Contaminated Sites* (EPA, 1997) · *Guidelines for the NSW Site Auditor Scheme* (EPA, 1998) · *Contaminated Sites - Sampling Design Guidelines* (EPA 1995) · *Contaminated Agricultural Land* (EPA Manual for Authorised Officers, 1995) · *Service Station Site: Assessment and Remediation* (EPA Manual for Authorised Officers, 1995)
LICENSING	· *Guide to Licensing Under the protection of the Environment Operations Act 1997 – Parts A and B* (EPA, 1999)

GRAINGER Andrew

From: Vicki McBride [Vicki.McBride@dipnr.nsw.gov.au]
Sent: Thursday, 19 January 2006 3:00 PM
To: GRAINGER Andrew
Subject: Proposed Continuation of State Highway No. 23 - REFrequirements
Attachments: RTA_Shortland.PDF

Andrew

Please find attached DNR (Hunter) response regarding the above matter. A hard copy is in the mail.

Regards

Vicki McBride
Acting Resource Access Manager
Hunter Region
Department of Natural Resources
PO Box 2213
DANGAR NSW 2309
Ph: 02 4929 9850
Fax: 02 4929 6364

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Department of Natural Resources

Your Ref: WBS D/00169/C/DI/04
Our Ref: EH6802

Roads and Traffic Authority
Environmental Technology
Level 5, Pod D
99 Philip Street
PARRAMATTA NSW 2150

Attention: Andrew Grainger

Dear Mr Grainger

Proposed Continuation of State Highway No. 23 (SH23) between Shortland and Sandgate

I refer to your letter of 4 January 2006 concerning the above proposal. The following advice is provided for consideration in the preparation of the Review of Environmental Factors (REF) for the proposed activity.

Water Act 1912

If any proposed works intercept the groundwater table, a licence under Part 5 of the *Water Act 1912* will be required. In order to assist determination of any application for a licence, the REF should include:

- Details of any proposed works likely to intercept groundwater
- Details of the predicted highest groundwater table at the development site
- Details of proposed method of disposal of tail or waste water
- Details of the predicted impacts of any final landform on the groundwater regime

Rivers and Foreshores Improvement Act 1948

Provided the works are carried out under the authority of the Roads and Traffic Authority (RTA) a permit under Part 3A of the *Rivers and Foreshores Improvement Act 1948* (RFIA) is not required for the proposed activity. However, DNR requests that the RTA consider the following in planning and undertaking the works:

- The works should not damage or interfere in any way with:
  - vegetation outside the area of the works,
  - the stability of any adjacent or nearby watercourse bank or bed; and
  - the quality of water in any watercourse.
- Any displaced materials should be stabilised or relocated and made secure so that these materials will not detrimentally affect any watercourse or riparian area.
- No materials should be used that may pollute any watercourse.
- Works should be designed and constructed such that there is no detrimental change in hydraulic behaviour, causing sedimentation, erosion, reduction in waterway or permanent diversion or pollution of any watercourse.

Should there be any further enquiry in this matter, please contact me on (02) 4929 9850.

Yours sincerely

Vicki McBride
Acting Resource Access Manager
Hunter Region

GRAINGER Andrew

From: John Simpson [JSIMPSON@ncc.nsw.gov.au]

Sent: Friday, 20 January 2006 9:55 AM

To: GRAINGER Andrew

Cc: Karenne Jurd; Frank Cosgrove; Tina Harding; Peter Coventry; Peter McMahon; Belinda Smith; Sharon Pope; Peter Sylvester; Mark Johnson; Robert Crook; Tanya Guthrie

Subject: RE: continuation of State Highway 23 - Shortland to Sandgate

Hello Andrew,

Further to our telephone discussion this morning, please find below brief comments regarding matters of interest to Newcastle Council/ suggested requirements for the REF on the above project. Other sections in Council have indicated that they have no specific comments on the project.

Notwithstanding acknowledgement of the existing long standing plan & easement for the SH23 northern extension and acknowledgement of existing provisions for its future construction (such as earlier negotiations with the Wetlands Centre (& poss Council?) and associated tenure modifications to accommodate the project), we consider the following matters to warrant attention in the preparation of the REF from a natural resources management viewpoint:

* adherence to the principles outlined in the NSW Floodplain & Estuary Management Manuals.

* recognition of significant wetland values in & around the study area, identification & assessment of wetland related issues and how to manage these (eg. Ramsar listed wetlands & associated habitats containing significant biota, hydrology regimes, economic importance of fishery production & tourism).

* assessment & management of significant biota occurring in & around the study area, including listed Threatened species & ecological communities, and species protected under international treaties. Examples include significant Green & Golden Bell Frog habitat & population known from the northern part of the study area, presence of freshwater wetlands and coastal floodplain forest in or in the near vicinity of the proposed road, the presence of migratory and other significant bird species in the near vicinity. The commissioning of specialist ecological studies is acknowledged and these will presumably deal comprehensively with these issues.

* assessment & management of floodplain & wetland hydrology, hydraulic & drainage issues, particularly including management of drainage in & around high value wetlands and sensitive habitats such as for Green & Golden Bell Frogs in the northern part of the study area. It is noted that a 240m bridge is proposed for crossing the wetland/ drainage system.

* assessment & management of soil materials & sediments, particularly including Potential Acid Sulphate Soils.

* assessment & management of indigenous cultural heritage values associated with the estuary. The specialist study commissioned on this subject is acknowledged.

Asset Management staff have indicated that they have no specific comments. I am not sure if, or to what extent, Council assets might be affected and what management measures might be required if that is the case. Possible impacts could include altered drainage patterns in upstream lands/ wetlands due to the road construction. Changes to site access are acknowledged.

Regards, JS

John Simpson

Coast & Estuary Program Coordinator

City Strategy Group

Newcastle City Council

PO Box 489

Newcastle NSW 2300

Telephone: 02 4974 2897

Mobile: 0438 626360

Facsimile: 02 4974 2804

email: jsimpson@ncc.nsw.gov.au

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Newcastle City Council

Home Page: http://www.newcastle.nsw.gov.au

E-mail: mailto:mail@ncc.nsw.gov.au

Department of Natural Resources

Your Ref: WBS D/00169/C/DI/04
Our Ref: ER6802

RECEIVED
25 JAN 2006
BY:.....

Roads and Traffic Authority
Environmental Technology
Level 5, Pod D
99 Philip Street
PARRAMATTA NSW 2150

Attention: Andrew Grainger

Dear Mr Grainger

Proposed Continuation of State Highway No. 23 (SH23) between Shortland and Sandgate

I refer to your letter of 4 January 2006 concerning the above proposal. The following advice is provided for consideration in the preparation of the Review of Environmental Factors (REF) for the proposed activity.

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If any proposed works intercept the groundwater table, a licence under Part 5 of the *Water Act 1912* will be required. In order to assist determination of any application for a licence, the REF should include:

- Details of any proposed works likely to intercept groundwater
- Details of the predicted highest groundwater table at the development site
- Details of proposed method of disposal of tail or waste water
- Details of the predicted impacts of any final landform on the groundwater regime

Rivers and Foreshores Improvement Act 1948
Provided the works are carried out under the authority of the Roads and Traffic Authority (RTA) a permit under Part 3A of the *Rivers and Foreshores Improvement Act 1948* (RFIA) is not required for the proposed activity. However, DNR requests that the RTA consider the following in planning and undertaking the works:

- The works should not damage or interfere in any way with:
  - vegetation outside the area of the works;
  - the stability of any adjacent or nearby watercourse bank or bed; and
  - the quality of water in any watercourse.
- Any displaced materials should be stabilised or relocated and made secure so that these materials will not detrimentally affect any watercourse or riparian area.
- No materials should be used that may pollute any watercourse.
- Works should be designed and constructed such that there is no detrimental change in hydraulic behaviour, causing sedimentation, erosion, reduction in waterway or permanent diversion or pollution of any watercourse.

Should there be any further enquiry in this matter, please contact me on (02) 4929 9850.

Yours sincerely

Vicki McBride

Vicki McBride
Acting Resource Access Manager
Hunter Region

Hunter Region 464 King Street Newcastle West NSW 2302 PO Box 2213 Dangar NSW 2309
Telephone (02) 4929 4345 Facsimile (02) 4929 6364 Website dnr.nsw.gov.au

GRAINGER Andrew

From: Paul McMurray [PMCMURRAY@ncc.nsw.gov.au]
Sent: Friday, 20 January 2006 5:11 PM
To: GRAINGER Andrew
Subject: RE: Proposed continuation of State Highway No.23 between Shortland and Sandgate

Dear Andrew,

I refer to your letter dated 4 January 2006 regarding the above proposal. I am aware that other sections of Council have provided comment on the proposal, and although I haven't seen their submissions given the timeframes for reply and holidays, I have an understanding of the type of issues they have raised.

I have listed below a couple of additional issues which I don't believe were raised in their submissions, but if they were, feel free to ignore my comments;

- Acid Sulphate soils – I assume that an acid sulphate soil assessment will be carried out over the proposal area. (addressed in previous council comment)

- Contaminated land investigation – although Council may not possess contaminated land reports specifically relating to the land in question, Council is aware of a of contaminated sites adjacent to the proposed land, which may have some impact on the land in question. In addition, the land in question may have been filled in the past with material that may contain contaminants. As such, the REF should consider this issue and address OH&S or environmental issues that arise as a result, including the appropriate assessment and reuse or disposal of any excavated material.

Yours sincerely,

Paul McMurray

Environmental Services Co-ordinator

Phone 02 49742533

Fax 02 49742501

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NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Now incorporating NSW Fisheries
ABN 51 73 412 4190-002

Our ref: CF06-017
Your ref: WBS D/00169/C/D1/04

23 January 2006

RECEIVED
30 JAN 2006
BY:.....

Andrew Grainger
RTA – Environmental Technology
Level 5, Pod D
99 Phillip Street
PARRAMATTA NSW 2150

Dear Sir,

Re: Proposed continuation of SH23 – Shortland to Sandgate

Thank you for your letter requesting REF requirements from Department of Primary Industries relating to Fisheries issues, for the proposal cited above. The information listed below and in the attachment may be of some assistance in the preparation of the REF for this proposal.

The Department has particular concerns with the crossing over Deepbridge Creek and the potential impacts of any pile or supports constructed in the vicinity of the creek and its floodways. This is of particular concern as there are potential plans to carry out rehabilitation works in the creek to assist in the reinstatement of substantial fisheries habitat in the creek. Consequently any design proposals should ensure the creek and its floodplain area is left as intact as possible.

Should you require any further information on these requirements please contact the Office of Conservation at Port Stephens on 4916 3931.

Yours sincerely

Scott Carter
Senior Conservation Manager - Central

Matters to be Addressed

Definitions

The definitions given below are relevant to these requirements:

Fish means any part of marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history (whether alive or dead). This includes aquatic molluscs, crustaceans, echinoderms, worms, aquatic insect larvae and other macroinvertebrates .

Marine vegetation means any species of plant that at any time in its life must inhabit water (other than fresh water).

Waters refers to all waters including tidal waters as well as flowing streams, irregularly flowing streams, gullies, rivers, lakes, coastal lagoons, wetlands and other forms of natural or man made water bodies on both private and public land.

GENERAL REQUIREMENTS

- Area which may be affected either directly or indirectly by the development or activity should be identified and shown on an appropriately scaled map (1:25000) and aerial photographs.
- All waterbodies and waterways within the proposed area of development are to be identified.
- Description and maps of aquatic vegetation, snags, gravel beds and any other protected, threatened or dominant habitats should be presented. Description should include area, density and species composition.
- A survey of fish species should be carried out and results included. Existing data should be used only if collected less than 5 years previously.
- Identification of recognised recreational and commercial fishing grounds, aquaculture farms and/or other waterways users.
- Details of the location of all component parts of the proposal, including any auxiliary infrastructure, timetable for construction of the proposal with details of various phases of construction
- Aspects of the management of the proposal, both during construction and after completion, which relate to impact minimisation and site rehabilitation eg Environment Management Plans, Rehabilitation Plans, Compensatory offsets
- For each freshwater body identified on the plan, the plan should include, either by annotation or by an accompanying table, hydrological and stream morphology information such as: flow characteristics, including any seasonal variations, bed substrate, and bed width
- For each marine or estuarine area identified on the plan, the plan should include, either by annotation or by an accompanying table, hydrological and stream morphology information such as: tidal characteristics, bed substrate, and depth contours

DREDGING AND RECLAMATION ACTIVITIES

- Purpose of works
- Type(s) and distribution of marine vegetation in the vicinity of the proposed works
- Method of dredging to be used
- Timing and Duration of works
- Dimension of area of works including levels and volume of material to be extracted or placed as fill
- Nature of sediment to be dredged, including Acid Sulphate Soil, contaminated soils etc
- Method of marking area subject to works
- Environmental safeguards to be used during and after works

- Measures for minimising harm to fish habitat under the proposal
- Spoil type and source location for reclamation activities
- Method of disposal of dredge material
- Location and duration of spoil stockpiling, if planned

ACTIVITIES THAT DAMAGE MARINE VEGETATION

- Type of marine vegetation to be harmed
- Map and density distribution of marine vegetation
- Reasons for harming marine vegetation
- Methods of harming marine vegetation
- Construction details
- Duration of works/activities
- Measures for minimising harm to marine vegetation under the proposal and details of compensatory habitat development to replace lost vegetation.
- Method and location of transplanting activities or disposal of marine vegetation

ACTIVITIES THAT BLOCK FISH PASSAGE

- Type of activity eg works in a stream that change flow or morphological characteristics of the stream, including culvert and causeway construction, sediment and erosion control measures, stormwater diversion structures.
- Length of time fish passage is to be restricted, whether permanent or temporary
- Timing of proposed restriction. Should be timed to avoid interfering with migratory movements of fish.
- Remediation or compensatory works to offset any impacts

THREATENED SPECIES

- Threatened aquatic species assessment (Section 5c, EP&A Act 1979). This must be addressed even if there are no Threatened Species present on the site.
- Eight Part Test

FISHING AND AQUACULTURE

- Outline and document commercial, recreational and indigenous fishing activities that may be affected by the activity, including regular commercial fishing grounds, popular recreational fishing sites, recognised indigenous harvesting sites.
- Will the activity interfere with or cause an impact on the continuing operation and viability of nearby aquaculture or mariculture ventures.

2. Initial Assessment

A list of threatened species, endangered populations and endangered ecological communities must be provided. In determining these species, consideration must be given to the habitat types present within the study area, recent records of threatened species in the locality and the known distributions of these species.

In describing the locality in the vicinity of the proposal, discussion must be provided in regard to the previous land and water uses and the effect of these on the proposed site. Relevant historical events may include land clearing, agricultural activities, water abstraction/diversion, dredging, de-snagging, reclamation, siltation, commercial and recreational activities.

A description of habitat including such components as stream morphology, in-stream and riparian vegetation, water quality and flow characteristics, bed morphology, vegetation (both aquatic and adjacent terrestrial), water quality and tide/flow characteristics must be given. The condition of the habitat within the area must be described and discussed, including the presence and prevalence of introduced species. A description of the habitat requirements of threatened species likely to occur in the study area must be provided.

In defining the proposal area, discussion must be provided in regard to possible indirect effects of the proposal on species/habitats in the area surrounding the subject site: for example, through altered hydrological regimes, soil erosion or pollution. The study area must extend downstream and/or upstream as far as is necessary to take all potential impacts into account.

Please Note: Persons undertaking aquatic surveys may be required to hold or obtain appropriate permits or licences under relevant legislation. For example:

Fisheries Management Act 1994

- Permit to take fish or marine vegetation for research or other authorised purposes (Section 37)
- Licence to harm threatened (aquatic) species, and/or damage the habitat of a threatened species (Section 220ZW).

Animal Research Act 1985:

- Animal Research Authority to undertake fauna surveys.

It is recommend that, prior to any field survey activities taking place, those persons proposing to undertake those activities give consideration to their obligation to obtain appropriate permits or licences which may be required in the specific context of the proposed survey activities.

3. Assessment of Likely Impacts

The REF must:

- describe and discuss significant habitat areas within the study area;
- outline the habitat requirements of threatened species likely to occur in the study area;
- indicate the location, nature and extent of habitat removal or modification which may result from the proposed action;
- discuss the potential impact of the modification or removal of habitat;
- identify and discuss any potential for the proposal to introduce barriers to the movement of fish species; and
- describe and discuss any other potential impacts of the proposal on fish species or their habitat.

For all species likely to have their lifecycle patterns disrupted by the proposal to the extent that individuals will cease to occupy any location within the subject site, the REF must describe and discuss other locally occurring populations of such species. The relative significance of this location for these species in the general locality must be discussed in terms of the extent, security and viability of remaining habitat in the locality.

4. Ameliorative Measures

The REF must consider how the proposal has been or may be modified and managed to conserve fisheries habitat on the subject site and in the study area.

In discussing alternatives to the proposal, and the measures proposed to mitigate any effects of the proposal, consideration must be given to developing long term management strategies to protect areas within the study area which are of particular importance for fish species. This may include proposals to restore or improve habitat.

Any proposed pre-construction monitoring plans or on-going monitoring of the effectiveness of the mitigation measures must be outlined in detail, including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency.

In the event of a request for concurrence or consultation of the Director of Department of Primary Industries, one (1) copy of the REF should be provided to Department of Primary Industries in order for the request to be processed.

It should be noted that Department of Primary Industries has no regulatory or statutory role to review draft REFs unless they are accompanied by or are requested as part of a licence application under Part 7A of the FM Act. However, Department of Primary Industries is available to provide advice to consent and determining authorities regarding Fisheries' opinion as to whether the requirements have been met if requested, pending the availability of resources and other statutory priorities.

Useful Information

To help you in the preparation of an REF, the publication "*Guidelines for the Assessment of Aquatic Ecology in EIA*" (Draft 1998) produced by the Department for Urban Affairs and Planning may prove useful in outlining appropriate procedures and methodologies for conducting aquatic surveys.

GRAINGER Andrew

From: Small Greg [greg.small@hunterwater.com.au]
Sent: Wednesday, 1 February 2006 3:21 PM
To: GRAINGER Andrew
Subject: Continuation of state highway 23 between Sandgate and Shortland

Andrew,

Thank you for your letter of 4 January 2006 re the above and the opportunity to comment on the proposal prior to the preparation of the REF.

Hunter Water operates two large diameter water mains (900mm diameter and 1350mm diameter) that roughly parallel and cross over the route of the proposed road. These will eventually need to be replaced or duplicated. There will likely be a range of smaller services that will also be affected by the proposed roadworks.

While none of these would present any issues that cannot be overcome it will be necessary to take account of these in the concept design phase and for RTA to liaise closely with HWC to ensure that the roadworks are designed to suitably allow for the operation and maintenacne of HWC assets and for the planned future works.

Please liaise further with HWC at the appropriate time re the a above issues.

regards

Greg Small
R/Manager Network Planning
HWC

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Australian Government

Department of the Environment and Heritage

Mr Andrew Grainger
Environmental Officer
RTA Environmental Technology
Level 5 Pod D
99 Phillip Street
PARRAMATTA NSW 2150

RECEIVED
30 JAN 2006
BY:

Dear Mr Grainger

PROPOSED CONTINUATION OF STATE HIGHWAY 23 – SHORTLAND TO SANDGATE NSW
APPLICATION OF THE *ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999*

I refer to your letter of 4 January 2006 seeking our input on the Review of Environmental Factors (REF) for the above proposal.

As you may be aware, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection of certain defined matters of national environmental significance (NES). Approval is needed under the Act for proposals or actions likely to have a significant impact these matters. In relation to the above proposal, potentially relevant protected matters are:

- wetlands which are listed as Ramsar wetlands of international importance;
- nationally threatened species and communities which are listed under the EPBC Act (note that these species may not be the same as those listed under state legislation);
- migratory species that are listed under the EPBC Act (these are migratory species protected under international agreements);

Not all actions potentially affecting these matters will have a significant impact and need referral or approval under the Act. The *Administrative Guidelines on Significance* give guidance on what types of actions and impacts may be considered significant and for which referral may be needed. These guidelines are available from Department's web site (www.deh.gov.au/epbc).

We have undertaken a search of our database and we have no record of having received a referral for the above action.

If significant impacts are likely on a matter protected as a result of this proposal proceeding, the NSW RTA will need to refer under the EPBC Act. If you are unsure as to whether or not the action is significant, it can still be referred and the Department will advise whether or not approval is needed within 20 business days. A form for making a referral is available from Department's web site.

If it is determined that an action is not likely to have a significant impact, then the action is not a controlled action and further involvement or environmental approvals are not needed. However, if it is determined that an action is likely to have a significant impact, and approval is therefore required, the action is called a controlled action. The proposal will then have to

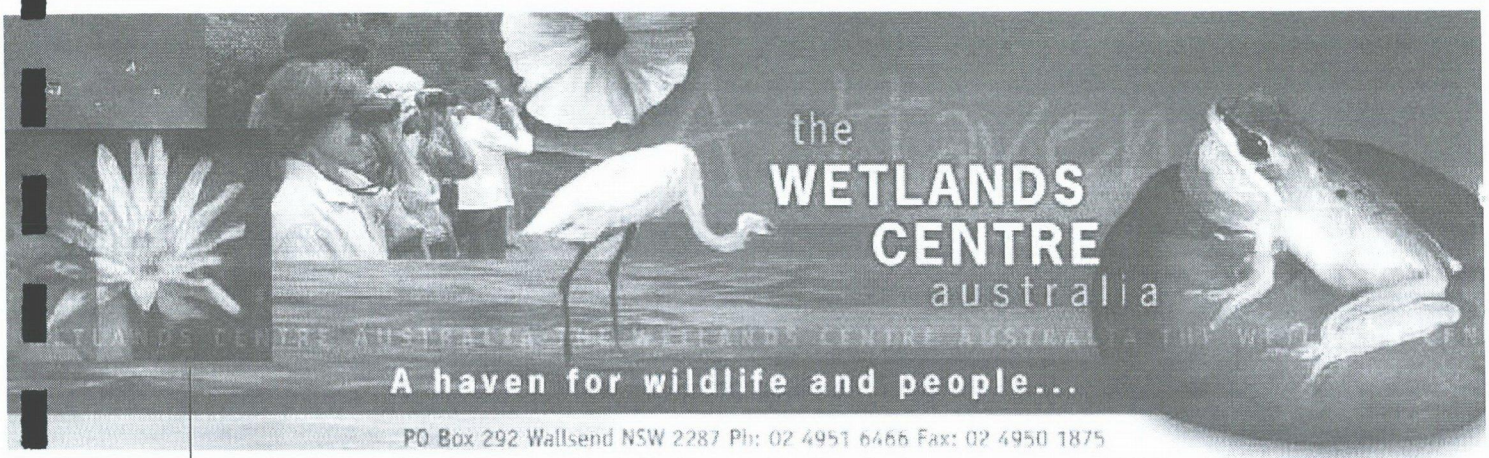
go through a formal assessment process (albeit through an accredited State process), and cannot proceed until approval has been granted.

Please do not hesitate to contact the undersigned (02 6274 1092) if you require further information.

Yours sincerely

Fiona Jinman
Acting Director
EPBC Act Referrals Section
Approvals and Wildlife Division

27 January 2006



PO Box 292 Wallsend NSW 2287 Ph: 02 4951 6466 Fax: 02 4950 1875
Off the roundabout, Sandgate Road, Shortland twc@wetlands.org.au www.wetlands.org.au

30 January 2006

Mr Andrew Grainger
Environmental Officer
RTA Environmental Technology
Level 5, Pod D
99 Phillip Street
PARRAMATTA NSW 2150

RE: SUBMISSION ON STATE HIGHWAY 23

Thank you for your letter of 4 January requesting input into your Review of Environmental Factors for the State Highway 23 proposal (between Shortland and Sandgate).

As you know, the construction will be alongside Shortland Wetlands, which is a Ramsar-listed wetland - a wetland of international significance, and therefore covered under the Environmental Protection and Biodiversity Conservation (EPBC) Act. As such we request that the works be referred to the Australian Government Dept of Environment & Heritage for consideration under EPBC.

We also offer the following items of concern and/or suggestion for more detailed consideration as requested:

<u>During construction:</u>

- Minimise impacts from roadworks on the operations of the Hunter Wetlands Centre. Impacts could include dust, noise and visitor access to the Hunter Wetlands Centre.
- Do not impede natural water flows into the wetlands and ensure that water quality is maintained (eg. no sediment loading).
- Note that water pumped from the creek draining the market site and used as inflow to our BHP Pond runs via pipe from the other side of the proposed highway. Thus an under highway pipe would be required.
- Ensure best practice environmental management during construction works. In particular, the following matters that are present in the vicinity of Deepbridge creek:

- minimise clearing of established or establishing native vegetation and habitats, such as Swamp Oak trees and reed beds, in the construction area;
- minimise disturbance of alluvial and wetland soils during construction and use of geotextile fabrics where relevant; and
- minimise disturbance of potential acid sulphate soils in establishing foundations for the road.

Design features that would add biodiversity and or tourism values could include:

- Recognition of the significant values of wetlands in the area and their interconnections. The proposed long span bridge over Deepbridge Creek is acknowledged. We would value the opportunity to discuss and comment on the adequacy of the proposed design for the bridge.
- Water management structures to minimise impacts on wetlands, control and treat run-off from the road.
- Small constructed wetlands to handle above, with opportunities to incorporate their design and function in the educational program at the Hunter Wetlands Centre.
- Methods to maintain the hydraulic connections between the Hunter Wetlands Centre land and adjacent wetlands and to minimise impacts on the local hydrology (maintain wetland species movement including the endangered Green and Golden Bell Frog, surface water hydraulics, groundwater interactions, local catchment drainage and flooding issues, etc.) in the surrounding wetlands.
- Environmental assessment to consider the implications for the canoe channel of the road construction and opening of the Ironbark Creek floodgates.
- Good screening of the road from the Centre so the sight of vehicles does not detract from the amenity of the place, and disturb the wildlife. At this stage we believe visual impacts can be best managed through mass plantings of suitable local species (advice from Hunter Wetlands Centre Site Management Committee on species is available).
- Plantings should be combined with sound barriers (designed to provide glimpses of the wetlands to passing motorists) to manage noise pollution. We note the planned bridge structures in the vicinity of the Centre and would appreciate the opportunity to discuss this aspect further to determine the likelihood and level of noise and visual impacts and how these can be best managed.
- Use wetland fauna for relief features on concrete sound walls and possible incorporation of other art work using native species into the road design.
- Management of significant habitats and species that occur in the vicinity of the planned road so that there is at least no net loss of biodiversity values and if possible, a net gain. The Hunter Wetlands Centre must maintain its connectivity to surrounding wetlands and natural habitats.

- Site rehabilitation that complements the existing values of the floodplain and wetland environments.
- Development of a secure access to the Newcastle Wetlands (and through to the University at some stage) so that utilisation of those areas in the future is not cut off. This access should include:
  - Adequate safe passage for ducks, swans, green and golden bell frogs and other wildlife;
  - People and cyclist safe access facility between the HWCA site and Newcastle Wetlands Reserve and Sandgate railway station. Planning for the proposed construction of a long span bridge over Deepbridge Creek could/should include such a facility and would provide an excellent opportunity for provision of recreation & tourism infrastructure in this area.
- Good signage for the centre and surrounding wetlands.
- Road entry and exit to HWCA should continue to be in same or improved conditions where possible.
- Safe access to the site for vehicles including buses.

We look forward to further consultation on this project.

Regards

Tara Ure
Chief Executive Officer

Appendix D

Database Searches

Australian Heritage Database

Search Results

edit search | new search | about the Australian Heritage Database | Heritage home | Australian Heritage Council home

1 result found.

Hunter Estuary Wetlands	Pacific Hwy	Kooragang, NSW	(Registered) Register of the National Estate

Report Produced: Wed Dec 21 12:28:55 2005

Australian Heritage Database

Place Details

edit search | new search | about the Australian Heritage Database | Heritage home | Australian Heritage Council home

Send Feedback

Hunter Estuary Wetlands, Pacific Hwy, Kooragang, NSW

Photographs: None
List: Register of the National Estate
Class: Natural
Legal Status: Registered (28/10/2003)
Place ID: 1296
Place File No: 1/09/063/0019
Statement of Significance:

The Hunter Estuary Wetlands are internationally significant as waterbird habitat. At least 45 migratory species presently listed under the Japan-Australia Migratory Bird Agreement (JAMBA) and/or the China-Australia Migratory Bird Agreement (CAMBA) are recorded. The place supports at least 1% of the total international populations of thirteen species of shorebirds and is nationally significant as both a feeding and roosting site for a large seasonal population of Palaearctic shorebirds and a way-lay site for transient migratory birds. The place also supports a significant number of birds that over-winter and is ranked fifth in Australia in terms of the total numbers of shorebird species present.

The abundance of wetland types and the favourable interspersion of habitats is responsible for the great numbers and diversity of waterbirds with over 250 species recorded. In 2000, 4,800 migratory shorebirds were recorded in the Estuary while in January 1995, 12,000 waterbirds of all classifications were recorded.

The place supports a large number of species at a critical seasonal stage in their breeding cycle with twenty-eight species of birds having been recorded breeding in the place. During winter, substantial numbers of immature migratory waders remain in the Hunter Estuary Wetlands and do not return to the northern hemisphere. These birds mature to form future breeding stocks and are thus critical to the species' survival. The place provides refuge for a number of species during periods of severe inland drought. Reedy margins provide breeding areas for native waterfowl and shallow pond margins provide foraging sites for shorebirds.

The mosaic of plant communities at Shortland Wetlands has significant value for biodiversity. The variety of plant communities represent a unique complex found nowhere else in the Sydney Basin biogeographic region. The melaleuca swamp forest in particular provides nesting and roosting habitat for egrets, herons and ibises and represents a wetland type that, although once very widespread, is poorly represented in the bioregion.

Kooragang Nature Reserve is ecologically diverse and represents a regionally significant genetic pool for wetland plant species. One hundred and twelve species of vascular plants have been identified at Kooragang Island forming many distinct habitat types of which the Mangrove and Saltmarsh areas are good examples.

Hexham Swamp has been recognised as the largest freshwater swamp on the NSW north

coast and comprises about 45% of the entire remaining freshwater wetland habitat in the Hunter Valley. The swamp is of vital importance as a storage area for flood waters, of regional and national importance for wildlife, valuable as a nutrient sink and nursery ground for fish and other estuarine life and a major open space landscape of regional significance.

A high number of threatened fauna and flora species occur in the Hunter Estuary Wetlands including the nationally vulnerable red goshawk (ERYTHROTRIORCHIS RADIATUS), grey-headed flying fox (PTEROPUS POLIOCEPHALUS), and the green and golden bell frog (LITORIA AUREA). Kooragang Island supports one of the largest known remaining populations of the green and golden bell frog in NSW with population studies indicating that up to 1,000 individuals occur.

In 1987, the Shortland Wetlands Centre initiated a reintroduction program for the locally extinct magpie goose (ANSERANAS SEMIPALMATA) and now supports a breeding population of over 100 individuals. The Wetlands centre is also one of only four centres in Australia that is hosting a freckled duck (STICTONETTA NAEVOSA) captive-breeding program.

The nationally endangered rainforest vine CYNANCHUM ELEGANS occurs adjacent to the western boundary of the Reserve and has only been recorded in 40 other sites in NSW. The estuarine herb ZANNECHELLIA PALUSTRIS has been recorded immediately adjacent to the western end of Kooragang Nature Reserve. This herb is only found in the Newcastle/Lake Macquarie area and along Ironbark Creek

The Hunter Estuary Wetlands offers significant opportunity for environmental education since it is readily accessible to a large number of people from Newcastle and the lower Hunter Valley. The Shortland Wetlands Centre educational programs and achievements have resulted in a greater understanding of wetlands in the Hunter region, increasing community support for other major wetland rehabilitation projects. Shortland Wetlands have retained their importance in the fabric of the local community since a community campaign to save and restore the wetlands was initiated.

The area includes one of the earliest railways in Australia, the Minmi-Hexham line which was built in the mid 1850s for the transport of coal. The line, later extended to Richmond Main and Pelaw Main collieries as part of the significant J & A Brown coalmining enterprise, is directly associated with the development of the coal industry in the Hunter Valley and it operated for well over a century. It was still a steam-operated line when it finally closed down in the 1980s, making it one of the last steam railways in Australia. (Criteria A.4 and B.2) (Theme: 3.8.6 Building and maintaining railways)

Official Values: Not Available

Description:

The Hunter Estuary Wetlands comprise Kooragang Nature Reserve, Hexham Swamp Nature Reserve, Shortland Wetlands and the SEPP 14 listed wetlands associated with the lower Hunter River Estuary, north of Newcastle in New South Wales. The place is within the Hunter River catchment, one of the largest coastal basins in New South Wales and extends further inland than any other coastal catchment. Kooragang Nature Reserve and Shortland Wetlands are listed under the Ramsar Convention on Wetlands of International Importance. Kooragang is the largest estuarine wetland reserve in NSW. Estuarine wetlands are defined as all areas above the low tide level, which are subject directly or indirectly to tidal influence. Estuarine wetlands support a highly productive food chain and comprise an essential nursery habitat for a wide variety of marine life. Less than 1% of the Australian continent is classed as estuarine wetland.

The lower Hunter River is a barrier estuary formed by the deposition of sediments in swamps and flats lying between the inner and outer coastal barrier sands. These barriers demonstrate the evolution of the coastline during changes in sea level during the Pleistocene and Recent geological periods as a result of world wide glacial cycles, with the latest most significant event occurring some six thousand years ago when the sea level rose over one hundred metres to its present level.

Kooragang Nature Reserve comprises Fullerton Cove, parts of Kooragang Island and the north channel of the Hunter River. Kooragang Island once consisted of several islands separated by small channels. Its present configuration is the result of dredging and land reclamation. The island now supports large areas of mangrove woodland, some mangrove forest, large areas of salt marsh and some sedge swamp, as well as open water, mudflats, pasture, sandy areas and rainforest remnants. Fifteen vegetation community types occur in the nature reserve including mangrove forests dominated by the grey mangrove (AVICENNIA MARINA) and the river mangrove (AEGICERAS CORNICULATUM), saltmarsh dominated by samphire (SARCOCORNIA sp.) and saltwater couch (SPOROBOLUS VIRGINICUS), swamp forest consisting of swamp oak (CASUARINA GLAUCA) and paperbark (MELALEUCA spp.) and rainforest remnants consisting of figs (FICUS spp.) and cabbage tree palms (LIVISTONA AUSTRALIS).

Fullerton Cove is a shallow estuarine embayment fringed with mangroves, with extensive mudflats exposed at low tide. South-west of the cove lies an open shallow swamp, up to 1m deep, which supports large numbers of waterfowl and a resident flying fox colony in the fringing mangroves. Many birds use both Kooragang Island and Fullerton Cove as complementary habitats, and a total of over 190 bird species have been observed in these two areas.

Hexham Swamp is the largest freshwater swamp on the north coast of NSW with an area of 2 500 ha and lies upstream of Kooragang Nature Reserve in the natural transition zone from saline through brackish waters. Most of Hexham Swamp is non-tidal and contains the largest samples of many fresh and brackish wetland plants on the Hunter floodplain The swamp contains estuarine habitat in the north-eastern corner adjacent to the Hunter River. This continues along Ironbark Creek to form strong ecological link between Hexham Swamp, Shortland Wetlands and the western end of Kooragang Nature Reserve. The wetlands are particularly important as a drought refuge and as fish nursery grounds.

From the turn of the twentieth century up until the 1950's it is understood that Hexham Swamp was covered by predominantly freshwater vegetation with saline communities restricted to the margins of creeks. The reclamation and amalgamation of the various islands in the Hunter River delta to form Kooragang Island apparently resulted in an elevated tidal influence along the southern arm of the river. This in turn encouraged an expansion of saline communities. The subsequent installation of the floodgates on Ironbark Creek in the 1970's restricted the saline intrusion and resulted in a partial return to freshwater conditions. More recent studies indicate that the swamp in now dominated by a single community, the reed PHRAGMITES, and there has been a large reduction in the extent of the reed FIBRISTYLIS FERRUGINEA, saltwater couch, red samphire and mangrove communities.

Shortland Wetlands is a small but unique complex of wetland types surrounded by urban development along three boundaries and Hexham Swamp to the west. Previously degraded, this urban wetland has been restored with the key objectives of wetland conservation, education and community involvement. The site provides habitat for a diverse range of wetland species, including waterbirds at a critical stage of their lifecycles and numerous threatened species. The main habitats and vegetation types on the site

include restored semi-permanent/seasonal freshwater ponds and marshes, natural semi-permanent/seasonal brackish ponds and marshes, freshwater swamp forests and a coastal estuarine creek. The most significant wetland plant community at Shortland Wetlands is the melaleuca swamp forest, dominated by broad-leaved paperbark (MELALEUCA QUINQUENERVIA). Twenty-one other plant communities occur on the site including open rainforest dominated by turpentine (SYNCARPIA GLOMULIFERA) and red cedar (TOONA CILIATA), open Eucalypt woodland dominated by swamp mahogany (EUCALYPTUS ROBUSTA), red bloodwood (E. GUMMIFERA) and grey gum (E. PUNCTATA), melaleuca shrubland dominated by ball honeymyrtle (M. NODOSA) and swamp paperbark (M. ERICIFOLIA), water couch wet meadow, closed TYPHA swamp rushland and closed PHRAGMITES reed swamp.

Other important feeding and roosting areas within the place include sand spits, artificial dykes, salt marsh communities, sedge swamps and mangroves. The place is an important breeding site for many birds including all four species of egret occurring in the Hunter region, being the great (ARDEA ALBA), little (EGRETTA GARZETTA), cattle (A. IBIS) and intermediate (A. INTERMEDIA). Other breeding species recorded at the place include the little pied (PHALACROCORAX MELANOLEUCOS) and little black cormorants (P. SULCIROSTRIS), magpie goose (ANSERANAS SEMIPALMATA) and nankeen night heron (NYCTICORAX CALEDONICUS).

Up to eleven frog species have been recorded including the striped marsh frog (LIMNODYNASTES PERONII), spotted grass frog (L. TASMANIENSIS) and common eastern froglet (CRINIA SIGNIFERA). Reptiles include the long-necked tortoise (CHELADINA LONGICOLLIS), striped skink (CTENOTUS ROBUSTUS), she-oak skink (TILIQUA CASUARINAE) and swamp snake (HEMIASPIS SIGNATA). There are few records of native mammals. Those recorded include northern brown bandicoot (ISOODON MACROURUS), water rat (HYDROMYS CHRYSOGASTER), grey-headed flying fox (PTEROPUS POLIOCEPHALUS) and red fruit-bat (PTEROPUS SCAPULATUS).

The Hunter Estuary contains about 15 species of commercially important fish, crustacea and molluscs. The industry has been estimated at around a half a million dollars annually with major components being mullet, jewfish, prawn and oyster fisheries, which together provide about 8% of the NSW annual catch. A wide diversity of macro-invertebrates is present including many sensitive insect larvae. Macro-invertebrate surveys routinely record molluscs, bloodworms, caddis fly larvae, gastropods, beetles, bugs, water fleas, seed shrimps, copepods and nymph forms of dragonfly, damselfly, stonefly and mayfly.

The area also contains one of Australia's oldest former railways. Coal mining began at Minmi in about 1848, and the coal was initially hauled by bullock teams around Hexham Swamp to the Hunter River. During the ownership of John Eales, the mining operation built a railway across the swamp to connect Minmi and wharves at Hexham, and the railway began operating in 1856. The rails were originally timber, which were soon replaced with iron. Horses hauled the first loads on the timber rails, then small 040 side tank locomotives operated on the iron rails. The area subsequently became part of the J & A Brown coalmining empire, and the private line was extended. New locomotives were purchased and in 1891 a passenger service was introduced. By the early 1900s the line had been extended to Richmond Main and to Pelaw Main collieries, and in 1909 the line across the swamp was duplicated. Coal may have been railed all the way to the Newcastle wharves. The line's embankment across the swamp was built with culverts to allow for the passage of flood waters, but floods still sometimes caused damage, as in February 1955. Following colliery closures, rail services from Stockrington to Pelaw ceased in the 1960s, and use of the line across Hexham Swamp ceased in the early

1980s. It was reputedly one of the oldest and last operating commercial steam railways in Australia.

The line essentially consists of the embankment (about one metre high above the level of the swamp), culverts, and the railway line which remains in situ for most of the swamp section. A number of other important features survive, including telegraph lines and some signalling equipment.

Other less significant historic heritage features are found at Kooragang Nature Reserve. Among these are the concrete footings from a dairy on Sandy Island, a timber bridge, a Moreton Bay Fig tree associated with early farming, and a partly submerged timber drogue.

History: Not Available

Condition and Integrity:

The lower catchment of the Hunter River is highly industrialised and urbanised and the mouth of river has been developed as one of Australia's most important ports. There is continuing land development in the catchment in close proximity to the listed area. Introduced animals include domestic dogs (CANIS FAMILIARIS), foxes (VULPES VULPES) and cats (FELIS CATTUS). The black rat (RATTUS RATTUS), brown rat (RATTUS NORVEGICUS) and house mouse (MUS MUSCULUS) also compete with native species in the area. Rats are known to take both waterfowl eggs and their hatchlings as food. Four major weeds are established within the place and include bitou bush (CHRYSANTHEMOIDES MONILIFERA), alligator weed (ALTERNANTHERA PHILOXEROIDES), water hyacinth (EICHORNIA CRASSIPES) and pampas grass (CORTADERIA SELLOANA). The most serious aquatic weed species include alligator weed, dock (RUMEX spp.) and pennywort (HYDROCOTYLE BONARIENSIS). Sharp rush (JUNCUS ACUTUS) occurs in part of the place but is considered a minor threat.

Hexham Swamp is a modified wetland environment. In 1971, floodgates were installed in Ironbark Creek. Since the construction of the floodgates the vegetation of the swamp has changed significantly, resulting in a reduction in mangrove and saltmarsh communities. A single community of the common reed (PHRAGMITES AUSTRALIS) now dominates the swamp. Some areas are being invaded by pasture grasses. Although the floodgates are still in place, their management is to be modified in the near future, allowing increased tidal flows into the creek system which may enhance the brackish wetland values on the site. Hexham Swamp provides the main pondage area for flood relief in the Hunter River estuary.

Some of the remnant natural wetlands on the site have exhibited signs of eutrophication, such as emission of odorous gases (e.g. Hydrogen sulphide), algal blooms and dominance by eutrophytes (e.g. TRIGLOCHIN PROCERA, SPIRODELA PUSILLA, AZOLLA spp.). Eutrophication may occur as a result of a concentration of nutrients, changes in water quality parameters such as pH, urban run-off and a build-up of bird faeces. Desktop review of condition in 2003.

In recent years there were plans for the railway to be reopened, but these did not proceed. (February 2003)

Location:

About 6500ha, at Kooragang, comprising the following areas:
1. Hunter Estuary Wetlands Ramsar Site comprising Kooragang Nature Reserve and Shortland Wetlands.
2. Hexham Swamp Nature Reserve.
3. Those parts of SEPP 14 Coastal Wetlands bounded by longitude 151 degrees 36 minutes 43 seconds in the west, longitude 151 degrees 49 minutes 08 seconds in the

east, latitude 32 degrees 48 minutes 50 seconds in the north, and latitude 32 degrees 53 minutes 42 seconds in the south.

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Report Produced: Wed Dec 21 12:29:37 2005

Click on the BACK button of your browser to return to the search.

Statutory Listed Items

Information and items listed in the State Heritage Inventory come from a number of sources. This means that there may be several entries for the same heritage item in the database. For clarity, the search results have been divided into two sections.

- Section 1. contains items listed by the **Heritage Council** under the NSW Heritage Act. This includes listing on the State Heritage Register, an Interim Heritage Order or protected under section 130 of the NSW Heritage Act. This information is provided by the NSW Heritage Office.
- Section 2. contains items listed by **Local Councils & Shires and State Government Agencies**. This section may also contain additional information on some of the items listed in the first section.

Section 1. Items listed under the NSW Heritage Act.

The search results can be re-sorted by clicking on the **(sort)** option at the top of each column.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Listed Under Heritage Act

There were no records in this section matching your search criteria.

Section 2. Items listed by Local Government and State agencies.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Information Source (sort)
2HD Studio	173 Maitland Road	Sandgate	Newcastle	LGOV
Ironbark Creek Underbridge, Sandgate	Steel Trusses 2 Km Past Station	Sandgate	Newcastle	SGOV
Sandgate Cemetery	108 Maitland Road	Sandgate	Newcastle	LGOV
Sandgate Cemetery Office	116 Maitland Road	Sandgate	Newcastle	LGOV
Sandgate Cemetery Railway Spur	108 Maitland Road	Sandgate	Newcastle	LGOV
Sandgate Footbridge	At Station	Sandgate	Newcastle	SGOV

There were **6** records in this section matching your search criteria.

There was a total of **6** records matching your search criteria.

Key:
LGA = Local Government Area
GAZ= NSW Government Gazette (statutory listings prior to 1997), HGA = Heritage Grant Application, HS = Heritage Study, LGOV = Local Government, SGOV = State Government Agency.

Note: The Heritage Office seeks to keep the State Heritage Inventory (SHI) up to date, however the latest listings in Local and Regional Environmental Plans (LEPs and REPs) may not yet be included. Always check with the relevant Local Council or Shire for the most recent listings.

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Click on the BACK button of your browser to return to the search.

Statutory Listed Items

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- Section 1. contains items listed by the **Heritage Council** under the NSW Heritage Act. This includes listing on the State Heritage Register, an Interim Heritage Order or protected under section 130 of the NSW Heritage Act. This information is provided by the NSW Heritage Office.
- Section 2. contains items listed by **Local Councils & Shires and State Government Agencies**. This section may also contain additional information on some of the items listed in the first section.

Section 1. Items listed under the NSW Heritage Act.

The search results can be re-sorted by clicking on the **(sort)** option at the top of each column.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Listed Under Heritage Act

There were no records in this section matching your search criteria.

Section 2. Items listed by Local Government and State agencies.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Information Source (sort)
Uniting Church	272 Sandgate Road	Shortland	Newcastle	LGOV

There was 1 record in this section matching your search criteria.

There was a total of 1 record matching your search criteria.

Key:
LGA = Local Government Area
GAZ= NSW Government Gazette (statutory listings prior to 1997), HGA = Heritage Grant Application, HS = Heritage Study, LGOV = Local Government, SGOV = State Government Agency.

Note: The Heritage Office seeks to keep the State Heritage Inventory (SHI) up to date, however the latest listings in Local and Regional Environmental Plans (LEPs and REPs) may not yet be included. Always check with the relevant Local Council or Shire for the most recent listings.

Australian Government
Department of the Environment and Heritage

Protected Matters Search Tool

You are here: DEH Home > EPBC Act > Search

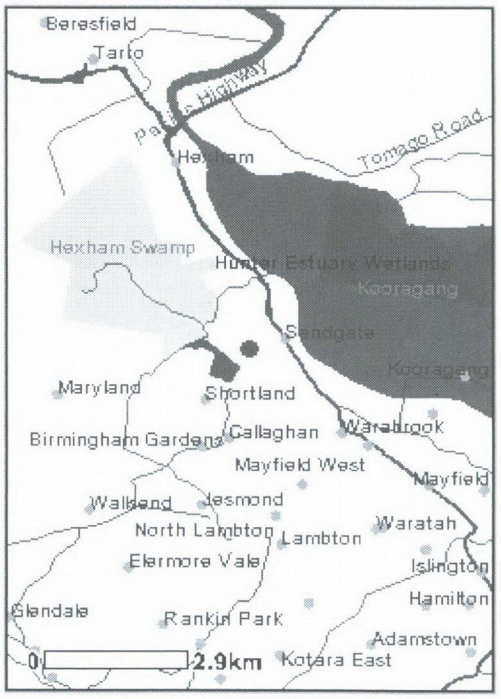
10 January 2006 09:40

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

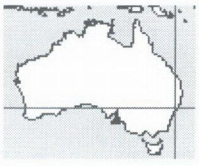
The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.deh.gov.au/epbc/assessmentsapprovals/index.html



Search Type: Point

Buffer: 5 km

Coordinates: -32.8701,151.70075



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.deh.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	1
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	12
Migratory Species:	20

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.deh.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species,

whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.deh.gov.au/epbc/permits/index.html.

Commonwealth Lands:	6
Commonwealth Heritage Places:	None
Places on the RNE:	1
Listed Marine Species:	24
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	2
Other Commonwealth Reserves:	None
Regional Forest Agreements:	1

Details

Matters of National Environmental Significance

Wetlands of International Significance [Dataset Information]
(Ramsar Sites)

HUNTER ESTUARY WETLANDS

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Lathamus discolor * Swift Parrot	Endangered	Species or species habitat may occur within area
Rostratula australis * Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Xanthomyza phrygia * Regent Honeyeater	Endangered	Species or species habitat likely to occur within area
Frogs		
Litoria aurea * Green and Golden Bell Frog	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Chalinolobus dwyeri * Large-eared Pied Bat, Large Pied Bat	Vulnerable	Species or species habitat may occur within area
*Dasyurus maculatus maculatus (SE mainland population)** Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	Endangered	Species or species habitat likely to occur within area

*Potorous tridactylus tridactylus** Long-nosed Potoroo (SE mainland)	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus * Grey-headed Flying-fox	Vulnerable	Species or species habitat likely to occur within area
Plants		
Cryptostylis hunteriana * Leafless Tongue-orchid	Vulnerable	Species or species habitat may occur within area
Eucalyptus camfieldii * Camfield's Stringybark	Vulnerable	Species or species habitat likely to occur within area
*Eucalyptus parramattensis subsp. decadens** Earp's Gum, Earp's Dirty Gum	Vulnerable	Species or species habitat likely to occur within area
Tetratheca juncea *	Vulnerable	Species or species habitat likely to occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Migratory	Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Breeding likely to occur within area
Rhipidura rufifrons Rufous Fantail	Migratory	Breeding may occur within area
Xanthomyza phrygia Regent Honeyeater	Migratory	Species or species habitat likely to occur within area
Migratory Wetland Species		
Birds		
Arenaria interpres Ruddy Turnstone	Migratory	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper	Migratory	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Migratory	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Limicola falcinellus Broad-billed Sandpiper	Migratory	Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit	Migratory	Species or species habitat likely to occur within area
Limosa limosa Black-tailed Godwit	Migratory	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew	Migratory	Species or species habitat likely to occur within area

Numenius phaeopus Whimbrel	Migratory	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover	Migratory	Species or species habitat likely to occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank	Migratory	Species or species habitat likely to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Migratory	Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper	Migratory	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Breeding likely to occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Breeding likely to occur within area
Arenaria interpres Ruddy Turnstone	Listed	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper	Listed - overfly marine area	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Listed	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Lathamus discolor Swift Parrot	Listed - overfly marine area	Species or species habitat may occur within area

Limicola falcinellus Broad-billed Sandpiper	Listed - overfly marine area	Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit	Listed	Species or species habitat likely to occur within area
Limosa limosa Black-tailed Godwit	Listed - overfly marine area	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Listed - overfly marine area	Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Breeding likely to occur within area
Numenius madagascariensis Eastern Curlew	Listed	Species or species habitat likely to occur within area
Numenius phaeopus Whimbrel	Listed	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover	Listed	Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Breeding may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank	Listed - overfly marine area	Species or species habitat likely to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Listed - overfly marine area	Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper	Listed - overfly marine area	Species or species habitat likely to occur within area

Commonwealth Lands [Dataset Information]

Commonwealth Trading Bank of Australia

Communications, Information Technology and

the Arts - Australian Postal Corporation

Communications, Information Technology and the Arts - Telstra Corporation Limited

Defence

Defence - Defence Housing Authority

Unknown

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Natural

Hunter Estuary Wetlands NSW

Extra Information

State and Territory Reserves [Dataset Information]

Hexham Swamp Nature Reserve, NSW

Kooragang Nature Reserve, NSW

Regional Forest Agreements [Dataset Information]
Note that all RFA areas including those still under consideration have been included.

Lower North East NSW RFA, New South Wales

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been

mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. Environment Australia acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCLIM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided

expert advice and information on numerous draft distributions.

Last updated:

Department of the Environment and Heritage
GPO Box 787 Canberra ACT 2601 Australia
Telephone: +61 (0)2 6274 1111

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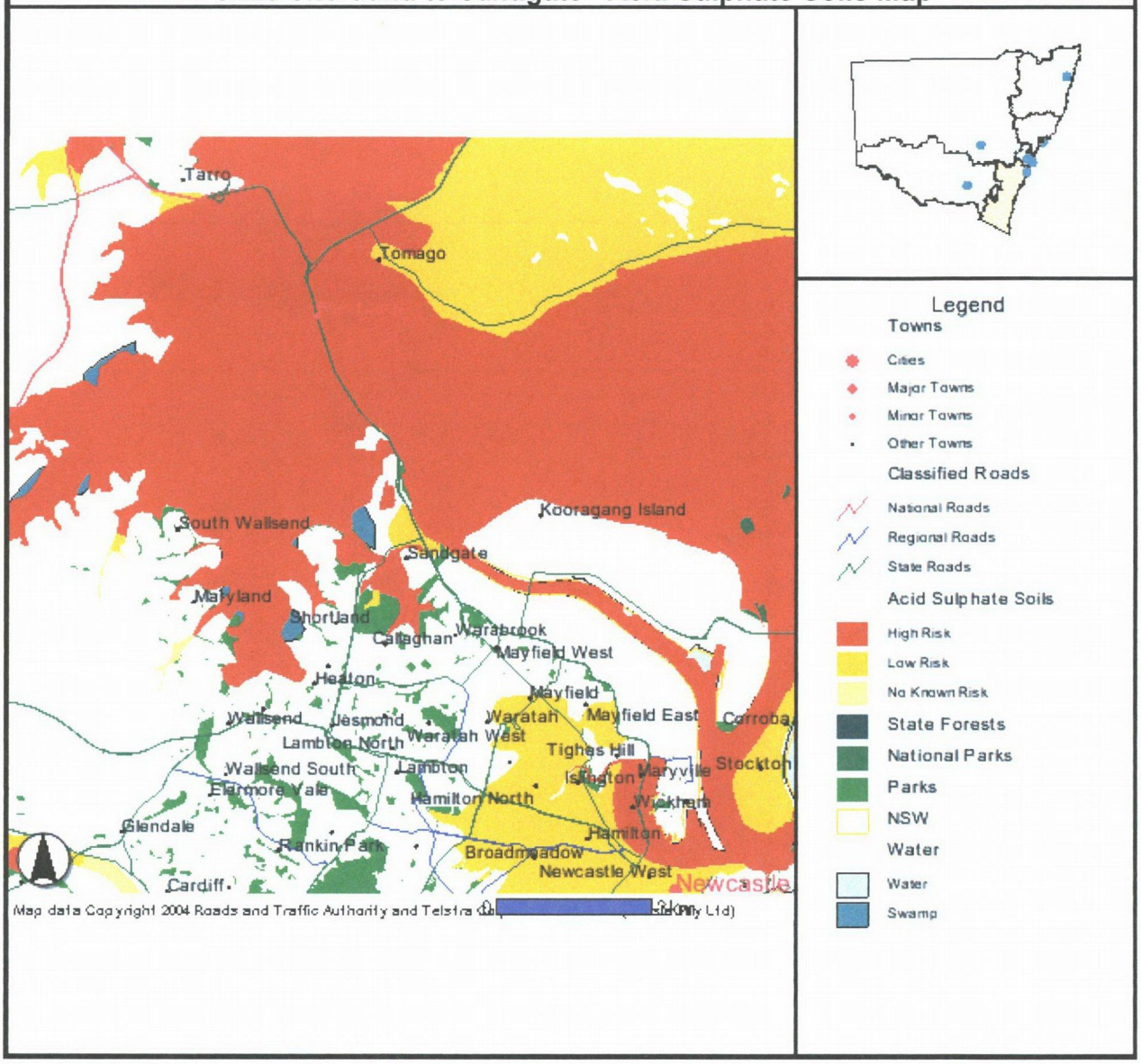
Sh23 Shortland to Sandgate - Acid Sulphate Soils Map



Print Close page

Site and notice details

Your search for: LGA: Newcastle City Council

30 notices on 17 sites were matched.

Area No: 3124

The information below was correct at the time the notices were issued.

Site: Storage Handling Facility
Address: Off Maitland Road, Sandgate, 2304
LGA: Newcastle City Council

Occupier: Sierra Sun (NSW) Pty Ltd
Owner: Sierra Sun (NSW) Pty Ltd

Lot 1 DP 547942 Lot 2 DP 547942 Lot 2 DP 553556 Lot 12 DP 625053 Lot 22 DP 627724

Notices relating to this site (1 current and 7 former)

(Map) where available, maps show the part of the site affected by the notice
* notice matched search criteria

Notice recipient	Notice type & number	Status	Date
Sierra Sun (NSW) Pty Ltd and Name Withheld	Notice for Maintaining Remediation* 28026	Current	Issued 12 Sep 2005
North Limited	Notice for Maintaining Remediation* 28012	Former	Issued 26 Aug 1998 Superseded 12 Sep 2005
North Limited	Revocation Notice* 515	Former	Issued 26 Aug 1998
North Limited	Revocation Notice* 501	Former	Issued 03 Aug 1998
North Limited	Remediation Order* 502	Former	Issued 03 Aug 1998 Revoked 01 Sep 1998
North Limited	Revocation Notice* 496	Former	Issued 15 Jun 1998
North Limited	Remediation Order* 497	Former	Issued 15 Jun 1998 Revoked 03 Aug 1998
North Limited	Remediation Order* 431	Former	Issued 12 Dec 1996 Revoked 15 Jun 1996

21 December 2005

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Site and notice details

Your search for: LGA: Newcastle City Council

30 notices on 17 sites were matched.

Area No: 3111

The information below was correct at the time the notices were issued.

Site: Astra Street Landfill
Address: 1,2, 28 Astra Street, Shortland, 2307
LGA: Newcastle City Council

Owner: Newcastle City Council

Lot 11 DP 594894 Lot 3 DP 1043133

Notices relating to this site (2 current and 0 former)

(Map) where available, maps show the part of the site affected by the notice
* notice matched search criteria

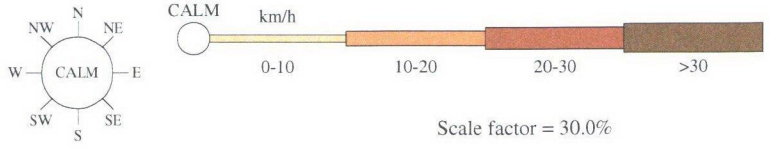
Notice recipient	Notice type & number	Status	Date
Newcastle City Council	Note of Existence of Voluntary Investigation Proposal* 19025	Current	Issued 18 May 2004
Not Applicable	Declaration of Investigation Area* 15025	Current	Issued 03 Dec 2003

21 December 2005

WIND FREQUENCY ANALYSIS (in km/h)

WILLIAMTOWN RAAF STATION NUMBER 061078

Latitude: -32.79 ° Longitude: 151.84 °



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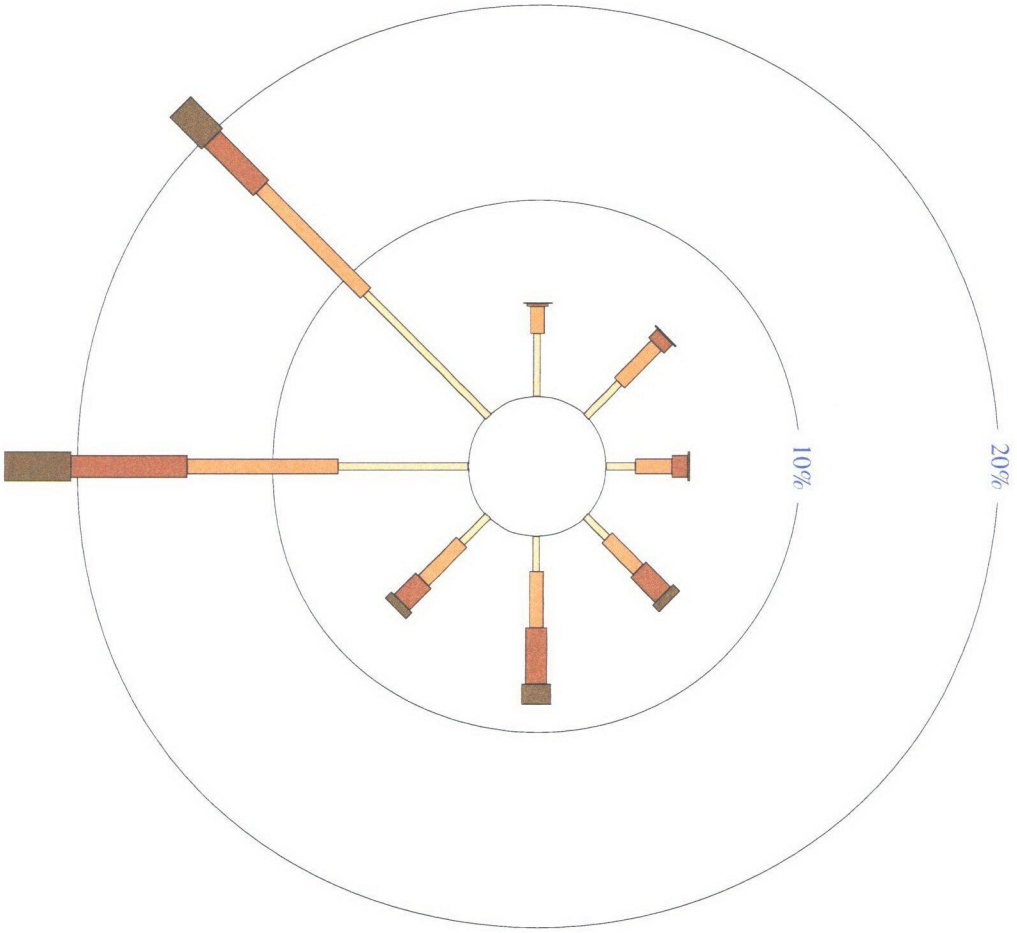
9 am
20627 Total Observations (1942 to 2004)

Calm 18%



Wind directions are divided into eight compass directions. Calm has no direction.
An asterisk (*) indicates that calm is less than 1% .
An observed wind speed which falls precisely on the boundary between two divisions (eg 10km/h) will be included in the lower range (eg 1-10 km/h). Only quality controlled data have been used.

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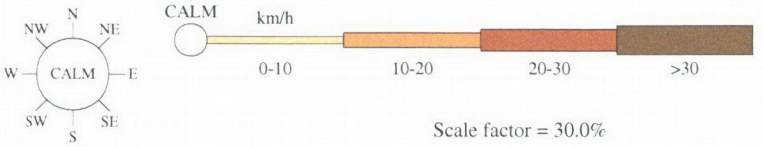
WIND FREQUENCY ANALYSIS (in km/h)

WILLIAMTOWN RAAF STATION NUMBER 061078

Latitude: -32.79 ° Longitude: 151.84 °



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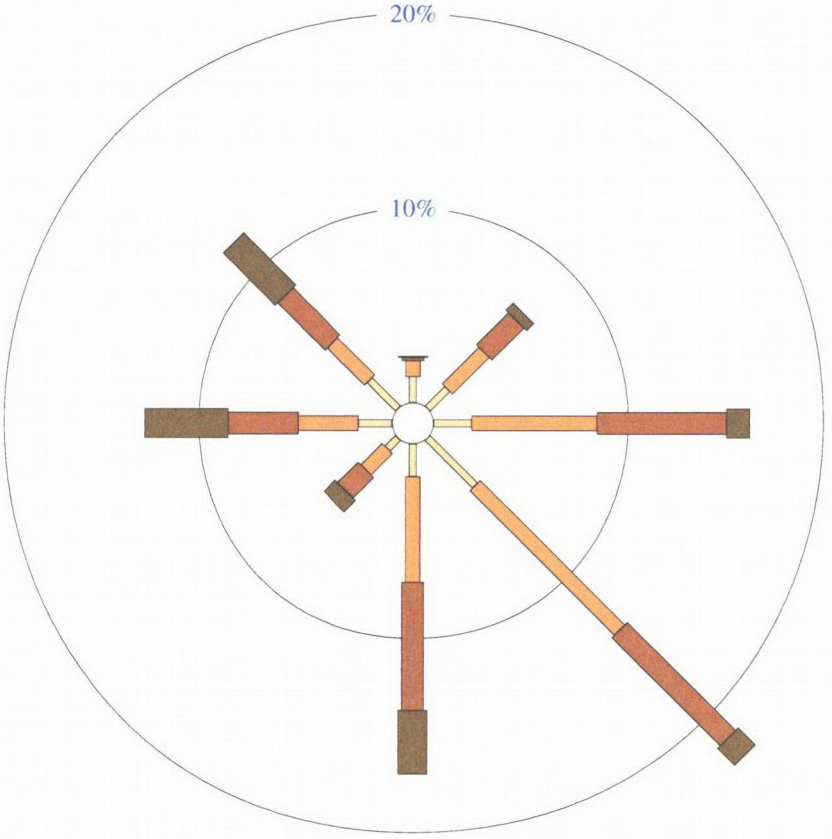
3 pm
20611 Total Observations (1942 to 2004)

Calm 5%



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Appendix E

Ecological Assessment

05462

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ecological research & innovation

Ecological Assessment for Proposed Upgrade of SH23 Shortland to Sandgate

Newcastle, Hunter Region

Roads and Traffic Authority

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Document Control

Issue Date	Purpose of Issue	Changes from Previous Issue	Authors	Checked	Director Authorisation
15 July 2005	First draft for client comment	n/a	WB/AC/NC	JPK	JPK
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11 November 2005	Final draft	Further corrections & additions.	WB/AC	JPK	JPK
10 January 2006	Revised final draft	Minor edits.	WB	GW	GW
7 May 2006	Final report	Minor edits & corrections, update s.5A assessments in response to legislative changes.	GW	GW	GW

EXECUTIVE SUMMARY

Introduction:

This report presents an assessment of the potential impacts to flora and fauna from proposed upgrades of State Highway 23 from Shortland to Sandgate (See Figure 1). As well as general flora and fauna issues, the report specifically addresses legislative planning requirements relating to flora and fauna, including:

- effects on threatened species, populations and ecological communities, as listed under the *Threatened Species Conservation Act 1995* (TSC Act), pursuant to section 5A of the *Environmental Planning & Assessment Act 1979* (EPA Act);
- effects on potential Koala habitat and core Koala habitat pursuant to *State Environmental Planning Policy 44 - Koala Habitat Protection* (SEPP 44);
- Likely impacts on Matters of National Environmental Significance, as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); and
- Likely impacts on fish and fish habitat in accordance with the *Fisheries Management Act 1994* (FM Act).

The NSW Roads and Traffic Authority (RTA) proposes to construct a two-way median-separated dual carriageway commencing at the intersection of Main Road (SH23) and Sandgate Road, continuing north-northeast to link up with Maitland Road south of St Josephs Nursing Home. The proposed highway would be located to the east of Shortland Wetlands before crossing Deep Bridge Creek and the Main Northern Railway continuing along the west side of Sandgate Cemetery before linking to Maitland Road at Sandgate. The investigation area comprises a mix of existing roads, cleared wastelands, a few small areas of remnant forest and wetland areas dominated by Common Reed (*Phragmites australis*). A concept design is provided in Appendix 1.

A Review of Environmental Factors (REF) is required for the Proposed Upgrade to fulfil the requirements of Section 111 (Part 5) of the EPA Act, and to take into account all matters affecting or likely to affect the environment as a result of the proposed action.

Description of Study Area:

The study area is located within the low lying areas of Shortland and Sandgate comprising a mix of cleared wastelands, remnant wetland areas, small patches of remnant forests and various infrastructure and land uses including minor roads, a railway line, a cemetery, industrial uses, residential areas and easements.

A number of larger remnant wetlands in the local area are covered by SEPP 14 (Figure 3) these comprise Hexham Swamp to the northwest, Newcastle Wetlands Reserve and Market Swamp to the east. However it should be noted that the mapping for SEPP 14 is broad scale and therefore not always accurate and the mapped boundaries do not coincide with the actual extent of wetlands in all cases, such as in this situation (Winning, 1991).

Although parts of the study area were historically subject to tidal inundation, the construction of floodgates in 1971 effectively prevented tidal inundation of the remnant wetlands. This combined with changes to hydrology resulting from filling and catchment development, has caused substantial changes in the wetlands. Fore example, much of the wetland areas have been colonised by Common Reed (*Phragmites australis*), Swamp Oak (*Casuarina glauca*) and Broad-leaf Cumbungi (*Typha*

orientalis). Previously seasonal ponds associated with Newcastle Wetlands Reserve and the Market Swamp have become more permanent as a result of sediment and reeds occluding drainage lines.

Flora and Fauna Investigation:

Given the limited habitats in the investigation area (i.e. no continuous eucalypt forests) and the existing knowledge base, it was considered unnecessary to undertake comprehensive surveys for all locally identified species. Instead, the adopted approach targeted the following species because literature pertaining to the local area identified these as key species:

- Australasian Bittern *Botaurus poiciloptilus*
- Black Bittern *Ixobrychus flavicollis*
- Latham's Snipe *Gallinago hardwickii*
- Painted Snipe *Rostratula benghalensis australis*
- Black-necked Stork *Ephippiorhynchus asiaticus*
- Threatened Plants such as *Zannichellia palustris*

Due to the timing of the project (winter surveys), surveys for Green and Golden Bell Frog *Litoria aurea* are outstanding and need to be completed during spring/summer following sufficient rainfall. The assessment for this species was, therefore, largely based on knowledge of its distribution in the local area and the likelihood of it occurring within or utilising habitats within the investigation area.

36 significant fauna species (26 threatened species and 10 migratory birds) were identified as likely to utilise habitats within the investigation area. In addition, 2 threatened flora species and 4 Endangered Ecological Communities were identified within and adjacent to the investigation area. These species and communities have therefore formed the basis of the assessment presented within this report.

The report presents an analysis of the potential impacts of the proposed actions on significant species and communities within the investigation area, and mitigation measures to ameliorate potential impacts have been provided for each species. As stated above, surveys for Green and Golden Bell Frog could not be undertaken due to the seasonal constraints (winter). Therefore, it was recommended that these surveys be conducted during spring-summer following sufficient rainfall in order to determine if and how this species utilises suitable habitat within the investigation area. Data limitations notwithstanding, it is concluded that if the proposed actions within the investigation area could not avoid Green and Golden Bell Frog habitat, a Species Impact Statement would likely be required and the Director Generals Requirements would need to be sought, moreover such an impact would also trigger the referral process pursuant to the EPBC Act.

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PART A
INTRODUCTION

1.0 Background

1.1 Scope of Report

This report presents an assessment of the potential impacts to flora and fauna from proposed upgrades of SH23 from Shortland to Sandgate (See Figure 1). As well as general flora and fauna issues, the report particularly addresses legislative planning requirements relating to flora and fauna, especially:

- effects on threatened species, populations and ecological communities, as listed under the *Threatened Species Conservation Act 1995* (TSC Act), pursuant to section 5A of the *Environmental Planning & Assessment Act 1979* (EPA Act);
- effects on potential Koala habitat and core Koala habitat pursuant to *State Environmental Planning Policy 44 - Koala Habitat Protection* (SEPP 44);
- Likely impacts on matters of national environmental significance, as listed under the *Environment Protection and Biodiversity Conservation Act 1999*; and
- Likely impacts on fish and fish habitat in accordance with the *Fisheries Management Act 1994*.

1.2 Abbreviations and Definitions

The following abbreviations and definitions are used within this report:

Abbreviations:

- ANCA = Australian Nature Conservation Agency.
- CAMBA = *China Australia Migratory Birds Agreement (1988).*
- CMS = International Convention on Migratory Species (Bonn Convention).
- DEC = NSW Department of Environment and Conservation.
- DEH = Commonwealth Department of Environment and Heritage.
- EPA Act = *Environmental Planning and Assessment Act (1979).*
- EPBC Act = *Commonwealth Environmental Protection and Biodiversity Conservation Act (1999).*
- FM Act = *Fisheries Management Act (1994).*
- GIS = Geographic Information System.
- HRPC = Hunter Rare Plants Committee.
- IUCN = The International Union for the Conservation of Nature and Natural Resources.
- JAMBA = *Japan Australia Migratory Birds Agreement (1981).*
- LHCCREMS = Lower Hunter and Central Coast Regional Environmental Management Strategy.
- ROTAP = Rare or Threatened Australian Plants (Briggs and Leigh 1995).

- RTA = NSW Roads and Traffic Authority.
- SEPP = NSW State Environmental Planning Policy.
- TSC Act = *NSW Threatened Species Conservation Act (1995).*

Definitions:

- Study Area = Area defined in Figure 1 as Study Area. This includes Newcastle Wetlands, Market Swamps, 2HD Swamp and Shortland Wetlands.
- Investigation Area = Area directly influenced by the proposed action (Figure 1).
- Local Area = Area within a five kilometre radius of the study area (Figure 2).
- Sub-regional Area = Area within a 30km radius of the study area.
- Significant Species = species listed as threatened under the TSC Act, EPBC Act, FM Act; migratory species listed under the EPBC Act and the international treaties CAMBA, JAMBA and the Bonn Convention; and regionally significant flora species listed on ROTAP or by HRPC.

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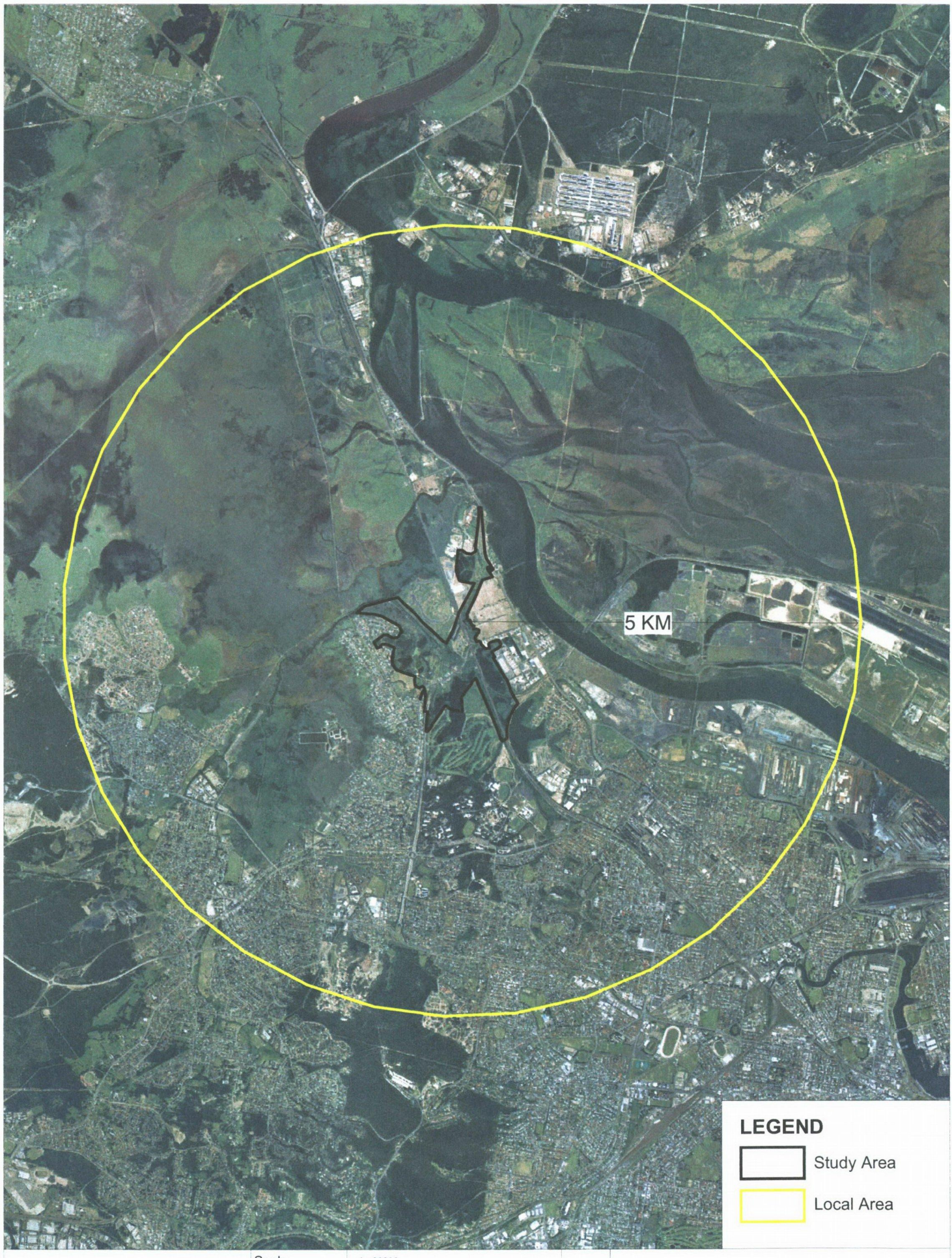
Study Area

Figure 1



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Local Area

Figure 2

1.3 Brief Description of the Proposed Action

The NSW Roads and Traffic Authority (RTA) proposes to construct a two-way median separated dual carriageway highway commencing at the intersection of Main Road (SH23) and Sandgate Road, continuing north-northeast to link up with Maitland Road south of St Josephs Nursing Home. The proposed highway would be located to the east of Shortland Wetlands before crossing Deep Bridge Creek and the Main Northern Railway continuing northwards on the western side of Sandgate Cemetery before linking to Maitland Road at Sandgate. The investigation area comprises a mix of existing roads, cleared wastelands, a few small areas of remnant forest and wetland areas dominated by Common Reed (*Phragmites australis*). A concept design is provided in Appendix 1.

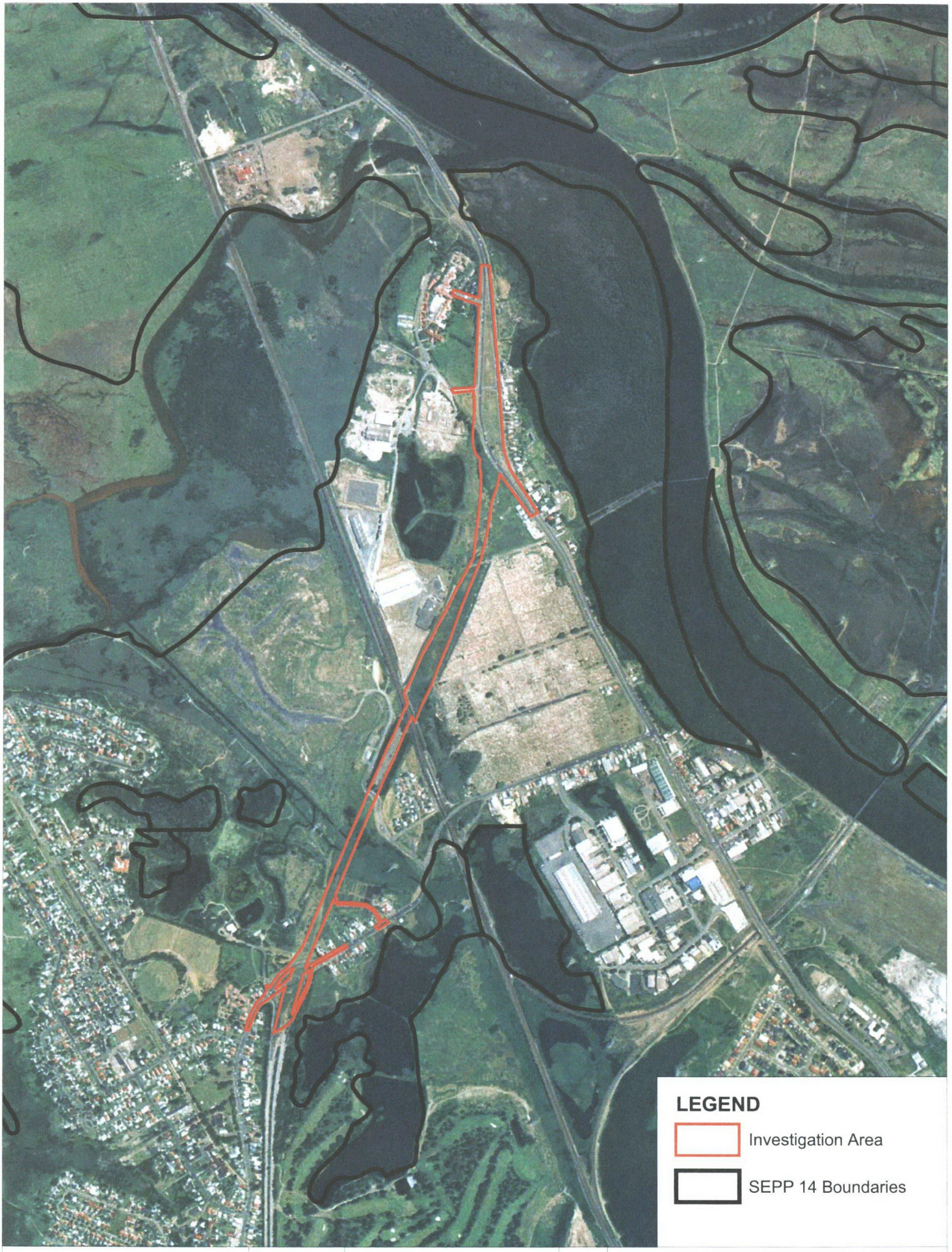
A Review of Environmental Factors (REF) is required for the Proposed Upgrade of SH23 – Shortland to Sandgate to fulfil the requirements of Section 111 (Part 5) of the *Environmental Planning and Assessment Act 1979* (EPA Act), and to take into account all matters affecting or likely to affect the environment as a result of the proposed action.

1.4 Description of Study Area

The study area is located within the low lying areas of Shortland and Sandgate comprising a mix of cleared wastelands, remnant wetland areas, small patches of remnant forests and various infrastructure and land uses including minor roads, a railway line, a cemetery, industrial uses, residential areas and easements.

A number of larger remnant wetlands in the study area are covered by SEPP 14 (Figure 3) these comprise Hexham Swamp to the northwest, Newcastle Wetlands Reserve and Market Swamp to the east. However it should be noted that the legal boundaries provided on SEPP 14 maps do not always coincide with the actual extent of wetlands in all cases, such as in this situation (Winning, 1991).

Although parts of the study area were historically subject to tidal inundation, the construction of floodgates in 1971 effectively prevented tidal inundation of the remnant wetlands. This combined with changes to hydrology resulting from filling and catchment development, has caused substantial changes in the wetlands. Fore example, much of the wetland areas have been colonised by Common Reed (*Phragmites australis*), Swamp Oak (*Casuarina glauca*) and Broad-leaf Cumbungi (*Typha orientalis*). Previously seasonal ponds associated with Newcastle Wetlands Reserve and the Market Swamp have become more permanent as a result of sediment and reeds occluding drainage lines.



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SEPP 14 Wetlands

Figure 3

1.4.1 Ramsar Wetlands

The Hunter Estuary Wetlands site comprises Kooragang Nature Reserve and the Shortland Wetlands site. The two areas are approximately 2.5 kilometres apart and are connected by a wildlife corridor consisting of Ironbark Creek, the Hunter River and Ash Island (NPWS 2004). These sites are situated on opposite sides of the investigation area and will not be affected by the action (Figure 4).

1.5 Assessment Approach

This report adopts a generally accepted approach to assessment of potential ecological impacts[1]. This approach involves:

Preliminary Investigations:

(i) search of literature and databases to determine the potential for threatened and otherwise significant species, populations and ecological communities to occur in the local area;
(ii) analysis of which of the threatened species, populations and ecological communities may occur in the study area;
(iii) initial field survey to obtain a broad understanding of the site characteristics, in part, to assist with the threatened species analysis described in (ii);
(iv) identification of significant species requiring targeted surveys, identified either as part of the threatened species analysis or observed on the site during the initial field survey.

Detailed Investigations:

(v) conduct of field sampling to gather data describing the flora and fauna assemblage of the study area and to detect threatened species, populations and ecological communities that are actually present in the study area and adjoining land - this is typically reconnaissance-level sampling designed to determine the species present;
(vi) conduct of field sampling specifically targeting those threatened species known to be present in the investigation area and which pose potential constraints to the proposed action - this is typically more detailed sampling that seeks to determine, among other things, the abundance and distribution of populations, where this is feasible - identification of a significant species in the study area during the detailed investigations (v) that was not identified as

[1] *There is no 'standard' that has been established for ecological assessments, mainly because each proposal and site are somewhat unique, often requiring a different approach to assessment. However, there is a generally accepted broad approach followed by ecological consultants which is followed here. It is also important to note that some Councils and other authorities have prepared 'guidelines' for ecological assessments, but these are just that, guidelines, and do not have any legal status in terms of requiring ecological assessments to follow a specific process or set of methods.*

being an issue during the preliminary investigations (i-iv) would generally warrant additional targeted sampling;

Threatened Species Assessment:

(vii) determination of those threatened species, populations and ecological communities most likely to be affected by the proposed action – this assessment pulls together information from the preliminary investigations and data from the detailed investigations to provide an evaluation of which threatened species, populations and ecological communities are likely to be affected by the proposed action;

Evaluation:

(viii) assessment of potential effects of the proposed action on flora and fauna, and identification of possible ameliorative measures for potential impacts - this is a subjective process relying on professional interpretation.

While field investigations typically concentrate on the investigation area, because this is where the main effects would occur, we also undertake less intensive investigations on adjoining land. In this case surveys were undertaken in areas surrounding the investigation area (the study area) to determine the location of important species and/or habitat.

LEGEND

Hunter Estuary Wetlands

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Ramsar Wetlands

Figure 4

1.6 Previous Flora & Fauna Studies

The flora and fauna of Hexham Swamp and the Sandgate area has been well documented by many previous studies (Briggs 1978; Pressey 1981; Broadbent *et al.* 1984; McDonald and Winning 1986; Winning 1986; Gilligan *et al.* 1990; Winning 1993; Winning 1996; Morrison 2000; MacDonald 2001) and unpublished investigations (e.g. Green & Golden Bell Frog surveys in the '2HD Swamp' by members of the Society of Frogs and Reptiles, and observations by members of Hunter Bird Observers Club in the various wetlands for many years).

Given the limited habitats in the investigation area (i.e. no continuous eucalypt forests) and the existing knowledge base, it was considered unnecessary to undertake comprehensive surveys for all locally identified species. Instead, the adopted approach targeted the species listed below which were considered to be most likely to occur in the study area based on the literature review undertaken and habitat availability.

- Australasian Bittern *Botaurus poiciloptilus*
- Black Bittern *Ixobrychus flavicollis*
- Latham's Snipe *Gallinago hardwickii*
- Painted Snipe *Rostratula benghalensis australis*
- Black-necked Stork *Ephippiorhynchus asiaticus*
- Threatened Plants such as *Zannichellia palustris*

Due to the timing of the project (winter surveys), surveys for Green and Golden Bell Frogs are outstanding and need to be completed during spring/summer following sufficient rainfall. The assessment for this species was, therefore, largely based on knowledge of its distribution in the local area and study area and the likelihood of it occurring within or utilising habitats within the investigation area.

PART B
PRELIMINARY INVESTIGATIONS

2.0 Initial Threatened Species Analysis

2.1 Background

Although many threatened species have been recorded or are considered likely to occur in the local area, not all would occur within the investigation area because habitats in these areas are unsuitable. An assessment to determine species that may occur on the site and, therefore, may potentially be affected by the proposed action, is undertaken by comparing the known habitat preferences of each species against the habitats present on the study area.

The analysis typically comprises two steps:

- determination of those threatened species that have been recorded within the local area (5km of study area - Figure 2; Table 2.2.1; Table 2.2.2);
- use of some form of decision process to determine which of those species would be likely to occur on the study area and/or potentially be affected by the proposed action.

The species, which are identified by this process as being within the local area, are then assessed against the habitats present within the investigation area. These species are listed in Table 2.2.

2.2 Local significant species

The purpose of this section is to identify significant species which occur in the local area and may require assessment if suitable habitat is present within the investigation area. To achieve this, the Atlas of NSW Wildlife (DEC 2005), FaunaNet (Australian Museum) and PlantNet (Royal Botanic Gardens) were searched on 26 May 2005 to determine which significant species (as defined in section 1.2) have been recorded in the local area (See Figures 5 & 6). Threatened flora and fauna species and Endangered Ecological Communities known to occur within the local area are listed in Table 2.2.1 and migratory species are listed in Table 2.2.2. A detailed assessment of the distribution and habitat requirements of these species is provided in section 6 of this report (Table 6.1.1).

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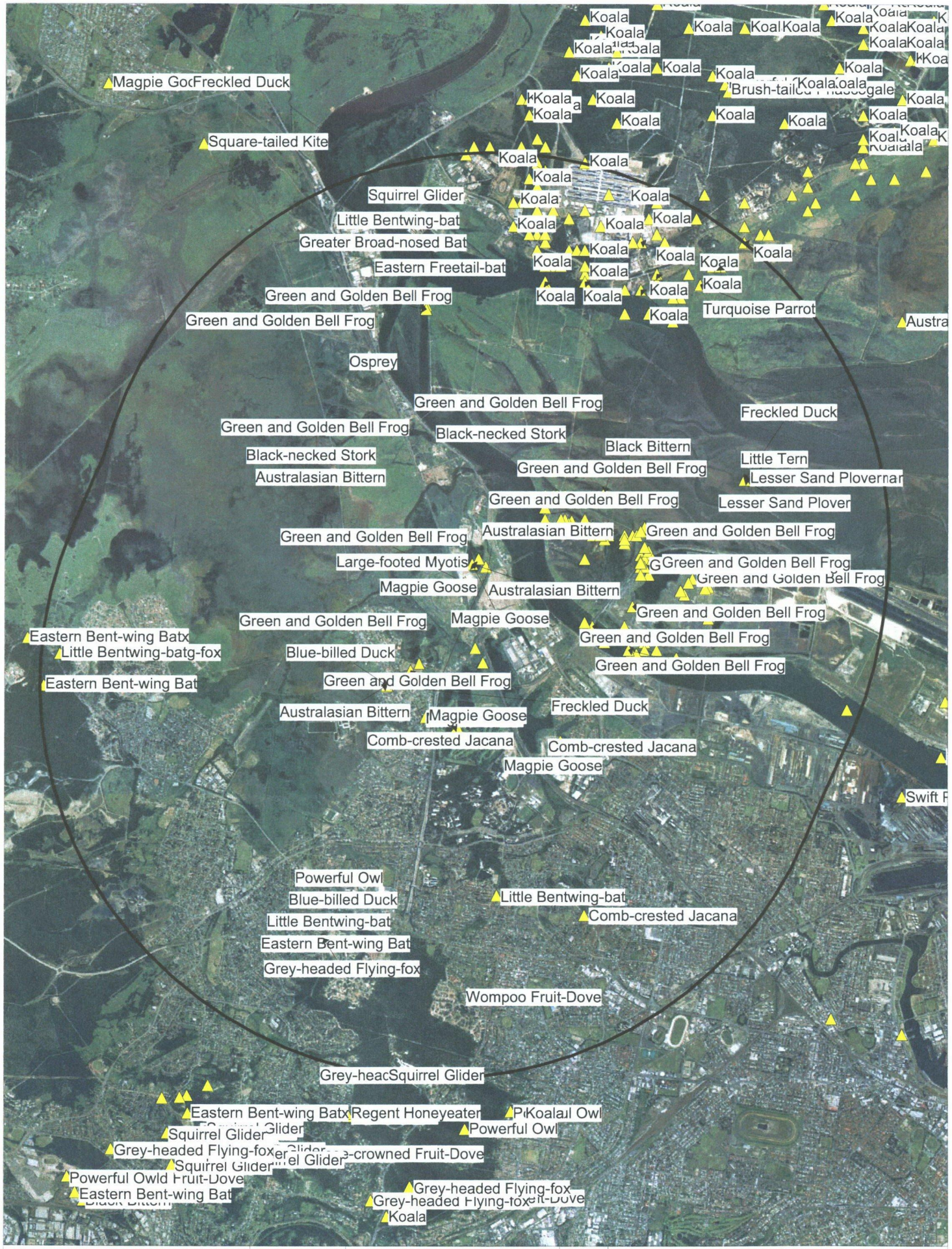
Threatened Flora Records

Figure 5



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Threatened Fauna Records

Figure 6

Table 2.2.1 - Threatened species and Endangered Ecological Communities known to occur within the local area

Common Name	Scientific Name	Legal Status*	Record Type** A	B	C
Flora					
Black-eyed Susan	*Tetratheca juncea*	V (TSC Act), V (EPBC Act)	✓		
Magenta Lilypily	*Syzygium paniculatum*	V (TSC Act), V (EPBC Act)		✓	
	Zannichellia palustris	E (TSC Act)	✓		
White-flowered Wax Plant	*Cynanchum elegans*	E (TSC Act), E (EPBC Act)			✓
Endangered Ecological Communities					
Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		EEC (TSC Act)		✓	
Swamp Oak Floodplain Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.		EEC (TSC Act)		✓	
River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.		EEC (TSC Act)		✓	
Subtropical Coastal Floodplain Forest on Coastal Floodplains of the NSW North Coast Bioregion.		EEC (TSC Act)		✓	
Birds					
Australasian Bittern	*Botaurus poiciloptilus*	V (TSC Act)	✓		
Black-necked Stork	*Ephippiorhynchus asiaticus*	E (TSC Act)	✓		
Magpie Goose	*Anseranas semipalmata*	V (TSC Act)	✓		
Little Tern	*Sterna albifrons*	E (TSC Act)	✓		
Freckled Duck	*Stictonetta naevosa*	T (TSC Act)	✓		
Powerful Owl	*Ninox strenua*	V (TSC Act)	✓		
Painted Snipe	*Rostratula benghalensis australis*	E (TSC Act)			✓
Greater Sand-plover	*Charadrius leschenaultia*	V (TSC Act)	✓		
Lesser Sand-plover	*Charadrius mongolus*	V (TSC Act)	✓		
Turquoise parrot	*Neophema pulchella*	V (TSC Act)			✓
Osprey	*Pandion haliaetus*	V (TSC Act)	✓		
Wompoo Fruit-dove	*Ptilinopus magnificus*	V (TSC Act)	✓		
Blue-billed Duck	*Oxyura australis*	V (TSC Act)	✓		
Comb-crested Jacana	*Irediparra gallinacean*	V (TSC Act)	✓		
Great Knot	*Calidris tenuirostris*	V (TSC Act);	✓		
Black Bittern	*Ixobrychus flavicollis*	V (TSC Act)	✓		
Broad-billed Sandpiper	*Limicola falcinellus*	V (TSC Act); M (CAMBA)	✓		
Black-tailed Godwit	*Limosa limosa*	V (TSC Act)	✓		
Square-tailed Kite	*Lophoictinia isura*	V (TSC Act)	✓		
Terek Sandpiper	*Xenus cinereus*	V (TSC Act); M (CAMBA; JAMBA)	✓		
Amphibians					
Green and Golden Bell Frog	*Litoria aurea*	E (TSC Act); V (EPBC Act)	✓		✓
Mammals					
Koala	*Phascolarctos cinereus*	V (TSC Act)	✓		
Squirrel Glider	*Petaurus norfolcensis*	V (TSC Act)	✓		

Table 2.2.1 - Threatened species and Endangered Ecological Communities known to occur within the local area

Common Name	Scientific Name	Legal Status*	Record Type**		
			A	B	C
Grey-headed Flying-fox	*Pteropus poliocephalus*	V (TSC Act); V (EPBC Act)	✓		
Little Bent-wing Bat	*Miniopterus australis*	V (TSC Act)	✓		
Eastern Freetail-bat	*Mormopterus norfolkensis*	V (TSC Act)	✓		
Eastern Bent-wing Bat	*Miniopterus schreibersii oceanensis*	V (TSC Act)	✓		
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V (TSC Act)	✓		
Large-footed Myotis	*Myotis adversus*	V (TSC Act)i	✓		

* V = Vulnerable, E = Endangered, EEC = Endangered Ecological Community, M = Migratory

** Record Type:

- A = Atlas of NSW Wildlife local area record (accessed 26 May 2005)
- B = Identified in Study Area
- C = Historical Record in Study Area

Table 2.2.2 - Migratory species recorded from the local area.

Common Name	Scientific Name	Legal Status*	Occurrence in Local Area
Garganey	*Anas querquedula*	M (CAMBA; JAMBA)	one record
Cattle Egret	*Ardeola ibis*	M (CAMBA ; JAMBA)	regular visitor
Great Egret	*Egretta alba*	M (CAMBA)	regular visitor
Glossy Ibis	*Plegadis falcinellus*	M (CAMBA)	rare visitor
White-bellied Sea Eagle	*Haliaeetus leucogaster*	M (CAMBA)	occasional visitor
Sharp-tailed Sandpiper	*Calidris acuminata*	M (CAMBA; JAMBA)	historical record
Curlew Sandpiper	*Calidris ferruginea*	M (CAMBA; JAMBA)	historical record
Red-necked Stint	*Calidris ruficollis*	M (CAMBA; JAMBA)	historical record
Latham's Snipe	*Gallinago hardwickii*	M (CAMBA)	seasonally resident
Bar-tailed Godwit	*Limosa lapponica*	M (CAMBA; JAMBA)	historical record
Greenshank	*Tringa nebularia*	M (CAMBA; JAMBA)	historical record
Marsh Sandpiper	*Tringa stagnatilis*	M (CAMBA)	historical record
Swamp Harrier	*Circus approximans*	M (CMS)	regular visitor
Fork-tailed Swift	*Apus pacificus*	M (CAMBA; JAMBA)	regular visitor
White-throated Needletail	*Hirundapus caudacutus*	M (CAMBA)	regular visitor
Great Knot	*Calidris tenuirostris*	M (CAMBA; JAMBA)	historical record
Broad-billed Sandpiper	*Limicola falcinellus*	M (CAMBA)	
Terek Sandpiper	*Xenus cinereus*	M (CAMBA; JAMBA)	

* M = Migratory; CAMBA = China Australia Migratory Bird Agreement (1988); JAMBA = Japan Australia Migratory Bird Agreement (1981); CMS = International Convention on Migratory Birds (Bonn Convention). NOTE: species listed under CAMBA and JAMBA are also considered to be migratory under CMS.

Overall, 51 significant species have been recorded in the local area. This consists of 4 threatened plant species, 29 threatened fauna species, 18 migratory species (note: of the 18 migratory species, 4 are also listed under the TSC Act) and 4 endangered ecological communities (EEC).

In addition to the species listed in Table 2.2.2, significant species also include the following families of migratory birds listed under the EPBC Act, these species are too numerous to list:

- All species in the family Accipitridae for which Australia is a Range State (Hawks, Kites).
- All species in the family Anatidae for which Australia is a Range State (Ducks).
- All species in the family Charadriidae for which Australia is a Range State (Plovers).
- All species in the family Falconidae for which Australia is a Range State (Falcons).
- All species in the family Muscicapidae (*sensu lato*), including the sub-family Sylviinae, formerly listed as the family Sylviidae, for which Australia is a Range State (Blackbird, warblers).
- All species in the family Phoenicopteridae for which Australia is a Range State (Flamingoes).
- All species in the family Recurvirostridae for which Australia is a Range State (Stilts, Avaocet).
- All species in the family Scolopacidae, including the sub-family Phalaropodinae, formerly listed as the family Phalaropodidae, for which Australia is a Range State (Waders).
- All species in the genus Grus for which Australia is a Range State (Cranes).

Aquatic and Marine Species:

There are 16 aquatic and marine species, 2 endangered populations and 2 ecological communities listed as threatened under the *Fisheries Management Act 1994* (FM Act) (see section 5.0 of this report). Some of these species are likely to utilise marine habitats in the local area however no habitat is present within the investigation area.

2.3 Other Important Issues

Apart from the presence of threatened and regionally significant species and ecological communities within the investigation area and the potential occurrence of other threatened species on the site and in the local area, we identified a number of other issues that require consideration, these being:

- Potential for soil erosion;
- Sedimentation of wetlands;
- Changes to water flow;
- Fuel/oil leaks;
- Weed control; and
- Incursions into sensitive areas.

It is beyond the scope of this report to provide detailed management strategies for these issues however the following points should be considered for future reference.

- A Soil and Water Management Plan should be prepared by a suitable qualified soil scientist/hydrologist. This plan should identify the Construction activities that could cause soil erosion or discharge sediment or water pollutants from the site; describe management methods to minimise soil erosion or discharge of sediment or water pollutants from the site including a strategy to minimise the area of bare surfaces during Construction; describe the location and capacity of erosion and sediment control measures; identify the timing and conditions under which Construction stage controls will be decommissioned; include contingency plans to be implemented for events such as fuel spills; and, identify how the effectiveness of the sediment and erosion control system will be monitored, reviewed and updated.
- A Weed Management Strategy should be prepared and implemented by a suitably qualified ecologist/bush regeneration contractor, including: identification of weeds within the Activity and adjoining areas; weed eradication methods and protocols for the use of herbicides; methods to treat and re-use weed infested topsoil; and, strategies to control the spread of weeds during Construction.
- Temporary fencing should be installed around sensitive areas adjacent to the construction site to ensure that there is no accidental incursion into these areas. Signs should be posted on the fences which clearly indicate that the areas are "Sensitive Environmental Area". The importance of these areas should be emphasised during staff inductions.

PART C
DETAILED INVESTIGATIONS

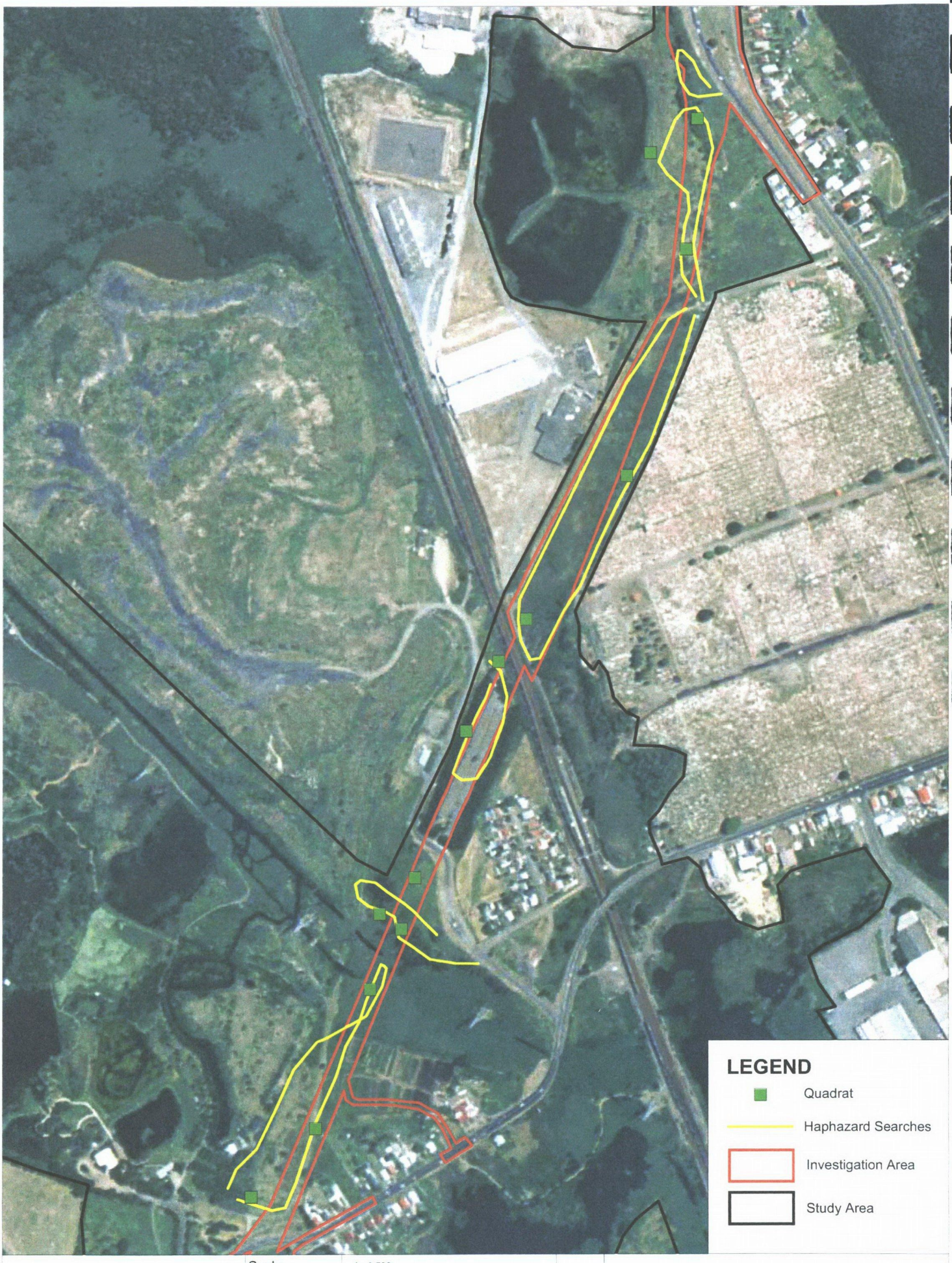
3.0 Flora Surveys

3.1 Flora Survey Methods

Fieldwork was undertaken on 24 May and 3 June 2005. The flora was sampled through haphazard searches and detailed quadrats and the investigation area (Figure 7). All species recorded during the flora surveys are listed in Appendix 3.

Haphazard searches were undertaken within the study area and investigation area to locate threatened and regionally significant flora species, and/or their potential habitat. The principle aim of the haphazard searches was to identify areas that are potentially constrained, and further develop an understanding of the surrounding vegetation communities.

The detailed quadrats targeted threatened flora and fauna species, fauna habitat attributes and endangered ecological communities. Vegetation structure and floristic data were recorded to develop map unit descriptions detailing flora associations within the investigation area. The vegetation associations have been mapped along and immediately surrounding the investigation area comprising approximately 23 hectares in total.



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Flora Surveys

Figure 7

3.2 Flora Survey Results

3.2.1 Flora Assemblage

The vegetation of the investigation area consists of 7 distinct vegetation associations. The vegetation associations are determined largely by past disturbances and activities, topography and hydrological regimes. Areas that have been cleared and previously used for agricultural purposes now support relatively dense areas of exotic weed species. Areas at lower elevations that are periodically inundated are generally less disturbed and support dense areas of Common Reed (*Phragmites australis*). A few small patches of remnant forest are present in the investigation area, generally comprising Forest Red Gum (*Eucalyptus tereticornis*) at higher elevations and Swamp Oak (*Casuarina glauca*) at lower elevations. There are a number of areas of planted native species, including areas surrounding the Shortland Wetland Centre, the end of the existing State Highway 23, on either side of the existing embankment on the southern side of the Main Northern Railway and along the western boundary of Sandgate Cemetery. Other areas comprise existing roads, railway, sealed surfaces, residential areas, and managed grassed areas.

Of the 23 hectares of mapped areas approximately 42% comprises infrastructure and managed landscapes, 28% comprises areas of exotic weed species (map unit 7), 18% are wetland areas (map units 1 & 2), 7% are planted native species (map units 3b & 6) and 5% are remnant forest (map units 3a, 4 & 5). Figure 8 shows the different units of vegetation identified, which are detailed below.

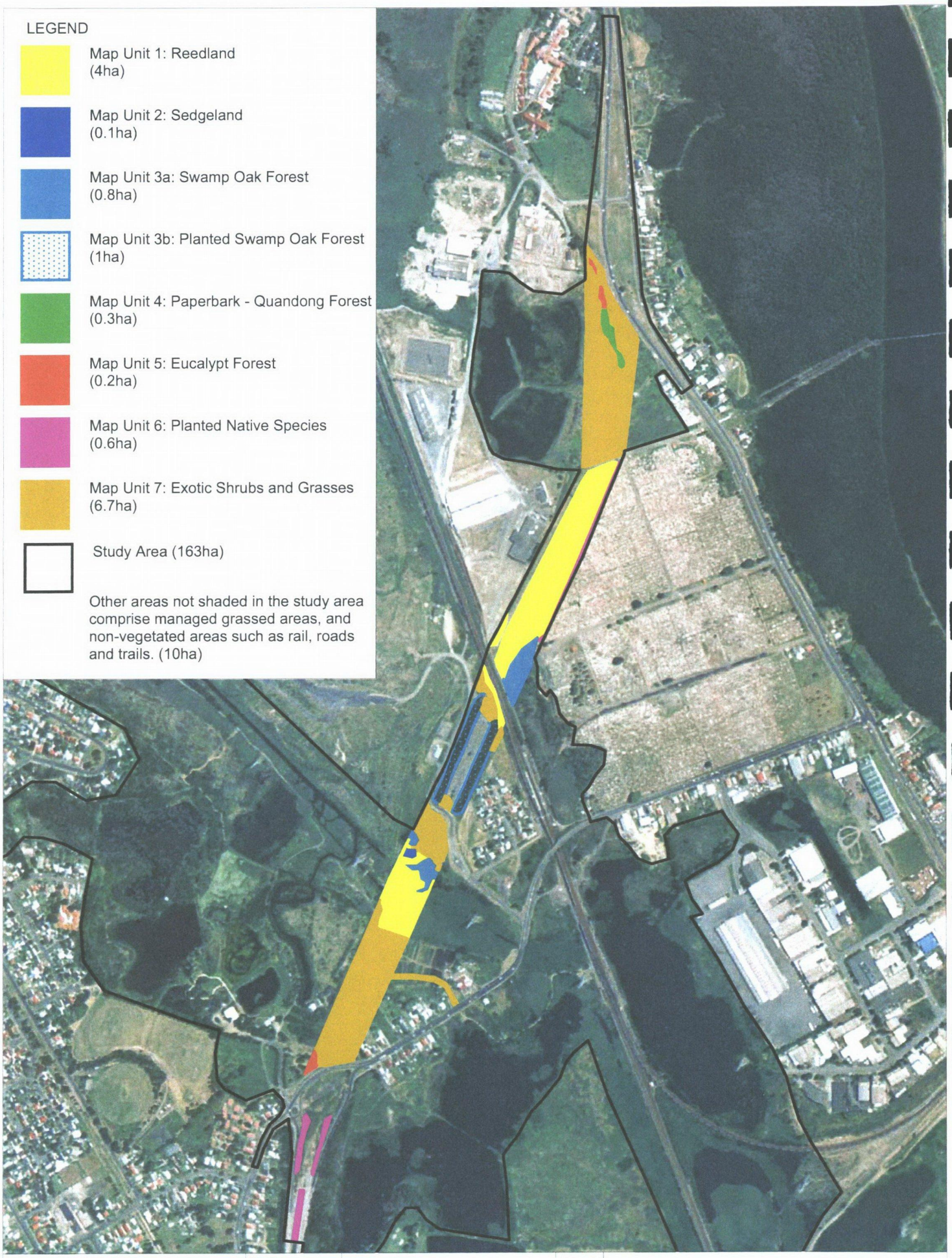
The seven map units described in this report comprise:

1. Reedland
2. Sedgeland

3a. Swamp Oak Forest

3b. Planted Swamp Oak Forest

4. Paperbark / Hard Quandong Forest
5. Eucalypt Forest
6. Planted Native species
7. Exotic Shrubs and Grasses



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Vegetation Communities (HWR 2005)

Figure 8

Map Unit 1 - Reedland

Dominant Species:
Phragmites australis,
Typha orientalis,
Juncus usitatus.

Height / Cover:
1-3 metres / Closed

Proportion of Investigation Area:
17% (4ha)

Map Colour:
Solid Yellow

Description:

This community occurs in two large patches in the investigation area generally in low lying areas permanently or periodically inundated with fresh water, particularly surrounding Deep Bridge Creek and adjacent to Sandgate Cemetery. There is also some evidence of saline influence in some areas.

Structurally it comprises closed reedlands dominated by Common Reed (*Phragmites australis*). There are some small pockets of deeper water where Cumbungi (*Typha orientalis*) is dominant. There are also some smaller Swamp Oaks (*Casuarina glauca*) scattered throughout this community in areas.

This map unit is moderately to highly disturbed in places with weed species become co-dominant in some pockets including Pampas Grass (*Cortadieria selloana*), Tobacco Bush (*Solanum mauritianum*) and Blackberry (*Rubus fruticosus*) (refer to Appendix 9 for weed management techniques). Other smaller native grasses, herbs and rushes also occur in places, including (*Paspalum distichum*), Mat Grass (*Hemarthria uncinata* var. *uncinata*), Water Peppers (*Persicaria* spp.) and *Juncus usitatus*.

Map Unit 2 - Sedgeland

Dominant Species:
Bolboschoenus caldwellii

Height / Cover:
1 metre / Closed

Proportion of Investigation Area:
0.4% (0.1ha)

Map Colour:
Solid Dark Blue

Description:

This community occurs in a small pocket adjacent to the northern side of Deep Bridge Creek adjacent to map unit 1 and 3a, where there has been relatively minor past disturbances.

Structurally it comprises a low closed sedgeland and is exclusively dominated by Caldwells Club-rush (*Bolboschoenus caldwellii*). This community is affected by weed species such as Curled Dock (*Rumex crispus*) and Pennywort (*Hydrocotyle bonariensis*).

Map Unit 3a - Swamp Oak Forest

Dominant Species:
Casuarina glauca, Elaeocarpus obovatus

Height / Cover:
7-12 metres / Closed-Open

Proportion of Investigation Area:
3% (0.8ha)

Map Colour:
Solid Light Blue

Description:

This community occurs in a number of small pockets in the investigation area surrounding Deep Bridge Creek and on the northern side of the Main Northern Railway where it merges with Map unit 1. It occurs in low lying areas with saline or sub-saline groundwater that are waterlogged or periodically inundated.

Structurally it comprises a patchy canopy layer of Swamp Oak (*Casuarina glauca*), with Hard Quandong (*Elaeocarpus obovatus*) being co-dominant in places. This community is generally highly disturbed, with weed species dominating the understorey including Torpedo Grass (*Panicum repens*), Vasey Grass (*Paspalum urvillei*) and Pennywort (*Hydrocotyle bonariensis*). Some native species persist in the understorey including Common Couch (*Cynodon dactylon*), Water Couch (*Paspalum distichum*) and Native Grape (*Cayratia clematidea*).

Map unit 3b - Planted Swamp Oak Forest

Dominant Species:
Casuarina glauca

Height / Cover:
5-10 metres / Closed

Proportion of Investigation Area:
4% (1ha)

Map Colour:
Spotted Light Blue

Description:

This community occurs on the southern side of the Main Northern Railway. The presence of this community is the result of landscaping activities previously undertaken following the development of an embankment for the proposed action.

It is dominated by Swamp Oak (*Casuarina glauca*) with other planted species including Fringed Wattle (*Acacia fimbriata*), Sydney Golden Wattle (*Acacia longifolia*) and Coastal Teatree (*Leptospermum laevigatum*) occurring at lower densities. Some weeds are also present mostly on the edges of this community including Lantana (*Lantana camara*), Golden Wreath Wattle (*Acacia saligna*), Coolatai Grass (*Hyparrhenia hirta*) and Red Natal Grass (*Melinis repens*).

Map unit 4 - Paperbark / Hard Quandong Forest

Dominant Species:
Melaleuca stypheloides,
Elaeocarpus obovatus

Height / Cover:
5-10 metres / Closed

Proportion of Investigation Area:
1% (0.3ha)

Map Colour:
Solid Light Green

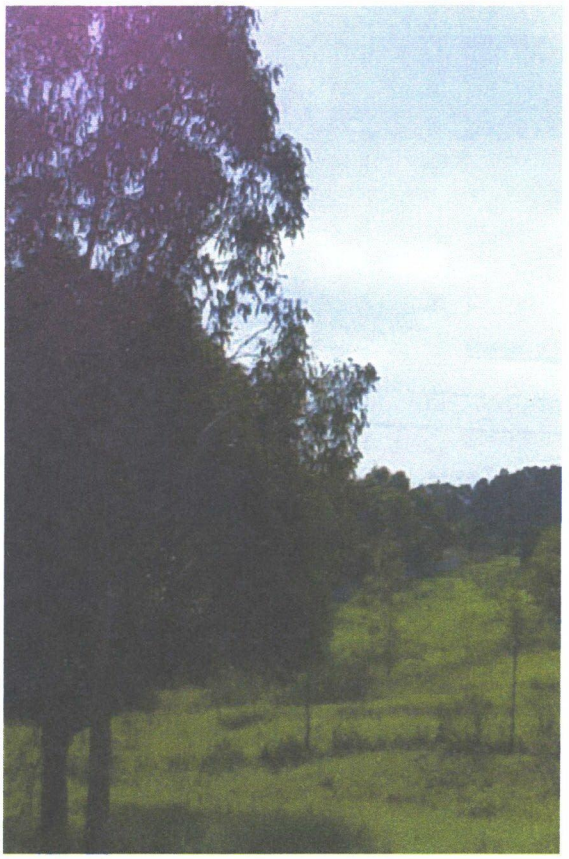
Description:

This community occurs adjacent to Maitland Road at the northern end of the investigation area on slopes surrounding low lying wetland areas.

Structurally it comprises a patchy closed canopy layer of Prickly-leaved Paperbark (*Melaleuca stypheloides*) and Hard Quandong (*Elaeocarpus obovatus*), along with Whale Bone Tree (*Streblus brunonianus*), Flintwood (*Scolopia braunii*), Sweet Pittosporum (*Pittosporum undulatum*), Cheese Tree (*Glochidion ferdinandii*) and Mock Olive (*Notelaea longifolia*).

This community is highly disturbed from edge effects with weeds present including *Lantana camara,* and Kikuyu (*Pennisetum clandestinum*) encroaching from the edges. Underneath areas of dense canopy cover there is a sparse groundcover of native species including Basket Grass (*Oplismenus aemulus*), Scurvy Weed (*Commelina cyanea*), Kidney Weed (*Dichondra repens*) and Sickle Fern (*Pellea falcata*). Climbing species present include Wonga Vine (*Pandorea pandorana*), Monkey Rope (*Parsonsia straminea*) and Cockspur Thorn (*Maclura cochinchinensis*).

Map unit 5 - Eucalypt Forest



Dominant Species:
Eucalyptus tereticornis, Eucalyptus molucanna, Corymbia maculata, Eucalyptus paniculata, Elaeocarpus obovatus

Height / Cover: 10-15 metres / Open

Proportion of Investigation Area:
0.8% (0.2ha)

Map Colour:
Solid Red

Description:

This community occurs on slopes surrounding low lying wetland areas in a number of small pockets in the investigation area near Shortland Wetland Centre at the southern end of the investigation area and adjacent to Maitland Road at the northern end of the investigation area.

Structurally it comprises a patchy canopy layer of Forest Red Gum (*Eucalyptus tereticornis*), Grey Box (*Eucalyptus molucanna*), Spotted Gum (*Corymbia maculata*) and Grey Ironbark (*Eucalyptus paniculata*). The understorey is moderately to highly disturbed, with weed species dominating the understorey including *Lantana camara*, Kikuyu (*Pennisetum clandestinum*), Purple Top (*Verbena banariensis*) and Fireweed (*Senecio madagascariensis*). Some native species still exist in the understorey at low densities including Gorse Bitter-Pea (*Davesia ulicifolia*) and Blackthorn (*Bursaria spinosa*).

Map unit 6 - Planted Native Species

Dominant Species:
Eucalyptus robusta, Banksia integrifolia, Leptospermum petersonii, Syzygium paniculatum.
Height / Cover: 5-12 metres / Closed - Open

Proportion of Investigation Area:
3% (0.6ha)

Map Colour:
Solid Pink

Description:

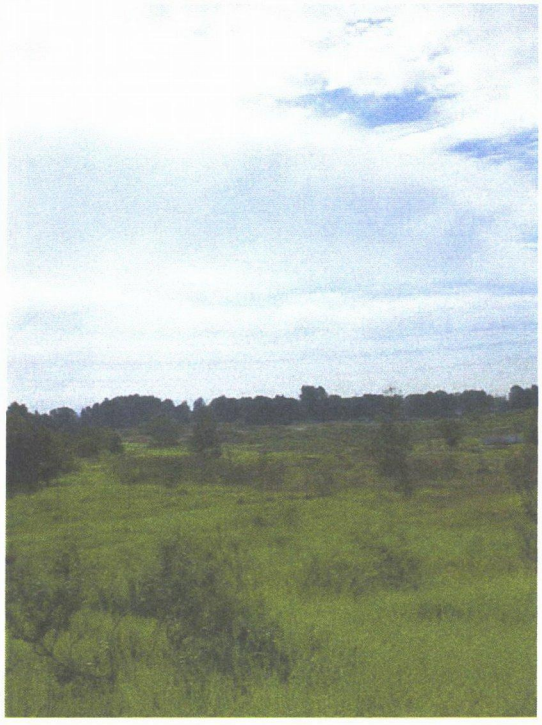
This community is associated with planted areas along the edge of Sandgate Cemetery and along the edges of the existing State Highway 23. It is well established adjacent to Sandgate Cemetery containing Swamp Mahogany (*Eucalyptus robusta*), Coastal Banksia (*Banksia integrifolia*), Lemon-scented Tea Tree (*Leptospermum petersonii*) and Magenta Lillypilly (*Syzygium paniculatum*). Understorey components include Mat Rush (*Lomandra longifolia*), Hairy Clerodendrum (*Clerodendrum tomentosum*), Fringed Wattle (*Acacia fimbriata*) and Climbing Guinea Flower (*Hibbertia scandens*). Along the edges of the existing State Highway 23 (picture above) the plantings are relatively sparse, generally comprising spaced Wattle species (*Acacia* spp.). Some weeds are present including Cobblers Peg (*Bidens pilosa*) and Flatweed (*Hypochoeris radicata*).

Map unit 7 - Exotic Shrubs and Grasses

Dominant Species:
Rubus fruticosus, Cortadieria selloana, Solanum mauritimum, Pennisetum clandestinum, Stenotaphrum secundatum
Height / Cover:
1-3 metres / Closed

Proportion of Investigation Area:
28% (6.7ha)

Map Colour:
Solid Orange



Description:

This community occurs on areas that have been cleared and subject to agricultural activities in the past. There is a diversity of weed species present throughout this community and generally grass species dominate including Kikuyu (*Pennisetum clandestinum*), Buffalo Grass (*Stenotaphrum secundatum*), Vasey Grass (*Paspalum urvillei*), Pampas Grass (*Cortadieria selloana*) and Rats-tail Grass (*Sporobolus indicus*). Other flora species that are dominant in different areas include Blackberry (*Rubus fruticosus*), Tobacco Bush (*Solanum mauritimum*), Green Cestrum (*Cestrum parqui*), Lantana (*Lantana camara*), Paddys Lucerne (*Sida rhombifolia*) and Purple Top (*Verbena bonariensis*). Some small fragmented patches of natives do persist within this community where conditions are suitable including Cumbungi (*Typha orientalis*), Common Reed (*Phragmites australis*), Harsh Ground Fern (*Hypolepis muelleri*), River Buttercup (*Hydocotyle inundatus*), White Root (*Pratia purperascens*) and Water Peppers (*Persicaria* spp.).

3.2.2 Significant Flora Species and Communities

Threatened Species, Populations and Communities:

In total 2 threatened plant species and 4 EECs have been identified within and/or adjacent to the investigation area. Plant species identified during this survey are shown in Appendix 3.

Magenta Lillypilly (*Syzygium paniculatum*) (Vulnerable TSC Act; Vulnerable EPBC Act) was recorded during the field work, and specifically occurs within a planted row of native species along the western boundary of Sandgate Cemetery.

Zannichellia palustris (Endangered TSC Act) has been recorded within the study area in the Sandgate Road drainage channel, Hexham Swamp and 2HD Swamp (Geoff Winning, HWR, pers. obs.) (Figure 9). The closest record to the investigation areas occurs in the man-made drainage channel on the northern side of the Shortland Wetlands Centre adjacent to the western side of the investigation area (Figure 9). This is an annual species that evidently requires a bare substrate in winter for germination, which is provided either by seasonal drying of the wetland or by deposition of a new sediment layer (Winning 1992; Greenwood 2001). It grows in shallow open water and as such the wetlands within the study area are unlikely to provide ideal habitat for this species, although its occasional occurrence in these wetlands is possible.

Zannichellia palustris is an aquatic halophyte that occurs in eutrophic lakes, rivers and estuarine areas in Europe and North America, where it occasionally requires control. It was first recorded in Australia near Murray Bridge in South Australia in 1887. Since 1971 it has been recorded in the Canoe Channel (a drain off Ironbark Creek), as well as near the Minmi Road bridge across Ironbark Creek, Black Creek at Cessnock, ponds on Kooragang Island, and from near Belmont (Winning 1996; Winning 1999b). Its occurrence in the Lower Hunter has been known since the 1970's (S.Jacobs, *pers. comm.*).

Given its worldwide distribution and its relatively recent discovery within the Hunter region, it is not clear whether the species is a recent introduction, possibly brought in on ballast water, or an indigenous species to NSW with a restricted range.

In a study of the ecology of *Zannichellia palustris* in the Lower Hunter, Greenwood (2001) suggested that the species is introduced, based mainly on its occurrence in estuaries near major sea ports in Australia. However, the current view in the botanical literature is that *Zannichellia palustris* is a native species (ie. present before 1788) and, in any case, it is listed as an endangered species in New South Wales.

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Significant Species

Figure 9

Regionally Significant Species:

Two flora species listed as Regionally Significant Cockspur Thorn (*Maclura cochinchinensis*) and Grey Ironbark (*Eucalyptus paniculata* ssp. *matutina*) were also recorded. These species are considered regionally significant pursuant to Stage 1 of the *Lower Hunter Regional Biodiversity Strategy* (Payne, 1998).

Endangered Ecological Communities:

Four EEC's were identified within and adjacent to the investigation area, comprising Freshwater Wetlands, Swamp Oak Floodplain Forest, River-flat Eucalypt Forest and Subtropical Coastal Floodplain Forest (refer to Table 2.2.1). The locations of Endangered Ecological Communities are shown in Figure 10.

Several floodplain EECs occur within and in the vicinity of the investigation area (Table 3.2.2). The final determinations for these are attached in Appendix 2.

Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions nominally covers forest, woodlands and scrubs dominated by Swamp Oak (*Casuarina glauca*) but can also include reedlands (such as *Phragmites australis* reedland) with scattered Swamp Oak trees. Map units 3a and 4 have affinities to this community.

Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions generally covers sedgelands, reedlands and aquatic herbfields occurring on coastal floodplains. Common Reed (*Phragmites australis*) is listed as one of the characteristic species of this plant assemblage. Map units 1 and 2 have strong affinities to this EEC.

River-flat Eucalypt Forest of the North Coast, Sydney Basin and South East Corner Bioregions generally consists of forest vegetation occurring on coastal floodplains. Forest Red Gum (*Eucalyptus tereticornis*) and Grey Box (*Eucalyptus molucanna*) are listed as characteristic species of this plant assemblage. Map unit 4 and 5 have some affinities to this EEC.

Map unit 4 has affinities to a number of EECs including *Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion*, and *Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions.* Species within Map unit 4 listed under the Final Determinations for these EECs include Prickly-leaved Paperbark (*Melaleuca stypheloides*), Sweet Pittosporum (*Pittosporum undulatum*), Cheese Tree (*Glochidion ferdinandii*), Mock Olive (*Notelaea longifolia*), Monkey Rope (*Parsonsia straminea*), Basket Grass (*Oplismenus aemulus*), Scurvy Weed (*Commelina cyanea*), Kidney Weed (*Dichondra repens*), Wonga Vine (*Pandorea pandorana*) and Cockspur Thorn (*Maclura cochinchinensis*). Many of these species are also listed under the Final Determination for *River-flat Eucalypt Forest of the North Coast, Sydney Basin and South East Corner Bioregions*.

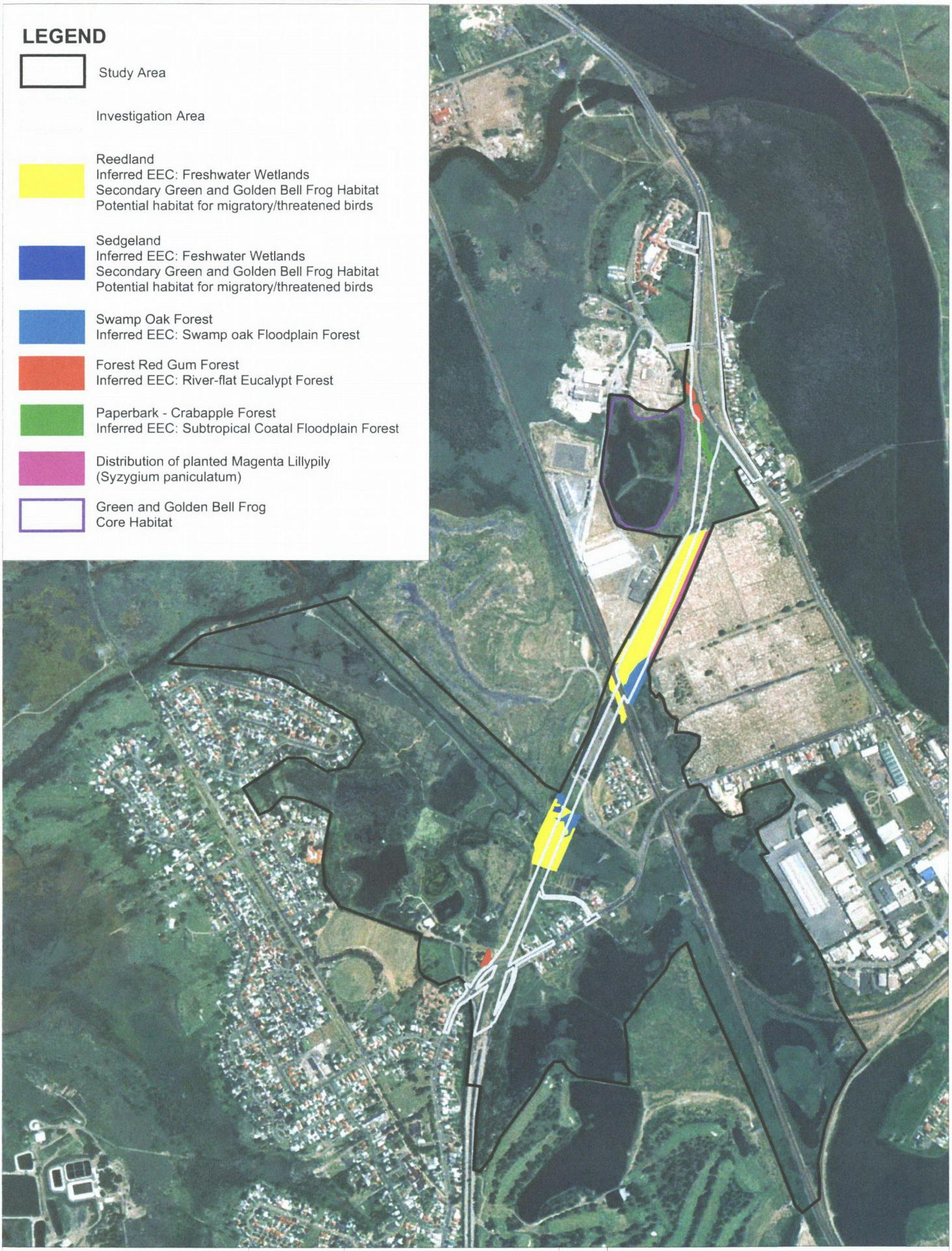
For the purposes of this assessment this area of forest would be regarded as Subtropical Coastal Floodplain Forest, because it shares the most affinities with those listed in the Final Determination for this EEC including 1 of the main canopy species and a number of listed sub-canopy species. There are as many species listed under the River-flat Eucalypt Forest Final Determination but these are mostly understorey species, therefore Subtropical Coastal Floodplain Forest has the most affinities (see Appendix 3).

The NSW Scientific Committee's final determinations for EECs lack precision and accordingly, are more of a description than a definition. Thus there is unavoidable subjectivity in interpreting and applying the Scientific Committee's final determinations. There is a considerable amount of overlap between the communities that the above Final Determinations describe, and therefore there is some confusion as to which community some areas of the vegetation within the investigation area should be classed as. However wetland and forest vegetation on and in the vicinity of the investigation area, as shown in Figure 11, is of types that were evidently intended to be covered by these EECs.

Table 3.2.2 - Threatened flora species and ecological communities recorded within the study area.

Name	Status		Occurrence in Area
	TSC Act	EPBC Act	
Syzygium panic latum	V	V	Has been planted adjacent to Sandgate Cemetery
Zannichellia palustris	E	-	Recorded in the study area
Swamp Oak Floodplain Forest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	EEC	-	Localised occurrences in study area. Scattered occurrences throughout the local area
Freshwater Wetlands on Coastal Floodplains in the NSW North Coast, Sydney Basin and South East Corner Bioregions	EEC	-	Includes areas of reeds and sedges which occur in the study area and are relatively widespread in the local area.
Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion	EEC	-	Generally includes rainforest vegetation on Coastal Floodplains
River-flat Eucalypt Forest on Coastal Floodplains in the NSW North Coast, Sydney Basin and South East Corner Bioregions	EEC	-	Generally includes forested vegetation on Coastal Floodplains.

No endangered flora populations are known to occur in the study area and none were located during the surveys.



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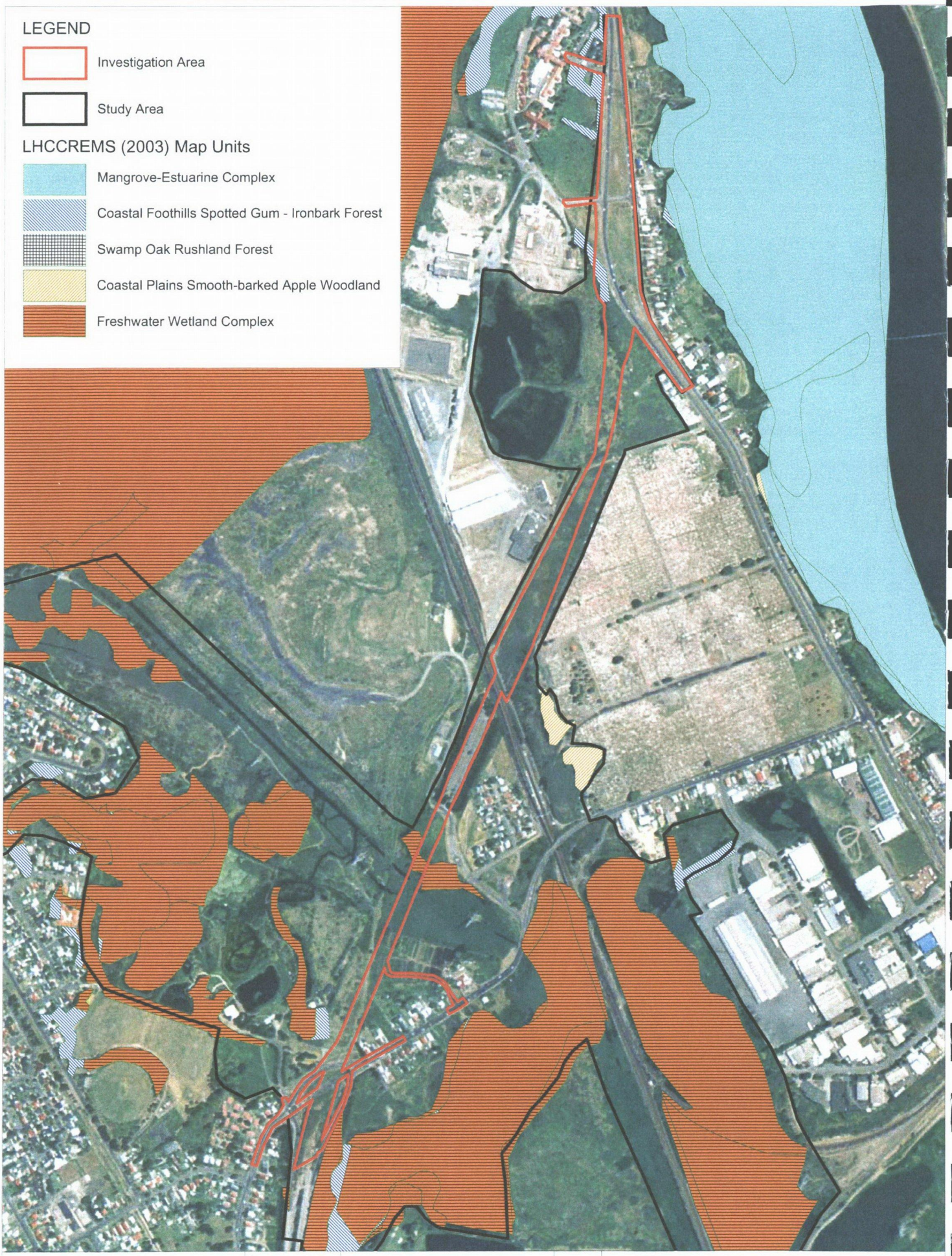
Endangered Ecological Communities

Figure 10



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LHCCREMS (2003)
Vegetation Communities

Figure 11

4.0 Fauna Surveys

4.1 Survey Limitations

Due to the timing of the project, surveys targeting amphibians, in particular Green and Golden Bell Frog (*Litoria aurea*), could not be undertaken. The investigation area includes key foraging habitat for the 2HD swamp population. Winning (2005) indicates that this population may disperse further south from the 2HD swamp during good breeding seasons. Therefore, it is recommended that targeted surveys for this species be undertaken during the breeding season (spring-summer) when climatic conditions are favourable.

4.2 Fauna Survey Methods

The general fauna investigation conducted for the preparation of this report had the objective of:

- Identifying the fauna assemblage of the study area;
- Identifying the habitat qualities of the study area;
- Locating important habitat in the study area;
- Identifying significant species habitat;
- Identifying fauna movement corridors and habitat connectivity; and
- Identifying conservation areas.

The review of the general fauna assemblage of the study area was conducted through scoping of fauna records and the correlation of habitat requirements of significant species with the vegetation units contained in the study area. The vegetation units were then examined based on their habitat characteristics in order to determine which of the significant species would be likely to inhabit those vegetation units, based on their habitat requirements.

A large number of studies have been conducted within the local area (section 1.5) and as such detailed field surveys targeting all significant fauna were considered unnecessary. However, targeted surveys were conducted for more cryptic species such as Australasian Bittern, Black Bittern, Latham's Snipe, Painted Snipe and Black-necked Stork and further surveys targeting Green and Golden Bell Frog are recommended.

4.2.1 Targeted Surveys for Bitterns and Latham's Snipe

Targeted surveys for Australasian Bittern, Black Bittern, Latham's Snipe, Painted Snipe and Black-necked Stork were conducted over 8 hours by two people on 6 July 2005 within suitable habitat in the study area (Figures 12). Two ecologists traversed suitable habitat on parallel transects spaced at ten metre intervals within suitable habitat in order to "flush" out any birds roosting in these areas.

This was repeated until all suitable habitats had been covered. Any birds observed or heard calling were recorded. Weather conditions were calm, mild to warm with no cloud cover.

4.3 Field Survey Results

Significant species recorded within the study area during field surveys conducted on 6 July 2005 are listed in Table 4.3.1 (see Appendix 5 for fauna species list). As stated earlier, due to the timing of the project, surveys for Green and Golden Bell Frog could not be undertaken; however, this species has been recorded in the study area previously (Winning 2005). Green & Golden Bell Frog has an established breeding colony at the 2HD Swamp and is known to disperse from this core habitat during good breeding seasons and has been observed along the rail corridor which crosses the study area (Figure 9) (Winning 2005).

Table 4.3.1 – Significant fauna species recorded during field surveys.

Common Name Scientific Name	Legal Status	Location
Tawney Grassbird *Megalurus timoriensis*	M (EPBC Act)	Northern side of Drainage Channel behind Shortland Wetland Centre (SWC); Newcastle Wetlands
Little Grassbird *Megalurus gramineus*	M (EPBC Act)	Northern side of Drainage Channel behind SWC; Newcastle Wetlands
Clamorous Reed Warbler *Acrocephalus stentoreus*	M (EPBC Act)	Northern side of Drainage Channel behind SWC; Newcastle Wetlands
Golden-headed Cisticola *Cisticola exilis*	M (EPBC Act)	Northern side of Drainage Channel behind SWC
Masked Lapwing *Vanellus miles*	M (EPBC Act)	Northern end of Constructed SH23
Chestnut Teal *Anas castanea*	M (EPBC Act)	Newcastle Wetlands
Wandering Whistling Duck *Dendrocygna arcuata*	M (EPBC Act)	Newcastle Wetlands
Whistling Kite *Haliastur sphenurus*	M (EPBC Act)	Observed over northern end of Shortland Golf Course from Newcastle Wetlands
Nankeen Kestrel *Falco cenchroides*	M (EPBC Act)	Foraging over *Phragmatis* reedland within investigation area.
White-bellied Sea Eagle *Haliaeetus leucogaster*	M (EPBC Act; CAMBA)	Flying over *Phragmatis* reedland within investigation area.

As shown in Table 4.3.1, 10 species listed as migratory under the EPBC Act and 1 species also listed under CAMBA were recorded within the study area on 6 July 2005.

Targeted Surveys for Bitterns, Snipe and Black-necked Stork:

No Bitterns, Snipe or Black-necked Stork were recorded during these surveys.

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Location of Surveys for Bittern and Snipe

Figure 12

4.3.1 Fauna Assemblage

The review of data records (refer to section 1.6 and section 2) for significant species conducted for the preparation of this report identified 18 threatened vertebrate fauna species (9 birds, 2 marsupials, 6 flying mammals and 1 amphibian) and 10 migratory birds within 5km of the study area which are likely to utilise habitats found within the investigation area (Table 6.1.1 and Table 6.1.2).

Most of the significant bird species identified in the local area during desktop studies are either unlikely to utilise habitats within the investigation area and/or visit the area infrequently (see Table 2.2.1 and 2.2.2). Two of the listed bird species, Australasian Bittern (*Botaurus poiciloptilus*) and Black Bittern (*Ixobrychus flavicollis*), may utilise reed habitats. Two others, Latham's Snipe (*Gallinago hardwickii*) and Painted Snipe (*Rostratula benghalensis australis*), are known to use edge habitats (low wet grassland and exposed mud). The former has been observed using edges of the Market Swamp; and the latter although not observed to do so, could also use these habitats.

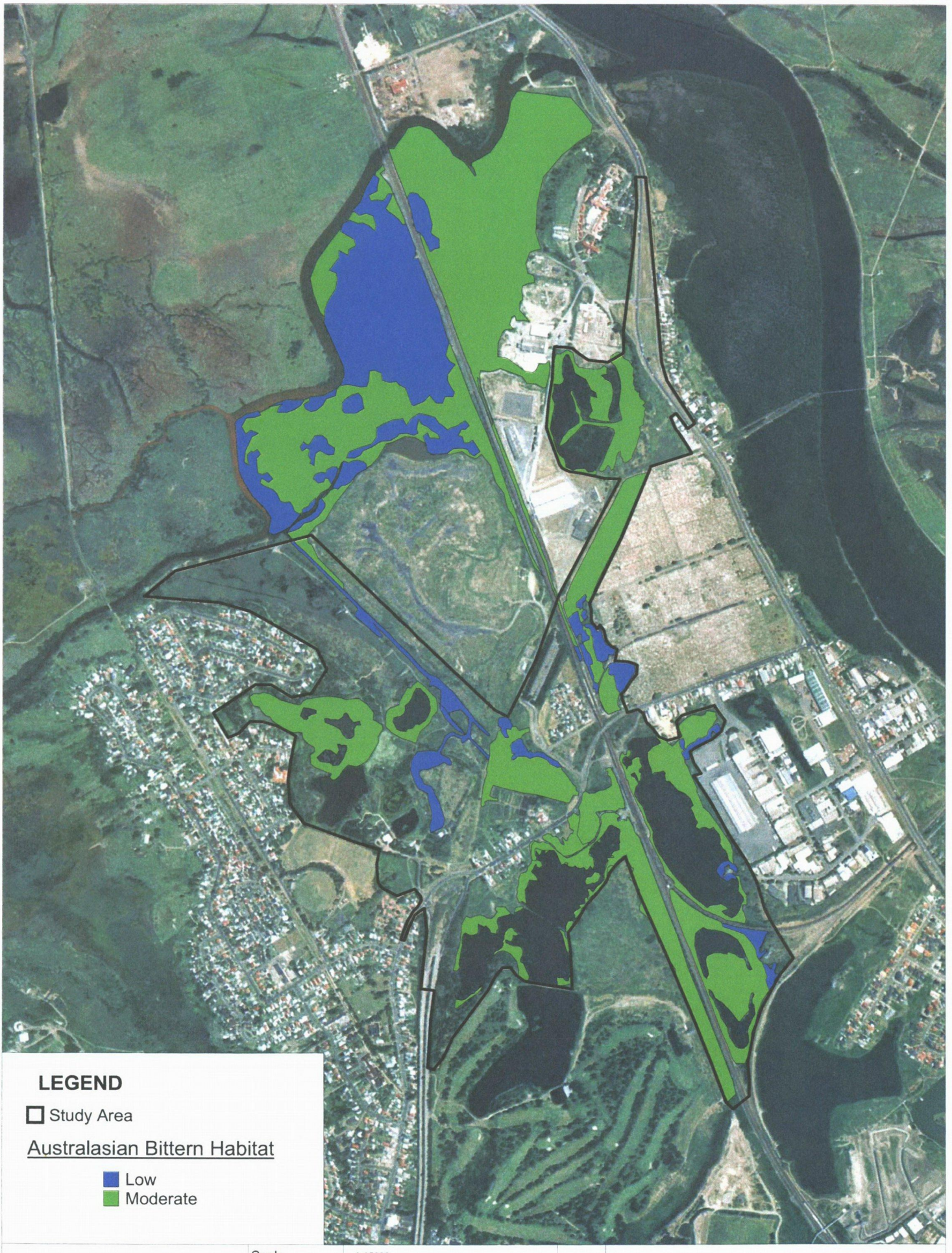
Green & Golden Bell Frog (*Litoria aurea*) (E TSC Act; V EPBC Act) has an established breeding colony at the 2HD Swamp (see Figure 9) and is known to disperse from this core habitat during good breeding seasons (Winning 2005). This species has been observed in suitable habitat in the study area.

4.3.2 Significant Fauna Species

Australasian Bittern and Black Bittern:

Australasian Bittern occurs in open areas and edge areas in reed-swamps, using the reeds for shelter and feeding in shallow water along the edges (Marchant & Higgins 1990). The study area provides habitat suitable for Australasian Bittern (Figure 13) but is relatively exposed to noise, traffic and predators. Given large areas of good habitat for Australasian Bittern occur elsewhere in Hexham Swamp; this species is likely to visit the investigation area infrequently at best. Further to this, this species was not recorded during targeted surveys conducted on 6 July 2005, however it is acknowledged that this cryptic species is difficult to locate.

The Black Bittern inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation (Marchant & Higgins 1990). Where permanent water is present, this species may occur in flooded grassland, forest, woodland, rainforest and mangroves (Marchant & Higgins 1990). One record of this species exists on Kooragang Island dating to 1999 (Atlas of NSW Wildlife – DEC 2005). While potential habitat exists within the investigation area (Figure 13), the scarcity of records within the local area, and the existence of large areas of suitable habitat within Hexham Swamp and Kooragang Island it is considered that this species is likely to visit the investigation area infrequently at best. Although this species was not recorded during targeted surveys conducted on 6 July 2005 it may from time to time use the local habitats.



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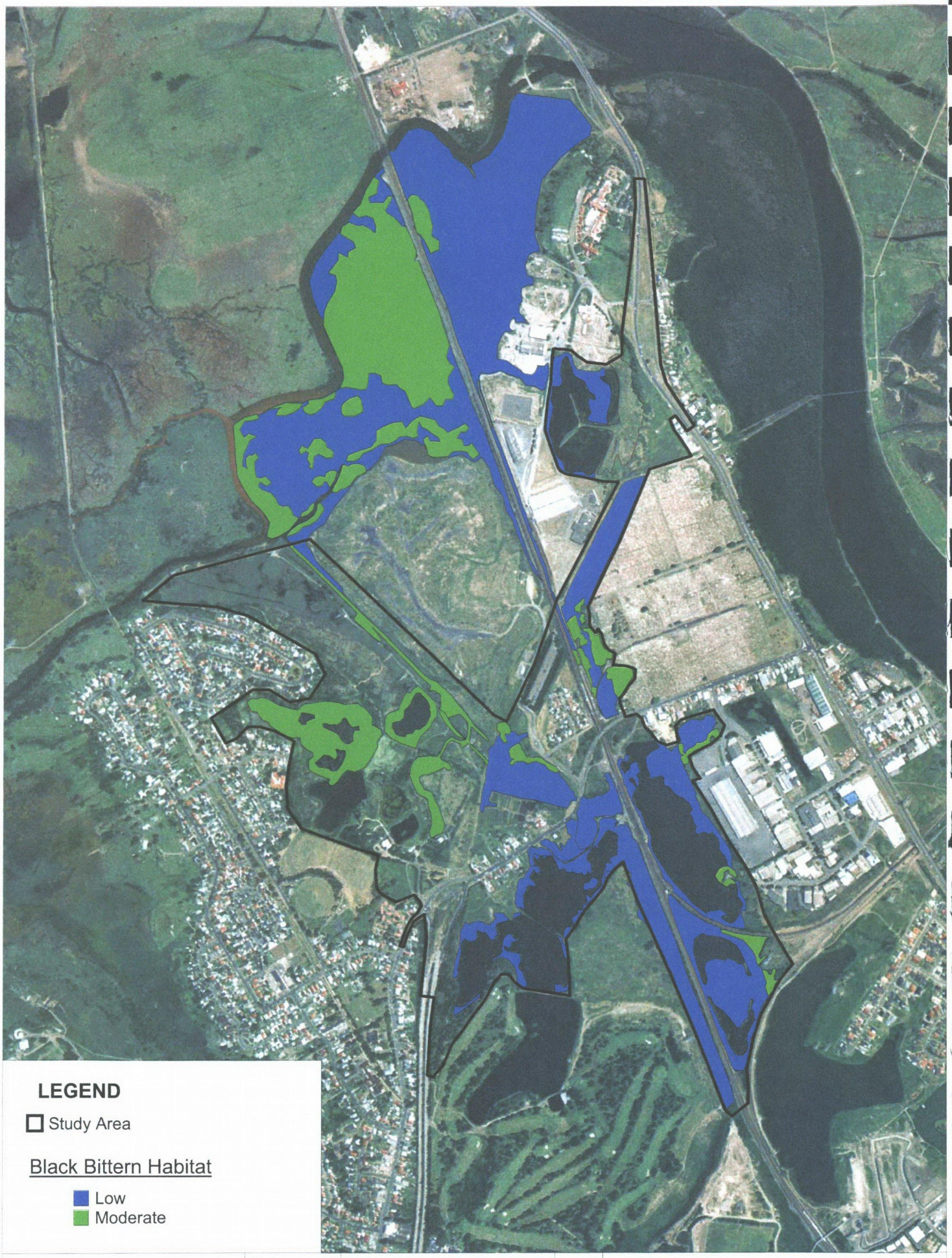
Australasian Bittern Habitat

Figure 13



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Black Bittern Habitat

Figure 14

Latham's Snipe and Painted Snipe:

Both of these species roost in shallowly inundated low grassland and sedgeland, and feed in the same habitat or on exposed mud flats of freshwater wetlands. Latham's Snipe was observed in the mid 1990s roosting and feeding in edge areas of the Market Swamp (G. Winning, pers. obs. HWR). Painted Snipe has not been observed in the wetland but has been observed in other parts of Hexham Swamp and during early December 2004 at least two individuals were regularly observed in wetlands on the western end of Kooragang Island (HBOC records). Although these species were not recorded during this assessment, these species could use the habitats from time to time. Habitat for Latham's Snipe is shown in Figure 15 while habitat for Painted Snipe is shown in Figure 16.

Green and Golden Bell Frog:

Due to the timing of the field surveys for this project (winter months), targeted surveys for Green and Golden Bell Frog (GGBF) were not undertaken. However, there is extensive information relating to the local population of this species within the local area and surveys have been undertaken along the railway line within the study area previously (Winning 2005). The following discussion is based on the information collected to date, however it is recommended that targeted surveys are undertaken during the appropriate seasons and conditions to determine whether the local population utilises the investigation area. As a precaution, mitigation measures designed to ameliorate any potential impacts on the local population of GGBF should be implemented in consultation with DEC, the Wetlands Centre, local interest groups such as the Society of Frogs and Reptiles (SOFAR) and local experts. The following should be considered in the design of mitigation measures:

- Position the highway on high ground to avoid habitat loss and minimise disturbance;
- Provide habitat augmentation (i.e. habitat ponds, movement corridors) to facilitate dispersal routes and improve habitat quality; and
- Provide barriers to frog movement to reduce risk of collision with cars and direct dispersal.

A survey of GGBF along the rail corridor of the main Northern Railway was undertaken on 3-4 & 8 December 2004 by Brad McPherson and John McGrath of the Society of Frogs and Reptiles. The survey used spot-light searches and call-back. No GGBF were heard calling in the rail corridor during the survey but one GGBF was observed in a small pond on the edge of the rail corridor. The frog observed in this pond was a small individual and was assumed to be a juvenile dispersing from the 2HD Swamp.

While a local population of GGBF is known to occur in the local area based on the 2HD Swamp, the size and viability of the population is not known. During the 2001/2002 breeding season, 100 frogs were captured in the 2HD Swamp. Although there have been no comprehensive surveys since then, observations suggest a decline in population size over the past two drought seasons and a possible increase in the current breeding season (Society of Frogs and Reptiles, unpublished data).

This pond is evidently poor habitat for GGBF, being populated by Plague Minnow (*Gambusia holbrooki*), a species that predates on tadpoles and is negatively correlated with the presence of GGBF.

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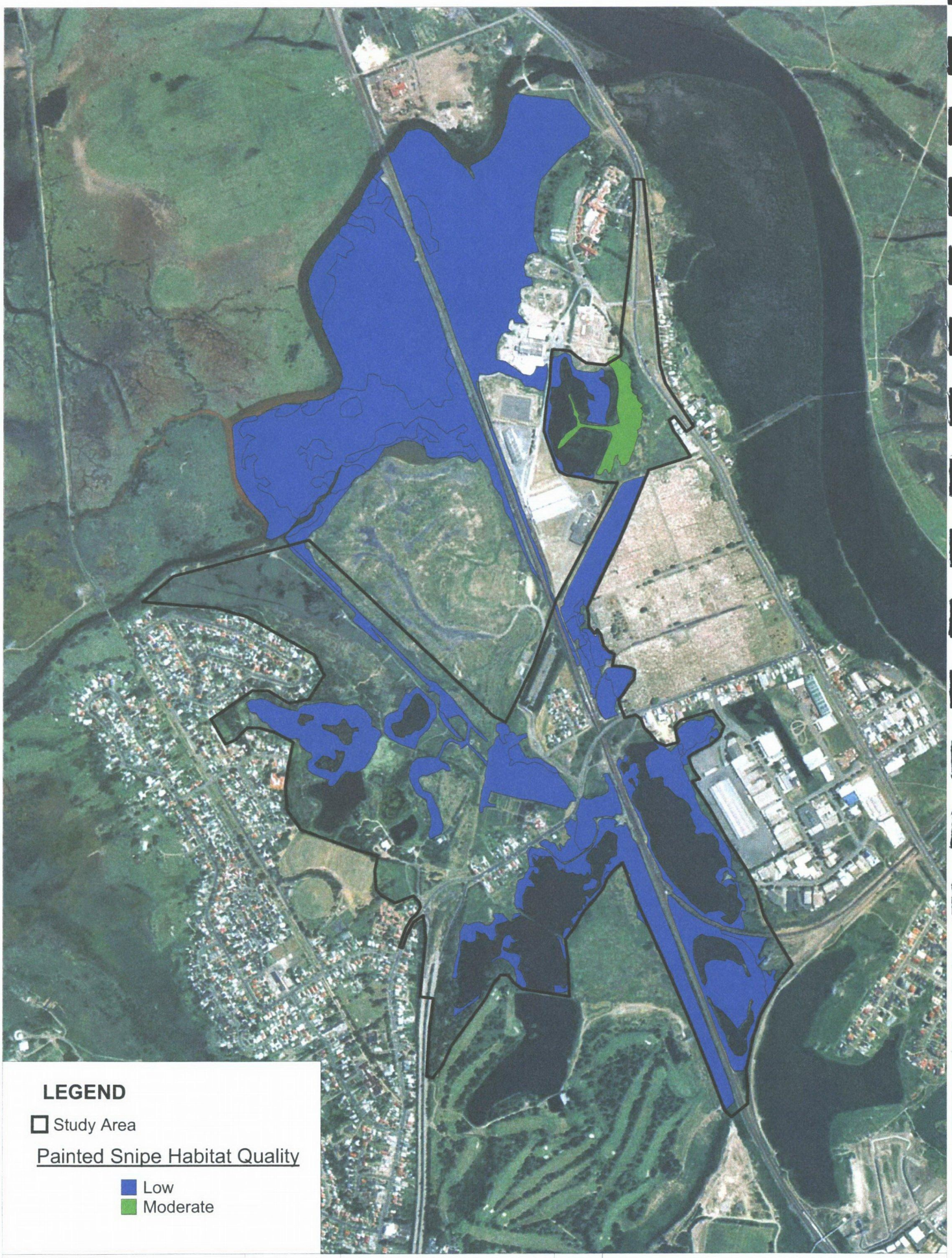
Latham's Snipe Habitat

Figure 15



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Painted Snipe Habitat

Figure 16

5.0 Marine Species & Communities

5.1 Waterway Characteristics

The main area of aquatic habitat on the site is a man-made channel (Winning pers. comm. 2005) known as Deep Bridge Creek, which consists of a channel of open water surrounded by reeds. Table 5.1 provides details of the characteristics of this water course.

Table 5.1 - Characteristics of Deep Bridge Creek

Characteristics of Watercourse	Description	Information Source
General description	More or less straight constructed drain, approximately 1300m long, from Sandgate Road to Ironbark Creek. Up to 10m wide, with a depth varying from approximately 2m for most of its length to approximately 1m in small sections where sediment has accumulated.	Aerial photograph interpretation (API) and observations by G. Winning (HWR).
Connections	Constructed in 1975 to provide drainage from the Shortland / Waratah West areas through to Ironbark Creek. Effectively replaces original drainage paths through wetlands filled in these areas in the 1950s to 1980s. Downstream connection is to Ironbark Creek, which flows into the Hunter River through partially opened floodgates. Constructed branch ('canoe trail') into Shortland Wetlands Centre site (not connected to SWC wetlands). Upstream connection is through culverts under Sandgate Road into a narrower channel from Waratah West. This channel is overgrown with *Phragmites australis* and *Typha orientalis*. Connects from the upper drain to the Newcastle Wetlands Reserve. Upper parts of drain are periodically dredged to maintain hydraulic flow.	API and observations by G. Winning (HWR). Warabrook Wetlands Draft Plan of Management (WBM, 2004).
Flow regime	Permanent. Essentially constructed as a stormwater drain, and given the small size of the catchment, stormwater flows tend to move quickly through the system. Limited tidal range up to about Sandgate Road resulting from partial opening of Ironbark Creek floodgates. Proposed opening of the floodgates in the near future would result in greater tidal influence.	API and observations by G. Winning (HWR).
Obstruction to flows	There are no weirs or other obstructions to flow. The Tomago water main crosses the drain at water height and while a concrete weir was originally constructed to protect the pipe, this has since been removed. There is a piped crossing comprising five approximately half metre diameter pipes.	Observations by G. Winning (HWR).
Water quality	Limited available data. Known to be fresh to brackish depending on rainfall.	Observations by G. Winning (HWR).
Substrate	Mainly exposed clays (as a result of excavation). Small areas of gravel as a result of sedimentation up stream of the piped crossing.	Observations by G. Winning (HWR).
Instream habitat	There are no substantial snags or other habitat instream.	Observations by G. Winning (HWR).
Instream vegetation	Largely unvegetated due to depth. Dense instream growth of *Phragmites australis* in the immediate vicinity of Sandgate Road.	API and observations by G. Winning (HWR).
Riparian vegetation	Generally steep-banked (excavated). Riparian vegetation of *Phragmites australis* various weeds and scattered (increasing) *Casuarina glauca*.	Observations by G. Winning (HWR).

Table 5.1 - Characteristics of Deep Bridge Creek

Characteristics of Watercourse	Description	Information Source
Known aquatic fauna	Fish: *Gambusia affinis, Gobiomorphus coxii, Philypnodon grandiceps, Anguillaria australis.* *Reptiles: Chelodina longicollis* Mammals: *Hydromys chrysogaster*	Flora & fauna of the Shortland Wetlands (McDonald & Winning, 1986).
Threatened species	The endangered plant *Zannichellia palustris* has been periodically recorded in the channel downstream of Sandgate Road.	Observations by G. Winning (HWR).
Adjoining landuses	Disused municipal waste disposal sites along north-eastern bank. Shortland Wetlands Centre along south-western bank. SWC is part of the Hunter Estuary Wetlands Ramsar site.	API and observations by G. Winning (HWR).

The waterway would be classified as a Class 2 stream with moderate fish habitat (Fairfull and Witheridge 2003). A class 2 stream has the following characteristics (Fairfull and Witheridge 2003):

> *"Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi - permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area."*

The NSW Fisheries policy and guidelines for fish friendly water crossings (NSW Fisheries 2003 - Appendix 10) specify that the design and construction of a water crossing must be in accordance with Fairfull and Witheridge (2003). Therefore, given that Deep Bridge Creek would be classified as a Class 2 stream, the water crossing must be one of the following:

- A bridge,
- Arch,
- High Flow Culvert, or
- Ford.

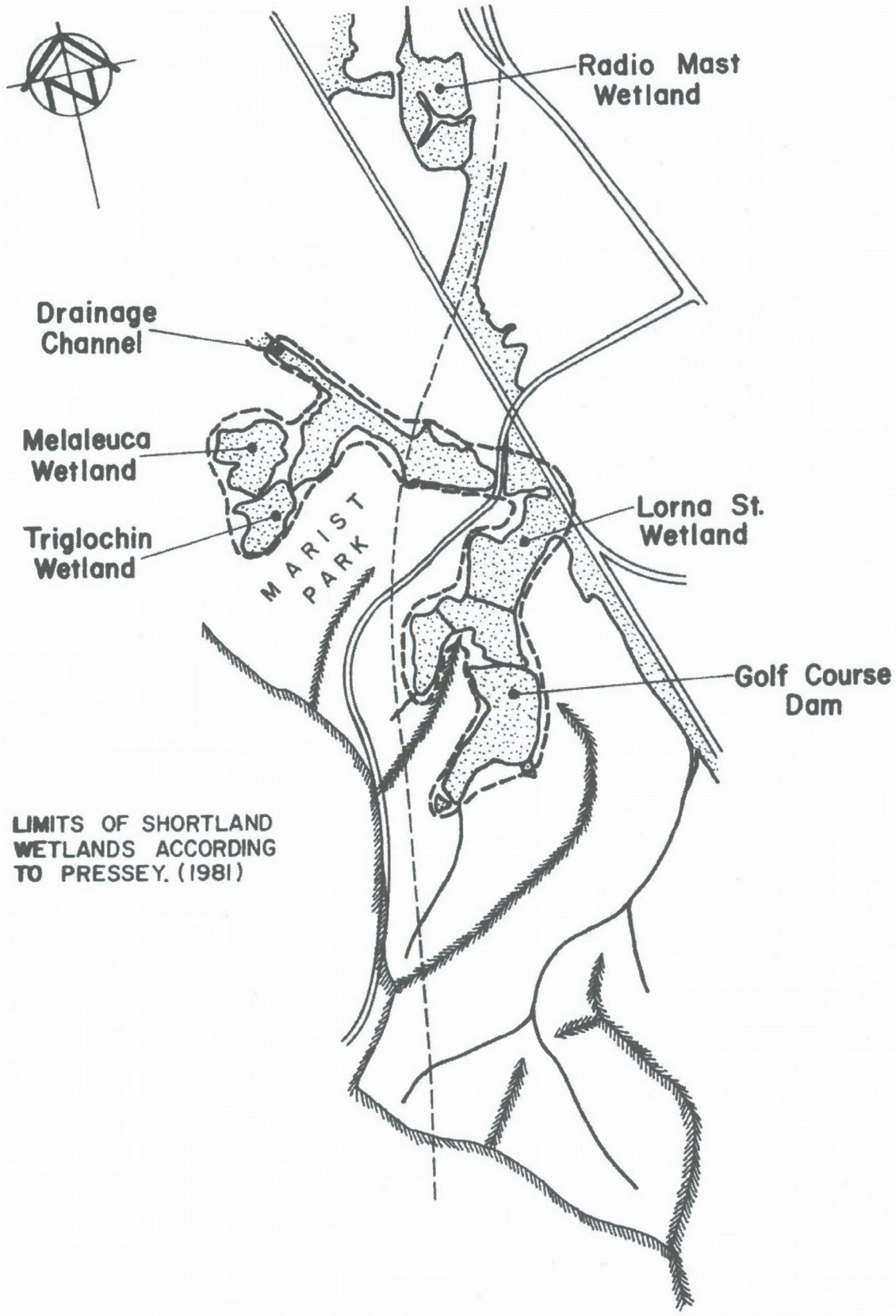
5.2 Previous Surveys

While no aquatic surveys were undertaken as part of this assessment, a number of surveys have been undertaken previously within and surrounding the study area.

Ecological Study of State Highway No. 23 (McDonald Wagner 1984):

A previous survey of SH 23 was undertaken by McDonald Wagner (1984) (Figure 17). During this survey collection of fishes within Ironbark Creek and tributaries (including the man-made channel) was undertaken. At the time of the survey, fish populations were limited to freshwater species; seven species were recorded. The most commonly recorded species was the introduced *Gambusia holbrookii* (syn. *Gambusia affinis*) which was found to be widely distributed being recorded everywhere with the exception of the radio mast wetland (McDonald Wagner 1984).

No currently listed threatened species, populations or ecological communities were recorded during this survey.



Source: Figure 5.1 McDonald Wagner (1984)

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Study Area
(McDonald Wagner 1984)

Figure 17

Hexham Swamp Rehabilitation Project (Haines *et al.* 2005):

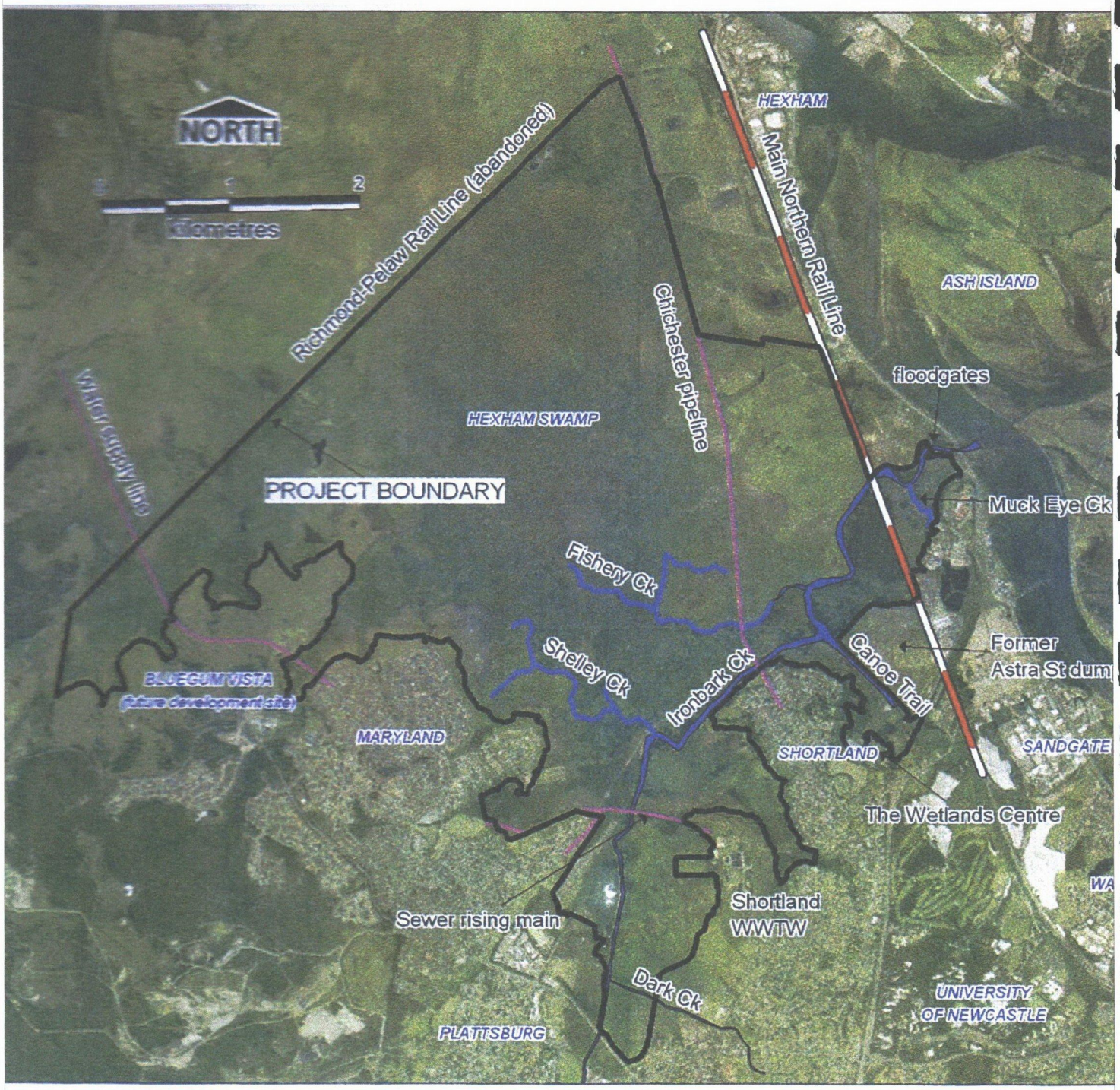
The aim of this project is to restore some of the previous estuarine habitats and their associated values within Hexham Swamp by opening the existing floodgates at the mouth of Ironbark Creek (Figure 18). Opening the gates would reinstate tidal flows to the swamp, resulting in saline inundation of some existing freshwater reed and pasture habitats.

An EIS was required because the majority of Hexham Swamp is gazetted under SEPP 14 and as such the project was deemed Designated Development under the EPA Act and as such is subject to consent by Newcastle City Council.

During this study included assessment of aquatic macro-invertebrates and fish. A total of 61 species were recorded (downstream and upstream from the floodgates) of which 39 are primarily estuarine/saltwater species, 19 are known to occur in both fresh and estuarine waters at some stage in their life history and 3 are primarily freshwater species (according to classification in Merrick and Schmida 1984; Grant 1985; Hutchins and Swainston 1986; Allen 1989; Wager 1993; McDowall 1996; and Allen 2002). Fish species recorded during this study are listed in Appendix 5.

This study found that the fish assemblages in the study area have the following ecological values:

- The fish assemblages are typical of those found in slightly brackish to fresh-waters. All fish recorded are relatively common and widespread throughout NSW;
- No endangered species, populations, ecological communities, or vulnerable fish species as currently listed under the FM Act or the EPBC Act have been recorded or are likely to occur in the study area;
- The purple spotted gudgeon (*Morgunda adspersa*), which is classified as restricted by the Australian Society of Fish Biologists, has been recorded in Ironbark Creek. This classification was given due to serious decline in distribution and abundance of this species in the Murray-Darling (MD) Drainage, particularly in South Australia (Extinct) and Victoria (Presumed Extinct) (Wager 1993). Electrophoretic studies (SA Department of Fisheries) indicate that the MD stock is considerably different from east coast stocks, therefore warrants classification as a separate taxon. For this reason, IUCN and ANCA only classify the MD stock as Endangered (ANCA) and Critical (IUCN), and does not apply to east coast stocks, which are considered as relatively common.
- No species listed as Endangered, Threatened, Potentially Threatened, Critical or Vulnerable by ANCA or IUCN were recorded or are likely to occur within the study area,



Source: Figure 3.1 Haines et al. (2005)

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Study Area
(Haines et al. 2005)

Figure 18

5.3 Habitat Assessment

Currently Listed Marine Threatened Species, Populations and Ecological Communities:

Table 5.3 identifies the species, populations and ecological communities listed pursuant to Part 7A of the *Fisheries Management Act 1994* (FM Act).

Table 5.3 – Threatened species, populations and communities under FM Act

Species / Population / Community	Legal Status*	Potential Habitat on site
CARTILAGINOUS FISHES		
Green Sawfish *Pristis zijsron*	E	No
Grey nurse shark *Carcharias taurus*	E	No
Great white shark *Carcharodon carcharias*	V	No
BONY FISHES		
Eastern freshwater cod *Maccullochella ikei*	E	No
Murray hardyhead *Craterocephalus fluviatilis*	E	No
Oxleyan pigmy perch *Nannoperca oxleyana*	E	No
Southern bluefin tuna *Thunnus maccoyii*	E	No
Trout cod *Maccullochella macquariensis*	E	No
Black cod *Epinephelus daemelii*	V	No
Macquarie perch *Macquaria australasica*	V	No
Southern pygmy perch *Nannoperca australis*	V	No
Silver perch *Bidyanus bidyanus*	V	No
INVERTEBRATES		
River snail *Notopala sublineata*	E	No
Adams emerald dragonfly *Archaeophya adamsi*	V	No
Buchanans fairy shrimp *Branchinella buchananensis*	V	No
FLORA		
Bennetts seaweed *Vanvoorstia bennettiana*	PE	No
ENDANGERED POPULATIONS		
Western populations of olive perchlet (*Ambassis agassizii*)	-	No
Western populations of purple spotted gudgeon (*Mogumda adspersa*)	-	No
ENDANGERED ECOLOGICAL COMMUNITIES		
Aquatic ecological community in the natural drainage system of the lower Murray River Catchment	-	No
Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River	-	No

* E = Endangered; V = Vulnerable; PE = Presumed Extinct

No habitats or aquatic species of significance were recorded within the aquatic habitat in the investigation area. No species or communities presently listed as threatened under the FM Act are known to occur in the investigation area, and further to this, the investigation area supports no habitat that is suitable for any of the listed species. Similarly, no protected marine species would be affected by the proposed action.

6.0 Habitat Analysis for Significant Species

As outlined in the habitat analysis (Table 6.1.1 and Table 6.1.2) different species are often found in specific or confined habitat niches where they require specific habitat structures and elements in order to maintain viability. Thus, it is likely that different vegetation units will contain a different suite of fauna species to other vegetation units. However given the similar attributes of some of the vegetation units, many local fauna species may find suitable habitat conditions in several or all of the vegetation units.

6.1 Habitat Suitability

Although 51 significant species were recorded within the local area not all habitats contained within the study area would be considered suitable for supporting all of these species. Table 6.1.1 provides information on the distribution; key habitat requirements and habitat assessment of each threatened species in order to determine whether they are likely to occur in any of the vegetation map units in proximity to the proposed action (refer to section 4 for map unit descriptions). The same assessment is provided for migratory and marine species protected under the EPBC Act, CAMBA, JAMBA and the Bonn Convention (Table 6.1.2).

Table 6.1.1 - Distribution, key habitat requirements and habitat assessment for threatened species of the local area.

Common Name Scientific Name	Distribution in NSW	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
THREATENED FLORA									
Black-eyed Susan *Tetratheca juncea*	Coast between Wyee and Bulahdelah	Typically eucalypt woodland or forest on conglomerate ridges but also recorded on sands and some volcanic ridges. *Tetratheca juncea* is often found in association with Red Bloodwood (*Corymbia gummifera*) dominated vegetation communities, within which Smooth-barked Apple (*Angophora costata*) or Scribbly Gum (*Eucalyptus haemastoma*) are co-dominant, with a dense understorey of herbs, forbs, grass trees and grasses (Landenberger, 2003).	No	NA	×	×	×	×	×
Magenta Lilypily *Syzygium paniculatum*	The current distribution of *S. paniculatum* indicates a narrow, linear coastal distribution, between Bulahdelah and Conjola State Forest (Mills 1996).	Grows in subtropical rainforest flowering between November to December. They often grow on rich soils where there is ample moisture (Wrigley & Fagg, 1996). On the Central Coast, *S. paniculatum* occurs on Quaternary gravels, sands, silts and clays, in riparian gallery rainforests and remnant littoral rainforest communities (Payne 1997).	Yes	NA	×	×	×	×	✓
White-flowered Wax Plant *Cyanchum elegans*	*C. elegans* is restricted to eastern NSW where it is recorded from 86 locations. The known geographic range of the species extends from Yabbra State Forest (north-east of Tenterfield) in the north to Gerroa in the south and west to Merriwa in the Upper Hunter.	*C. elegans* occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities (NPWS 1993).	No	NA	×	×	×	×	×
Zannichellia palustris	*Zannichellia palustris* has a cosmopolitan distribution, but in Australia is known only from the Murray River estuary in South Australia and the lower Hunter region in NSW. It is considered to be indigenous in NSW and is recognized as rare nationally (NSW Scientific Committee 1998)	This is an annual species that evidently requires a bare substrate in winter for germination, which is provided either by seasonal drying of the wetland or by deposition of a new sediment layer (Winning, 1992; Greenwood, 2001). It grows in shallow open water.	Yes	NA	✓	✓	×	×	×

Table 6.1.1 - Distribution, key habitat requirements and habitat assessment for threatened species of the local area.

Common Name Scientific Name	Distribution in NSW	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
THREATENED BIRDS									
Australian Bittern *Botaurus poiciloptilus*	In NSW, the species has been observed along the coast as well as in wetlands of the Murrumbidgee and Lachlan Rivers and is frequently recorded in the Murray-Darling Basin (Marchant & Higgins 1990; NPWS 1999).	Inhabits terrestrial and estuarine wetlands, generally where there is permanent water. The species prefers wetlands with dense vegetation, including sedges, rushes and reeds. (Marchant & Higgins 1990; Garnett 1992).	Yes	Yes	✓	✓	×	×	×
Black Bittern *Ixobrychus flavicollis*	Wet coastal areas of Australia recorded at low elevations <200 asl; rarely recorded inland and south of Sydney (NPWS 1999).	Hunt at dusk and dawn, usually solitary but may occur in pairs (NPWS 1999), requires dense riparian vegetation, forested rivers, inlets and estuarine wetlands (DLWC 2000). Feeds on invertebrates, fish, reptiles and other small marine animals (Frith 1976).	Limited	Limited	✓	✓	×	×	×
Black-necked Stork *Ephippiorhynchus asiaticus*	Coastal areas north of Newcastle	The Black-necked Stork inhabits wetlands, such as floodplains, large shallow swamps, pools, mangroves and deeper permanent bodies of water. Mainly forages over open fresh waters; or extensive sheets of shallow water over grassland or sedgeland; shallow swamps with short emergent vegetation and abundant aquatic flora; and permanent billabongs and pools on floodplains (Marchant and Higgins 1990). Also use freshwater meadows, wet heathland, seepage from springs, semi-permanent swamps with tall emergent vegetation (eg. *Eleocharis, Typha*) *Melaleuca* swamps, watercourses and reservoirs (Marchant and Higgins 1990). Builds a large, bulky stick platform often within a large tree offering a commanding view of the surrounding area but occasionally on low shrubs or on ground; usually but not always in wetlands (Frith 1976; Marchant and Higgins 1990).	Limited	Limited	✓	✓	×	×	×

Table 6.1.1 - Distribution, key habitat requirements and habitat assessment for threatened species of the local area.

Common Name Scientific Name	Distribution in NSW	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Great Knot *Calidris tenuirostris*	This species has been recorded in scattered sites along the coast to about Narooma. The species has also been observed inland at Tullakool Evaporation Ponds, Armidale, Gilgandra and Griffith (NPWS 1999b).	Sheltered coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons (NPWS 1999b). Individuals have often been recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms. A small proportion of individuals have also been sighted in inland fresh and salt water lakes (NPWS 1999b).	No	No	×	×	×	×	×
Osprey *Pandion haliaetus*	Coast and inland rivers. Is distributed around almost the entire coastline, sometimes inland on rivers and lakes (Debus, 1998).	Is often located in coastal areas, especially along lagoons, rivers, and watercourses where it perches in prominent locations overlooking foraging areas. Ospreys forage mainly for fish, but occasionally take crustaceans, reptiles, small mammals, or birds (Debus, 1998).	Limited	Limited	✓	×	×	×	×
Square-tailed Kite *Lophoictinia isura*	Endemic to Australia being widespread but sparsely distributed throughout the mainland. In NSW scattered records occur throughout the state indicating the Square-tailed Kite is a regular resident on the north, north-east along the Barwon, Culgoa, Darling and Murray Rivers and in the Paroo (NPWS 1999c).	Ridge and gully forests dominated by woollybutt (*Eucalyptus longifolia*), spotted gum (*Corymbia maculata*) and peppermints (*E.elata* & *E.smithii*) (Marchant and Higgins 1993). During breeding season female roosts on nest at night while male roosts in nearby live tree (Marchant and Higgins 1993).	No	No	×	×	×	×	×

Table 6.1.1 - Distribution, key habitat requirements and habitat assessment for threatened species of the local area.

Common Name Scientific Name	Distribution in NSW	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Wompoo Fruit-dove *Ptilinopus magnificus*	Australia has three discrete populations along the east coast: from central eastern New South Wales to central eastern Queensland; north-eastern Queensland; and northern Cape York Peninsula. It is more common and abundant in northern parts of its range (Australian Museum, 2003).	Mainly occurs in large undisturbed patches of tall tropical or subtropical rainforest but occasionally occur in patches of monsoon forest, closed galley forest, wet sclerophyll forest, tall open forest, open woodland or vine-thickets near rainforest (Higgins and Davies 1996). They generally forage in dense canopy of large rainforest trees and, occasionally, in lower strata; occasionally forage in nearby open forest, woodland or deciduous vine-thickets (Higgins and Davies 1996). Little is known about the movements of the species however it is thought the birds do not travel large distances, but move around in small, localised areas in search of fruit-bearing trees. They breed in the middle strata of dense rainforest building a frail, flat or slightly concave nest consisting of a few thin sticks or twigs, intermingled and lined with vine tendrils (Higgins and Davies 1996).	No	Very Limited	×	×	×	×	✓
Painted Snipe *Rostratula benghalensis australis*	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowal, Macquarie Marshes and Hexham Swamp, although is most common in the Murray-Darling basin (Smith 1991; Garnett 1992; NPWS 1999).	Inhabits inland and coastal shallow freshwater wetlands (Smith 1991). The species occurs in both ephemeral and permanent wetlands, particularly where there is a cover of vegetation, inciuding grasses, Lignum and Samphire (Smith 1991). Individuals have also been known to use artificial habitats, such as sewage ponds, dams and waterlogged grassland (Marchant & Higgins 1993).The Painted Snipe nests on the ground amongst tall vegetation, such as grass tussocks or reeds. Nests are often located on small islands (Marchant & Higgins 1993). The nest consists of a scrape in the ground, lined with grass and leaves (Pringle 1987).	Limited	Limited	✓	×	×	×	×

Table 6.1.1 - Distribution, key habitat requirements and habitat assessment for threatened species of the local area.

Common Name Scientific Name	Distribution in NSW	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Terek Sandpiper *Xenus cinereus*	The Terek Sandpiper is a non-breeding migratory visitor to Australia. Breeding occurs south of the Arctic from southern Finland to north-eastern Siberia (Higgins and Davies 1996). When visiting Australia, from August to April, the species ranges along the west, north and east coasts. Individuals have been infrequently sighted on the southern Australian coast and inland, being far more common in northern Australia (Higgins and Davies 1996).	Recorded on coastal mud-flats, lagoons, creeks and estuaries. Records indicate that the species favours muddy beaches near mangroves but may also be observed on rocky pools and coral reefs and occasionally up to 10km inland around brackish pools (Higgins and Davies 1996; NPWS 1999d).	No	No	×	×	×	×	×
Greater Sand-plover *Charadrius leschenaultia*	Coastal areas	Wide sandy and shelly beaches, tidal areas, mudflats and is seldom found far inland.	No	No	×	×	×	×	×
Lesser Sand-plover *Charadrius mongolus*	Coastal areas	Tidal mudflats, sandy beaches & estuaries	No	No	×	×	×	×	×
Blue-billed Duck *Oxyura australis*	Breeding occurs in the Murray-DarlingBasin and has been recorded from WillandraCreek, other tributary creeks of the Lachlan River, Narran Lake and in Lignum swamps of the Paroo (Pizzey 1991). Within the species range, new areas of suitable habitat are readily colonised following floods (Frith1982).	The species favours deep, permanent, well vegetated freshwater swamps, especially those with beds of Cumbungi Typha species (Frith 1982). Daylight hours are spent alone in small, concealed bays within vegetation or communally in large exposed rafts far from shore (Smith et al. 1995).	No	No	×	×	×	×	×
Magpie Goose *Anseranas semipalmata*	The Magpie Goose occurs in coastal areas of northern Australia. But they travel throughout Australia during the dry season. Formerly bred along the Murrumbidgee & Lachlan Rivers. Some introductions in the southern areas but still remains a rare vagrant in NSW.	The Magpie Goose (Pied Goose) is restricted to terrestrial wetlands, predominantly in monsoonal regions, with the presence of surface water and food being the principal determinants of the species' distribution. Documented habitat includes extensive wetlands especially with dense rushes; sedges; black-soil food plains (both wet & dry); wet grasslands, (Seventy, V.N. (ed), 1995). Also utilises wet grasslands and floodplains and, during the dry season, dry floodplains.	No	Limited	✓	✓	×	×	×

Table 6.1.1 - Distribution, key habitat requirements and habitat assessment for threatened species of the local area.

Common Name Scientific Name	Distribution in NSW	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Little Tern *Sterna albifrons*	The Little tern is found across the Indo-pacific region. Northern and eastern coastal areas of Australia from Derby (WA) to the Bass Strait and South Australia (Kippell, 1992). The species is restricted to the coast fringe of NSW.	Breeds in NSW on sandy islands and beaches. Documented habitat includes coastal waters, bays, shallow inlets and salt or brackish lakes (Kippell, 1992). Breeding occurs on undisturbed, un-vegetated sites near estuaries & adjacent to freshwater lakes, islands & coral cays (Garnett, S., 1992a).	No	No	×	×	×	×	×
Freckled Duck *Stictonetta naevosa*	Endemic to SE & SW Aust. occurring as a vagrant elsewhere eg. coastal areas in drought	The Freckled Duck is found in lentic freshwaters. Waterbodies of various salinity are used usually with dense swamps of lignum, cane grass or paperbark (Klippel, 1992). Typically in extensive dense perm. cumbungi & lignum swamps: also large open lakes & their shores or those areas inundated by floodwaters, (Seventy, V.N. (ed), 1990)	No	No	×	×	×	×	×
Comb-crested Jacana *Irediparra gallinacean*	Occurs from coastal & subcoastal N & E Australia, W to Kimberleys & SE to Hawkesbury River, NSW where it is irregularly observed. On deeper permanent still freshwater swamps ponds billabongs is moderately abundant (Schodde, R. & Tidemann, S.C. , 1990) Occasionally recorded well inland Mudgee: Mt Isa & Bermagui (Marchant, S. and Higgins, P.J. (Editors), 1993).	Inhabits freshwater wetlands, lagoons, swamps, lakes, rivers & reservoirs (deep or shallow water) generally with abundant floating aquatic vegetation: often flat-leaved plants such as water lillies. Sometimes on grass & weeds & on mud or sand banks (Marchant, S. and Higgins, P.J. (Editors), 1993). Breeds in swamps, lagoons, large dams, reservoirs, lakes; on floating or emergent vegetation usually water-lily *Nymphaea* (Marchant, S. and Higgins, P.J. (Editors), 1993).	No	Limited	✓	✓	×	×	×
Turquoise parrot *Neophema pulchella*	The Turquoise Parrot occurs from the eastern coast and ranges from Nambour (Qld) to Canberra. Also areas of the upper Murray valley (Klippel, 1992). In NSW the species principally the western slopes & hills. Also occurs NE NSW. Documented from Richmond, Clarence & Hunter valleys, (Gilmore, A & Parnaby, H., 1994). E NSW-SE Qld & along upper reaches Murray R.	Lives on the edges of eucalypt woodland where it has access to grassy areas, particularly in sheltered valleys amongst rocky hills (Klippel, 1992). Occur in woodlands & dry sclerophyll forests (Gilmore, A & Parnaby, H., 1994).	No	No	×	×	×	×	×

Table 6.1.1 - Distribution, key habitat requirements and habitat assessment for threatened species of the local area.

Common Name Scientific Name	Distribution in NSW	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Powerful Owl *Ninox strenua*	Coast and ranges. Distribution Limits - N-Border Ranges National Park. S-Eden.	Wet or dry sclerophyll forest with mature trees. Roost and breeding trees usually in densely vegetated gullies. Require a large home range (800-1000 ha). Powerful Owl is the largest of Australia's owls (Debus & Chafer 1994). It feeds on larger arboreal mammals, megabats, and other fauna captured in trees. It forages mostly in open forests and typically roosts in tall trees in moist gullies. It nests in a very large hollow, typically in large tree in a moist gully. Pairs maintain and hunt throughout a home range that may be up to 1000 ha. (Garnett 1992, Fleay 1944).	No	Limited	×	×	×	×	✓
THREATENED AMPHIBIANS									
Green and Golden Bell Frog *Litoria aurea*	The distribution ranges through the coastal lowland areas of eastern NSW from approximately 50 km south of the NSW Queensland border and extending south into northeast Victoria. Within the local area the 2HD Swamp has been identified as an area of core habitat for the species.	A study by Pyke and White (1996) suggested that the habitat requirements for Green and Golden Bell frogs include the following features. Grassy areas close to water bodies and other vegetation should be a woodland or lower in maximum height. The substrate of the pond should be sand or rock, with waterbodies being still, shallow, ephemeral and unpolluted. The shape of waterbody should be shallow at one end (10-15cm) and deep at the other (0.5-1m). The waterbodies should be unshaded and free of predatory fish such as Gambusia, with aquatic plants present (e.g. *Typha* spp.) with a range of possible diurnal shelter sites available including vegetation and rocks.	Limited	Yes	✓	✓	×	×	×
THREATENED MARSUPIALS									
Koala *Phascolarctos cinereus*	Patchily distributed throughout coast, ranges and western slopes, but concentrated on north coast.	Eucalypt forest and woodland on higher nutrient soils. Although the Koala feeds on a range of tree species, a small number of eucalypt species provide its staple diet.	Very Limited	Very Limited	×	×	×	×	×

Table 6.1.1 - Distribution, key habitat requirements and habitat assessment for threatened species of the local area.

Common Name Scientific Name	Distribution in NSW	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Squirrel Glider *Petaurus norfolcensis*	Patchily distributed along ranges, western slopes, and the coast north of Sydney.	Eucalypt forest or woodland with mature or mixed-age trees, with a variety of species. The presence of winter-flowering species appears to be important.	No	Yes	×	×	×	×	×
THREATENED FLYING MAMMALS									
Grey-headed Flying-fox *Pteropus poliocephalus*	North to south coast	Their natural diet consists of fruits from rainforest trees, and nectar from nectiferous trees, such as Swamp Mahogany. Roost and breed in large 'camps' that are most often located in rainforests or other dense-canopied forests.	No	Limited	×	×	×	×	✓
Eastern Freetail-bat *Mormopterus norfolkensis*	*Mormopterus norfolkensis* is thought to be 'uncommon' and distributed east of the Great Dividing range to the coastline, and ranging in latitude from Picton (New South Wales) in the south, as far north as south-east Queensland (DEH, 1999). Most recent records come from north-eastern New South Wales (Parnaby 1992, Gilmore and Parnaby 1994 cited in DEH 1999).	*Mormopterus norfolkensis* is a tree-dwelling (Allison & Hoye, 1995) insectivorous bat which is often located in dry eucalypt forest and coastal woodlands, although individuals have also been captured within riparian zones, wet sclerophyll and rainforest (Allison & Hoye, 1995). They forage above the canopy or in unobstructed corridors in open areas (Strahan, 1995) on either winged or wingless ants (Allison, 1989). Roost together in small colonies in hollows or under loose bark (Australian Museum, 2004).	No	Yes	×	×	✓	✓	✓
Little Bentwing-bat *Miniopterus australis*	Coast north of the Central Coast	Little Bent-wing Bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel 100s km from feeding home ranges to breeding sites. (Law 1996, Wilson P. 1982)	No	Yes	×	×	✓	✓	✓

Table 6.1.1 - Distribution, key habitat requirements and habitat assessment for threatened species of the local area.

Common Name Scientific Name	Distribution in NSW	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis*	Coast and ranges	Forages above dry and moist forest, and can be found on edges of urban areas. Roost in caves, in old mines, in tunnels, under bridges, or in similar structures. Specific maternity caves are used by females during summer to give birth.	No	Yes	×	×	✓	✓	✓
Large-footed Myotis *Myotis adversus*	*Myotis adversus* is known to be distributed along the east coast of Australia, along the top of Queensland, the Northern Territory and north-western Australia. Sites inhabited are usually far between, and as such it is regarded as sparse in Australia (State Forests of NSW, 1995).	Large-footed Myotis are small bats that live in caves, tunnels, under bridges and in trees in eastern and northern Australia. They are about 5 cm long with a grey-brown back and grey belly. They have very large feet to help them catch insects from the water and narrow wings to help them fly fast. Large-footed Myotis hunt for food at night. They fly over creeks and rake their clawed hind feet through the water to catch fish and insects. Lives in harems, usually with 8 females for every male (Dwyer, 1970a).	No	Yes	✓	✓	✓	✓	✓
Greater Broad-nosed Bat *Scoteanax rueppellii*	Predominantly coastal (altitudes under 500 metres) and less than 100km inland (Hoye & Richards, 1995)	The Greater Broad-nosed bats are found in a variety of habitats ranging from woodlands, to moist and dry eucalypt forest and rainforest (Hoye & Richards, 1995). They prefer open habitats in which they can fly straight and direct and are known to utilise artificial openings in forests, with their favoured habitats being river and creek corridors (Hoye & Richards, 1995). Individuals have been recorded roosting in tree hollows, cracks and fissures in the trunk and boughs of stags, and under exfoliating bark. A recent study on the north coast of NSW by Campbell (2001) found roost habitat occurred in a Melaleuca swamp woodland habitat (Wallum) in areas of low relief.	No	Yes	×	×	✓	✓	✓

Table 6.1.2 - Distribution; key habitat requirements and habitat assessment of investigation area for migratory and marine species known to occur in t

Common Name Scientific Name	Distribution in Australia	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Latham's Snipe *Gallinago hardwickii*	Non-breeding visitor to the SE of Australia. In NSW they are scattered from the coast to west of the Great Divide. They often found south of the Hunter River, but are migrant to the north and occasionally occur on plains and inland rivers (Marchant & Higgins, 1993).	Occur in a wide variety of ephemeral and permanent wetlands which have cover (e.g. meadows) nearby in which they can hide. They forage in soft mud or shallow water on seeds, worms, spiders and insects. Roost during the day in dense vegetation or under trees near the feeding areas (Marchant & Higgins, 1993).	Limited	Limited	✓	✓	✓	✓	✓
Garganey *Anas querquedula*	Summer visitor of wetlands	Freshwater wetlands, swamps, shallow lakes, flooded grasslands, floodplains, sewage farms.	No	Limited	✓	✓	×	×	×
Cattle Egret *Ardeola ibis*	Arrived in N Australia about 1950 and has spread to SW, SE and Tas. Common in N Australia, population expanding in S.	Moist pastures with tall grass; shallow open wetlands and margins, mudflats.	No	Limited	✓	✓	×	×	×
Great Egret *Egretta alba*	Common and widespread throughout Australia in any suitable permanent or temporary habitat.	Wetlands, flooded pastures, dams, estuarine mudflats, mangroves and reefs.	No	Yes	✓	✓	×	×	×
Great Knot *Calidris tenuirostris*	This species has been recorded in scattered sites along the coast to about Narooma. The species has also been observed inland at Tullakool Evaporation Ponds, Armidale, Gilgandra and Griffith (NPWS 1999b)	Sheltered coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons (NPWS 1999b). Individuals have often been recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms. A small proportion of individuals have also been sighted in inland fresh and salt water lakes (NPWS 1999b).	No	No	×	×	×	×	×
Glossy Ibis *Plegadis falcinellus*	Common across coastal N, generally uncommon elsewhere; nomadic.	Shallows of swamps, floodwaters and sewage ponds, flooded or irrigated pastures. More often found concentrated along inland river systems and inland swamps, than on the coast.	Yes	Yes	✓	✓	×	×	×

Table 6.1.2 - Distribution; key habitat requirements and habitat assessment of investigation area for migratory and marine species known to occur in t

Common Name Scientific Name	Distribution in Australia	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Terek Sandpiper *Xenus cinereus*	The Terek Sandpiper is a non-breeding migratory visitor to Australia. Breeding occurs south of the Arctic from southern Finland to north-eastern Siberia (Higgins and Davies 1996). When visiting Australia, from August to April, the species ranges along the west, north and east coasts. Individuals have been infrequently sighted on the southern Australian coast and inland, being far more common in northern Australia (Higgins and Davies 1996).	Recorded on coastal mud-flats, lagoons, creeks and estuaries. Records indicate that the species favours muddy beaches near mangroves but may also be observed on rocky pools and coral reefs and occasionally up to 10km inland around brackish pools (Higgins and Davies 1996; NPWS 1999d).	No	No	×	×	×	×	×
Broad-billed Sandpiper *Limicola falcinellus*	The Broad-billed Sandpiper is a non-breeding migratory visitor to Australia. Breeding range is poorly known however records occur in Scandinavia and scattered locations throughout Russia (Higgins and Davies 1996). In Australia it is most common on north and north west coasts however it is regularly recorded scattered throughout south. In NSW it is a regular visitor in small numbers in coastal areas from Ballina south to Shoalhaven Heads with highest densities recorded at Kooragang Island (Higgins and Davies 1996).	In Australasia prefers sheltered parts of coast, such as estuaries, harbours, embayments and lagoons, with large soft intertidal mudflats which may have shell or sandbanks nearby. Occasionally on reefs and rocky platforms and near coastal sewerage ponds and saltworks; lagoons, creeks, swamps, sand exposed by receding water (Higgins and Davies 1996). Forage on exposed flats of soft mud or wet sand at edges of coastal and near-coastal wetlands, often round channels on mudflats or in accumulated mud in swales between shell banks (Higgins and Davies 1996).	No	No	×	×	×	×	×
White-bellied Sea Eagle *Haliaeetus leucogaster*	Found across coastal and inland eastern Australia	It is found around rivers, dams, inland rivers and coastal areas. It builds large nests in tall live trees, usually near water.	Limited	Yes	✓	✓	✓	✓	✓
Sharp-tailed Sandpiper *Calidris acuminata*	Wide spread through out Australia's coastal and wetland habitats. Migrates annually from north-eastern Siberia to Australia where it occupies freshwater wetlands and coastal areas during the non-breeding season (mid-September to late February). About 40 000 birds arrive in NSW each year.	Prefer muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation; including lagoons, swamps, lakes and pools near coast; and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland (Higgins and Davies 1996).	No	No	×	×	×	×	×

Table 6.1.2 - Distribution; key habitat requirements and habitat assessment of investigation area for migratory and marine species known to occur in t

Common Name Scientific Name	Distribution in Australia	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Curlew Sandpiper *Calidris ferruginea*	Breed mainly high Arctic. Scattered records in Gulf of Carpentaria, between Massacre Inlet and Torres Strait between Torres Strait and Cairns, recorded only from Quintell Beach, Iron Range; widespread along coast S of Cairns. Inland, sparsely scattered records, including regular sightings around Mt Isa. In NSW, widespread east of Great Dividing Range, especially in coastal regions (Higgins and Davies 1996).	In Australasia mainly intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons near coast, and ponds in saltworks and sewage farms (Higgins and Davies 1996).	No	No	×	×	×	×	×
Red-necked Stint *Calidris ruficollis*	Breed NE Siberia and sporadically in N and W Alaska. Most common Palaearctic wader in Australia. Widespread; recorded all coastal regions, with sporadic inland records from all States; mainly inland records in S NSW, Vic and E SA not of transient birds; other inland records probably birds on passage (Higgins and Davies 1996).	In Australasia, mostly coastal, in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats; often near spits, islets and banks; sometimes on protected sandy or coralline shores. Occasionally on exposed or ocean beaches, sometimes on stony or rocky shores, reefs or shoals. Also occur in saltworks and sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats (Higgins and Davies 1996).	No	No	×	×	×	×	×
Bar-tailed Godwit *Limosa lapponica*	Breed N Scandinavia, Russia and NW Alaska. Scattered records in Gulf of Carpentaria; widespread Torres Strait; recorded Iron Range; widespread along E and SE coasts, including offshore islands, S from Cooktown to Port Phillip Bay. Few inland records in NSW and Vic (Higgins and Davies 1996).	Mainly coastal on large intertidal sandflats, spits and banks, and, less often, mudflats, estuaries, inlets, harbours, coastal lagoons and bays; often round beds of seagrass and sometimes in nearby saltmarsh. Also, coastal sewage farms and saltworks; sandy ocean beaches, rock platforms and coral reef flats (Higgins and Davies 1996).	No	No	×	×	×	×	×

Table 6.1.2 - Distribution; key habitat requirements and habitat assessment of investigation area for migratory and marine species known to occur in t

Common Name Scientific Name	Distribution in Australia	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
Common Greenshank *Tringa nebularia*	Breed Eurasia. Most widespread scolopacid in Australia with Atlas records in 39% of all 1 degree blocks (Higgins and Davies 1996). Widespread in Gulf Country and E Gulf of Carpentaria; recorded most coastal regions. In NSW recorded in most coastal regions, widespread W of Great Divide, especially between Lachlan and Murray Rivers, the Darling River drainage basin, including Macquarie Marshes and NW regions (Higgins and Davies 1996).	Occur in a wide variety of inland wetlands and sheltered coastal habitats, of varying salinity. Occur in sheltered coastal habitats, typically with large mudflats, and saltmarsh, mangroves or seagrass, including embayments, harbours, river estuaries, deltas and lagoons. Frequently utilises permanent or ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats; also use artificial wetlands, including sewage farms and saltworks dams inundated rice crops and bore drains (Higgins and Davies 1996).	No	Limited	✓	×	×	×	×
Marsh Sandpiper *Tringa stagnatilis*	Breed from E Europe to E Siberia. Recorded in all regions of NSW, sparsely distributed on N coast; more widespread around central and S coasts (Higgins and Davies 1996).	Permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats; also regularly at sewage farms and saltworks (Higgins and Davies 1996).	No	No	×	×	×	×	×
Fork-tailed Swift *Apus pacificus*	Common migrant throughout Australia, mostly west of the Great Divide. Widespread non-breeding visitor. Recorded more frequently in closely settled areas, such as SE Queensland, coastal NSW and S Vic where more observers present which may distort picture of true distribution and abundance (Higgins and Davies 1996).	Almost exclusively aerial from <1m to at least 300m and probably much higher. In Australia, mostly over inland plains but sometimes above foothills or in coastal areas. Mostly over dry or open habitats including: riparian woodland and tea-tree swamps; low scrub, heathland or saltmarsh; treeless grassland and sandplains covered with Spinifex; open farmland; and inland and coastal sand-dunes (Higgins and Davies 1996).	No	Yes	✓	✓	✓	✓	✓

Table 6.1.2 - Distribution; key habitat requirements and habitat assessment of investigation area for migratory and marine species known to occur in t

Common Name Scientific Name	Distribution in Australia	Preferred habitat	Habitat Present		Map Unit				
			Breeding	Foraging	1	2	3a	3b	4
White-throated Needletail *Hirundapus caudacutus*	Breed throughout Asia. Widespread in E and SE. In NSW widespread on E of Great Divide.	Almost exclusively aerial in Australasian region from < 1m to > 1000m. Occur over most types of habitat but prefer wooded areas, including open forest and rainforest. Less often above treeless areas such as grassland, swamps or farmland (Higgins and Davies 1996). Almost always forage aerially; over wide variety of habitats, from open areas (clearings, pasture, heathland or mudflats), to above canopy of forests (Higgins and Davies 1996).	No	Yes	✓	✓	✓	✓	✓
Swamp Harrier *Circus approximans*	Mostly SE and SW Australia, S of Fraser Island, Qld, to Streaky Bay SA, and from Israelite Bay to near Perth, WA. Regular winter visitor to N regions (Higgins and Davies 1996).	Terrestrial wetlands and open country of tropical and temperate Australia and NZ. Mainly confined to wetlands, fresh or salt; often deep swamps with tall emergent vegetation of rush, reeds or sedge (*Phgragmites, Typha, Scirpus, Eleocharis, Juncus, Baumea*) and areas of open water. Other habitats include shallow open swamps; swamps with other emergent vegetation (eg. *Eragrostis, Lepidosperma*); wooded swamps (e.g. casuarina); freshwater meadows; open, shrubby wooded lakes; billabongs; reservoirs; sewage ponds; saltpans and saltfields (Higgins and Davies 1996).	Yes	Yes	✓	✓	×	×	×

6.2 Assessment Results

Based on the analysis presented in Table 6.1.1, 19 threatened species were identified as likely to utilise the types of habitats provided by the study area for foraging and/or breeding. Based on the analysis presented in Table 6.1.2, 10 migratory species were identified as likely to occur in the types of habitats provided by the study area. Species identified in previous sections for which the study area does not provide potential habitat will not be considered any further in this report. Table 6.2 provides a list of the species which need to be assessed in this report owing to the existence of potential habitat within the study area. While Table 6.1.1 indicates that there is potential foraging habitat for Squirrel Glider within forest remnants in the study area, the lack of tree hollows and isolation of these remnants indicate that Squirrel Glider is highly unlikely to occur in the study area. For this reason it is not considered necessary to assess Squirrel Glider in this report.

Table 6.2 - Significant species identified as likely to occur in the study area.

Common Name	Scientific Name	Legal Status
FLORA		
Magenta Lilypily	*Syzygium paniculatum*	V (TSC Act); V (EPBC Act)
	Zannichellia palustris	E (TSC Act)
AMPHIBIANS		
Green and Golden Bell Frog	*Litoria aurea*	E (TSC Act); V (EPBC Act)
BIRDS		
Black-necked Stork	*Ephippiorhynchus asiaticus*	E (TSC Act)
Wompoo Fruit-Dove	*Ptilinopus magnificus*	V (TSC Act)
Osprey	*Pandion haliaetus*	V (TSC Act);
Powerful Owl	*Ninox strenua*	V (TSC Act)
Australasian Bittern	*Botaurus poiciloptilus*	V (TSC Act)
Black Bittern	*Ixobrychus flavicollis*	V (TSC Act)
Painted Snipe	*Rostratula benghalensis australis*	E (TSC Act); M (CAMBA)
Magpie Goose	*Anseranas semipalmata*	V (TSC Act)
Comb-crested Jacana	*Irediparra gallinacean*	V (TSC Act)
Latham's Snipe	*Gallinago hardwickii*	M (CAMBA)
Garganey	*Anas querquedula*	M (CAMBA; JAMBA)
Great Egret	*Egretta alba*	M (CAMBA)
Cattle Egret	*Ardeola ibis*	M (CAMBA; JAMBA)
Glossy Ibis	*Plegadis falcinellus*	M (CAMBA)
White-bellied Sea Eagle	*Haliaeetus leucogaster*	M (CAMBA)
Common Greenshank	*Tringa nebularia*	M (CAMBA; JAMBA)
Fork-tailed Swift	*Apus pacificus*	M (CAMBA; JAMBA)
White-throated Needletail	*Hirundapus caudacutus*	M (CAMBA)
Swamp Harrier	*Circus approximans*	M (EPBC Act)
MAMMALS		
Koala	*Phascolarctos cinereus*	V (TSC Act)
Grey-headed Flying-fox	*Pteropus poliocephalus*	V (TSC Act); V (EPBC Act)
Eastern Freetail-bat	*Mormopterus norfolkensis*	V (TSC Act)
Little Bent-wing Bat	*Miniopterus australis*	V (TSC Act)
Eastern Bent-wing Bat	*Miniopterus schreibersii oceanensis*	V (TSC Act)
Large-footed Myotis	*Myotis adversus*	V (TSC Act)
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V (TSC Act)

7.0 Significant Areas

As noted above, Hexham Swamp and the Market Swamp are coastal wetlands covered by SEPP 14 and as such these wetlands are conferred as State significant (see Figure 3). The investigation area does not occur within mapped SEPP 14 boundaries. While the wetlands within the investigation area are strictly not defined as State significant under SEPP 14, they still provide habitat for significant local species and as such have local importance. The impact of the action on these wetlands has been fully assessed by this report.

PART D
IMPACT ASSESSMENT & MITIGATION

8.0 Potential Impacts on Flora and Fauna

8.1 Impact Assessment and Mitigation for Significant Flora

The proposed action would require the filling of approximately 2.5 hectares of disturbed wetland surrounding Deep Bridge Creek and adjacent to Sandgate Cemetery (Figure 8). The area to be filled comprises disturbed reedland vegetation, with exotic weeds interspersed. Approximately 2.5 hectares of vegetation dominated by exotic weed species would also require removal (Figure 8). This vegetation is floristically very disturbed but may still provide important habitat for significant fauna species. Some small patches of forest vegetation would also require removal, comprising approximately 3500m^2 of Swamp Oak Forest (Map Unit 3a), 1000m^2 of Eucalypt Forest (Map Unit 5) and 2000m^2 of Paperbark – Hard Quandong Forest (Map Unit 4).

Apart from the direct loss of vegetation, there would also be a loss of fauna habitats provided by this type of vegetation. The loss of this habitat would reduce the total area of these habitat types in the local area, albeit by a small amount. A separate impact assessment is given in Section 8.2 for threatened fauna species.

The direct impacts of the proposed action would be relatively minor; however they would contribute to the cumulative loss of wetland in the local area and thus need to be ameliorated. Accordingly, the proposed action includes measures to offset these losses. Any activity in close proximity to a natural area has the potential to result in indirect impacts on the natural area. In the case of the proposed action, these impacts are most likely to be associated with the construction phase, and include accidental intrusion of plant or material into the wetland beyond the identified impact area, and spills of hydrocarbons and other fluids that may flow into the wetlands. An environmental management plan would be prepared for works which would include measures to mitigate these potential impacts. Such measures would need to be best practice given the sensitivity of the environments. Ongoing indirect impacts would be minor and no greater than the existing conditions.

The overall impacts of the proposed action on flora and fauna and mitigation measures designed to ameliorate these impacts are detailed in Table 8.1 and Table 8.2.

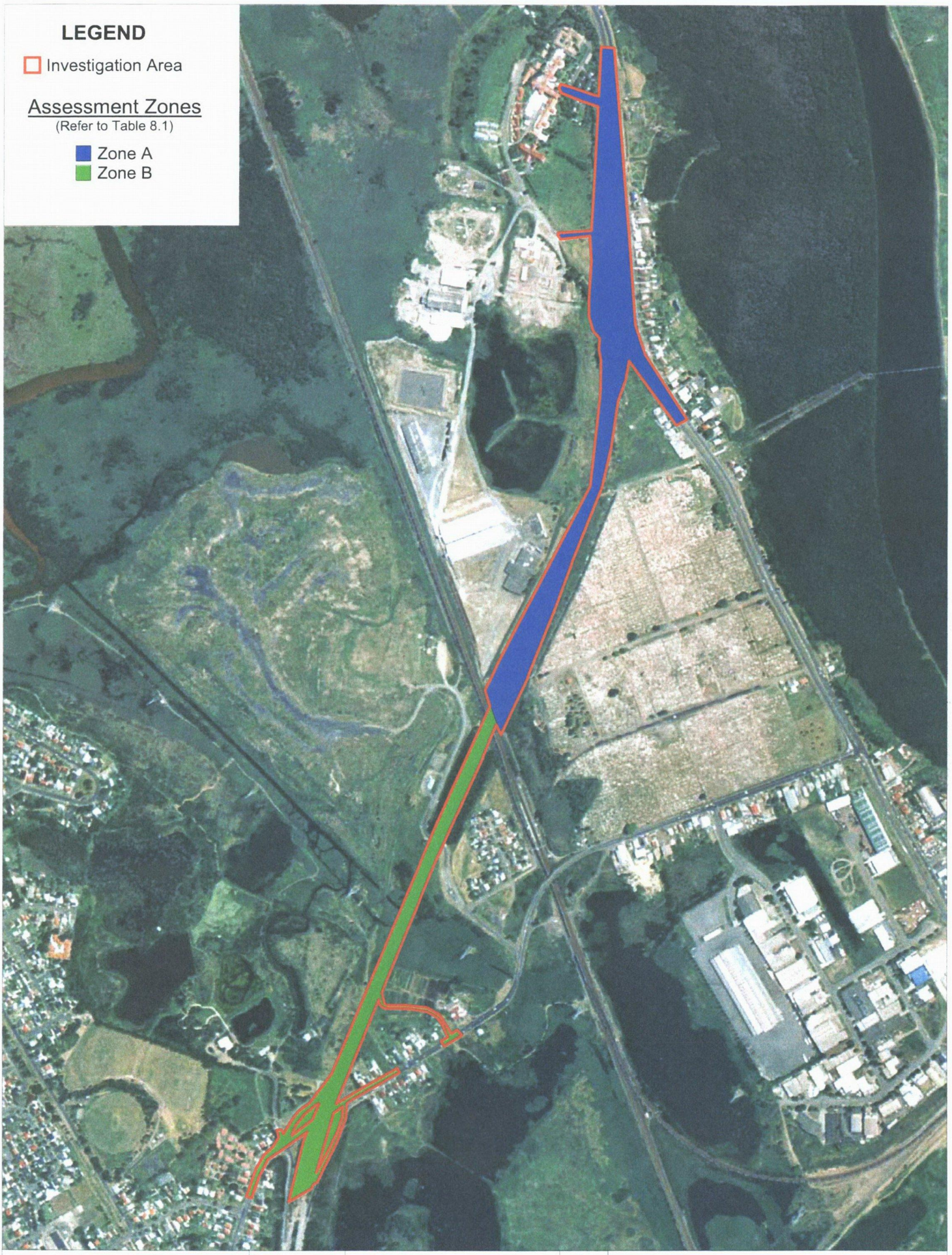
Table 8.1 – Impact Assessment and Mitigation for Vegetation.

Zone*	Zone Attributes	Possible Ecological Impacts	Mitigation measures
A	This zone comprises the northern half of the investigation area, and comprises all areas north of the Main Northern Railway. Most of this zone is low lying comprising reedland vegetation adjacent to Sandgate Cemetery and other less swampy areas dominated by exotic flora. The 2HD Swamp is located to the immediate west of the investigation area, and is recognised as being important habitat for Green and Golden Bell Frog, and threatened bird species including Australasian Bittern and Magpie Geese.	Approximately 2ha of reedland (an EEC) would require filling for the proposed development, and an embankment is required to be built in this area for the crossing of the Main Northern Railway. Approximately 1.2ha swampy areas containing exotic weeds also require removal. This vegetation may provide secondary habitat for Green and Golden Bell Frogs dispersing from the 2HD Swamp. As well as habitat for a range of threatened and migratory bird species in the local area.	Alternative areas of habitat should be created adjacent to the proposed highway, comprising pond areas containing a mix of reeds and open water, as well as forested areas including Swamp Oaks and native species from map units 4 and 5. Seeds should be collected from native species present within all vegetation layers of map units 1, 2, 3, 4 & 5 for use in landscaping / restoration activities, some form of connectivity for dispersing Green and Golden Bell Frogs and other fauna should also be considered. The construction phase should implement best-practice sediment and erosion controls, and be managed to ensure no additional volumes of sediments and water flow into adjacent wetland areas. The construction phase should be managed to ensure no accidental incursions into wetland and forest areas outside of the investigation area Immediately prior to the initiating of the construction phase, surveys for Green and Golden Bell Frog should be conducted and any found should be relocated to adjacent habitats An ecologist to be on site during the removal of any vegetation, and any fauna and/or habitat elements relocated into adjacent areas of habitat. Develop and implement environmental management plans for the above mitigation measures
	There is a small remnant of forest vegetation containing Forest Red Gums (*Eucalyptus tereticornis*) as well as a number of flora species associated with lowland and littoral rainforest areas, including Flintwood (*Scolopia braunii*), Hard Quandong (*Elaeocarpus obovatus*), Cockspur Thorn (*Maclurra cochinchinensis*) and Whalebone Tree (*Streblus brunonianus*).	The removal of approximately 0.3ha of forest vegetation with affinities to a number of EECs would have direct impacts on an EEC, as well as removing a small area of vegetation for highly mobile species that utilise forested areas including Grey-headed Flying Fox, and nectar and fruit eating Microbat and Bird species. There was no hollow bearing trees or other significant habitat attributes within this area. There are some areas of dense vegetation that would provide suitable roosting/nesting for some fauna species.	

Table 8.1 – Impact Assessment and Mitigation for Vegetation.

Zone*	Zone Attributes	Possible Ecological Impacts	Mitigation measures
	A small area of Swamp Oak Forest near the Main northern Railway would require removal	This community is classed as an EEC under the TSC Act. Apart from the direct impacts of removing an EEC, there would be a small loss of habitat for threatened fauna in the local area that utilise this type of forest.	
B	This zone comprises the southern half of the investigation area. Most of this zone is low lying comprising reedland vegetation (2.4ha) surrounding Deep Bridge Creek and other less swampy areas dominated by exotic flora (2.7ha). The Shortland Wetlands Centre is located to the immediate west of the investigation area, and is recognised as being important habitat for a range of threatened and migratory bird species. There is a small remnant of Swamp Oak forest vegetation approximately 0.35ha on the northern side of Deep Bridge Creek that would require removal.	Approximately 0.4ha of reedland would require filling for the proposed development. Approximately 1.4ha of swampy areas containing exotic weeds also require removal. This vegetation may provide secondary habitat for Green and Golden Bell Frogs dispersing from adjacent wetland areas, as well as habitat for a range of threatened and migratory bird species in the local area. SEPP14 wetland areas exist to the east of this section including Market Swamp and Newcastle Wetlands Reserve. This community is classed as an EEC under the TSC Act. Apart from the direct impacts of removing an EEC, there would be a small loss of habitat for threatened fauna in the local area that utilise this type of forest.	Alternative areas of habitat should be created adjacent to the proposed highway, comprising pond areas containing a mix of reeds and open water, as well as Swamp Oak forest. Seeds should be collected from native species present within all vegetation layers of map units 1, 2, & 3 for use in landscaping / restoration activities The construction phase should implement best-practice sediment and erosion controls, and be managed to ensure no additional volumes of sediments and water flow into adjacent wetland areas The construction phase should be managed to ensure no accidental incursions into wetland and forest areas outside of the investigation area Immediately prior to the initiating of the construction phase, surveys for Green and Golden Bell Frog should be conducted and any found should be relocated to adjacent habitats An ecologist to be on site during the removal of any vegetation, and any fauna and/or habitat elements relocated into adjacent areas of habitat. Develop and implement environmental management plans for the above mitigation measures

* The investigation area was split into a northern zone (Zone A) and a southern zone (Zone B) at the main northern railway for ease of assessment (Figure 19).



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Scale	1 : 10000
Projection	MGA / GDA 94
Drafter	Andrew Carty
Prepared	25 May 2005
Last amended	29 November 2005

N

Assessment Zones

Figure 19

8.2 Impact Assessment and Mitigation for Significant Fauna

The proposed action would require the filling of approximately 2.5ha of freshwater wetland vegetation. The area to be lost comprises vegetation dominated by Common Reed (*Phragmites australis*) that is moderately to highly infested with weed species such as Black Berry (*Rubus fruiticosus*). Additionally there are some areas (approx. 2ha) of vegetation dominated by exotic species that are relatively swampy and may provide wetland type habitats for fauna species. Some small patches of forest vegetation would also require removal, comprising approximately 3500m^2 of Swamp Oak Forest (Map Unit 3a), 1000m^2 of Eucalypt Forest (Map Unit 5) and 2000m^2 of Paperbark – Hard Quandong Forest (Map Unit 4). The impact of vegetation loss on significant fauna species is discussed below.

The loss of vegetation within the investigation area represents a very small proportion of the regional distribution of these habitat types. Wetland vegetation in the local area comprises the Market Swamp (13ha), the 2HD Swamp (6ha), Newcastle Wetland Reserve (15ha) and Hexham Swamp (2500ha). The loss of 2.5ha of wetland vegetation comprises approximately 0.1% of wetland areas in the local area. With regards to the regional distribution of this community this proportion would be even smaller.

While these losses are relatively minor in terms of proportion, they still represent a loss of wetland in the local area, and contribute to the incremental loss of wetland area in New South Wales. Accordingly, the proposed action includes measures to offset these losses.

As discussed above, the proposed action would also require the removal of small patches of forest vegetation which would provide limited habitat for significant fauna species (refer to table 6.1.1 and 6.1.2). Forest communities within the study area are relatively isolated from other areas of forest and are highly disturbed. This limits the habitat opportunities for significant species such as Koala which would have difficulty immigrating into the study area. No hollow bearing trees were located during the survey period and as such the study area is unlikely to provide roosting habitat for hollow dependant fauna including arboreal mammals, microchiropteran bats and large forest owls.

Table 8.2 outlines the potential impacts of the proposed action on the threatened and migratory species which were identified as having suitable habitat within the investigation area. Measures to mitigate impacts are included for each species.

Table 8.2 – Impact Assessment and Mitigation for Significant Fauna

Species	Legal Status*	Possible Impacts	Mitigation Measures
		THREATENED AMPHIBIANS	
Green and Golden Bell Frog *Litoria aurea*	E (TSC Act); V (EPBC Act)	Loss of foraging habitat (map unit 7) where grassy habitat adjoins known Green and Golden Bell Frog population. Potential runoff from road works into Green and Golden Bell Frog habitat. Potential changes to hydrological regime to Green and Golden Bell Frog through infilling of land to raise height for road. Further isolation of known Green and Golden Bell Frog population Increased risk of collision with motor vehicles	Investigation area crosses actual foraging habitat but there is scope to position highway on high ground (as far east and north as possible) this may avoid habitat and minimise disturbance.
		THREATENED AND MIGRATORY BIRDS	
Australian Bittern *Botaurus poiciloptilus*	V (TSC Act)	Loss of 4ha of suitable habitat, comprising wetland areas where permanent water is present. Map unit 1 provides potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Black Bittern *Ixobrychus flavicollis*	V (TSC Act)	Loss of 4.1ha of suitable habitat, comprising wetland areas where permanent water is present and dense wetland vegetation occurs. Map units 1 & 2 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Black-necked Stork *Ephippiorhynchus asiaticus*	E (TSC Act)	Loss of 2.5ha of suitable habitat, comprising wetland areas where permanent water is present. Map units 1, 2 & 7 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Painted Snipe *Rostratula benghalensis australis*	E (TSC Act); M (CAMBA)	Loss of 4ha of suitable habitat, comprising wetland areas where permanent water is present. Map unit 1 provides potential foraging and nesting habitat. Map units 1, 2 & 7 provide potential foraging and nesting habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Latham's Snipe *Gallinago hardwickii*	M (CAMBA)	Loss of 10.8ha of suitable habitat, comprising wetland areas where permanent water is present, dense wetland vegetation, and cover of grasses occurs. Map units 1, 2 & 7 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Magpie Goose *Anseranas semipalmate*	V (TSC Act)	Loss of 10.8ha of suitable habitat, comprising wetland areas where permanent water is present, dense wetland vegetation, and grass areas where presence of surface water and food occurs. Map units 1, 2 & 7 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.

Table 8.2 – Impact Assessment and Mitigation for Significant Fauna

Species	Legal Status*	Possible Impacts	Mitigation Measures
Great Egret *Egretta alba*	M (CAMBA)	Loss of 10.8ha of suitable habitat, comprising wetland areas where permanent water is present, dense wetland vegetation, and grass areas where presence of water and food occurs. Map units 1, 2 & 7 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Cattle Egret *Ardea ibis*	M (CAMBA; JAMBA)	Loss of 10.8ha of suitable habitat, comprising wetland areas where permanent water is present, dense wetland vegetation, and grass areas where presence of water and food occurs. Map units 1, 2 & 7 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Glossy Ibis *Plegadis falcinellus*	M (CAMBA)	Loss of 10.8ha of suitable habitat, comprising wetland areas where permanent water is present, dense wetland vegetation, and grass areas where presence of water and food occurs. Map units 1, 2 & 7 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
White-bellied Sea Eagle *Haliaeetus leucogaster*	M (CAMBA)	Loss of 11ha of suitable habitat, comprising of suitable foraging areas in wetland areas where permanent water is present, dense wetland vegetation, and grass areas. Suitable roosting habitat in taller eucalypt forest away from the ocean. Map units 1, 2, 5 & 7 provide potential foraging and roosting habitat.	Minimise clearing required for proposed works.
Fork-tailed Swift *Apus pacificus*	M (CAMBA; JAMBA)	Loss of 11ha for roosting in map units 3a, 3b, 4, 5 & 6.	Minimise clearing required for proposed works.
Swamp Harrier *Circus approximans*	M (EPBC Act)	Loss of 10.8ha of suitable foraging habitat, comprising wetland areas where permanent water is present, dense wetland vegetation, and grass areas where presence of water and food occurs. Map units 1, 2 & 7 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely. Minimise clearing required for proposed works.
Tawny Grassbird *Megalurus timoriensis*	M (EPBC Act)	Loss of 4.1ha of suitable habitat, comprising wetland areas where permanent water is present and dense wetland vegetation occurs. Map units 1 & 2 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Little Grassbird *Megalurus gramineus*	M (EPBC Act)	Loss of 4.1ha of suitable habitat, comprising wetland areas where permanent water is present and dense wetland vegetation occurs. Map units 1 & 2 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Clamorous Reed Warbler *Acrocephalus stentoreus*	M (EPBC Act)	Loss of 4.1ha of suitable habitat, comprising wetland areas where permanent water is present and dense wetland vegetation occurs. Map units 1 & 2 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.

Table 8.2 – Impact Assessment and Mitigation for Significant Fauna

Species	Legal Status*	Possible Impacts	Mitigation Measures
Golden-headed Cisticola *Cisticola exilis*	M (EPBC Act)	Loss of 10.8ha of suitable habitat, comprising wetland areas where permanent water is present, dense wetland vegetation, and cover of grasses occurs. Map units 1, 2 & 7 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Masked Lapwing *Vanellus miles*	M (EPBC Act)	Loss of 6.7ha of suitable open grassy areas of foraging and nesting. Map unit 7 provides suitable resources of foraging and nesting.	Minimise clearing required for proposed works. Maintain grassed lawns.
Whistling Kite *Haliastur sphenurus*	M (EPBC Act)	Loss of 4.3ha of suitable foraging and roosting habitat, comprising wetland areas where permanent water is present, dense wetland vegetation and Eucalypt forest occurs. Map units 1, 2, & 5 provide potential foraging habitat.	Given the small area of potential habitat for wetland birds and its marginal nature, the need for mitigation for the loss of habitat is unlikely.
Nankeen Kestrel *Falco cenchroides*	M (EPBC Act)	Loss of 7.8ha of habitat comprising of forested areas with suitable foraging and roosting resources. Map units 4, 5, 6, & 7 provide foraging and roosting habitat.	Minimise clearing required for proposed works.
THREATENED NON-FLYING MAMMALS			
Koala *Phascolarctos cinereus*	V (TSC Act)	Loss of a small area (2.9ha) of potential habitat comprising of forested areas with known feed trees such as Forest Red Gum (*Eucalyptus tereticornis*) and Swamp Mahogany (*Eucalyptus robusta*) (Map units 5 and 6).	Minimise clearing required for proposed works particularly Swamp Mahogany (*E. robusta*) and Forest Red Gum (*E. tereticornis*). Use these species in landscaping works associated with the proposed action.
THREATENED FLYING MAMMALS			
Grey-headed Flying-fox *Pteropus poliocephalus*	V (TSC Act); V (EPBC Act)	Loss of a small area (2.9ha) of potential habitat comprising of forested areas with nectar resources. Map units 3a, 3b, 4, 5, & 6 provide potential foraging resources.	Minimise clearing required for proposed works, particularly Swamp Mahogany (*Eucalyptus robusta*) trees.
Eastern Free-tail Bat *Mormopterus norfolkensis*	V (TSC Act)	Loss of 13.7ha of potential foraging habitat within map units 1, 2, 3a, 3b, 4, 5, 6 & 7.	Minimise clearing required for proposed works.
Little Bent-wing Bat *Miniopterus australis*	V (TSC Act)	Loss of 13.7ha of potential foraging habitat within map units 1, 2, 3a, 3b, 4, 5, 6 & 7.	Minimise clearing required for proposed works.
Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis*	V (TSC Act)	Loss of 13.7ha of potential foraging habitat within map units 1, 2, 3a, 3b, 4, 5, 6 & 7.	Minimise clearing required for proposed works.
Large-footed Myotis *Myotis adversus*	V (TSC Act)	Loss of 13.7ha of potential foraging habitat within map units 1, 2, 3a, 3b, 4, 5, 6 & 7.	Minimise clearing required for proposed works.

Table 8.2 – Impact Assessment and Mitigation for Significant Fauna

Species	Legal Status*	Possible Impacts	Mitigation Measures
Greater Broad-nosed Bat *Scoteanax rueppellii*	V (TSC Act)	Loss of 13.7ha of potential foraging habitat within map units 1, 2, 3a, 3b, 4, 5, 6 & 7.	Minimise clearing required for proposed works.

* V = Vulnerable; E = Endangered; M = Migratory
TSC Act = *NSW Threatened Species Conservation Act (1995)*
EPBC Act = *Commonwealth Environment Protection and Biodiversity Conservation Act (1999)*
CAMBA = *China Australia Migratory Bird Agreement (1988)*
JAMBA = *Japan Australia Migratory Bird Agreement (1981)*

9.0 Legislative Assessments

Table 9.0 indicates the legislative assessments required for significant species and endangered ecological communities identified in this report. These species are known to occur in the study area or have potential habitat within the study area. The species and communities requiring assessment are either listed as threatened pursuant to the TSC Act and/or are recognised as Matters of National Environmental Significance (MNES) pursuant to the EPBC Act. Results of these assessments are summarised below, s.5A assessments are in Appendix 7 while EPBC Act assessments are in Appendix 8.

Table 9.0 – Required Legislative Assessments

Species/Community	Legal Status*	Assessment Required**	
		s.5A EPA Act	EPBC Act
	FLORA		
Zannichellia palustris	E (TSC Act)	✓	×
	COMMUNITIES		
Freshwater Wetlands	EEC (TSC Act)	✓	×
Swamp Oak Floodplain Forest	EEC (TSC Act)	✓	×
River-flat Eucalypt Forest	EEC (TSC Act)	✓	×
Sub-tropical Coastal Floodplains	EEC (TSC Act)	✓	×
	FAUNA		
Green and Golden Bell Frog *Litoria aurea*	E (TSC Act); V (EPBC Act)	✓	✓
Black-necked Stork *Ephippiorhynchus asiaticus*	E (TSC Act)	✓	×
Osprey *Pandion haliaetus*	V (TSC Act);	✓	×
Powerful Owl *Ninox strenua*	V (TSC Act)	✓	×
Australasian Bittern *Botaurus poiciloptilus*	V (TSC Act)	✓	×
Black Bittern *Ixobrychus flavicollis*	V (TSC Act)	✓	×
Painted Snipe *Rostratula benghalensis australis*	E (TSC Act); M (CAMBA)	✓	✓
Latham's Snipe *Gallinago hardwickii*	M (CAMBA)	×	✓
Magpie Goose *Anseranas semipalmata*	V (TSC Act)	✓	×
Great Egret *Egretta alba*	M (CAMBA)	×	✓
Cattle Egret *Ardeola ibis*	M (CAMBA; JAMBA)	×	✓
Glossy Ibis *Plegadis falcinellus*	M (CAMBA)	×	✓
White-bellied Sea Eagle *Haliaeetus leucogaster*	M (CAMBA)	×	✓
Fork-tailed Swift *Apus pacificus*	M (CAMBA; JAMBA)	×	✓
Swamp Harrier *Circus approximans*	M (EPBC Act)	×	✓
Tawny Grassbird *Megalurus timoriensis*	M (EPBC Act)	×	✓
Little Grassbird *Megalurus gramineus*	M (EPBC Act)	×	✓

Table 9.0 – Required Legislative Assessments

Species/Community	Legal Status*	Assessment Required**	
		s.5A EPA Act	EPBC Act
Clamorous Reed Warbler *Acrocephalus stentoreus*	M (EPBC Act)	×	✓
Golden-headed Cisticola *Cisticola exilis*	M (EPBC Act)	×	✓
Masked Lapwing *Vanellus miles*	M (EPBC Act)	×	✓
Whistling Kite *Haliastur sphenurus*	M (EPBC Act)	×	✓
Nankeen Kestrel *Falco cenchroides*	M (EPBC Act)	×	✓
Grey-headed Flying-fox *Pteropus poliocephalus*	V (TSC Act); V (EPBC Act)	✓	✓
Eastern Freetail-bat *Mormopterus norfolkensis*	V (TSC Act)	✓	×
Little Bent-wing Bat *Miniopterus australis*	V (TSC Act)	✓	×
Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis*	V (TSC Act)	✓	×
Greater Broad-nosed Bat *Scoteanax ruepelli*	V (TSC Act)	✓	×

*V = Vulnerable; E = Endangered; EEC = Endangered Ecological Community; M = Migratory.
**s.5A EPA Act = 8 part test; EPBC Act = Assessment of Matters of National Environmental Significance

9.1 SEPP 44 – Koala Habitat Protection

While the requirements of SEPP 44 do not technically apply to the proposed action, as it is not subject to Council consent, it is the RTA's practice to considered SEPP 44 criteria in its EIA process. These criteria relate to the percentages of feed tree cover, particularly trees listed under Schedule 2 – Known Feed Trees. The assessment criteria consider the percentage cover of known feed trees, and whether these are greater or less than 15% of the total tree canopy.

Assessment of the investigation area identified 2 tree species *Eucalyptus robusta* and *E. tereticornis* which are listed as "feed tree species" under Schedule 2 of SEPP 44. Quantitative assessment of the investigation area indicates that these species do not constitute greater than 15% of the canopy and as such the investigation area would not be considered Potential Koala Habitat under SEPP 44. Therefore, no further assessment of Koala habitat is required for this proposed action.

9.2 Assessment Pursuant to s.5A EP&A Act

As indicated in table 9.0, 14 threatened species and 4 EEC's require assessment under s.5A of the EPA Act owing to their presence within the study area and/or the existence of potential habitat within the study area. Species found to occur in the local area through data base searches (refer to Part B) for which the study area **does not** provide potential habitat do not require assessment.

No potentially significant impacts were identified by this assessment and it is considered that the proposed action would have a minor ecological impact on species and communities listed as threatened in NSW pursuant to the TSC Act.

9.3 Environment Protection & Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act) provides for the need for the approval of the Commonwealth Environment Minister for all actions that will or are likely to have a significant impact on a matter of national environmental significance. Matters of national environmental significance are:

- World Heritage properties,
- Ramsar wetlands of international importance,
- listed threatened species and communities,
- migratory species protected under international agreements,
- nuclear actions, and
- the Commonwealth marine environment.

The process established under the EPBC Act compels the person proposing the action to refer that action to the Commonwealth Environment Minister where that person thinks that the proposed action will or is likely to have a significant impact on a matter of national environmental significance (MNES).

This assessment identified 17 MNES which require further assessment under the EPBC guidelines (see Table 9.0). The 17 MNES identified consisted of 2 threatened fauna species and 15 migratory birds.

9.3.1 EPBC Assessment Guidelines

According to the EPBC Act in order to decide whether an action is likely to have a significant impact, it is necessary to take into account the nature and magnitude of potential impacts.

In determining the nature and magnitude of an action's impact, it is important to consider matters such as:

- all on-site and off-site impacts,
- all direct and indirect impacts,
- the frequency and duration of the action,
- the total impact which can be attributed to that action over the entire geographic area over time,
- the sensitivity of the receiving environment, and
- the degree of confidence with which the impacts of the action are known and understood.

An action does not require approval from the Commonwealth Minister for the Environment under the Act if:

- the action is approved under, and taken in accordance with, a State management plan that is accredited by the Commonwealth for the purposes of a bilateral agreement (see section 46 of the Act), or
- the action is approved under, and taken in accordance with, a Commonwealth management plan that is accredited by the Environment Minister for the purposes of a Ministerial declaration (see section 33 of the Act), or

- the action is a forestry operation taken in a Regional Forest Agreement region (see Part 4, Division 2 of the Act), or
- the action is taken in the Great Barrier Reef Marine Park and is authorised by certain instruments issued under the *Great Barrier Marine Park Act (1975)* (see section 43 of the Act), or
- the action has been authorised by a Government decision on which the Minister's advice has been sought (see section 160 of the Act).

In addition, an approval is not required for an action if:

- the action was authorised by the Commonwealth, a State or a Territory prior to the EPBC Act commencing (16 July 2000), and
- at the time the EPBC Act commences, no further authorisation is required to allow the action to be lawfully taken.
- Finally, the EPBC Act provides that approval is not required for an action that is a lawful continuation of a use of land, sea or seabed that was occurring immediately before the commencement of the Act (this exception does not apply to an enlargement, intensification or expansion of an existing use).

9.3.2 Assessment of Critical Habitat

Habitat critical to the survival of a species or ecological community will depend largely on the particular requirements of the species/community in question. For example, areas only incidentally used by a vulnerable species, and which the species is unlikely to be dependent upon for its survival or recovery, are not areas of habitat critical to the survival of a species or ecological community.

Critical habitat is defined as:

> *Habitat critical to the survival of a species or ecological community may include areas that are necessary: for activities such as foraging, breeding, roosting, or dispersal, for succession, to maintain genetic diversity and long term evolutionary development, or for the reintroduction of populations or recovery of the species / community.*

Depending on the level of endangerment and the nature of the action, not all actions which create an immediate decrease in the population of a nationally listed threatened species or impact on a community will have long-term consequences. However, any actions likely to lead to a "long-term decrease" in the size of a population or a "long-term adverse affect" on a community need to be assessed and recognised.

No areas of habitat listed on the register of critical habitat (DEH 2005) occur within the study area (inclusive of the investigation area). Therefore, the proposed action would not affect critical habitat.

9.3.3 Significance for Critically endangered, Endangered and Vulnerable species

An action that has, will have, or is likely to have a significant impact on a critically endangered or endangered species must be assessed for significance under the EPBC Act. Actions which contribute to any of the following factors needs to be considered:

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

Both the threatened fauna species identified as requiring assessment under the EPBC Act are listed as vulnerable species.

The breeding population of Green and Golden Bell Frog known to occur within the 2HD swamp is likely to utilise foraging habitat found within the investigation area. Due to the timing of this project (winter), surveys targeting this species could not be undertaken and as such further surveys are required to determine if and how this species utilises the investigation area and to determine the extent of the habitat. This population of Green and Golden Bell Frog is relatively isolated from other populations in the local area and the proposed action could potentially contribute to some or all of the above factors in relation to this species.

The proposed action is unlikely to contribute to any of the factors listed above for Grey-headed Flying Fox.

Details of the assessment of each of these species can be found in Appendix 7.

9.3.4 Significance for Critically endangered, Endangered or Vulnerable Populations

An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

No important populations were identified in the processes undertaken for this REF.

9.3.5 Wetlands of international importance

A Ramsar declared wetland is an area designated under Article 2 of the Ramsar Convention or declared by the Minister for the Environment to be a declared Ramsar wetland in accordance with section 16 of the Act.

Any action which will have, or is likely to have a significant impact on the ecological character of a declared Ramsar wetland requires approval from the Commonwealth Minister for the Environment. Actions which occur outside of the boundaries of a declared Ramsar wetland, but which contribute to its degradation must be considered and assessed in accordance with the EPBC Act guidelines.

Actions which have, or are likely to result in a significant impact (even if it is outside the boundaries of a declared Ramsar wetland) on the ecological character of a declared Ramsar wetland, must be assessed under the EPBC Act. If a proposed action is likely to result in any of the following then an assessment for the proposed action must be undertaken. These factors are:

- areas of the wetland being destroyed or substantially modified, or
- a substantial and measurable change in the hydrological regime of the wetland - for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland, or
- the habitat or lifecycle of native species dependant upon the wetland being seriously affected, or
- a substantial and measurable change in the physico-chemical status of the wetland - for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or
- an invasive species that is harmful to the ecological character of the wetland being established in the wetland*.

No Ramsar listed wetlands occurred within the investigation area however Shortland Wetlands forms part of the Hunter Estuary Wetlands (a declared Ramsar wetland) and occurs in close proximity to the investigation area. Table 9.3.5 provides an assessment of the proposed action in relation to the above factors.

Table 9.3.5 - Assessment of the impact of the Proposed Action on Wetlands of International Importance

	Factor	Response
1	Will the proposed action result in a significant area of the wetland being substantially modified or destroyed?	No.
2	Will the proposed action result in a substantial and measurable change in the hydrological regime of the wetland - for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland?	While the proposed action is unlikely to result in a substantial and measurable change in the hydrology of Shortland Wetlands, as a precaution it is recommended that a Soil and Water Management Plan be prepared to ensure that the hydrology of the study area is maintained in its current state. Implementation of such a plan would ensure the proposed action would not result in a substantial and measurable change in the hydrological regime of the wetland.
3	Will the proposed action seriously affect the habitat or lifecycle of native species dependant upon the wetland?	No.
4	Will the proposed action result in a substantial and measurable change in the physico-chemical status of the wetland - for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health?	The proposed action is unlikely to result in a substantial and measurable change in the physico-chemical status of Shortland Wetlands. Control of nutrients and pollutants in runoff will be outlined in the Soil and Water Management Plan.
5	Will the proposed action result in the establishment of an invasive species that is harmful to the ecological character of the wetland.	No. A Weed Management Plan will be prepared to ensure that noxious species do not become established within or adjacent to the study area as a result of the proposed action.

As indicated in table 9.3.5, the proposed action is unlikely to have a significant impact on the adjacent Shortland Wetlands.

9.3.6 Migratory Species of international importance

An assessment of the EPBC register and the assessment of habitats contained on the study area identified 15 migratory species of conservation significance that are likely to utilise habitat contained within the investigation area (Table 9.0).

The EPBC Act requires that if any action has, will have, or is likely to have a significant impact on a migratory species then an assessment of these factors must be undertaken in relation to the proposed action. An assessment is required when the proposed action to be undertaken does or is likely to result in any of the following:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or
- result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

Migratory species cover a broad range of species with different life cycles and population sizes, it is therefore important, to evaluate for each species what is an ecologically significant proportion of the population and what is to be considered important or critical habitat for these species.

Under the EPBC Act an area of important habitat for migratory species is considered to be:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or
- habitat utilised by a migratory species which is at the limit of the species range, or
- habitat within an area where the species is declining.

Assessment of potential impacts to migratory species listed in Table 9.0 is provided in Appendix 8. The assessment concluded that the proposed action is unlikely to seriously disrupt the lifecycle of any migratory species assessed in this report. The overall impacts of the proposed action are considered to be short-term and relatively minor.

9.3.7 Is a referral required under the EPBC Act

The action would potentially have an impact on the breeding population of Green and Golden Bell Frog known to occur within the 2HD Swamp. Further surveys during the appropriate season and climatic conditions would be required to verify the extent of habitat within the investigation area and to determine how it is utilised by this species. If the action cannot avoid Green and Golden Bell Frog habitat it is likely to require referral to the Commonwealth Minister of the Environment.

Part E
Conclusions and Recommendations

10.0 Conclusions

Assessment of the potential impacts of the proposed action pursuant to s.5A of the EPA Act was conducted for 14 Threatened Species and 4 EEC's (see Appendix 7) for which known or potential habitat occurred within the study area. The assessment concluded that the proposed action was unlikely to have a significant impact on the species and communities assessed. However, an accurate assessment of potential impacts on Green and Golden Bell Frog could not be completed because timing of surveys (winter surveys) was such that information relating to how secondary habitat found in the investigation area is utilised by this species could not be collected. Further survey for this species would be warranted in order to collect the required information and in turn to allow an accurate assessment of the potential impacts of the proposed action.

Assessment of the potential impacts of the proposed action pursuant to the EPBC Act was conducted for 17 MNES consisting of 2 threatened fauna species and 15 migratory birds (see Appendix 8). It was concluded that the proposed action was unlikely to have a significant impact on the 15 migratory species or Grey Headed Flying fox. As indicated above, timing of surveys (winter surveys) were such that Green and Golden Bell Frog could not be effectively surveyed for and due to the presence of suitable habitat for Green and Golden Bell Frog within the area likely to be affected by the proposed action and the existence of a known breeding population in the 2HD swamp within the study area, further investigation would be warranted in order to determine the extent of Green and Golden Bell Frog habitat. If the proposed action cannot avoid Green and Golden Bell Frog habitat the action would trigger the referral process under the EPBC Act.

11.0 Recommendations

The following recommendations should be considered to ensure that the proposed action does not have a significant impact on Threatened Species listed pursuant to the TSC Act or MNES listed pursuant to the EPBC Act:

- Further surveys should be conducted for Green and Golden Bell Frog during appropriate conditions in order to determine the extent of habitat within the investigation area,
- Waterway Crossing for Deep Bridge Creek should be designed in accordance with Fairfull and Witheridge (2003) as specified by NSW Fisheries (2003) (Appendix 10),
- A Flora and Fauna Management Plan should be prepared and implemented by an appropriately qualified ecologist to manage and restore flora and fauna habitats adjacent to the proposed highway,
- A Soil and Water Management Plan should be prepared by a suitable qualified soil scientist/hydrologist. This plan should identify the Construction activities that could cause soil erosion or discharge sediment or water pollutants from the site; describe management methods to minimise soil erosion or discharge of sediment or water pollutants from the site including a strategy to minimise the area of bare surfaces during Construction; describe the location and capacity of erosion and sediment control measures; identify the timing and conditions under which Construction stage controls will be decommissioned; include contingency plans to be implemented for events such as fuel spills; provide recommendations on design features that will ensure that there is no significant changes to the hydrology of adjacent wetlands; and, identify how the effectiveness of the sediment and erosion control system will be monitored, reviewed and updated,

- A Weed Management Strategy should be prepared and implemented by a suitably qualified ecologist/bush regeneration contractor, including: identification of weeds within the Activity and adjoining areas; weed eradication methods and protocols for the use of herbicides; methods to treat and re-use weed infested topsoil; and, strategies to control the spread of weeds during Construction,
- Temporary fencing should be installed around sensitive areas adjacent to the construction site to ensure that there is no accidental incursion into these areas. Signs should be posted on the fences which clearly indicate that the areas are "Sensitive Environmental Area". The importance of these areas should be emphasised during staff inductions, and
- Landscaping associated with the proposed action should consist of locally occurring native species.

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Appendix 1:
Concept Design for Proposed action

Appendix 2:
Final Determinations for Endangered Ecological Communities

Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Swamp Oak Floodplain Forest generally occurs below 20 m (rarely above 10 m) elevation in the NSW North Coast, Sydney Basin and South East Corner bioregions. The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees. Typically these forests, woodlands, scrubs and reedlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (e.g. Pressey 1989a).

The composition of Swamp Oak Floodplain Forest is primarily determined by the frequency and duration of waterlogging and the level of salinity in the groundwater. Composition also varies with latitude. The community is characterised by the following assemblage of species:

Acmena smithii
Alternanthera denticulata
Blechnum indicum
Carex appressa
Centella asiatica
Crinum pedunculatum
Cynodon dactylon
Entolasia marginata
Flagellaria indica
Geitonoplesium cymosum
Glochidion sumatranum
Imperata cylindrica var. *major*
Juncus kraussii subsp. *australiensis*
Juncus usitatus
Lomandra longifolia
Maundia triglochinoides
Melaleuca ericifolia
Melaleuca styphelioides
Oplismenus imbecillis
Persicaria decipiens
Alphitonia excelsa
Baumea juncea
Callistemon salignus
Casuarina glauca
Commelina cyanea
Cupaniopsis anacardioides
Dianella caerulea
Enydra fluctuans
Gahnia clarkei
Glochidion ferdinandi
Hypolepis muelleri
Isolepis inundata
Juncus planifolius
Lobelia alata
Lophostemon suaveolens
Melaleuca alternifolia
Melaleuca quinquenervia
Myoporum acuminatum
Parsonsia straminea
Persicaria strigosa

Phragmites australis
Smilax australis
Viola banksii
Selliera radicans
Stephania japonica var. *discolor*

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including fire, grazing, flooding and land clearing) history. The number and relative abundance of species will change with time since fire, flooding or significant rainfall, and may also change in response to changes in grazing regimes. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Hawkesbury, Baulkham Hills, Hornsby, Lane Cove, Blacktown, Auburn, Parramatta, Canada Bay, Rockdale, Kogarah, Sutherland, Penrith, Fairfield, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions. Bioregions are defined in Thackway and Creswell (1995). Major examples once occurred on the floodplains of the Clarence, Macleay, Hastings, Manning, Hunter, Hawkesbury, Shoalhaven and Moruya Rivers.

4. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions has a dense to sparse tree layer in which *Casuarina glauca* (swamp oak) is the dominant species northwards from Bermagui. Other trees including *Acmena smithii* (lilly pilly), *Glochidion* spp. (cheese trees) and *Melaleuca* spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude, and *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui (Keith and Bedward 1999). The understorey is characterised by frequent occurrences of vines, *Parsonsia straminea* (common silkpod), *Geitonoplesium cymosum* (scrambling lily) and *Stephania japonica* var. *discolor* (snake vine), a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter. The composition of the ground stratum varies depending on levels of salinity in the groundwater. Under less saline conditions prominent ground layer plants include forbs such *Centella asiatica* (pennywort), *Commelina cyanea, Persicaria decipiens* (slender knotweed) and *Viola banksii*; graminoids such as *Carex appressa* (tussock sedge), *Gahnia clarkei* (a saw-sedge), *Lomandra longifolia* (spiny-headed mat-rush), *Oplismenus imbecillis*; and the fern *Hypolepis muelleri* (batswing fern). On the fringes of coastal estuaries, where soils are more saline, the ground layer may include the threatened grass species, *Alexfloydia repens*, as well as *Baumea juncea, Juncus kraussii* subsp. *australiensis* (sea rush), *Phragmites australis* (common reed), *Selliera radicans* and other saltmarsh species. The composition and structure of the understorey is also influenced by grazing history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.

5. Unlike most other coastal floodplain communities, Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions are not a significant habitat for waterbirds (Goodrick 1970). However, they do sometimes provide food resources for the Glossy Black Cockatoo (*Calyptorhynchus lathami lathami*), and Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*) (Marchant and Higgins 1990). The fauna of Swamp Oak Floodplain Forest also includes the Squirrel Glider (*Petaurus norfolcensis*) and several species of frogs in the families Myobatrachidae (southern frogs) and Hylidae (tree frogs).

6. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions forms part of a complex of forested wetland and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified a distinct grouping of vegetation samples attributable to this community (Keith and Scott 2005). The combination of features that distinguish Swamp Oak Floodplain Forest from other endangered ecological communities on the coastal floodplains include: its dominance by a tree canopy of either *Casuarina glauca* or, more rarely, *Melaleuca ericifolia* with or without subordinate tree species; the relatively low abundance of *Eucalyptus* species; and the prominent groundcover of forbs and graminoids. It generally occupies low-lying parts of floodplains, alluvial flats, drainage lines, lake margins and fringes of estuaries; habitats where flooding is periodic and soils show some influence of saline ground water. This latter habitat feature sets it apart from other floodplain communities.

7. Swamp Oak Floodplain Forest may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, Subtropical Floodplain Forest of the NSW North Coast bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal River-Flat Forest in the Sydney Basin bioregion), Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion) and Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, in less saline habitats, Swamp Oak Floodplain Forest may adjoin or intergrade with several other endangered ecological communities including River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions and Subtropical Floodplain Forest of the NSW North Coast bioregion. The most saline forms of Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions may adjoin or intergrade with Coastal Saltmarsh of the NSW North Coast, Sydney Basin and South East Corner bioregions. The boundaries between these communities are dynamic and may shift in response to changes in hydrological regimes, fire regimes or land management practices (e.g. Johnston *et al.* 2003). The Determinations for these communities collectively encompass the full range of intermediate assemblages in transitional habitats.

8. A number of vegetation surveys and mapping studies have been conducted across the range of Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. This community includes 'Sheoak Swamps' in the general coastal wetlands classification of Goodrick (1970). In the Tweed valley lowlands, this community includes '*Casuarina glauca* tall to very tall open to closed forest' (F10) of Pressey and Griffith (1992) and parts of the 'Floodplain Wetland Complex' (FL) that include *Casuarina glauca* with *Melaleuca* spp. (Pressey and Griffith 1992). In the Comprehensive Regional Assessment of the north-eastern NSW (NPWS 1999), areas mapped as 'Forest Ecosystem 143, Swamp Oak', fall within this community. In the lower Hunter valley, 'Swamp Oak – Rushland Forest' (map unit 40) and 'Swamp Oak Sedge Forest' (map unit 41) of NPWS (2000) fall within this community. On the Cumberland Plain, 'Riparian Woodland' (map unit 5) of Tozer (2003) and parts of 'Alluvial Woodland' (map unit 11) dominated by *Casuarina glauca* (Tozer 2003) are included within this community, while those parts of Benson's (1992) 'River Flat Forest' (map unit 9f) dominated by *C. glauca* also fall within this community, as do parts of the 'River-flat forests' of Benson and Howell (1990) and Benson et al. (1996) that are dominated by *C. glauca*. On the Illawarra Plain, 'Coastal Swamp Oak Forest' (map unit 36) of NPWS (2002) occurs within this community. In the Comprehensive Regional Assessment of southern New South Wales (Thomas *et al.* 2000), this community includes 'Coastal Wet Heath Swamp Forest' (forest ecosystem 24), 'South Coast Swamp Forest' complex (forest ecosystem 25) and those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) dominated by *Casuarina glauca.* In the Sydney - South Coast region, this community includes parts of 'Floodplain Swamp Forest' (map unit 105) dominated by *Casuarina glauca*, 'Estuarine Fringe Forest' (map unit 106) and 'Estuarine Creek Flat Scrub' (map unit 107) of Tindall *et al.* (2004). In the Eden region, this community includes 'Estuarine Wetland Scrub' (map unit 63) of Keith and Bedward (1999) and parts of 'Floodplain Wetlands' (map unit 60) that include *Casuarina glauca* or *Melaleuca ericifolia* (Keith and

Bedward 1999). Swamp Oak Floodplain Forest South East Corner is included within the 'Coastal Floodplain Wetlands' vegetation class of Keith (2002, 2004). There may be additional or unmapped occurrences of Swamp Oak Floodplain Forest within and beyond these surveyed areas.

9. The extent of the Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions prior to European settlement has not been mapped across its entire range. However, one estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Swamp Oak Floodplain Forest, currently cover 800-1400 km2, representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004). Compared to this combined estimate, the remaining area of Swamp Oak Floodplain Forest is likely to be considerably smaller and is likely to represent much less than 30% of its original range. Major occurrences include: less than 350 ha on the Tweed lowlands in 1985 (Pressey and Griffith 1992); less than 650 ha on the lower Clarence floodplain in 1982 (Pressey 1989a); less than 400 ha on the lower Macleay floodplain in 1983 (Pressey 1989b); less than 3200 ha in the lower Hunter – central Hunter region in the 1990s (NPWS 2000); less than 5200 ha in the Sydney - South Coast region in the mid 1990s (Tindall *et al*. 2004), including up to 4700 ha on the Cumberland Plain in 1998 (Tozer 2003) and less than 250 ha on the Illawarra Plain in 2001 (NPWS 2002); and less than 1000 ha in the Eden region in 1990 (Keith and Bedward 1999).

10. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market gardens, other cropping enterprises (e.g. sorghum, corn, poplars, etc.) and, on the far north coast, canefields. On the Tweed lowlands, Pressey and Griffith (1992) estimated that less than 3% of the original Floodplain Wetlands and Floodplain Forest remained in 1985. Similar estimates are likely to apply to Swamp Oak Floodplain Forests in other parts of the NSW North Coast bioregion (Pressey 1989a, 1989b, NPWS 1999). In the lower Hunter – central coast region, less than 30-40% was estimated to have remained during the 1990s (NPWS 2000), while approximately 13% remained on the Cumberland Plain in 1998 (Tozer 2003). In the Sydney – South Coast region, less than 20% was estimated to remain in the mid 1990s (Tindall *et al*. 2004), in the Eden region about 30% was estimated to remain during the 1990s (Keith and Bedward 1999).

11. Land clearing continues to threaten Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. A small minority of the remaining area occurs on public land (e.g. Pressey 1989a, b; Pressey and Griffith 1992), with most occurring on productive agricultural land or in close proximity to rural centres. The remaining stands are severely fragmented by past clearing and further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, overgrazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs, activation of 'acid sulfate soils' and rubbish dumping (e.g. Pressey 1989a, b; Pressey and Griffith 1992, Boulton and Brock 1999, Johnson *et al*. 2003). Anthropogenic climate change may also threaten Swamp Oak Floodplain Forest if sea levels rise as predicted or if future flooding regimes are affected (IPCC 2001, Hughes 2003). Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species. Clearing of native vegetation; Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; Anthropogenic climate change and High frequency fire are listed as Key Threatening Processes under the Threatened Species Conservation Act (1995).

12. Large areas of habitat formerly occupied by Swamp Oak Floodplain Forest have been directly drained by construction of artificial channels (e.g. Pressey 1989a, Boulton and Brock 1999). By the early 1900s, drainage unions or trusts were formed on the major floodplains to enable adjacent landholders to arrange for co-ordinated drainage systems, which were designed and constructed by the NSW Department of Public Works. Additional areas that have not been directly drained may have been altered hydrologically by changed patterns of flooding and

drainage following flood mitigation works, particularly the construction of drains, levees and floodgates (Pressey and Griffith 1992). On the north coast of NSW, expansion of *Melaleuca quinquenervia* and *Casuarina glauca* into open floodplain swamps has been attributed to artificial drainage and shortening of the hydroperiod (Johnston *et al*. 2003, Stevenson 2003). There have also been anecdotal reports of recruitment by *Casuarina glauca* in pastures during extended dry periods, though not necessarily by other components of the community. These changes appear to be closely associated with enhanced acidity, altered ionic ratios, increased dissolved organic carbon and sulfide oxidation in the soil profile (Johnston *et al*. 2003). Alteration of tidal flows may have lead to decreased soil salinity and localised expansion of *Casuarina glauca* into areas that previously supported Coastal Saltmarsh or mangroves (Stevenson 2003).

13. Very few examples of Swamp Oak Floodplain Forest remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community, dumping of landfill rubbish and garden refuse, polluted runoff from urban and agricultural areas, construction of roads and other utilities, and grazing by domestic livestock. The principal weed species affecting Swamp Oak Floodplain Forest include *Araujia sericiflora* (moth plant), *Asparagus asparagoides* (bridal creeper), *Baccharis halimifolia* (groundsel bush), *Cyperus eragrostis* (umbrella sedge), *Cinnamomum camphora* (camphor laurel), *Conyza* spp. (fleabanes), *Hydrocotyle bonariensis* (American pennywort), *Ipomoea cairica*, *I. purpurea* and *I. indica* (morning glories), *Lantana camara, Paspalum dilatatum* (paspalum), *Pennisetum clandestinum* (kikuyu) *Rubus fruticosis* agg. (blackberries), *Solanum pseudocapsicum* (Madeira winter cherry), *S. nigrum* (black-berry nightshade), *Tradescantia fluminensis* (wandering jew) and *Verbena bonariensis* (purpletop), (Tozer 2003, Keith and Scott 2005). In general, remaining examples of Swamp Oak Floodplain Forest from the most saline environments are in better condition, while those from less saline habitats are generally more degraded.

14. Small areas of Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Stotts Island, Ukerebagh, Tuckean, Pambalong, Wamberal, Towra Point and Cullendulla Creek Nature Reserves and Bongil Bongil, Myall Lakes and Conjola National Parks. These occurrences are unevenly distributed throughout the range and unlikely to represent the full diversity of the community. In addition, wetlands within protected areas are exposed to hydrological changes that were, and continue to be initiated outside their boundaries. Some areas of Swamp Oak Floodplain Forest are protected by State Environmental Planning Policy 14, although this has not always precluded impacts on wetlands from the development of major infrastructure.

15. Given the dynamic hydrological relationship between Swamp Oak Floodplain Forest, Coastal Saltmarsh and other endangered ecological communities on coastal floodplains, future management of water and tidal flows may result in the expansion of some communities at the expense of others. Proposals for the restoration of natural hydrological regimes and for the rehabilitation of acid sulfate soils may also result in changes to the distribution and composition of floodplain communities. Co-ordinated planning and management approaches across whole catchments will be required to address and resolve priorities between different management objectives.

16. In view of the above the Scientific Committee is of the opinion that Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam
Chairperson
Scientific Committee

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About the NSW Scientific Committee

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Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Freshwater Wetlands on Coastal Floodplains generally occur below 20 m elevation in the NSW North Coast, Sydney Basin and South East Corner bioregions. The structure of the community may vary from sedgelands and reedlands to herbfields, and woody species of plants are generally scarce. Typically these wetlands form mosaics with other floodplain communities, and often they include or are associated with ephemeral or semi-permanent standing water (e.g. Goodrick 1970).

The composition of Freshwater Wetlands on Coastal Floodplains is primarily determined by the frequency, duration and depth of waterlogging and may be influenced by the level of nutrients and salinity in the water and substrate. The community is characterised by the following assemblage of species:

Alisma plantago-aquatica
Azolla pinnata
Baumea rubiginosa
Bolboschoenus fluviatilis
Carex appressa
Ceratophyllum demersum
Eclipta platyglossa
Eleocharis acuta
Eleocharis minuta
Fimbristylis dichotoma
Hemarthria uncinata
Hydrocharis dubia
Juncus usitatus
Lemna spp.
Ludwigia peploides subsp. *montevidensis*
Maundia triglochinoides
Myriophyllum latifolium
Myriophyllum variifolium
Najas tenuifolia
Azolla filiculoides var. *rubra*
Baumea articulata
Bolboschoenus caldwellii
Brasenia schreiberi
Centipeda minima
Cyperus lucidus
Eclipta prostrata
Eleocharis equisetina
Eleocharis sphacelata
Gratiola pedunculata
Hydrilla verticillata
Juncus polyanthemos
Leersia hexandra
Lepironia articulata
Marsilea mutica
Myriophyllum crispatum
Myriophyllum propinquum
Najas marina
Nymphaea gigantea

Nymphoides geminata
Ottelia ovalifolia
Panicum vaginatum
Persicaria attenuata
Persicaria hydropiper
Persicaria strigosa
Phragmites australis
Potamogeton ochreatus
Potamogeton tricarinatus
Ranunculus inundatus
Schoenoplectus mucronatus
Spirodella spp.
Typha orientalis
Vallisneria spp.
Nymphoides indica
Panicum obseptum
Paspalum distichum
Persicaria decipiens
Persicaria lapathifolia
Philydrum lanuginosum
Potamogeton crispus
Potamogeton perfoliatus
Pseudoraphis spinescens
Schoenoplectus litoralis
Schoenoplectus validus
Triglochin procera sensu lato
Utricularia australis
Wolffia spp.

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance history (including grazing, flooding, land clearing and pollution in the catchment). The number and relative abundance of species will change with time since flooding or significant rainfall, and may also change in response to changes in grazing regimes and land use in the catchment. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Penrith, Fairfield, Liverpool, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions. Bioregions are defined in Thackway and Creswell (1995). Examples include Swan Bay, Gundurimba wetland, Bungawalbin Swamp, Dyraaba Creek and Tuckean Swamp on the Richmond floodplain; Southgate wetlands and Trenayr Swamp on the Clarence floodplain; Seven Oaks Swamp, Swan Pool, Kinchela Creek and Upper Belmore Swamp on the Macleay floodplain; Great Swamp on the Manning floodplain; Wentworth Swamp, Hexham Swamp, Wallis Creek and Ellalong Lagoon on the Hunter floodplain; Bushells, Pitt Town, Long Neck and Broadwater Lagoons on the Hawkesbury floodplain; Coomonderry Swamp on the Shoalhaven floodplain; Pedro and Old Man Bed Swamps on the Moruya floodplain; and Jellat Jellat Swamp on the Bega floodplain (Goodrick 1970).

4. Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is dominated by herbaceous plants and have very few woody species. The structure and composition of the community varies both spatially and temporally depending on the water regime (Yen and Myerscough 1989, Boulton and Brock 1999). Wetlands or parts of wetlands that lack standing water most of the time are usually dominated by dense grassland or sedgeland vegetation, often forming a turf less than 0.5 metre tall and dominated by amphibious plants including *Paspalum distichum* (water couch), *Leersia hexandra* (swamp rice-grass), *Pseudoraphis spinescens* (mud grass) and *Carex appressa* (tussock sedge). Wetlands or parts of wetlands subject to regular inundation and drying may include large emergent sedges over 1 metre tall, such as *Baumea articulata, Eleocharis equisetina* and *Lepironia articulata*, as well as emergent or floating herbs such as *Hydrocharis dubia* (frogbit), *Philydrum lanuginosum* (frogsmouth), *Ludwigia peploides* subsp. *montevidensis* (water primrose), *Marsilea mutica* (nardoo) and *Myriophyllum* spp. (milfoils). As standing water becomes deeper or more permanent, amphibious and emergent plants become less abundant,

while floating and submerged aquatic herbs become more abundant. These latter species include *Azolla filiculoides* var. *rubra*, *Ceratophyllum demersum* (hornwort), *Hydrilla verticillata* (water thyme), *Lemna* spp. (duckweeds), *Nymphaea gigantea* (giant waterlily), *Nymphoides indica* (water snowflake), *Ottelia ovalifolia* (swamp lily) and *Potamageton* spp. (pondweeds). The threatened aquatic plants, *Aldrovanda vesiculosa* and *Najas marina*, also occur within this community. The composition and structure of the vegetation is also influenced by grazing history, changes to hydrology and soil salinity, catchment runoff and disturbance, and may have a substantial component of exotic grasses and forbs. Artificial wetlands created on previously dry land specifically for purposes such as sewerage treatment, stormwater management and farm production, are not regarded as part of this community, although they may provide habitat for threatened species.

5. Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has a distinctive fauna that includes frogs, fish, freshwater tortoises, waterbirds and a diversity of micro- and macro-invertebrates. The frog families represented are Myobatrachidae (southern frogs) and Hylidae (tree frogs), including the threatened Green and Golden Bell Frog (*Litoria aurea*). Waterbirds include Black Swan (*Cygnus atratus*), Pacific Black Duck (*Anas superciliosa*), Australian Grey Teal (*Anas gracilis*), Pacific Heron (*Ardea pacifica*), White-faced Heron (*Ardea novaehollandiae*), Great Egret (*Ardea alba*), Intermediate Egret (*Ardea intermedia*), Little Egret (Ardea garzetta), Straw-necked Ibis (*Threskiornis spinicollis*), Sacred Ibis (*Threskiornis aethiopica*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Royal Spoonbill (*Platalea regia*), Yellow-billed Spoonbill (*Platalea flavipes*), Japanese Snipe (*Gallinago hardwickii*), Black-winged Stilt (*Himantopus himantopus*), Dusky Moorhen (*Gallinula tenebrosa*), Comb-crested jacana (*Jacana gallinacea*) and Purple swamphen (*Porphyrio porphyrio*).

6. Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions forms part of a complex of forested wetland and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified several types of forested wetlands that are distinct from this treeless wetland community (Keith and Scott 2005). The combination of features that distinguish Freshwater Wetlands on Coastal Floodplains from other endangered ecological communities on the coastal floodplains include its scarcity or complete absence of woody plant species and the presence of amphibious, emergent, floating or submerged aquatic forbs, grasses or sedges. It generally occupies low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes; habitats where flooding is periodic and standing fresh water persists for at least part of the year in most years. The community also occurs in backbarrier landforms where floodplains adjoin coastal sandplains (e.g. Pressey and Griffith 1992). However, it is distinct from Sydney Freshwater Wetlands, which may include a component of woody plant species and are associated with sandplains in the Sydney Basin bioregion.

7. Freshwater Wetlands on Coastal Floodplains may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, Subtropical Floodplain Forest of the NSW North Coast bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal River-flat Forest in the Sydney Basin bioregion), Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal Estuary Swamp Forest Complex in the Sydney Basin bioregion) and Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, Freshwater Wetlands on Coastal Floodplains are sometimes fringed by trees, such as *Casuarina glauca* (swamp oak) and *Melaleuca quinquenervia* (paperbark), indicating transitional zones to forested communities of the floodplains. The boundaries between these communities are dynamic and may shift in response to changes in hydrological regimes, fire regimes or land management practices (e.g. Johnston *et al.* 2003, Stevenson 2003). In addition, Freshwater Wetlands on Coastal Floodplains may adjoin or intergrade with Coastal Saltmarsh of the NSW North Coast, Sydney Basin and South East Corner bioregions and Sydney Freshwater Wetlands

of the Sydney Basin bioregion. The Determinations for these communities collectively encompass the full range of intermediate assemblages.

8. A number of vegetation surveys and mapping studies have been conducted across the range of Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. This community includes 'Fresh meadows', Seasonal fresh swamps', 'Semi-permanent fresh swamps', and 'Open fresh waters' in the general coastal wetlands classification of Goodrick (1970). In the Tweed valley lowlands, this community includes '*Eleocharis equisetina* tall closed sedgeland' (E2) and '*Triglochin procera* tall forbland to tall open forbland' (E3) of Pressey and Griffith (1992) and parts of the 'Floodplain Wetland Complex' (FL) that are dominated by herbaceous plants (Pressey and Griffith 1992). In the lower Hunter valley, 'Freshwater Wetland Complex' (map unit 46) of NPWS (2000) falls within this community. In the Sydney region, this community includes 'Freshwater wetlands on the floodplains' of Benson and Howell (1990); 'Freshwater reed swamps' (map unit 28a) of Benson (1992) and Ryan *et al.* (1996) in the Penrith-St Albans district; '*Lepironia* freshwater swamp' (map unit 75 and part of map unit 79) of NPWS (2002a) in the Warragamba area; and 'Freshwater wetlands' (map unit 36) of Tozer (2003) on the Cumberland Plain. On the Illawarra plain, this community includes 'Floodplain Wetland' (map unit 54) of NPWS (2002b). In the Comprehensive Regional Assessment of southern New South Wales (Thomas et al. 2000), this community includes 'Coastal alluvial valley floor wetlands' (map unit 189). This community also includes those parts of 'Coastal freshwater lagoon' (map unit 313) of Tindall et al. (2004), on the south coast of NSW, and parts of 'Floodplain Wetlands' (map unit 60) of Keith and Bedward (1999), in the Eden region, that are dominated by herbaceous aquatic plants. Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is included within the 'Coastal Freshwater Lagoons' vegetation class of Keith (2002, 2004). There may be additional or unmapped occurrences of Freshwater Wetlands on Coastal Floodplains within and beyond these surveyed areas.

9. The extent of the Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions prior to European settlement has not been mapped across its entire range. Estimates of wetland area also vary, depending on the scale of mapping (coarse scale maps may exclude many small wetlands), wetland definition and the occurrence of recent flooding. Mapping carried out by Kingsford *et al.* (2004), for example, focused on areas of open water and thus excluded many wetlands attributable to this community. One estimate based on a compilation of regional vegetation maps suggests that Coastal Freshwater Lagoons, which include Freshwater Wetlands on Coastal Floodplains, currently cover 90-160 km2, representing less than 60-90% of the original extent of this broadly defined vegetation class (Keith 2004). However, the remaining area of Freshwater Wetlands on Coastal Floodplains is likely to represent much less than 60-90% of its original range, because this combined estimate for the Coastal Freshwater Wetlands class (Keith 2004) is likely to include a considerable area of freshwater wetlands on coastal sandplains, which are excluded from this Determination. Goodrick (1970) estimated that approximately 21 700 ha of 'Fresh meadows', 'Seasonal fresh swamps', 'Semi-permanent fresh swamps', and 'Open fresh waters' remained on NSW coastal floodplains in 1969, representing less than 39% of their original area. Continued clearing and drainage works in the 35 years since Goodrick's (1970) survey are likely to have resulted in a substantial diminution of Freshwater Wetlands on Coastal Floodplains. More detailed surveys have identified the following areas attributable to Freshwater Wetlands on Coastal Floodplains: less than 150 ha on the Tweed lowlands in 1985 (Pressey and Griffith 1992); about 10 600 ha on the lower Clarence floodplain in 1982 (Pressey 1989a); about 11 200 ha on the lower Macleay floodplain in 1983 (Pressey 1989b); about 3500 ha in the lower Hunter – central Hunter region in 1990s (NPWS 2000); less than 2700 ha on the NSW south coast from Sydney to Moruya in the mid 1990s (Tindall *et al.* 2004), including about 660 ha on the Cumberland Plain in 1998 (Tozer 2003) and about 100 ha on the Illawarra Plain in 2001 (NPWS 2002); and less than 1000 ha in the Eden region in 1990 (Keith and Bedward 1999). The wetlands included in these estimates exist in various states of modification.

10. Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market

gardens, other cropping enterprises (e.g. sorghum, corn, poplars, etc.) and, on the far north coast, canefields. On the Tweed lowlands, Pressey and Griffith (1992) estimated that less than 3% of the original Floodplain Wetlands remained in 1985. Similar estimates are likely to apply tc Freshwater Wetlands on Coastal Floodplains in other parts of the NSW North Coast bioregion (Pressey 1989a, 1989b). In the lower Hunter – central coast region, about two-thirds was estimated to have remained during the 1990s (NPWS 2000), while approximately 40% remained on the Cumberland Plain in 1998 (Tozer 2003). In the Sydney – South Coast region, about 70% was estimated to remain in the mid 1990s (Tindall *et al*. 2004), in the Eden region about 30% was estimated to remain during the 1990s (Keith and Bedward 1999).

11. Land clearing continues to threaten Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. A small minority of the remaining area occurs on public land (e.g. Pressey 1989a, b; Pressey and Griffith 1992), with most occurring on productive agricultural land or in close proximity to rural centres. The remaining stands are severely fragmented by past clearing and are further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, filling associated with urban and industrial development, pollution and eutrophication from urban and agricultural runoff, weed invasion, overgrazing, trampling by livestock, soil disturbance by pigs, activation of 'acid sulfate soils' and rubbish dumping (e.g. Goodrick 1970; Pressey 1989a, b; Pressey and Griffith 1992; Boulton and Brock 1999, Johnston *et al*. 2003). The native fauna of Freshwater Wetlands on Coastal Floodplains is threatened by predation, particularly by mosquito fish and cane toads. Anthropogenic climate change may also threaten Freshwater Wetlands on Coastal Floodplains if sea levels rise and future flooding regimes change as predicted (IPCC 2001; Hughes 2003). Clearing of native vegetation; Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; and Anthropogenic climate change are listed as Key Threatening Processes under the Threatened Species Conservation Act (1995).

12. Large areas of habitat formerly occupied by Freshwater Wetlands on Coastal Floodplains have been directly drained by construction of artificial channels (e.g. Pressey 1989a, Boulton and Brock 1999). By the early 1900s, drainage unions or trusts were formed on the major floodplains to enable adjacent landholders to arrange for co-ordinated drainage systems, which were designed and constructed by the former NSW Department of Public Works. Additional areas that have not been directly drained may have been altered hydrologically by changed patterns of flooding and drainage following flood mitigation works, particularly the construction of drains, levees and floodgates (Pressey and Griffith 1992). On the north coast of NSW, expansion of *Melaleuca quinquenervia* and *Casuarina glauca* into open floodplain swamps has been attributed to artificial drainage and shortening of the hydroperiod (Johnston *et al*. 2003, Stevenson 2003). These changes appear to be closely associated with enhanced acidity, altered ionic ratios, increased dissolved organic carbon and sulfide oxidation in the soil profile (Johnston *et al*. 2003). Conversely, alteration of tidal flows may have led to decreased soil salinity and localised expansion of Freshwater Wetland into areas that previously supported Coastal Saltmarsh or mangroves (Stevenson 2003). Re-instatement of tidal flows and other natural hydrological processes may therefore lead to contraction of Freshwater Wetlands. In addition, sedimentation and eutrophication of wetlands is associated with development of their catchments for intensive agriculture or urban or industrial infrastructure. Harmful runoff from developed catchments may include herbicides, pesticides, fertilisers, sewerage, industrial waste and polluted stormwater. The widespread degradation of Freshwater Wetlands on Coastal Floodplains has led to regional declines in their dependent fauna including Magpie Geese (*Anseranas semipalmata*), Cotton Pygmy Geese (*Nettapus coromandelianus*), Hardhead (*Aythya australis*), Black-necked Stork (*Ephippiorhynchus asiaticus*), and Wandering Whistling Duck (*Dendrocygna arcuata*).

13. Very few examples of Freshwater Wetlands on Coastal Floodplains remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community; the dumping of landfill, rubbish and garden refuse; eutrophication and polluted runoff from urban and agricultural areas; construction of roads and other utilities; soil disturbance by feral pigs and grazing by domestic livestock. In addition, mechanical and

chemical methods of controlling aquatic weeds may threaten native components of the flora. The principal weed species affecting Freshwater Wetlands on Coastal Floodplains include *Alternanthera philoxeroides* (alligatorweed), *Baccharis halimifolia* (groundsel bush), *Echinochloa crus-galli* (barnyard grass), *Eichhornia crassipes* (water hyacinth), *Hygrophila costata* (glush weed), *Ludwigia longifolia, L. peruviana*, *Nymphaea capensis* (Cape waterlily), *Panicum repens* (torpedo grass), *Pennisetum clandestinum* (kikuyu) and *Salvinia molesta,* (Sainty and Jacobs 1981).

14. Small areas of Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Ukerebagh, Tuckean, Tabbimoble Swamp, Hexham Swamp, Pambalong and Pitt Town Nature Reserves and Bungawalbin, Scheyville and Seven Mile Beach National Parks, although these are unevenly distributed throughout the range and unlikely to represent the full diversity of the community. In addition, wetlands within protected areas are exposed to hydrological changes that were, and continue to be initiated outside their boundaries. Some Freshwater Wetlands on Coastal Floodplains are protected by State Environmental Planning Policy 14, although this has not always precluded impacts on wetlands from the development of major infrastructure.

15. Given the dynamic hydrological relationship between Freshwater Wetlands on Coastal Floodplains, Coastal Saltmarsh and other endangered ecological communities on coastal floodplains, future management of water and tidal flows may result in the expansion of some communities at the expense of others. Proposals for the restoration of natural hydrological regimes and for the rehabilitation of acid sulfate soils may also result in changes to the distribution and composition of floodplain communities. Co-ordinated planning and management approaches across whole catchments will be required to address and resolve priorities between different management objectives.

16. In view of the above the Scientific Committee is of the opinion that Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam
Chairperson
Scientific Committee

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About the NSW Scientific Committee

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River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act, and as a consequence to omit reference to Sydney Coastal River-Flat Forest from Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). River-Flat Eucalypt Forest on Coastal Floodplains generally occurs below 50 m elevation, but may occur on localised river flats up to 250 m above sea level in the NSW North Coast, Sydney Basin and South East Corner bioregions. The structure of the community may vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees. Typically these forests and woodlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (e.g. Goodrick 1970).

The composition of River-Flat Eucalypt Forest on Coastal Floodplains is primarily determined by the frequency and duration of waterlogging and the texture, nutrient and moisture content of the soil. Composition also varies with latitude. The community is characterised by the following assemblage of species:

Acacia floribunda
Acacia parramattensis
Acmena smithii
Adiantum aethiopicum
Angophora floribunda
Angophora subvelutina
Austrostipa ramosissima
Backhousia myrtifolia
Breynia oblongifolia
Bursaria spinosa
Casuarina cunninghamiana subsp. *cunninghamiana*
Casuarina glauca
Cayratia clematidea
Centella asiatica
Cheilanthes sieberi subsp. *sieberi*
Clematis aristata
Clematis glycinoides
Commelina cyanea
Cymbopogon refractus
Desmodium varians
Dichelachne micrantha
Dichondra repens
Digitaria parviflora
Doodia aspera
Echinopogon caespitosus var. *caespitosus*
Echinopogon ovatus
Einadia hastata
Einadia trigonos
Entolasia marginata
Entolasia stricta
Eragrostis leptostachya
Eucalyptus amplifolia
Eucalyptus baueriana
Eucalyptus benthamii

Eucalyptus botryoides
Eucalyptus grandis
Eucalyptus moluccana
Eucalyptus saligna
Eucalyptus viminalis
Eustrephus latifolius
Geitonoplesium cymosum
Glycine clandestina
Glycine tabacina
Hydrocotyle peduncularis
Hypolepis muelleri
Livistona australis
Lomandra longifolia
Melaleuca decora
Melaleuca styphelioides
Microlaena stipoides var. *stipoides*
Oplismenus aemulus
Ozothamnus diosmifolius
Paspalidium distans
Phyllanthus gunnii
Poranthera microphylla
Pteridium esculentum
Sigesbeckia orientalis subsp. *orientalis*
Stephania japonica var. *discolor*
Trema aspera
Vernonia cinerea
Viola hederacea
Eucalyptus elata
Eucalyptus longifolia
Eucalyptus ovata
Eucalyptus tereticornis
Euchiton sphaericus
Galium propinquum
Geranium solanderi
Glycine microphylla
Hardenbergia violacea
Hymenanthera dentata
Imperata cylindrica var. *major*
Lomandra filiformis
Lomandra multiflora subsp. *multiflora*
Melaleuca linariifolia
Melia azedarach
Opercularia diphylla
Oxalis perennans
Pandorea pandorana
Persicaria decipiens
Plectranthus parviflorus
Pratia purpurascens
Rubus parvifolius
Solanum prinophyllum
Themeda australis
Tristaniopsis laurina
Veronica plebeia
Wahlenbergia gracilis

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including fire, grazing, flooding and land clearing) history. The number and relative abundance of species will change with time since fire, flooding or significant rainfall, and may also change in response to changes in grazing regimes. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is known from parts of the Local Government Areas of Port Stephens, Maitland, Singleton, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Parramatta, Penrith, Blue Mountains, Fairfield, Holroyd, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Eastern Capital City Regional, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions. Bioregions are defined in Thackway and Creswell (1995). Major examples once occurred on the floodplains of the Hunter, Hawkesbury, Moruya, Bega and Towamba Rivers, although many smaller floodplains and river flats also contain examples of the community.

4. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple) and *A. subvelutina* (broad-leaved apple). *Eucalyptus baueriana* (blue box), *E. botryoides* (bangalay) and *E. elata* (river perppermint) may be common south from Sydney, *E. ovata* (swamp gum) occurs on the far

south coast, *E. saligna* (Sydney blue gum) and *E. grandis* (flooded gum) may occur north of Sydney, while *E. benthamii* is restricted to the Hawkesbury floodplain. Other eucalypts including *Eucalyptus longifolia* (woollybutt), *E. moluccana* (grey box) and *E. viminalis* (ribbon gum) may be present in low abundance or dominant in limited areas of the distribution. A layer of small trees may be present, including *Melaleuca decora, M. styphelioides* (prickly-leaved teatree), *Backhousia myrtifolia* (grey myrtle), *Melia azaderach* (white cedar), *Casuarina cunninghamiana* subsp. *cunninghamiana* (river oak) and *C. glauca* (swamp oak). Scattered shrubs include *Bursaria spinosa* subsp. *spinosa* (blackthorn), *Solanum prinophyllum* (forest nightshade), *Rubus parvifolius* (native raspberry), *Breynia oblongifolia* (coffee bush), *Ozothamnus diosmifolius, Hymenanthera dentata* (tree violet), *Acacia floribunda* (white sally) and *Phyllanthus gunnii*. The groundcover is composed of abundant forbs, scramblers and grasses including *Microlaena stipoides* (weeping grass), *Dichondra repens* (kidney weed), *Glycine clandestina, Oplismenus aemulus, Desmodium gunnii, Pratia purpurascens* (whiteroot), *Entolasia marginata* (bordered panic), *Oxalis perennans* and *Veronica plebeia* (trailing speedwell). The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic shrubs, grasses, vines and forbs.

5. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law *et al*. 2000a, b). These include cormorants (*Phalacrocorax* spp.) and egrets (*Ardea* spp. and *Egrettia* spp.), the Osprey (*Pandion haliaetus*), Whistling Kite (*Haliastur sphenurus*), White-bellied Sea-eagle (*Haliaeetus leucogaster*), as well as the Brush-tailed Phascogale (*Phascogale tapoatafa*), Yellow-bellied Glider (*Petaurus australis*), Squirrel Glider (*Petaurus norfolcensis*) (Law *et al*. 2000a), Sugar Glider (*Petaurus breviceps*) and Grey-headed Flying Fox (*Pteropus poliocephalus*). The fauna of River-Flat Eucalypt Forest also includes a number of species of frogs in the families Myobatrachidae and Hylidae, particularly *Litoria* spp., and many species of forest birds including honeyeaters, kingfishers, cuckoos, owls, doves, whistlers and fantails.

6. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions forms part of a complex of forested wetland and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified a distinct grouping of vegetation samples attributable to this community (Keith and Scott 2005). The combination of features that distinguish River-Flat Eucalypt Forest on Coastal Floodplains from other endangered communities on the coastal floodplains include: its dominance by either a mixed eucalypt canopy or by a single species of eucalypt belonging to either the genus *Angophora* or the sections *Exsertaria* or *Transversaria* of the genus *Eucalyptus* (Hill 2002); the relatively low abundance or sub-dominance of *Casuarina* and *Melaleuca* species; the relatively low abundance of *Eucalyptus robusta*; and the prominent groundcover of soft-leaved forbs and grasses. It generally occupies central parts of floodplains and raised levees; habitats where flooding is periodic and soils are rich in silt, without deep humic horizons and show little or no influence of saline ground water.

7. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions includes and replaces Sydney Coastal River-Flat Forest Endangered Ecological Community. River-Flat Eucalypt Forest on Coastal Floodplains may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, Subtropical Floodplain Forest of the NSW North Coast bioregion, Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion), Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions and Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, northwards from the Hunter valley, River-Flat Eucalypt Forest on Coastal Floodplains may intergrade with, or be replaced by, Subtropical Floodplain Forest of the NSW North Coast bioregion. As soil salinity increases, River-Flat Eucalypt Forest

may adjoin or intergrade with Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. The boundaries between all of these communities are dynamic and may shift in response to changes in hydrological regimes, fire regimes or land management practices. The Determinations for these communities collectively encompass the full range of intermediate assemblages in transitional habitats.

8. A number of vegetation surveys and mapping studies have been conducted across the range of River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. In the Comprehensive Regional Assessment of the north-eastern NSW (NPWS 1999), areas that were mapped on coastal floodplains of the Manning River as 'Forest Ecosystem 47, Escarpment Red Gums' are included within this community. In the lower Hunter valley, 'Central Hunter Riparian Forest' (map unit 13), 'Wollombi Redgum-River Oak Woodland' (map unit 14) and 'Redgum Roughbarked Apple Swamp Forest' (map unit 38) of NPWS (2000) fall within this community. On the Cumberland Plain, 'Riparian Forest' (map unit 12) of Tozer (2003) and parts of 'Alluvial Woodland' (map unit 11) that are dominated by eucalypts (Tozer 2003) are included within this community. Benson's (1992) 'Camden White Gum Forest' (map unit 6d) and those parts of 'River Flat Forest' (map unit 9f) dominated by eucalypts also fall within this community, as do parts of the 'River-flat forests' of Benson and Howell (1990) and Benson *et al.* (1996) that are dominated by eucalypts. In the Warragamba catchment, small areas of 'Burragorang River Flat Forest' (map unit 88b) and 'Oakdale Alluvial Rough-barked Apple Forest' (map unit 88c) of NPWS (2002) are included within this community. On the south coast of NSW, this community includes those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) of Thomas *et al.* (2000) dominated by eucalypts, those parts of 'Coastal Lowlands Riparian Herb/Grass Forest' (forest ecosystem 48) and 'Southern Hinterland Shrub/Herb/Grass Riparian Forest' (forest ecosystem 49) of Thomas *et al*. (2000) mapped on alluvial soils, and those parts of 'Cumberland River Flat Forest' (map unit 33) and 'Floodplain Swamp Forest' (map unit 105) of Tindall et al. (2004) that are dominated by eucalypts. In the Eden region, this community includes forested parts of 'Floodplain Wetlands' (map unit 60) that are dominated by eucalypts and parts of 'Bega Wet Shrub Forest' (map unit 19) that are mapped on floodplains (Keith and Bedward 1999). River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is included within the 'Coastal Floodplain Wetlands' vegetation class of Keith (2002, 2004). There may be additional or unmapped occurrences of River-Flat Eucalypt Forest on Coastal Floodplains within and beyond these surveyed areas.

9. The extent of the River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions prior to European settlement has not been mapped across its entire range. However, one estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Temperate Eucalypt Forest on Coastal Floodplains, currently cover 800-1400 km2, representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004). Compared to this combined estimate, the remaining area of River-Flat Eucalypt Forest on Coastal Floodplains is likely to be considerably smaller and is likely to represent much less than 30% of its original range. Major occurrences include: about 2000 ha in the lower Hunter region in 1990s (NPWS 2000); less than 10 000 ha on the NSW south coast from Sydney to Moruya in the mid 1990s (Tindall et al. 2004), of which up to about three-quarters occurred on the Cumberland Plain in 1998 (Tozer 2003); and less than 1000 ha in the Eden region in 1990 (Keith and Bedward 1999).

10. River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market gardens and other cropping enterprises (e.g. turf). In the lower Hunter region, about one-quarter of the original extent was estimated to have remained during the 1990s (NPWS 2000), while less than one-quarter remained on the Cumberland Plain in 1998 (Tozer 2003). In the Sydney – South Coast region, less than one-fifth was estimated to remain in the late 1990s (Tindall et al. 2004), in the Eden region about 30% was estimated to remain during the 1990s (Keith and Bedward 1999).

11. Land clearing continues to threaten River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. A small minority of the remaining area occurs on public land (e.g. Benson and Howell 1990), with most occurring on productive agricultural land or in close proximity to rural centres. The remaining stands are severely fragmented by past clearing and are further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, overgrazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs, activation of 'acid sulfate soils', removal of dead wood and rubbish dumping (e.g. Benson and Howell 1990, Boulton and Brock 1999, Johnston *et al*. 2003). Anthropogenic climate change may also threaten River-Flat Eucalypt Forest on Coastal Floodplains if this affects future flooding regimes (IPCC 2001, Hughes 2003). Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species. Clearing of native vegetation; Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; Anthropogenic climate change; High frequency fire; and Removal of dead wood and dead trees are listed as Key Threatening Processes under the Threatened Species Conservation Act (1995).

12. Very few examples of River-Flat Eucalypt Forest on Coastal Floodplains remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community, dumping of landfill rubbish and garden refuse, polluted runoff from urban and agricultural areas, construction of roads and other utilities, and grazing by domestic livestock. The principal weed species affecting River-Flat Eucalypt Forest on Coastal Floodplains include *Anredera cordifolia* (madeira vine), *Araujia sericiflora* (moth plant), *Asparagus asparagoides* (bridal creeper), *Axonopus fissifolius* (narrow-leaved carpet grass), *Bidens pilosa* (cobbler's peg), *Cardiospermum grandiflorum* (balloon vine), *Cirsium vulgare* (spear thistle), *Conyza bonariensis* (flaxleaf fleabane), *C. sumatrensis* (tall fleabane), *Gleditsea triacanthos* (honey locust), *Hypochaeris radicata* (catsear), *Ipomoea* spp. (morning glories), *Lantana camara* (lantana), *Ligustrum lucidum* (large-leaved privet), *L. sinense* (small-leaved privet), *Lonicera japonica* (Japanese honeysuckle), *Macfaydyena unguis-cati* (cat's claw creeper), *Olea europea* subsp. *cuspidata* (African olive), *Plantago lanceolata* (plantain), *Rubus* fruticosis agg. (blackberries), *Senecio madagascariensis* (fireweed), *Senna pendula* var. *glabrata, Setaria parviflora* (slender pigeon grass), *Sida rhombifolia* (paddy's lucerne), *Sonchus oleraceus* (common sowthistle), *Tradescantia fluminensis* (wandering jew), *Verbena bonariensis* (purpletop), *Paspalum dilatatum* (paspalum), *P. urvillei* and *Pennisetum clandestinum* (kikuyu) (Tozer 2003, Keith and Scott 2005, J. R. Hosking, pers. comm.).

13. Small areas of River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Blue Mountains, Cattai, Dharug, Georges River, Marramarra, Morton, Deua and Wadbilliga National Parks, and Gulguer and Mulgoa Nature Reserves, and these are unevenly distributed throughout the range and unlikely to represent the full diversity of the community. The reserved examples are on localised, sheltered river flats between hills, rather than the large open floodplains that comprised the majority of the original habitat (Keith 2004).

14. In view of the above the Scientific Committee is of the opinion that River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam
Chairperson
Scientific Committee

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About the NSW Scientific Committee

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Subtropical coastal floodplain forest of the NSW North Coast bioregion - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion is the name given to the ecological community associated with clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Subtropical Coastal Floodplain Forest generally occurs below 50 m, but may occur on localised river flats up to 250 m elevation in the NSW North Coast bioregion. The structure of the community may vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees. Typically these forests and woodlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (e.g. Pressey 1989a).

The composition of Subtropical Coastal Floodplain Forest is primarily determined by the frequency and duration of waterlogging and the texture, nutrient and moisture content of the soil. Composition also varies with latitude. The community is characterised by the following assemblage of species:

Acacia concurrens
Acacia disparrima subsp. *disparrima*
Allocasuarina torulosa
Alphitonia excelsa
Angophora paludosa
Angophora subvelutina
Angophora woodsiana
Aristida vagans
Brachychiton populneus subsp. *populneus*
Breynia oblongifolia
Brunoniella australis
Callistemon salignus
Callistemon viminalis
Callitris columellaris
Casuarina cunninghamiana subsp. *cunninghamiana*
Casuarina glauca
Centella asiatica
Cheilanthes sieberi subsp. *sieberi*
Cissus hypoglauca
Commelina cyanea
Commersonia bartramia
Commersonia fraseri
Cordyline congesta
Corymbia intermedia
Cupaniopsis anacardioides
Cupaniopsis parviflora
Cymbidium suave
Cymbopogon refractus
Cyperus enervis
Desmodium rhytidophyllum
Desmodium varians
Dianella caerulea
Dianella longifolia
Dichelachne micrantha
Dichondra repens
Digitaria parviflora
Drypetes australasica
Echinopogon caespitosus var. *caespitosus*
Elaeocarpus reticulatus
Entolasia marginata
Entolasia stricta
Eragrostis leptostachya

Eucalyptus acmeniodes
Eucalyptus moluccana
Eucalyptus resinifera subsp. *hemilampra*
Eucalyptus seeana
Eucalyptus tereticornis
Ficus macrophylla subsp. *macrophylla*
Ficus superba var. *henneana*
Gahnia clarkei
Glochidion ferdinandii
Hardenbergia violacea
Hibiscus diversifolius
Hovea acutifolia
Kennedia rubicunda
Laxmannia gracilis
Lomandra longifolia
Lophostemon suaveolens
Mallotus philippensis
Melaleuca decora
Melaleuca quinquenervia
Microlaena stipoides var. *stipoides*
Notelaea longifolia
Oplismenus imbecillis
Parsonsia straminea
Phyllanthus virgatus
Pittosporum revolutum
Pteridium esculentum
Smilax australis
Stephania japonica var. *discolor*
Tricoryne elatior
Viola hederacea
Eucalyptus amplifolia
Eucalyptus propinqua
Eucalyptus robusta
Eucalyptus siderophloia
Eustrephus latifolius
Ficus obliqua
Gahnia aspera
Geitonoplesium cymosum
Glycine clandestina
Hibbertia scandens
Hibiscus tiliaceus
Imperata cylindrica var. *major*
Lagenifera stipitata
Lomandra filiformis
Lomandra multiflora subsp. *multiflora*
Maclura cochinchinensis
Melaleuca alternifolia
Melaleuca nodosa
Melaleuca styphelioides
Morinda jasminoides
Oplismenus aemulus
Panicum simile
Persoonia stradbrokensis
Pimelea linifolia
Pratia purpurascens
Sigesbeckia orientalis
Smilax glyciphylla
Themeda australis
Vernonia cinerea
Wikstroemia indica

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including fire, grazing, flooding and land clearing) history. The number and relative abundance of species will change with time since fire, flooding or significant rainfall, and may also change in response to changes in grazing regimes. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. Some of these components of the community are poorly documented.

3. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, but may occur elsewhere in this bioregion. Bioregions are defined in Thackway and Creswell (1995). Major examples once occurred on the floodplains of the Tweed, Richmond, Clarence, Macleay, Hastings and Manning Rivers, although smaller floodplains would have also supported considerable areas of this community.

4. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. siderophloia* (grey ironbark), *Corymbia intermedia* (pink bloodwood) and, north of the Macleay floodplain, *Lophostemon suaveolens* (swamp turpentine). Other trees may be scattered throughout at low abundance or locally common at few sites, particularly where there is an influence from lithic substrates upslope. These include

Eucalyptus moluccana (grey box), *E. propinqua* (grey gum), *E. seeana* (narrow-leaved red gum), *Angophora subvelutina* (broad-leaved apple), *E. robusta* (swamp mahogany), *Eucalyptus resinifera* subsp. *hemilampra* (red mahogany), *E. acmenoides* (white mahogany), *Angophora woodsiana, A. paludosa* and rainforest trees such as *Ficus* spp. (figs) and *Cupaniopsis* spp (tuckeroos). A layer of small trees may be present, including *Allocasuarina torulosa* (forest oak), *Alphitonia excelsa* (red ash), *Glochidion ferdinandi* (cheese tree), *Callistemon* spp. (bottlebrushes), *Melaleuca* spp. (paperbarks) *and Casuarina glauca* (swamp oak). Scattered shrubs include *Breynia oblongifolia* (coffee bush), *Acacia concurrens* (curracabah), *Commersonia* spp., and *Hibiscus* spp. Occasional vines include *Eustrephus latifolius* (wombat berry), *Parsonsia straminea* (common silkpod) and *Geitonoplesium cymosum* (scrambling lily). The groundcover is composed of abundant forbs, scramblers and grasses including *Imperata cylindrica* var. *major* (blady grass), *Themeda australis* (kangaroo grass), *Vernonia cinerea, Dianella caerulea* (blue flax lily), *Pratia purpurascens* (whiteroot), *Cheilanthes sieberi* subsp. *sieberi,* and *Dichondra repens* (kidney weed). The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.

5. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law *et al*. 2000). These include species of Cormorant (*Phalacrocorax* spp.) and Egret (*Ardea* spp. and *Egrettia* spp.), the Black-necked Stork (*Ephippiorhynchus asiaticus*), Osprey (*Pandion haliaetus*), Brahminy Kite (*Haliastur indus*), Whistling Kite (*Haliastur sphenurus*), White-bellied Sea-eagle (*Haliaeetus leucogaster*), as well as the Brush-tailed Phascogale (*Phascogale tapoatafa*), Squirrel Glider (*Petaurus norfolcensis*), Common Blossum Bat (*Syconycteris australis*) (Law 1994) and Grey-headed Flying Fox (*Pteropus poliocephalus*). The fauna of Subtropical Coastal Floodplain Forest also includes several species of southern frog (family Myobatrachidae) and tree frog (family Hylidae), such as the threatened *Litoria brevipalmata,* , and many species of forest birds including honeyeaters, kingfishers, cuckoos, owls, doves, whistlers and fantails.

6. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion forms part of a complex of forested and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified a distinct grouping of vegetation samples attributable to this community (Keith and Scott 2005). The combination of features that distinguish Subtropical Coastal Floodplain Forest from other endangered ecological communities on the coastal floodplains include: its dominance by a mixed eucalypt canopy, often with *Lophostemon suaveolens*; the presence of rainforest elements as scattered trees or understorey plants; the relatively low abundance or sub-dominance of *Casuarina* and *Melaleuca* species; the relatively low abundance of *Eucalyptus robusta*; and the prominent groundcover of soft-leaved forbs and grasses. It may occupy central or marginal parts of floodplains and sandy flats, including Pleistocene back-barrier flats (Pressey and Griffith 1992); habitats where flooding is periodic and soils are rich in silt and sand, sometimes humic, and show little influence of saline ground water.

7. Subtropical Coastal Floodplain Forest may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal River-flat Forest in the Sydney Basin bioregion), Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion), Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions and Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, south from the Manning valley, Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion may adjoin or intergrade with River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. As soil salinity increases Subtropical Coastal Floodplain Forest may intergrade with, and be replaced by, Swamp Oak Floodplain Forest of the

NSW North Coast, Sydney Basin and South East Corner bioregions. As soils become sandier and more waterlogged, Subtropical Coastal Floodplain Forest may intergrade with, and be replaced by, Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. The boundaries between all of these communities are dynamic and may shift in response to changes in hydrological regimes, fire regimes or land management practices The Determinations for these communities collectively encompass the full range of intermediate assemblages in transitional habitats.

8. A number of vegetation surveys and mapping studies have been conducted across the range of Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion. In the Comprehensive Regional Assessment of the north-eastern NSW (NPWS 1999), areas mapped as 'Forest Ecosystem 46, Eastern Red Gum', and those parts of areas mapped as 'Forest Ecosystem 73, Lowland Red Gum' on coastal floodplains are included within this community. On the Tweed lowlands, this community includes *Eucalyptus tereticornis-E. intermedia-Lophostemon suaveolens* tall to very tall open forest' (F5) of Pressey and Griffith (1992) and parts of the 'Floodplain Wetland Complex' (FL) dominated by eucalypts or *Lophostemon suaveolens* (Pressey and Griffith 1992). Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion is included within the 'Coastal Floodplain Wetlands' vegetation class of Keith (2002, 2004). There may be additional or unmapped occurrences of Subtropical Floodplain Forest within and beyond these surveyed areas.

9. The extent of the Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion prior to European settlement has not been mapped across its entire range. However, one estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Subtropical Coastal Floodplain Forest, currently cover 800-1400 km2, representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004). Compared to this combined estimate, the remaining area of Subtropical Coastal Floodplain Forest is likely to be considerably smaller and is likely to represent much less than 30% of its original range. For example, there were less than 350 ha of native floodplain vegetation on the Tweed lowlands in 1985 (Pressey and Griffith 1992).

10. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market gardens, other cropping enterprises (e.g. sorghum, corn, poplars, etc.) and, on the far north coast, canefields and tea-tree plantations. On the Tweed lowlands, Pressey and Griffith (1992) estimated that less than 3% of the original Floodplain Wetlands and Floodplain Forest remained in 1985. Similar estimates are likely to apply to Subtropical Coastal Floodplain Forest in other parts of the NSW North Coast bioregion (Goodrick 1970, Pressey 1989a, 1989b, NPWS 1999).

11. Land clearing continues to threaten Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion. Little of the remaining area occurs on public land (e.g. Pressey and Griffith 1992), with most occurring on productive agricultural land or in close proximity to rural centres. Conversion of grazing farms to cropping often involves removal of isolated paddock trees and disturbed patches of vegetation, which locally may be the only remnants of the community. The remaining stands are severely fragmented by past clearing and further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, inappropriate grazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs, activation of 'acid sulfate soils' and rubbish dumping (e.g. Pressey 1989a, b; Pressey and Griffith 1992, Boulton and Brock 1999). Anthropogenic climate change may also threaten Subtropical Coastal Floodplain Forest if future flooding regimes are affected (IPCC 2001, Hughes 2003). Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species. Clearing of native vegetation; Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; Anthropogenic climate change; High frequency fire and Removal of dead wood and dead trees are listed as Key Threatening Processes under the Threatened Species Conservation Act

(1995).

12. Large areas of habitat formerly occupied by Subtropical Coastal Floodplain Forest have been directly drained by construction of artificial channels (e.g. Pressey 1989a, Boulton and Brock 1999). By the early 1900s, drainage unions or trusts were formed on the major floodplains to enable adjacent landholders to arrange for co-ordinated drainage systems, which were designed and constructed by the NSW Department of Public Works. Additional areas that have not been directly drained may have been altered hydrologically by changed patterns of flooding and drainage following flood mitigation works, particularly the construction of drains, levees and floodgates (Pressey and Griffith 1992). On the north coast of NSW, expansion of *Melaleuca quinquenervia* and *Casuarina glauca* has been attributed to artificial drainage and shortening of the hydroperiod (Johnston *et al*. 2003). These changes appear to be closely associated with enhanced acidity, altered ionic ratios, increased dissolved organic carbon and sulfide oxidation ir the soil profile (Johnston *et al*. 2003).

13. Very few examples of Subtropical Coastal Floodplain Forest remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community, dumping of landfill rubbish and garden refuse, polluted runoff from urban and agricultural areas, construction of roads and other utilities, and grazing by domestic livestock. The principal weed species affecting Subtropical Coastal Floodplain Forest include *Araujia sericiflora* (moth plant), *Asparagus asparagoides* (bridal creeper), *A. plumosus* (climbing asparagus fern), *Axonopus* spp. (carpet grasses), *Baccharis halimifolia* (groundsel bush), *Bidens pilosa* (cobbler's peg), *Cinnamonum camphora* (camphor laurel), *Conyza* spp. (fleabanes), *Hypochaeris radicata* (catsear), *Ipomoea* spp. (morning glories), *Lantana camara, Ligustrum sinense* (small-leaved privet), *L. lucidum* (large-leaved privet), *Lonicera japonica* (Japanese honeysuckle), *Olea europacea* subsp. *cuspidata* (African olive), *Paspalum dilatatum* (paspalum), *Pennisetum clandestinum* (kikuyu), *Rubus fruticosis* agg. (blackberries), *Senecio madagascariensis* (fireweed), *Setaria parviflora* (slender pigeon grass), *Sida rhombifolia* (Paddy's lucerne), *Solanum mauritianum* (wild tobacco bush), *S. nigrum* (black-berry nightshade), *Tradescantia fluminensis* (wandering jew) and *Verbena bonariensis* (purpletop) (Keith and Scott 2005).

14. Small areas of Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion are contained within existing conservation reserves, including Stotts Island, Ukerebagh and Limeburners Creek Nature Reserves and Bundjalung and Myall Lakes National Parks, and these are unevenly distributed throughout the range and unlikely to represent the full diversity of the community.

15. In view of the above the Scientific Committee is of the opinion that Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam
Chairperson
Scientific Committee

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About the NSW Scientific Committee

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Appendix 3:
Flora List

Classification/ Scientific name	Recent synonyms[1]	Common Name	
DIVISION TRACHEOPHYTA - Vascular Plants			
Subdivision Pteridophytina -Seedless Vascular Plants			
CLASS FILICOPSIDA - Ferns			
Order Pteridales			
SINOPTERIDACEAE			
Pellaea falcata var. *falcata*		Sickle Fern	
Order Dennstaedtiales			
DENNSTAEDTIACEAE			
Hypolepis muelleri		Harsh Ground-fern	
Pteridium esculentum		Bracken	
Order Salviniales			
AZOLLACEAE			
Azolla filiculoides var. *rubra*		Crimson Azolla	
Azolla pinnata		Rufous Azolla	
Subdivision Spermatophytina - Seed Plants			
CLASS CYCADOPSIDA - Cycads			
Order Zamiales			
ZAMIACEAE			
Macrozamia communis		Burrawang	
CLASS MAGNOLIOPSIDA - Flowering Plants			
SUBCLASS MAGNOLIIDAE - Dicotyledons			
Order Laurales			
LAURACEAE			
Cinnamomum camphora		Camphor Laurel	i
Order Ranunculales			
MENISPERMACEAE			
Stephania japonica		Snake Vine	
RANUNCULACEAE			
Clematis aristata		Toothed Clematis	
Ranunculus inundatus		River Buttercup	
Order Caryophyllales			
PORTULACACEAE			
Portulaca olearacea		Pigweed	
CACTACEAE			
Opuntia stricta var. *stricta*		Common Prickly Pear	i
AMARANTHACEAE			
Alternanthera denticulata		Lesser Joyweed	
CARYOPHYLLACEAE			
Stellaria media		Common Chickweed	i
Order Polygonales			
POLYGONACEAE			
Acetosa sagittata		Rambling Dock	i
Persicaria decipiens	*Polygonum decipiens*	Slender Knotweed	
Persicaria hydropiper	*Polygonum hydropiper*	Water Pepper	
Persicaria strigosa	*Polygonum strigosa*	Spotted Knotweed	
Rumex crispus		Curled Dock	i
Order Dilleniales			
DILLENIACEAE			
Hibbertia scandens		Climbing Guinea-flower	
Order Malvales			
ELAEOCARPACEAE			
Elaeocarpus reticulatus		Blueberry Ash	
MALVACEAE			

Classification/ Scientific name	Recent synonyms[1]	Common Name	
Modiola caroliniana		Red-flowered Mallow	i
Sida rhombifolia		Paddys Lucerene	i
Order Urticales			
MORACEAE			
Ficus macrophylla		Moreton Bay Fig	n
Maclura cochinchinensis		Cockspur Thorn	
Streblus brunonianus		Whalebone Tree	
Order Rhamnales			
RHAMNACEAE			
Alphitonia excelsa		Red Ash	
Order Euphorbiales			
EUPHORBIACEAE			
Glochidion ferdinandi		Cheese Tree	
Ricinus communis		Castor Oil Plant	i
Order Violales			
FLACOURTIACEAE			
Scolopia braunii		Flintwood	
Order Salicales			
SALICACEAE			
Salix babylonica		Weeping Willow	i
Order Theales			
OCHNACEAE			
Ochna serrulata		Ochna	i
Order Casuarinales			
CASUARINACEAE			
Casuarina glauca		Swamp Oak	
Order Rosales			
CUNONIACEAE			
Elaeocarpus obovatus		Crab-apple	
ROSACEAE			
Rubus fruticosus agg.		Blackberry	i
Rubus parviflorus		Small-leaf Bramble	
Order Proteales			
PROTEACEAE			
Banksia integrifolia		Coastal Banksia	
Banksia spinulosa var. *collina*		Hill Banksia	
Grevillea robusta		Silky Oak	n
Order Myrtales			
MYRTACEAE			
EUCALYPTS			
Corymbia maculata	*Eucalyptus maculata*	Spotted Gum	
Eucalyptus microcorys		Tallowwood	n
Eucalyptus moluccana	*Eucalyptus hemiphloia*	Grey Box	
Eucalyptus paniculata subsp. *paniculata*		Grey Ironbark	
Eucalyptus robusta		Swamp Mahogany	n
Eucalyptus tereticornis		Forest Red Gum	
OTHER MYRTACEAE			
Callistemon viminalis		Weeping Bottlebrush	
Leptospermum laevigatum		Coast Tea-tree	
Leptospermum pertersonii		Lemon-scented Tea-tree	n
Melaleuca ericifolia		Heath Paperbark	
Melaleuca quinquenervia		Broad-leaved Paperbark	
Melaleuca styphelioides		Prickly Paperbark	
Syzygium paniculatum		Magneta Lilypily	t
LYTHRACEAE			
Lythrum hyssopifolia		Hyssop Loosestrife	
ONAGRACEAE			

Classification/ Scientific name	Recent synonyms[1]	Common Name	
Ludwigia peploides subsp. *montevidensis*		Water Primrose	
Order Sapindales			
SAPINDACEAE			
Cupaniopsis anacardioides		Tuckeroo	
Order Fabales			
FABACEAE			
CAESALPINIOIDEAE			
Senna septemtrionalis	*Senna x floribunda, Cassia floribunda*	Cassia	i
FABOIDEAE			
Daviesia ulicifolia		Gorse Bitter-pea	
Erythrina cristi-galli		Cockspur Coral Tree	i
Medicago polymorpha		Burr Medic	i
Trifolium repens		White Clover	i
Vicia sativa subsp. *sativa*		Common Vetch	i
MIMOSOIDEAE			
Acacia falcata		Sickle Wattle	
Acacia fimbriata		Fringed Wattle	
Acacia implexa		Hickory	
Acacia irrorata subsp. *irrorata*		Rough Green Wattle	
Acacia longifolia		Sydney Golden Wattle	
Acacia parvipinnula		Silver-stemmed Wattle	
Acacia saligna		Golden-wreath Wattle	i
Order Vitidales			
VITACEAE			
Cayratia clematidea		Slender Grape	
Order Santalales			
LORANTHACEAE			
Muellerina eucalyptoides		Creeping Mistletoe	
Order Pittosporales			
PITTOSPORACEAE			
Bursaria spinosa		Blackthorn	
Pittosporum undulatum		Native Daphne	
Order Araliales			
APIACEAE			
Centella asiatica		Swamp Pennywort	
Hydrocotyle bonariensis		Pennywort	i
Hydrocotyle inundatus		River Buttercup	
Order Campanulales			
LOBELIACEAE			
Pratia purpurescens		White Root	
Order Asterales			
ASTERACEAE			
Ageratina adenophora	*Eupatorium adenophorum*	Crofton Weed	i
Ambrosia artemisiifolia		Annual Ragweed	i
Aster subulatus		Wild Aster	i
Bidens pilosa		Cobblers Peg	i
Cirsium vulgare		Scotch Thistle	i
Conyza canadiensis		Canadian Fleabane	i
Hypochoeris radicata		Flatweed	i
Senecio madagascariensis		Fireweed	i
Sonchus oleraceus		Common Sow-thistle	i
SOLANACEAE			
Cestrum parqui		Green Cestrum	i
Solanum mauritianum		Wild Tobacco	i
Solanum nigrum		Black Nightshade	i
CONVOLVULACEAE			
Calystegia marginata		Forest Bindweed	

Classification/ Scientific name	Recent synonyms[1]	Common Name	
Calystegia sepium		Large White Bindweed	
Dichondra repens		Kidney Weed	
Ipomoea indica		Blue Morning Glory	i
Order Cornales			
CAPRIFOLIACEAE			
Lonicera japonica		Honeysuckle	i
Order Oleales			
OLEACEAE			
Jasminum volubile			
Ligustrum lucidum		Large-leaf Privet	i
Ligustrum sinense		Small-leaf Privet	i
Notelaea longifolia		Large Mock Olive	
Olea europaea subsp. *africana*		African Olive	i
Order Gentianales			
RUBIACEAE			
Galium asparine		Cleavers	i
APOCYNACEAE			
Parsonsia straminea		Common Silkpod	
ASCLEPIDACEAE			
Araujia hortorum		Moth Vine	i
Order Scrophulariales			
BIGNONIACEAE			
Pandorea pandorana		Wonga Vine	
SCROPHULARIACEAE			
Veronica plebia		Speedwell	
PLANTAGINACEAE			
Plantago lanceolata		Plantain	i
Order Lamiales			
VERBENACEAE			
Clerodendrum tomentosum		Hairy Clerodendrum	
Lantana camara		Lantana	i
Verbena bonariensis		Purple Top	i
LAMIACEAE			
Plectranthus amboinicus		Allspice	i
SUBCLASS LILIIDAE		Monocotyledons	
Order Alismatales			
ALISMATACEAE			
Alisma plantago-aquatica		Water Plantain	
Order Arales			
LEMNACEAE			
Lemna spp		Duckweed	
Spirodela spp	*Spriodela oligorrhiza, Spirodela pusilla*	Round Spirodela	
Wolffia spp		Wolffia	
Order Dioscoreales			
LUZURIAGACEAE			
Eustrephus latifolius		Wombat Berry	
Order Liliales			
LOMANDRACEAE			
Lomandra longifolia subsp. *longifolia*		Spiny Mat-rush	s
Order Typhales			
TYPHACEAE			
Typha orientalis		Broad-leaf Cumbungi	
Order Commelinales			
COMMELINACEAE			
Commelina cyanea		Scurvy Weed	
Order Juncales			

Classification/ Scientific name	Recent synonyms[1]	Common Name	
JUNCACEAE			
Juncus kraussii subsp. *australiensis*	*Juncus maritimus* var. *australiensis*	Saltmarsh Rush	
Juncus usitatus		Common Rush	
Order Cyperales			
CYPERACEAE			
Bolboschoenus caldwellii	*Scirpus caldwellii*	Caldwells Club-rush	
Cyperus eragrostis		Umbrella Sedge	i
Cyperus odoratus		Lacey Sedge	
Cyperus polystachyos		Bunchy Flat-sedge	
Isolepis prolifera	*Scirpus prolifer*	Club-rush	i
Order Poales			
POACEAE			
Andropogon virginicus		Whisky Grass	i
Chloris gayana		Rhodes Grass	i
Cortadieria selloana		Pampas Grass	i
Cynodon dactylon		Common Couch	
Ehrharta erecta		Panic Veldtgrass	i
Hemarthria uncinata var. uncinata		Matgrass	
Hyparrhenia hirta		Coolatai Grass	i
Imperata cylindrica		Blady Grass	
Melinis repens	*Rhynchelytrum repens*	Red Natal Grass	i
Microlaena stipoides var. *stipoides*		Weeping Grass	
Oplismenus imbecillis		Narrow-leaf Beard-grass	
Panicum maximum var. *maximum*		Guinea Grass	i
Panicum repens		Torpedo Grass	i
Paspalum dilatatum		Paspalum	i
Paspalum distichum		Water Couch	
Paspalum urvillei		Vasey Grass	i
Paspalum vaginatum		Salt-water Couch	
Pennisetum clandestinum		Kikuyu	i
Phragmites australis		Common Reed	
Setaria gracilis		Slender Pigeon Grass	i
Sporobolus indicus var. *capensis*	*Sporobolus africanus*	Parramatta Grass	i
Stenotaphrum secundatum		Buffalo Grass	i

ABBREVIATIONS:
i = introduced (i.e. not indigenous to Australia)
n = native Australian species not considered to be indigenous to the site
c = cultivated (i.e. planted on the site)
t = threatened
spp. = several species of the one genus (sometimes occurring as a hybrid swarm)
sp. = unidentified species[3]
sp. aff. = unidentified species with characteristics similar to the indicated species or genus[3]
? = unconfirmed species[3]
var. = variety
subsp. = subspecies
cv. = cultivar (i.e. a anthropogenic form of the species)
agg. = an aggregate of several yet to be defined species
NOTES:
1. Recent 'synonyms' include misapplied names.
2. A sample flora assemblage obtained from a short term survey, such as the present one, cannot be considered to be comprehensive, but rather indicative of the actual flora assemblage. It can take many years of flora surveys to record all of the plant species occurring within any area, especially species that are only apparent in some seasons.
3. Not all species can be accurately identified in a 'snapshot' survey due to absence of flowering or fruiting material, etc.
SCIENTIFIC NAMES & AUTHORITIES:
Scientific names are those used in the *Flora of New South Wales* as maintained by the Royal Botanic Gardens (http://.plantnet.rbgsyd.gov.au)
For sake of simplicity, scientific names in this list do not include authorities. These can be found in the *Flora of New South Wales.*

Appendix 4:
Analysis of Endangered Ecological Communities

Subtropical Coastal Floodplain Forest	Presence in Map Unit 4	River flat Eucalypt Forest	Presence in Map Unit 4	Littoral Rainforest	Presence in Map Unit 4
Acacia concurrens	0	*Acacia floribunda*	0	*Acacia binervata*	0
Acacia disparrima	0	*Acacia parramattensis*	0	*Acmena hemilampra*	0
Allocasuarina torulosa	0	*Acmena smithii*	0	*Acmena smithii*	0
Alphitonia excelsa	0	*Adiantum aethiopicum*	0	*Acronychia imperforata*	0
Angophora paludosa	0	*Angophora floribunda*	0	*Acronychia oblongifolia*	0
Angophora subvelutina	0	*Angophora subvelutina*	0	*Alectryon coriaceus*	0
Angophora woodsiana	0	*Austrostipa ramosissima*	0	*Alpinia caerulea*	0
Aristida vagans	0	*Backhousia myrtifolia*	0	*Alyxia ruscifolia*	0
Brachychiton populneus	0	*Breynia oblongifolia*	1	*Aphananthe philippinensis*	0
Breynia oblongifolia	1	*Bursaria spinosa*	0	*Archontophoenix cunninghamiana*	0
Brunoniella australis	0	*Casuarina cunninghamiana* subsp. *cunninghamiana*	0	*Arthropteris tenella*	0
Callistemon salignus	0	*Casuarina glauca*	0	*Arytera divaricata*	0
Callistemon viminalis	0	*Cayratia clematidea*	1	*Asplenium australasicum*	0
Callitris columellaris	0	*Centella asiatica*	1	*Baloghia marmorata*	0
Casuarina cunninghamiana subsp. *cunninghamiana*	0	*Cheilanthes sieberi*	0	*Banksia integrifolia* subsp. *integrifolia*	0
Casuarina glauca	0	*Clematis aristata*	1	*Beilschmiedia obtusifolia*	0
Centella asiatica	1	*Clematis glycinoides*	0	*Breynia oblongifolia*	1
Cheilanthes sieberi	0	*Commelina cyanea*	1	*Bridelia exaltata*	0
Cissus hypoglauca	0	*Cymbopogon refractus*	0	*Calamus muelleri*	0
Commelina cyanea	1	*Desmodium varians*	0	*Canthium coprosmoides*	0
Commersonia bartramia	0	*Dichelachne micrantha*	0	*Capparis arborea*	0
Commersonia fraseri	0	*Dichondra repens*	1	*Cayratia clematidea*	1
Cordyline congesta	0	*Digitaria parviflora*	0	*Celtis paniculata*	0
Corymbia intermedia	0	*Doodia aspera*	0	*Cissus antarctica*	0
Cupaniopsis anacardioides	0	*Echinopogon caespitosus* var. *caespitosus*	0	*Cissus hypoglauca*	0
Cupaniopsis parviflora	0	*Echinopogon ovatus*	0	*Cissus sterculiifolia*	0
Cymbidium suave	0	*Einadia hastata*	0	*Claoxylon australe*	0
Cymbopogon refractus	0	*Einadia trigonos*	0	*Cordyline congesta*	0
Cyperus enervis	0	*Entolasia marginata*	1	*Cordyline stricta*	0
Desmodium rhytidophyllum	0	*Entolasia stricta*	1	*Cryptocarya glaucescens*	0
Desmodium varians	0	*Eragrostis leptostachya*	0	*Cryptocarya microneura*	0
Dianella caerulea	0	*Eucalyptus amplifolia*	0	*Cryptocarya triplinervis*	0

Subtropical Coastal Floodplain Forest	Presence in Map Unit 4	River flat Eucalypt Forest	Presence in Map Unit 4	Littoral Rainforest	Presence in Map Unit 4
Dianella longifolia	0	*Eucalyptus baueriana*	0	*Cupaniopsis anacardioides*	1
Dichelachne micrantha	0	*Eucalyptus benthamii*	0	*Cynanchum elegans*	0
Dichondra repens	1	*Eucalyptus botryoides*	0	*Dendrocnide excelsa*	0
Digitaria parviflora	0	*Eucalyptus elata*	0	*Dendrocnide photinophylla*	0
Drypetes australasica	0	*Eucalyptus grandis*	0	*Dioscorea transversa*	0
Echinopogon caespitosus var. *caespitosus*	0	*Eucalyptus longifolia*	0	*Diospyros australis*	0
Elaeocarpus reticulatus	0	*Eucalyptus moluccana*	0	*Diospyros pentamera*	0
Entolasia marginata	1	*Eucalyptus saligna*	0	*Doodia aspera*	0
Entolasia stricta	1	*Eucalyptus tereticornis*	0	*Duboisia myoporoides*	0
Eragrostis leptostachya	0	*Eucalyptus viminalis*	0	*Dysoxylum fraserianum*	0
Eucalyptus acmeniodes	0	*Euchiton sphaericus*	0	*Ehretia acuminata*	0
Eucalyptus amplifolia	0	*Eustrephus latifolius*	1	*Elaeocarpus obovatus*	0
Eucalyptus moluccana	0	*Galium propinquum*	0	*Elattostachys nervosa*	0
Eucalyptus propinqua	0	*Geitonoplesium cymosum*	0	*Endiandra discolor*	0
Eucalyptus resinifera	0	*Geranium solanderi*	0	*Endiandra sieberi*	0
Eucalyptus robusta	0	*Glycine clandestina*	0	*Eucalyptus botryoides*	0
Eucalyptus seeana	0	*Glycine microphylla*	0	*Eucalyptus tereticornis*	0
Eucalyptus siderophloia	0	*Glycine tabacina*	0	*Eupomatia laurina*	0
Eucalyptus tereticornis	0	*Hardenbergia violacea*	0	*Eustrephus latifolius*	1
Eustrephus latifolius	1	*Hydrocotyle peduncularis*	1	*Ficus coronata*	0
Ficus macrophylla subsp. *macrophylla*	0	*Hymenanthera dentata*	0	*Ficus obliqua*	0
Ficus obliqua	0	*Hypolepis muelleri*	0	*Ficus rubiginosa*	0
Ficus superba var. *henneana*	0	*Imperata cylindrica*	0	*Ficus watkinsiana*	0
Gahnia aspera	0	*Livistona australis*	0	*Flagellaria indica*	0
Gahnia clarkei	0	*Lomandra filiformis*	0	*Geitonoplesium cymosum*	0
Geitonoplesium cymosum	0	*Lomandra longifolia*	0	*Glochidion ferdinandi*	1
Glochidion ferdinandii	1	*Lomandra multiflora*	0	*Glycine clandestina*	0
Glycine clandestina	0	*Melaleuca decora*	0	*Gossia bidwillii*	0
Hardenbergia violacea	0	*Melaleuca linariifolia*	0	*Guioa semiglauca*	0
Hibbertia scandens	0	*Melia azedarach*	0	*Ixora beckleri*	0
Hibiscus diversifolius	0	*Microlaena stipoides*	1	*Jagera pseudorhus*	0
Hibiscus tiliaceus	0	*Opercularia diphylla*	0	*Lepidozamia peroffskyana*	0
Hovea acutifolia	0	*Oplismenus aemulus*	1	*Litsea reticulata*	0
Imperata cylindrica	0	*Oxalis perennans*	0	*Livistona australis*	0
Kennedia rubicunda	0	*Ozothamnus diosmifolius*	0		0

Subtropical Coastal Floodplain Forest	Presence in Map Unit 4	River flat Eucalypt Forest	Presence in Map Unit 4	Littoral Rainforest	Presence in Map Unit 4
				Lomandra longifolia	
Lagenifera stipitata	0	*Pandorea pandorana*	1	*Lophostemon confertus*	0
Laxmannia gracilis	0	*Paspalidium distans*	0	*Maclura cochinchinensis*	1
Lomandra filiformis	0	*Persicaria decipiens*	0	*Mallotus philippensis*	0
Lomandra longifolia	0	*Phyllanthus gunnii*	0	*Melaleuca quinquenervia*	0
Lomandra multiflora subsp. *multiflora*	0	*Plectranthus parviflorus*	0	*Melicope micrococca*	0
Lophostemon suaveolens	0	*Poranthera microphylla*	0	*Melicope vitiflora*	0
Maclura cochinchinensis	1	*Pratia purpurascens*	1	*Mischocarpus pyriformis*	0
Mallotus philippensis	0	*Pteridium esculentum*	0	*Monococcus echinophorus*	0
Melaleuca alternifolia	0	*Rubus parvifolius*	0	*Morinda jasminoides*	0
Melaleuca decora	0	*Sigesbeckia orientalis* subsp. *orientalis*	0	*Mucuna gigantea*	0
Melaleuca nodosa	0	*Solanum prinophyllum*	0	*Myoporum acuminatum*	0
Melaleuca quinquenervia	0	*Stephania japonica* var. *discolor*	1	*Notelaea longifolia*	1
Melaleuca styphelioides	1	*Themeda australis*	0	*Olea paniculata*	0
Microlaena stipoides var. *stipoides*	1	*Trema aspera*	0	*Oplismenus imbecillis*	1
Morinda jasminoides	0	*Tristaniopsis laurina*	0	*Pandanus pedunculatus*	0
Notelaea longifolia	1	*Vernonia cinerea*	0	*Pandorea pandorana*	1
Oplismenus aemulus	1	*Veronica plebeia*	0	*Pararchidendron pruinosum* var. *pruinosum*	0
Oplismenus imbecillis	1	*Viola hederacea*	0	*Parsonsia straminea*	1
Panicum simile	0	*Wahlenbergia gracilis*	0	*Pentaceras australis*	0
Parsonsia straminea	1			*Piper novae-hollandiae*	0
Persoonia stradbrokensis	0			*Pisonia umbellifera*	0
Phyllanthus virgatus	0			*Pittosporum multiflorum*	0
Pimelea linifolia	0			*Pittosporum undulatum*	1
Pittosporum revolutum	0			*Platycerium bifurcatum*	0
Pratia purpurascens	1			*Podocarpus elatus*	0
Pteridium esculentum	0			*Pollia crispata*	0
Sigesbeckia orientalis	0			*Polyscias elegans*	0
Smilax australis	0			*Pouteria australis*	0
Smilax glyciphylla	0			*Pouteria cotinifolia* var. *cotinifolia*	0
Stephania japonica var. *discolor*	0			*Pouteria myrsinoides*	0
Themeda australis	0			*Rapanea variabilis*	0
Tricoryne elatior	0			*Rhodamnia rubescens*	0
Vernonia cinerea	0			*Rhodomyrtus psidioides*	0
Viola hederacea	0				0

Subtropical Coastal Floodplain Forest	Presence in Map Unit 4	River flat Eucalypt Forest	Presence in Map Unit 4	Littoral Rainforest	Presence in Map Unit 4
				Ripogonum album	
Wikstroemia indica	0			*Ripogonum discolor*	0
				Sarcomelicope simplicifolia	0
				Scolopia braunii	1
				Smilax australis	0
				Smilax glyciphylla	0
				Sophora tomentosa subsp. *australis*	0
				Stephania japonica var. *discolor*	1
				Synoum glandulosum	0
				Syzygium australe	0
				Syzygium luehmannii	0
				Syzygium oleosum	0
				Syzygium paniculatum	0
				Tetrastigma nitens	0
				Trophis scandens subsp. *scandens*	0
				Viola banksii	0
				Wilkiea huegeliana	0
TOTALS 102	16	86	15	117	13

Appendix 5:
Fauna Species

Table A5.1 – Fish species recorded during the Hexham Swamp Rehabilitation Project (Haines *et al.* 2005)..... 143

Table A5.2 - Fauna Species recorded by HWR Ecological Pty Ltd..... 144

Table A5.1 – Fish species recorded during the Hexham Swamp Rehabilitation Project (Haines *et al.* 2005)

Family	Species	Common Name
Elopidae	*Elops australis*	Giant herring
Anguillidae	*Anguilla australis*	Short-finned eel
	Anguilla reinhardtii	Long-finned eel
Clupeidae	*Herklotsichthys castelnaui*	Castelnau's herring
	Hyperlophus vittatus	Sandy spratt
	Potamatolosa richmondia	Freshwater herring
	Harengula abbreviate	Southern herring
Cyprinidae	*Cyprinus carpio*	Carp
Galaxiidae	*Galaxias maculatus*	Common jollytail
Hemiramphidae	*Hemiramphus ardelio*	River garfish
Poecilliidae	*Gambusia holbrooki*	Mosquito fish
Pseudomugilidae	*Pseudomugil signifier*	
Scopaenidae	*Notesthes robusta*	Bullyrout
	Centropogon australis	Fortesque
Platycephalidae	*Platycephalus fuscus*	Dusky flathead
Teraponidae	*Terapon jarbua*	Crescent perch
Sillaginidae	*Sillago ciliata*	Whiting
Ambassidae	*Ambassis jacksoniensis*	Jackson's glassfish
	Ambassis marianus	Glass perchlet
Percichthyidae	*Macquaria novemaculeata*	Australian bass
Pomatomidae	*Pomatomus saltatrix*	Tailor
Sparidae	*Acanthopagrus australis*	Yellow-finned bream
	Rhabodosargus sarba	Tarwhine
Girellidae	*Girella tricuspidata*	Blackfish
Gerridae	*Gerres ovatus*	Silver biddy
	Gerres subfasciatus	Common silver belly
Mugilidae	*Liza argentea*	Flat-tailed mullet
	Mugil cephalus	Bully mullet
	Myxus elongatus	Sand mullet
Eleotridae	*Gobiomorphus australis*	Striped gudgeon
	Hypseleotris compressa	Empire gudgeon
	Morgurnda adspersa	Purple spotted gudgeon
	Hypseleotris galli	Firetail gudgeon
	Philypnodon grandiceps	Flat headed gudgeon
	Philypnodon Sp 1	Dwarf flathead gudgeon
Gobiidae	*Gobiopterus semivestita*	Glass goby
	Cristatogobius gobioides	Oyster goby
	Arenigobius bifrenatus	Bridled goby
	Acanthigobius flaviomonius	Oriental goby
	Arenigobius frenatus	Frenatus goby
	Mugilogobius paludis	Mangrove goby
	Redigobius macrostoma	Large-mouthed goby
	Gobiomorpus sp.?	Goby species
	Pseudogobius olorum	Blue-spot goby
	Pseudogobius sp.	Goby species
	Favonigobus tamarensis	Tamar river goby
	Favonigobius exquisitus	Exquisite goby
Soleidae	*Synaptura nigra*	Black sole
Bothidae	*Pseudorhombus arsius*	Large-toothed flounder
Monocanthidae	*Meuschenia trachylepis*	Yellow-finned leatherjacket
Tetraodontidae	*Tetractenos hamiltoni*	Common toadfish

Table A5.2 - Fauna Species recorded by HWR Ecological Pty Ltd

Appendix 6:
Interpretation of Section 5A Assessment

In determining whether there is likely to be a significant effect on threatened species, populations, or ecological communities the consent authority must take into account the factors listed in section 5A of the EPA Act, which was amended by the *Threatened Species Conservation (Amendment) Act 2002* (commenced on 31 October 2005).

The new section 5A lists seven factors which must be taken into account (s.5A(2)) and, in addition, makes provision for the gazettal of guidelines which must also be taken into account (s.5A(1) & (3)). No guidelines have yet been gazetted. The seven factors under s.5A(2) are often referred to as the 'seven-part test' (replacing the previously 'eight-part test').

While an ecological assessment provides the data, and an interpretation of these data, on which the decision is based, the actual decision as to whether a proposed development will have "a significant effect on threatened species", and therefore whether a species impact statement is required, is a legal one not an ecological one, with the decision being that of the consent authority. The assessment presented in this report of the potential effects of the proposed action is intended as guidance to the client and the consent authority and not a legal consideration of the Section 5A factors as this can only be done by the consent authority. The opinions expressed as to the significance of any predicted effects are our interpretation of the available data.

A 'side-by-side' comparison of the 'old' and 'new' section 5A is presented in Table A6-1. As can be seen from Table A6-1, s5A includes factors which need to be addressed for each threatened species, population or ecological community, as well as several factors that generally relate to the proposed activity, and are not addressed differently for each species, etc. The application of the factors is summarised below:

(a) each threatened species, only;
(b) each endangered population, only;
(c) each endangered ecological community, only;
(d) each threatened species, population and ecological community;
(e) proposed activity, generally;
(f) each threatened species, population and ecological community;
(g) proposed activity, generally.

The details provided in Appendix 7 for each threatened species, population and ecological community presents information relevant to the above factors.

Table A6-1. Comparison of 'old' and 'new' s5A.

Old s5A ('8-part test)		**New s5A ('7-part test)**	
(a)	in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction	(a)	in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,
(b)	in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.	(b)	in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,
		(c)	in the case of an endangered ecological community, whether the action proposed: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
(c)	in relation to the regional distribution of the habitat of a threatened species, population of ecological community, whether a significant area of known habitat is to be modified or removed.	(d)	in relation to the habitat of a threatened species, population or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
(d)	whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.		
(e)	whether critical habitat will be affected.	(e)	whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),
		(f)	whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,
(f)	whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.		
(g)	whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.	(g)	whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.
(h)	whether any threatened species, population or ecological community is at the limit of its known distribution.		

Appendix 7:
s.5A Assessments

A7.1 - FACTORS RELEVANT TO THE PROPOSED ACTIVITY, GENERALLY **149**
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A7.18 – EASTERN FREE-TAIL BAT **187**
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A7.19 - EASTERN FALSE PIPISTRELLE **192**
A7.20 - S YELLOW-BELLIED SHEATH-TAILED BAT **193**

A7.1 - Factors Relevant to the Proposed Activity, Generally

Critical Habitat
The proposed activity would not affect any areas of critical habitat presently gazetted un the *Threatened Species Conservation Act 1995.*

Threatening Processes
Several gazetted threatening processes are potentially relevant to the proposed activity:

Clearing:
The proposed activity would result in the clearing of native vegetation, specifically various wetland communities which are discussed in detail below.

Weed Invasion:
Considering the remnants on the investigation area have been modified by a number of disturbances, the degree of weed invasion is moderate to high. Weeds include a range of pasture species such as Kikuyu (*Pennisetum clandestinum*) and Buffalo Grass (*Stenotaphrum secundatum*) as well as a number of herb weeds such as Swamp Pennywort (*Hydrocotyle bonariensis*). The proposed action with the implementation of a vegetation management plan would contribute towards the removal of weed species and the reintroduction of native species. The proposed action would not result in further degradation or weed invasion of the remaining remnant vegetation in the study area.

Grazing:
Grazing and agricultural activities have been the major activity throughout the study area causing degradation of the native vegetation along with the installation of flood mitigation works that have highly altered the hydrology regime and hence the remnant vegetation. Grazing would be excluded with the proposed development, alleviating these pressures upon native vegetation.

Fragmentation:
The remnant vegetation within the study area is highly fragmented. A small area of reedland vegetation (0.5ha) would become isolated at the northern end of the investigation area, bound by the proposed highway and Sandgate Cemetery and approximately 2.5ha would become isolated between Sandgate Road and the proposed highway, however some connectivity would be retained to vegetation to the west through an underpass along Deep Bridge Creek.

Altered Fire Regime:
It is difficult to determine the natural fire regime of an area or a particular ecological community. However considering this community comprises wetland vegetation fire is not an integral part of the ecological functioning of this community.

Rubbish Dumping:
Rubbish dumping is generally due to unrestricted access to vegetation remnants. A vegetation management plan should address issues of pedestrian and vehicle access, which would limit or remove impacts from rubbish dumping.

Alteration to Natural Flow Regimes of Rivers, Streams, Floodplains and Wetlands:
The proposed action would avoid blocking or otherwise altering water flows. Underpasses under the proposed highway would allow natural flow regimes particularly along Deep Bridge Creek to be maintained. The stormwater system for the proposed highway should be managed to ensure the natural flow regimes are maintained.

A7.2 - Freshwater Wetlands

There have been no comprehensive studies to document the extent of this EEC within the relevant bioregions (NSW North Coast, Sydney Basin and South East Corner Bioregions), nor within any component of these bioregions. Accordingly, it is necessary to rely on existing mapping prepared for other purposes (and typically using different definitions of communities) to develop a picture of the extent of these communities. For the purposes of this assessment, the extant of this community in parts of the lower Hunter has been derived from existing mapping and information in the Final Determination for this EEC.

The most recent vegetation mapping of Hexham Swamp was prepared by (Morrison, 2000). Morrison's (2000) mapping is very broad (i.e. does not consider fine scale variation and lumps small areas of different communities together). However, it provides an indication of the extent of the relevant communities in Hexham Swamp. The area of the communities with inferred equivalence to this EEC comprises 575ha of Freshwater Swamp, 918ha of Common Reed and 110ha of Broad-leaved Cumbungi, totalling 1603ha.

An earlier study of wetlands of the lower Hunter floodplain undertaken by (Pressey, 1981) provides data on the extent of communities throughout the floodplain. There would clearly have been changes in these wetlands since 1981, with some areas filled and the vegetation in others would have changed as a result of landuse activities, etc. However, again, it is indicative of the local extent of these communities. This study (Pressey 1981) identified the following areas of vegetation communities in the lower Hunter.

Table A7.1.1 – Area of vegetation communities in the Lower Hunter (Pressey 1981)

Community Description (Pressey 1981)	Area (ha)
Phragmites australis	592
Typha orientalis	128
Juncus spp.	624
Eleocharis spp.	268
Bolboschoenus caldwellii	203
Triglochin procera sens. lat.	122
Paspalum paspalodes (now *P. distichum*)	1249
Shallow open water	967
other sedges and herbs	202

More recent mapping undertaken for the Lower Hunter and Central Coast Regional Environmental Management Study (LHCCREMS) provides an indication of the extent of vegetation communities in the Gosford, Wyong, Lake Macquarie, Newcastle, Port Stephens, Maitland and Cessnock local government areas (House, 2003). There is no easy way from the LHCCREMS mapping to determine whether all of this wetland area occurs on coastal floodplains or on other geomorphological units. The "freshwater wetland

complex", in particular, could include sandplain wetlands as well as floodplain wetlands. The following areas are of vegetation units with affinities to the EEC Freshwater Wetlands:

Table A7.1.2 – Vegetation units with affinities to the EEC - Freshwater Wetlands

LHCCREMS Community Description	Area (ha)
Rushland	96
Freshwater Wetland Complex	3867

The LHCCREMS mapping of the study area has not mapped areas of reedland vegetation on the study area, and areas of Swamp Oak forest have been mapped as Freshwater Wetlands, see Figure 11.

Given that none of the mapping described above was prepared using the EECs' descriptions, there are obvious short-comings in using it to assess the local distribution of the EECs. However, allowing for a reasonable potential error deriving from differences in community map units (say, ± 20%), it is still evident that there are of the order of thousands of hectares of the EEC in the lower Hunter. The following are areas of Freshwater Wetland that were mapped in each of the studies:

Table A7.1.3 – Areas of freshwater wetland within local area

Coverage	Freshwater Wetlands (ha)
Hexham Swamp (Morrison 2000)	1200
lower Hunter floodplain (Pressey 1981)	3500
lower Hunter & Central Coast (House 2003)	3200

An area of disturbed reedland vegetation would be required to be removed as part of the proposed action comprising approximately 2.5ha. In relation to the regional distribution of this community the proposed development would remove a very small proportion of the available habitat for this community. As stated in the Scientific Committees Preliminary Determination about 3500 ha of freshwater wetlands exist in the lower Hunter and Central Hunter region in 1990s (NSW Scientific Committee, 2004, para.9). The reedland vegetation proposed for removal represents 0.07% of the estimated extant of the community in the lower Hunter area. There is a larger area of this ecological community within the bioregion including 660 ha on the Cumberland Plain in 1998 (Tozer 2003) and about 100 ha on the Illawarra Plain in 2001 (NSW Scientific Committee, 2004, para.9). The proposed action, therefore, would not result in the modification or removal of a significant area of known habitat within the regional distribution of this community.

There are two areas where reedland vegetation is required to be removed. A small area of reedland vegetation (0.5ha) would become isolated at the northern end of the investigation area, bound by the proposed highway and Sandgate Cemetery. The other area of reedland vegetation surrounding Deep Bridge Creek would be fragmented by the proposed highway. This patch of reed land vegetation is currently bound by Sandgate Road to east and has a patchy distribution along Deep Bridge Creek to the west.

Approximately 2.5ha would become isolated between Sandgate Road and the proposed highway, however some connectivity would be retained to vegetation to the west through an underpass along Deep Bridge Creek.

A7.3 - Swamp Oak Floodplain Forest

There have been no comprehensive studies to document the extent of this EEC within the relevant bioregions (NSW North Coast, Sydney Basin and South East Corner Bioregions), nor within any component of these bioregions. Accordingly, it is necessary to rely on existing mapping prepared for other purposes (and typically using different definitions of communities) to develop a picture of the extent of these communities. For the purposes of this assessment, the extant of this community in parts of the lower Hunter has been derived from existing mapping and information in the Final Determination for this EEC.

The most recent vegetation mapping of Hexham Swamp was prepared by (Morrison, 2000). Morrison's (2000) mapping is very broad (i.e. does not consider fine scale variation and lumps small areas of different communities together). However, it provides an indication of the extent of the relevant communities in Hexham Swamp. Morrison mapped 47ha of Swamp Oak Forest in Hexham Swamp.

An earlier study of wetlands of the lower Hunter floodplain undertaken by (Pressey, 1981) provides data on the extent of communities throughout the floodplain. There would clearly have been changes in these wetlands since 1981, with some areas filled and the vegetation in others would have changed as a result of landuse activities, etc. However, again, it is indicative of the local extent of these communities. This study (Pressey, 1981) identified 115ha of Swamp Oak Forest in the lower Hunter:

More recent mapping undertaken for the Lower Hunter and Central Coast Regional Environmental Management Study (LHCCREMS) provides an indication of the extent of vegetation communities in the Gosford, Wyong, Lake Macquarie, Newcastle, Port Stephens, Maitland and Cessnock local government areas (House, 2003). There is no easy way from the LHCCREMS mapping to determine whether all of this wetland area occurs on coastal floodplains or on other geomorphological units. The "freshwater wetland complex", in particular, could include sandplain wetlands as well as floodplain wetlands. The following are areas of vegetation with affinities to the EEC Swamp Oak Floodplain Forest:

Table A7.2.1 – Vegetation with affinities to Swamp Oak Floodplain Forest

LHCCREMS Community Description	Area (ha)
Swamp Oak Rushland Forest	2406
Swamp Oak Sedge Forest	543

Given that none of the mapping described above was prepared using the EECs' descriptions, there are obvious short-comings in using it to assess the local distribution of the EECs. However, allowing for a reasonable potential error deriving from differences in community map units (say, ± 20%), it is still evident that there are of the order of thousands of hectares of this EEC in the lower Hunter.

An area of Swamp Oak vegetation would be required to be removed as part of the proposed action comprising approximately 0.35 hectares of disturbed vegetation. In relation to the regional distribution of this community the proposed development would remove a very small proportion of the available habitat for this community. As stated in the Scientific Committees Preliminary Determination "less than 3200ha in the lower Hunter and central Hunter region in the 1990s" (NSW Scientific Committee, 2004, para.9). The Swamp Oak vegetation proposed for removal represents a very small proportion (0.01%) of this extant of the community in the lower Hunter area.

A small number Swamp Oaks would be separated by the proposed action, However the patches of Swamp Oak vegetation present in the study area are isolated patches, and therefore no larger areas of this community would become significantly isolated as a result of the proposed highway.

The LHCCREMS mapping for the study area is relatively incorrect (see Figure 11) with the Swamp Oak Floodplain Forest in the study area being mapped as Freshwater Wetlands. Additionally the areas of reedland vegetation on the study area have not been included in the mapping.

A7.4 - River-flat Eucalypt Forest on Coastal Floodplains

Approximately 0.1ha of vegetation with some affinities to River-flat Eucalypt Forest would be removed as part of the proposed action. The regional distribution of River-Flat Eucalypt Forest includes a very large area generally comprising Eucalypt forests in riparian areas on Coastal Floodplains along the NSW East Coast. This area includes the NSW North Coast, Sydney Basin and South East Corner Bioregions. Major occurrences of this community include 2000ha in the lower Hunter region and less than 10000ha on the NSW south coast (NSW Scientific Committee 2004). Therefore the removal of 0.5ha on the study area represents a very small fraction of the known area of habitat. Additionally, areas of vegetation with affinities to River-flat Eucalypt Forest would be restored along the edges of the proposed highway.

No area of vegetation would become isolated as a result of the proposed highway. The remnant Eucalypt Forest within the study area is highly fragmented and is already isolated. Connectivity would be improved along the edges of the proposed highway with the implementation of restoration activities.

A7.5 - Subtropical Coastal Floodplain Forest

Approximately 0.2ha of vegetation with some affinities to Subtropical Coastal Floodplain Forest would be removed as part of the proposed action. The regional distribution of Subtropical Coastal Floodplain Forest includes a very large area generally comprising subtropical forests on Coastal Floodplains within the NSW North Coast Bioregion. The forest within the study area is on the southern boundary of the NSW North Coast Bioregion with the boundary between the Sydney basin Bioregion and the NSW North Coast Bioregion is the Hunter River. This community has not been mapped across its range, however, one study estimated that Coastal Floodplain Wetlands, which include Subtropical Coastal Floodplain Forest, currently cover 800-1400 km2, representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004; NSW Scientific Committee 2004). Therefore the removal of 0.2ha on the study area represents a very small fraction of the known area of habitat. Additionally, areas of vegetation with affinities to Subtropical Coastal Floodplain Forest would be restored along the edges of the proposed highway.

No area of vegetation would become isolated as a result of the proposed highway. The remnant forest within the study area is highly fragmented and is already isolated. Connectivity would be improved along the edges of the proposed highway with the implementation of restoration activities.

A7.6 - *Zannichellia palustris*

The annual aquatic halophyte, *Zannichellia palustris* is considered endangered within NSW. *Z. palustris* is a submerged, weakly rhizomatous aquatic annual or perennial plant species. The literature on *Z. palustris* in Australia is scant, therefore, most of the key observations for the purpose of this Eight Part Test are sourced from unpublished reports, personal communications, and surveys conducted for this EIS.

Z. palustris has a worldwide distribution and occurs in eutrophic lakes, rivers, and estuarine habitats in Europe and North America, where it occasionally requires control. *Z. palustris* was fist recorded in Australia in 1887 near Murray Bridge in South Australia (Black 1965). Since 1971 it has also been recorded in NSW at;

- Ash Island;
- Ironbark Creek and its tributaries;
- Black Creek and Cessnock;
- Ponds at Kooragang Island; and
- Near Belmont.

Within the study area, *Z. palustris* has been recorded in the Canoe Channel between the Shortland Wetland Centre and Ironbark Creek, where it was first observed in 1986 (Winning, pers comm.). *Z. palustris* has also been observed in several ephemeral ponds throughout Hexham Swamp, though it has not been detected every year in these ponds (Winning & King, 2002).

As habitat conditions within the Ironbark Creek catchment have been subject to considerable change in the last 30 years, the occurrence of *Z. palustris* within the catchment may be relatively recent. Factors which may have favoured its establishment and spread in the area include, generally still, eutrophic waters with stable and relatively low salinities, and a lack of competition. The main requirement for the plant appears to be shallow water and limited competition (Greenwood 2001). However, during surveys by Winning (2005) extensive areas of the species were recorded in moderately deep (0.5m-0.7m) permanent channels with little or no other plant growth.

A7.7 – Australasian Bittern

The Australasian Bittern is a large stocky heron with mottled brown, light brown and buff plumage which emits a booming call at dawn and dusk.

It generally occurs in terrestrial and estuarine habitats which contain permanent water often with dense sedges, rushes and reeds (Marchant and Higgins 1990). Australasian Bittern forage from platforms constructed from bent over reeds searching for frogs, fish, invertebrates in shallow water up to 30cm deep (Barker & Vestjens 1989).

Bitterns are able to move between wetlands as suitability changes. However, they have comparatively specialised habitat requirements, so are more sensitive to overall habitat loss than are many wetland species.

Roosting and Nesting Habitat:

Australasian Bittern roost during the daytime amongst dense reeds and rushes. Their nest is constructed in a similar manner over water and often contains a clutch size of 4 – 5 eggs.

The proposed action is likely to remove approximately 0.5 hectares of moderate quality potential roosting habitat for this species. This equates to approximately 3% of similar habitat identified within the study area and is considered to be a minor impact. Therefore, the proposed action is unlikely to disrupt the life cycle of this species such that a viable local population would be placed at risk of extinction.

Access to Foraging Habitat:

The proposed upgrade would involve the net loss of approximately 0.5 hectares of moderate quality potential foraging habitat for this species which is comprised of wetlands where permanent water is available. No Australasian Bittern were observed in this area during field investigations. This habitat is only likely to be utilised during flood conditions or when water is overlying the habitat. Therefore, the proposed action is unlikely to disrupt this aspect of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Access to breeding partners:

The species is often seen singularly, in pairs, or in groups of up to 12 individuals. They are generally sedentary within an area and breed between October – January (Frith 1976). Pairs of individuals build their nests well away from other breeding pairs.

Regional habitat:

Estimating the amount of habitat available within the region is problematic. Limitations, notwithstanding, based on a sub-regional circular range of 30 km (diameter) from the

study area there are 41,033 remnants ranging in size from <1 hectare to 3,058 hectares. In total these remnants make up over 100,013 hectares of remnant vegetation at the sub-regional scale. However the mean size of these remnants are relatively small (m= 2.4), which emphasises the pressures of clearing in the region.

Within the sub-regional area there are seven state forests (13,724 hectares) and fourteen reserves under DEC jurisdiction (7,287 hectares). Thus, within the sub-regional area 14% of potential habitat occurs within state forest while 7% occurs within land administered by DEC.

Whilst the roost and nesting locations of this species is unknown within this region the removal of approximately 0.5 hectares of vegetation from the investigation area is not likely to be considered a significant affect given that this represents only a very small proportion of the regional habitat for this species.

Security of habitats:

The security of these remnants within the regional landscape are of concern given that 79% the foraging habitat is in private ownership and has the potential to be developed. A further 14% occurs within state forest. While this habitat would be potentially more secure than that in private ownership, commercial timber operations are a threat to the long term security. Approximately 7% of remnant vegetation within the sub-regional area occurs within land administered by DEC and is considered to be secure.

In the Hunter region much of the Australasian Bittern Habitat is reserved in conservation areas covering Hexham Swamp and Kooragang Nature Reserves. Bitterns are able to readily move between wetlands as their suitability changes. However, they have comparatively specialised habitat requirements, so are more sensitive to overall habitat loss than are many wetland species. Thus, the fact that much of the coastline habitat in the Newcastle region has been removed and the majority of the remaining habitat is in private ownership, indicates that the Australasian Bittern at risk of habitat loss.

Geographical genetics:

Fragmentation of habitats alone is not ubiquitous with the isolation of genetic material, or the corresponding reduction of a local or meta-population range. The most important determinant of which species are retained in isolated patches appears to be the interaction of patches with the surrounding habitat matrix (Debinski & Holt 2000). Habitat islands can occur as a part of habitat matrix that includes fragmented remnants or as part of landscapes comprised largely of continuous vegetation. Avian communities may persist on habitat islands in spite of pressures, but the long-term prospect of persistence may be illusionary. The persistence may be due only to immigration from less impacted "source" populations (Pulliam 1988; Robinson et al. 1997). Detailed study of reproduction, survival, and dispersal is the only way to determine this and identify effective management solutions.

A7.8 – Magpie Goose

Magpie geese are large noisy birds with several distinctive features including a conspicuous knob on its head, half-webbed feet, and black and white plumage. Magpie Geese live in shallow swamps and associated grassland, feeding on seeds or tubers and green grass (Frith and Davies, 1961, Whitehead and Tschirner, 1992, Wilson, 1997). During the wet season, the geese usually nest in extensive colonies. They move hundreds of kilometres to perennial swamps in the dry season (Frith and Davies, 1961, Bayliss, 1989, Bayliss and Yeomans, 1990).

Roosting and Nesting Habitat:

Each flock of Magpie Geese have a favoured roosting place perching at the edge of a swamp or a paperbark grove. The proposed action is unlikely to disturbed roosting and nesting habitat for this species.

Access to foraging habitat:

At dawn flocks of Magpie Geese fly from their roost location to mingle with other flocks on the plains where they forage on bulbs of spike rush and seeds from swamp grasses. Due to the mobility of this species, the proposed action is unlikely to affect the ability of this species to access areas of suitable foraging habitat. As such, the proposed action is unlikely to disrupt this aspect of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Access to breeding partners:

At the start of each wet season flocks of Magpie Geese move to breeding swamps and as the swamps begin to fill individuals from the flock pair off and begin building floating platforms of spike rush for nesting (Frith 1976). Each nesting platform is only used once, and the platform is elaborately piled with new shoots before eggs are laid. 6 – 9 eggs are laid and pairs continually add material to platform to form a deep cupped nest. The proposed action is unlikely to affect the ability of this species to access breeding partners and as such the proposed action is unlikely to disrupt this aspect of the life cycle such that a viable local population would be placed at risk of extinction.

Regional habitat:

Estimating the amount of habitat available within the region is problematic. Limitations, notwithstanding, based on a sub-regional circular range of 30 km (diameter) from the study area there are 41,033 remnants ranging in size from <1 hectare to 3,058 hectares. In total these remnants make up over 100,013 hectares of remnant vegetation at the sub-regional scale. However the mean size of these remnants are relatively small (m= 2.4), which emphasises the pressures of clearing in the region.

Within the sub-regional area there are seven state forests (13,724 hectares) and fourteen reserves under DEC jurisdiction (7,287 hectares). Thus, within the sub-regional area 14% of potential habitat occurs within state forest while 7% occurs within land administered by DEC.

Whilst the roost and nesting locations of this species is unknown within this region the removal of approximately 4 hectares of vegetation from the investigation area is not likely to be considered a significant affect given that this represents only 0.07% of the regional habitat (Hexham NR and Kooragang NR) for this species.

Security of habitats:

The security of these remnants within the regional landscape are of concern given that 79% the foraging habitat is in private ownership and has the potential to be developed. A further 14% occurs within state forest. While this habitat would be potentially more secure than that in private ownership, commercial timber operations are a threat to the long term security. Approximately 7% of remnant vegetation within the sub-regional area occurs within land administered by DEC and is considered to be secure.

In the Hunter region much of the Magpie Goose habitat is reserved in conservation areas covering Hexham Swamp and Kooragang Nature Reserves. Magpie Geese are able to readily move between wetlands as their suitability changes. However, they have comparatively specialised habitat requirements, so are more sensitive to overall habitat loss than are many wetland species. Thus, the fact that much of the swamp habitat in the Newcastle region has been removed and the majority of the remaining habitat is in private ownership, places the Magpie Goose at risk of habitat loss.

Geographical genetics:

Fragmentation of habitats alone is not ubiquitous with the isolation of genetic material, or the corresponding reduction of a local or meta-population range. The most important determinant of which species are retained in isolated patches appears to be the interaction of patches with the surrounding habitat matrix (Debinski & Holt 2000). Habitat islands can occur as a part of habitat matrix that includes fragmented remnants or as part of landscapes comprised largely of continuous vegetation. Avian communities may persist on habitat islands in spite of pressures, but the long-term prospect of persistence may be illusionary. The persistence may be due only to immigration from less impacted "source" populations (Pulliam 1988; Robinson et al. 1997). Detailed study of reproduction, survival, and dispersal is the only way to determine this and identify effective management solutions.

A7.9 –Freckled Duck

The Freckled Duck has a large pointed head and dark brownish-black colouring which is flecked all over with white or buff. It has a grey-slate bill with a distinctive crimson colouring during breeding season. Freckled duck are often found in phytoplankton rich wetlands or swamps heavily vegetated with Cumbungi, Lignum, Canegrass or Ti-tree. They can also be found to utilise open lakes and their shores, creeks, farm dams and sewage ponds.

Roosting:

Freckled ducks are often found to roost in small or large flocks on permanent waterbodies resting on fallen trees, sand spits or flattened down platforms. The proposed action is unlikely to affect roosting habitat for this species.

Access to foraging habitat:

Freckled Duck forage at the edges of wetlands in shallow productive waters. They use a number of foraging techniques to obtain food resources including, bottom filtering, surface filtering and up-ending (Frith 1982). They forage on algae, aquatic grass and sedge seeds, small invertebrates, fish and vegetative parts of aquatic plants (Martindale 1986; Barker & Vestjens 1989). The proposed action is unlikely to affect the ability of this species to access areas of potential foraging habitat. As such, the proposed action is unlikely to disrupt this aspect of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Access to breeding partners:

Freckled duck are a gregarious species which often form congregations of up 100 individuals, but in wet years they become sedentary, and in dry seasons move towards coastal habitats. They breed between June and December with the female exclusively incubating the eggs while the male guards the nest. The proposed action is unlikely to affect the ability of this species to access breeding partners and as such is unlikely to disrupt this aspect of the life cycle such that a viable local population would be placed at risk of extinction.

A7.10 – Powerful Owl

Roosting and Den Habitat:

Open sclerophyll forests and woodlands in elevation up to 1500m asl (Higgins 1999). Has been noted as occurring in open and tall wet sclerophyll forests with permanent streams dominated by Mountain Ash (*Eucalyptus regnans),* Manna Gum (*Eucalyptus viminalis)* or Narrow-leafed Peppermint (*Eucalyptus radiata)* (Higgins 1999). Has also been associated with dry sclerophyll forests and woodlands dominated by Ironbark, Candlebark (*Eucalyptus rubida),* Messmate (*Eucalyptus obliqua),* River Red Gum (*Eucalyptus camaldulensis)* and open casuarina (Higgins 1999).

Diurnal roost sites for adults are usually found on bare, horizontal branches, between 2-20m above ground which allow for clear vision in several directions, from tree canopy to the understorey vegetation (Higgins 1999). Pairs may use a number of roosts, in a rotating pattern from several days to weeks, within their home range (Higgins 1999).

Kavanagh (1997, Cited Higgins 1999) suggested that the breeding roost, essentially several different trees, was used for many months of the year. Before nesting a pair may been seen on one of their roost sites between 10-20m apart from one another, the female will then move into the nesting hollow alone and the male take up roost nearby (generally within a 50m radius of the nest but can be much more) (Higgins 1999).

The study area did not contain any potential den sites for this species and as such the proposed action is unlikely to affect denning habitat.

Access to Foraging Habitat:

Nocturnal hunters, taking mostly arboreal prey from forest/woodland canopy, understorey and less frequently the forest floor (Higgins 1999). Debus and Chafey (1994) found that 85% of prey in NSW was arboreal, 7% terrestrial and 8% from either trees or substrate (Higgins 1999).

The study area provides very limited habitat for favoured prey species and as such the proposed action is unlikely to disrupt the foraging aspects of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Access to breeding partners:

Breed in winter, lay around May-June (Higgins 1999). Laying may start slightly earlier in NSW, generally between late autumn and mid-winter (Higgins 1999). The study area does not contain suitable habitat for nesting. As such the proposed action is unlikely to affect the ability of this species to access breeding partners. Therefore, the proposed action would not disrupt the breeding aspects of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Regional habitat:

Estimating the amount of habitat available within the region is problematic. Limitations, notwithstanding, based on a sub-regional circular range of 30 km (diameter) from the study area there are 41,033 remnants ranging in size from <1 hectare to 3,058 hectares. In total these remnants make up over 100,013 hectares of remnant vegetation at the sub-regional scale. However the mean size of these remnants are relatively small (m= 2.4), which emphasises the pressures of clearing in the region.

Within the sub-regional area there are seven state forests (13,724 hectares) and fourteen reserves under DEC jurisdiction (7,287 hectares). Thus, within the sub-regional area 14% of potential habitat occurs within state forest while 7% occurs within land administered by DEC.

Whilst the roost and nesting locations of this species is unknown within this region the removal of approximately 13 hectares of vegetation from the investigation area is not likely to be considered a significant affect given that this represents only 0.2% of the regional habitat (Hexham NR and Kooragang NR) for this species.

Security of habitats:

The security of these remnants within the regional landscape are of concern given that 79% the foraging habitat is in private ownership and has the potential to be developed. A further 14% occurs within state forest. While this habitat would be potentially more secure than that in private ownership, commercial timber operations are a threat to the long term security. Approximately 7% of remnant vegetation within the sub-regional area occurs within land administered by DEC and is considered to be secure.

Geographical genetics:

Fragmentation of habitats alone is not ubiquitous with the isolation of genetic material, or the corresponding reduction of a local or meta-population range. The most important determinant of which species are retained in isolated patches appears to be the interaction of patches with the surrounding habitat matrix (Debinski & Holt 2000). Habitat islands can occur as a part of habitat matrix that includes fragmented remnants or as part of landscapes comprised largely of continuous vegetation. Avian communities may persist on habitat islands in spite of pressures, but the long-term prospect of persistence may be illusionary. The persistence may be due only to immigration from less impacted "source" populations (Pulliam 1988; Robinson *et al.* 1997). Detailed study of reproduction, survival, and dispersal is the only way to determine this and identify effective management solutions.

A7.11 – Painted Snipe

The Australian Painted Snipe is a stocky wading bird around 220-250 mm in length with a long pinkish bill. The adult female, more colourful than the male, has a chestnut-coloured head, with white around the eye and a white crown stripe, and metallic green back and wings, barred with black and chestnut. There is a pale stripe extending from the shoulder into a V down its upper back. The adult male is similar to the female, but smaller and duller with buff spots on the wings.

Little is known of the ecology, habitat requirements and reproductive biology of Australian Painted Snipe. Its rarity and perceived decline is of concern and its conservation status is nationally vulnerable, though with a population estimate as low as 1,500 birds, it is considered endangered in NSW.

Roosting and Nesting Habitat;

The Painted Snipe is a secretive bird that shelters in dense vegetation during the day and emerges to forage at dusk. It nests among tall rank tussocks of grass, rushes or samphire, frequently on small, muddy islands or mounds surrounded by shallow fresh water and sometimes on shores of swamps or on banks of channels (Marchant and Higgins 1993). Parts of the study area provides potential roosting habitat for this species, however these areas occur outside of the investigation area and are unlikely to be affected by the proposed action.

Access to foraging habitat:

The Painted Snipe inhabits inland and coastal shallow freshwater wetlands (Smith 1991). The species occurs in both ephemeral and permanent wetlands, particularly where there is a cover of vegetation, including grasses, Lignum and Samphire (Smith 1991). Individuals have also been known to use artificial habitats, such as sewage ponds, dams and waterlogged grassland (Marchant & Higgins 1993). This species forages nocturnally on mud flats and in shallow water. It feeds on plant material, including the seeds of *Bromus* sp., *Heliotropium supinum* and *Atriplex* sp., and invertebrates, such as worms, snails and water beetles (Barker & Vestjens 1989; Marchant & Higgins 1993). The proposed action is unlikely to affect preferred breeding habitat for this species and as such it is unlikely to disrupt the foraging aspects of the life cycle of this specie such that a viable local population would be placed at risk of extinction.

Access to breeding partners:

The Painted Snipe nests on the ground amongst tall vegetation, such as grass tussocks or reeds. Nests are often located on small islands (Marchant & Higgins 1993). The nest consists of a scrape in the ground, lined with grass and leaves (Pringle 1987). Breeding is often in response to local conditions but generally occurs from September to December (Pringle 1987). Females, which are larger and more brightly coloured than males, are thought to sometimes be polyandrous, mating with several males and leaving each one to

incubate and raise chicks. They lay 3-4 eggs per clutch and incubation lasts about 15-16 days. Most breeding records are from the Murray-Darling region (Marchant and Higgins 1993) and as such it is unlikely that this species would utilise the study area for breeding. Therefore, the proposed action is unlikely to disrupt the breeding aspects of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Regional habitat:

Estimating the amount of habitat available within the region is problematic. Limitations, notwithstanding, based on a sub-regional circular range of 30 km (diameter) from the study area there are 41,033 remnants ranging in size from <1 hectare to 3,058 hectares. In total these remnants make up over 100,013 hectares of remnant vegetation at the sub-regional scale. However the mean size of these remnants are relatively small (m= 2.4), which emphasises the pressures of clearing in the region.

Within the sub-regional area there are seven state forests (13,724 hectares) and fourteen reserves under DEC jurisdiction (7,287 hectares). Thus, within the sub-regional area 14% of potential habitat occurs within state forest while 7% occurs within land administered by DEC.

Whilst the roost and nesting locations of this species is unknown within this region the removal of approximately 4 hectares of vegetation from the investigation area is not likely to be considered a significant affect given that this represents only 0.07% of the regional habitat (Hexham NR and Kooragang NR) for this species.

Security of habitats:

The security of these remnants within the regional landscape are of concern given that 79% the foraging habitat is in private ownership and has the potential to be developed. A further 14% occurs within state forest. While this habitat would be potentially more secure than that in private ownership, commercial timber operations are a threat to the long term security. Approximately 7% of remnant vegetation within the sub-regional area occurs within land administered by DEC and is considered to be secure.

In the Hunter region much of the Australasian Painted Snipe habitat is reserved in conservation areas covering Hexham Swamp and Kooragang Nature Reserves. Painted Snipe move between wetlands as their suitability changes. However, they have comparatively specialised habitat requirements, so are more sensitive to overall habitat loss than are many wetland species. Thus, considering the fact that much of the swamp habitats within the Hunter region have been developed or degraded and the remainder is in private ownership places Painted Snipe at risk of habitat loss.

Geographical genetics:

Fragmentation of habitats alone is not ubiquitous with the isolation of genetic material, or the corresponding reduction of a local or meta-population range. The most important

determinant of which species are retained in isolated patches appears to be the interaction of patches with the surrounding habitat matrix (Debinski & Holt 2000). Habitat islands can occur as a part of habitat matrix that includes fragmented remnants or as part of landscapes comprised largely of continuous vegetation. Avian communities may persist on habitat islands in spite of pressures, but the long-term prospect of persistence may be illusionary. The persistence may be due only to immigration from less impacted "source" populations (Pulliam 1988; Robinson et al. 1997). Detailed study of reproduction, survival, and dispersal is the only way to determine this and identify effective management solutions.

A7.12 – Blue-billed Duck

The Blue-billed duck has a slate-blue bill with a glossy black neck and head with a chestnut coloured back. The female is darker than the male and has barred feathers which run in narrow bands.

Roosting Habitat:

They seldom seen on land and is almost wholly an aquatic species often congregating in non-breeding flocks of several hundred in large deep open freshwater dams and lakes in autumn and winter. Daylight hours are spent alone in small concealed bays within vegetation or communally in large exposed rafts far from shore. The investigation area is unlikely to provide roosting habitat for this species and as such the proposed action is unlikely to disrupt this aspect of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Access to Foraging Habitat:

Blue-billed Ducks forage on aquatic insects, invertebrates (crustaceans, molluscs, etc.) on the surface of the water or by diving. They also forage on seeds, stems, leaves, and fruit of a wide variety of emergent and submerged plants. They favour deep permanent freshwater swamps, especially those with beds of cumbungi. Feeding occurs in permanent freshwater zones where the water is clear and substrate is firm and clear of turbulence. They forage late in the afternoon and early morning. Newcastle Wetlands provide the best quality foraging habitat for this species within the study area. The investigation area does not contain foraging habitat for this species and as such the proposed action is unlikely to disrupt this aspect of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Access to Breeding Partners:

Breeding occurs in secluded densely vegetated situations with the nest constructed in Cumbungi beds or other vegetation generally over water. The proposed action is unlikely to affect breeding habitat for this species and as such would not disrupt this aspect of the life cycle of this species such that a viable local population would be placed at risk of extinction.

A7.13 – Green and Golden Bell Frog

The Green and Golden Bell frog is a relatively large, muscular frog species with robust body form. Adult size ranges from approximately 45mm to approximately 100mm with most individuals being in the 60-80 mm size class. The dorsal colouration is quite variable being a vivid pea green splotched with an almost metallic brass brown or gold. The backs of some individuals may be almost entirely green whilst in others the golden brown markings may almost cover the dorsum. The patterning of the gold markings over green is individually unique. The tadpoles of the Green and Golden Bell Frog are relatively large reaching 65-100mm at limb bud development stage (Stage 26 of Gosner, 1960). They are deep bodied and possess long tails with a high fin that extends almost half way along the body. Mouthparts consist of two upper and three lower labial rows (Martin, 1965; Courtice and Grigg, 1975; Tyler and Davies, 1978)

The habitat preference and requirements of the Green and Golden Bell Frog are not well understood and difficult to define (Mahony, 1999), and is often found in the most unlikely locations. It would appear that the species makes use of a number of habitat components to fulfil its life-cycle requirements. These include breeding, foraging and refuge habitat and perhaps suitable habitat to facilitate its movement patterns. The current general view of what constitutes the species habitat has emerged from the collective observations of habitat use by various authors but most of these observations have been heavily biased toward breeding habitat when the species is most obvious (see Pyke and White, 1996; Gillespie, 1996; Mahony, 1999; Pyke and White, 2002).

The species utilises a wide range of waterbodies including natural and man-made structures (Pyke and White, 1996). For example the species has been recorded associated with coastal swamps, marshes, dune swales, lagoons, lakes and other estuary wetlands as well as riverine floodplain wetlands and billabongs. Constructed water bodies such as storm water detention basins, farm dams, bunded areas, drains, ditches and other excavations capable of capturing water such as quarries and brick pits are also known to be occupied, even relatively minor structures such as tanks, safety bunds surrounding storage tanks, wells, cavitation pits, water troughs, old laundry tubs and baths have all been recorded as being utilised by the GGBF for breeding purposes.

The features of waterbodies used are that they are shallow, still or slow flowing, ephemeral and/or widely fluctuating, unpolluted and without heavy shading. There is still some debate as to the relative importance of some of these attributes (Gillespie, 1996; Patmore, 2001; Pyke and White, 2001; Hamer *et al.*, 2002). Other associated terrestrial habitat attributes which are extremely important include extensive grassy areas and an abundance of shelter sites such as rocks, logs, tussock forming vegetation and other cover adjacent to the investigation area (Pyke and White, 1996; Mahony, 1999; Patmore, 2001; Pyke and White, 2001). There is also a clear preference shown by GGBF for sites with a complexity of vegetation structure (Patmore, 2001; Hamer *et al.*, 2002).

Habitat features are often found peripheral to the breeding habitat and are considered foraging and/or refuge habitat. Refuge habitat is the least well understood component of

this species lifecycle but it is considered to be important for the species especially during the cooler parts of the year ("over-wintering" habitat) when they are not metabolically efficient, but also at other times when they are seeking shelter from adverse conditions or predators. The range of habitat that has been recorded as being used for this purpose includes:

- Dense tussock forming vegetation (Hamer, 1998 and pers. comm.; Patmore, 2001);
- deep fissures in mud (R. Wells pers. comm.; M. Christy vide Patmore, 2001);
- amongst rocks (White and Pyke, 1996; Hamer, 1998; Pyke and White, 2001; M. Christy vide Patmore, 2001);
- underground holes or burrows (Patmore, 2001);
- within rotting logs or under embedded logs and timber piles (R. Wells pers. comm., R. Wellington unpublished; Pyke and White 2001); and
- other human refuse such as sheet iron, fibro, bricks etc (Pyke and White, 2001; R.Wells pers. comm.). Such shelter has been recorded utilised by aggregations of the GGBF (R. Wells pers. comm.; R. Wellington unpublished; Pyke and White, 2001; Patmore, 2001).

A population of GGBF resides in a wetland adjacent to the western side of the proposed highway in the northern section of the study area, informally known as "2HD Swamp" (see Figure 9). Based on data compiled by the Society of Frogs and Reptiles over several years, it is inferred that this pond is the core habitat for this local population of GGBF. Individuals have been recorded to disperse from this pond after good breeding seasons and occupy lower quality habitats in the surrounding area. After a series of poor seasons, the population contracts back to the core habitat. The size and viability of this population is not known although during the 2001/2002 breeding season, 100 frogs were captured within the 2HD Swamp. Although there have been no comprehensive surveys since then, observations suggest a decline in population size over the past two drought seasons and a possible increase in the current breeding season (Society of Frogs and Reptiles, unpublished data).

It is unknown how this species utilises the investigation area and this information would need to be collected before an assessment of the potential impact on this population is possible.

The population dynamics of GGBF are yet to be fully understood, but like many frogs it has a boom and bust breeding cycle in response to seasonal conditions. It is probable that a large area of secondary habitat is required in addition to core breeding habitat to maintain a population of GGBF. While it remains unclear to what extent the secondary habitat is important, the precautionary principle requires that the secondary habitat be considered to be important. In relation to the investigation area, wetland remnants supporting Broad-leaf Cumbungi and, in some situations, Common Reed, including some small areas of deeper water and drainage channels are potential habitat for GGBF.

Breeding Habitat:

Breeding events and other associated reproductive behaviours have been recorded from late winter to early autumn but generally between September and February (Fletcher, 1889; Harrison, 1922; Barker *et al.*, 1995; Pyke and White, 2001) with a peak around January-February after heavy rain/storm events, (White, 1995a; Daly, 1995a; Griffiths, 1997; Anstis, 2002). Reproductive events are however clearly influenced by the prevailing weather conditions from season to season and also appear to be influenced by geography. More southerly and higher altitude populations appear to have a narrower window of opportunity for breeding than more northerly and lower altitude populations. More northerly populations appear to more often commence breeding earlier and continue longer than southern and tableland populations which appear to have a much shorter breeding period (Humphries, 1979; Clancy, 1986; Daly, 1995a; Patmore, 2001; G. Daly pers. comm.; Wellington and Parsons, in prep.).

The 2HD Swamp, adjacent to the proposed highway provides known breeding habitat for a local population of this species. The proposed action is unlikely to directly affect this habitat, however the importance of secondary habitat contained within the investigation area is not known and would need to be verified before an accurate assessment of the impacts on this species is possible.

Access to Foraging Habitat:

Dietary preference of tadpoles of the GGBF has been summarised in Pyke and White, (2001) where it is suggested that they predominantly graze on the algal or bacterial scum growing on submerged rocks and other substrata. More advanced tadpoles may show some preference for vegetable matter but also scavenge or become carnivorous on other aquatic organisms (Pyke and White, 2001). The behaviour of tadpoles is variable and is likely influenced by water depth, clarity, benthic vegetation and the presence of predators.

The investigation area is likely to provide foraging habitat for the local population of GGBF however the extent and importance of this habitat to the local population would need to be verified before an accurate assessment can be completed.

Access to Breeding Partners:

Breeding events and other associated reproductive behaviours have been recorded from late winter to early autumn but generally between September and February (Fletcher, 1889; Harrison, 1922; Barker et al., 1995; Pyke and White, 2001) with a peak around January-February after heavy rain/storm events, (White, 1995a; Daly, 1995a; Griffiths, 1997; Anstis, 2002). Reproductive events are however clearly influenced by the prevailing weather conditions from season to season and also appear to be influenced by geography.

Only males elicit the mating call and can be heard throughout the breeding period. Calling is mostly at night, although occasionally also by day. Calls are usually made whilst floating in water but also occasionally from positions amongst pond-side vegetation (Barker and Grigg, 1977; Barker et al., 1995; Pyke and White, 2001; Anstis, 2002). Males appear to reach maturity at around 45-50mm (9-12 months) and at this size begin to develop a grey to brownish yellow wash beneath the chin (Pyke and White, 2001). This discolouration indicates the development of a vocal sac (Tyler, 1994) and consequently that an individual has commenced calling behaviour.

The Green and Golden Bell Frog is a highly fecund species with average clutch size has also been estimated and in rounded figures is about 3700 eggs per clutch with 3-5 thousand apparently the norm (White, 1995; Daly, 1995a; Pyke and White, 2001; Anstis, 2002; Mahony, 2002). The spawn can be described as clear and gelatinous rather than foamy. The eggs are laid on the water surface where they float initially and then sink after 2-3 hours adhering to fringing vegetation (Harrison, 1922; Tyler and Davies, 1978; Barker, Grigg and Tyler, 1995; White, 1995).

The 2HD Swamp, adjacent to the proposed highway provides known breeding habitat for a local population of this species. The proposed action is unlikely to directly affect this habitat, however the importance of secondary habitat contained within the investigation area is not known and would need to be verified before an accurate assessment of the impacts on this species is possible.

Regional habitat:

There is evidence the species can show strong site fidelity with individuals returning to or remaining at an identified site (Murphy, 1994; Patmore, 2001; Hamer, 1998; M. Christy pers. comm.; R. Wellington unpublished). The species is capable of making quite large movements in a single day/night up to 1-1.5 km (A. White, pers. comm; Pyke and White, 2001; R. Wellington unpublished).

Within the Hunter region there are a number of 'key' Green and Golden Bell Frog populations identified within the recovery plan for this species, although all are disjunct and isolated from each other.

There are key populations at:

- Kooragang Island (>300);
- Ravensworth Liddell area Singleton; and
- Wentworth Swamps (Gillieston Heights)

Security of habitats:

Of the 43 known key populations, comprised of around 110 'satellite' sub-populations, only 12 are located predominantly within DEC estate equating to approximately 21%.

Geographical genetics:

Fragmentation of habitats alone is not ubiquitous with the isolation of genetic material, or the corresponding reduction of a local or meta-population range. The most important determinant of which species are retained in isolated patches appears to be the interaction of patches with the surrounding habitat matrix (Debinski & Holt 2000). Habitat islands can occur as a part of habitat matrix that includes fragmented remnants or as part of landscapes comprised largely of continuous vegetation. Avian communities may persist on habitat islands in spite of pressures, but the long-term prospect of persistence may be illusionary. The persistence may be due only to immigration from less impacted "source" populations (Pulliam 1988; Robinson *et al.* 1997). Detailed study of reproduction, survival, and dispersal is the only way to determine this and identify effective management solutions.

A7.14 – Black Bittern

The Black Bittern is a cryptic bird that can be difficult to locate during surveys. The species roost sites may either be on the ground amongst dense reed vegetation or within nearby trees (NPWS 1999). Can be found hunting at dusk and dawn, usually solitary but may occur in pairs (NPWS 1999), requires dense riparian vegetation, forested rivers, inlets and estuarine wetlands (DLWC 2000).

The Black Bittern Feeds on invertebrates, fish, reptiles and other small marine animals (Frith 1976). Breeds December-March (Marchant & Higgins 1990 cited NPWS 1999). Nest built of sticks; often in trees over water (DLWC 2000). Recorded at low elevations <200 asl; rarely recorded inland and south of Sydney (NPWS 1999).

The dense vegetation and riparian habitats that are vital for the species would not be impacted by the proposed action and therefore it is considered that the proposed action would not disrupt the life cycle of this species such that a viable local population would be placed at risk of extinction

A7.15 –Grey-headed Flying Fox

The Grey-headed Flying Fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps (Churchill 1998; Hall and Richards 2000; NPWS 2001). Urban gardens and cultivated fruit crops also provide habitat for this species. The main threats to the survival of this species are on-going habitat clearance particularly along the northern NSW coast. Un-regulated culling may also pose a threat to this species (DEH 2003).

Roosting Habitat:

Roost sites (camps) occur within rainforest patches, *Melaleuca* stands, mangroves, riparian woodland or modified vegetation in urban areas (NPWS 2004). Within the local area, a camp site occurs at Blackbutt Reserve. Protection of camp sites is a major factor in the successful management of this species as it has been shown to have a high fidelity for such sites. For example, some camps in NSW have been used for over a century (Eby 2000b cited in NPWS 2001).

No camp sites were identified within the study area during the survey period and as such the proposed action is unlikely to affect roosting habits of a local population of this species.

Access to Foraging Habitat:

Grey-headed Flying Foxes forage in the nectar and pollen of native trees, in particular *Eucalyptus* spp., *Melaleuca* spp. and *Banksia* spp. (Eby 2000a cited in NPWS 2001), and fruits of rainforest trees and vines.

Foraging movements are related to food availability, with movements of hundreds of kilometres being recorded (NPWS 2001). However, opportunistic foraging generally occurs at distances < 30 km from camps (occasionally < 60–70 km when food resources inconsistent) per night (Augee and Ford 1999; Tidemann 1999 cited NPWS 2004).

Between May and June the Grey-headed Flying Fox occurs in northern NSW and Queensland feeding on winter-flowering trees such as Swamp Mahogany (*Eucalyptus robusta*), Forest Red Gum (*E. tereticornis*) and Paperbark (*Melaleuca quinquenervia*) (Eby *et al.* 1999; P. Birt and L. Hall pers. comm. cited NPWS 2004).

Given the foraging habits of this species, the proposed action is unlikely to affect the ability of a local population to access areas of foraging habitat.

Access to Breeding Partners:

Reproductive age is reached between 2-3 years with only one offspring (generally) produced each year (Martin *et al.* 1996). They return annually to traditional camps to give birth and rear young (Lunney and Moon 1997; Augee and Ford 1999 cited NPWS 2004). There is a known camp site in Blackbutt Reserve approximately 4 kilometres to the south of the study area. The proposed action is unlikely to affect access to breeding partners for the local population.

Regional habitat:

Estimating the amount of habitat available within the region is problematic. Limitations, notwithstanding, based on a sub-regional circular range of 30 km (diameter) from the study area there are 41,033 remnants ranging in size from <1 hectare to 3,058 hectares. In total these remnants make up over 100,013 hectares of remnant vegetation at the sub-regional scale. However the mean size of these remnants are relatively small (m= 2.4), which emphasises the pressures of clearing in the region.

Within the sub-regional area there are seven state forests (13,724 hectares) and fourteen reserves under DEC jurisdiction (7,287 hectares). Thus, within the sub-regional area 14% of potential habitat occurs within state forest while 7% occurs within land administered by DEC.

The removal of approximately 2.9 hectares (0.003% of the regional habitat) of vegetation from the investigation area is not likely to be considered a significant affect given the regional distribution of this species and the amount of available habitat.

Security of Habitats:

The security of these remnants within the regional landscape are of concern given that 79% the foraging habitat is in private ownership and has the potential to be developed. A further 14% occurs within state forest. While this habitat would be potentially more secure than that in private ownership, commercial timber operations are a threat to the long term security. Approximately 7% of remnant vegetation within the sub-regional area occurs within land administered by DEC and is considered to be secure.

Thus, the insecurity of habitat within the region needs to be considered, especially areas which may contain suitable roost habitat which need to be protected in order to ensure the longevity of this species.

Geographical genetics:

Fragmentation of habitats alone is not ubiquitous with the isolation of genetic material, or the corresponding reduction of a local or meta-population range. The most important determinant of which species are retained in isolated patches appears to be the interaction of patches with the surrounding habitat matrix (Debinski & Holt 2000). Habitat islands

can occur as a part of habitat matrix that includes fragmented remnants or as part of landscapes comprised largely of continuous vegetation. Flying fox communities may persist on habitat islands in spite of pressures, but the long-term prospect of persistence may be illusionary. The persistence may be due only to immigration from less impacted "source" populations (Pulliam 1988; Robinson *et al.* 1997). Detailed study of reproduction, survival, and dispersal is the only way to determine this and identify effective management solutions.

A7.16 –Little Bent-wing Bat

Bats are known to spend over half their lives within their roosting environment (Kunz, 1982) suggesting that the protection of roosting habitats are extremely important to the management and conservation of bat species, especially species such as *Miniopterus australis* which occupy habitat limited structures including caves and mining tunnels as well as structures such as railway tunnels, storm water drains and houses (Hoye and Spence 2004).

While little information has been provided about the activities of *M. australis* within its roosting environment, it is likely to follow a similar pattern of activity to *M. schreibersii oceanensis* which shares its roost and breeding environment. A study by Codd *et al.* (2003) reported that within their cave-dwelling environment *M. schreibersii oceanensis* spent an average of 62% of its time at rest (not moving), 16% grooming (scratching, licking, preening) and 22% of the time active (head raised, alert, stretching). The study also identified that the time of day, location of the chamber, clustering of bats and their location on the cave wall all influenced the observed patterns of activity, however the relationships between these factors are difficult to determine.

Female *M. australis* undertake a regional migration in spring where they form maternity colonies in certain caves each year, whilst males undertake a much smaller migration to summer roost locations. It is speculated that this migration is undertaken as a reflection of resource requirements of the sexes. As females have higher energetic requirements during pregnancy and lactation (Kunz *et al.* 1995; Kurta *et al.* 1989; Speakman and Racey 1987) the benefits obtained from moving to high resource abundant areas may outweigh the costs of migration (Kunz 2003), further to this by establishing maternity roosts, a favourable temperature for maternity related activities can be established (Baundinette *et al.* 1994). Males with lower energetic demands are thought to accept lower resource densities in order to reduce migratory costs.

M. australis colonise in large numbers mainly in caves but also within man made structures such as bridge culverts, drains and buildings (DEH 2004; Hoye and Spence 2004). They are known to travel large distances between different roosts according to changing seasonal needs with winter roosting sites being located in cooler caves to aid in hibernation (Strahan 2000). As a result of migratory habits of this species, defining a local population is nearly impossible.

Roost Habitat:

For a subterranean roost to be considered significant it must have at least two of the following (DEH 2004):

- Mines or caves that are nearly horizontal tunnels ranging from several metres to deep interconnecting complex passageways;
- The presence of standing water or a damp floor;
- A domed area where temperature and humidity can be elevated through accumulation of heat or by retaining heat;

- High humidity;
- Be deep enough to have a fully dark area with constant temperatures; and
- Restricted airflow by partial collapse of entrance.

There are only a few known nursery sites for this species which are widespread throughout the region with females showing some fidelity for these sites (Hoye and Spence 2004). Nursery caves are large but must contain specific conditions of high temperature and humidity to be suitable. They are often large, dome-shaped chambers which allow them to house large numbers of juvenile bats and to retain warmed air created from bat activities.

Over-wintering roosts are generally cooler which assists bats to enter extended periods of torpor through periods of low food availability (Hoye and Spence 2004).

No potential roosting habitat was recorded within the study area during the survey period and as a result the proposed action is unlikely to have a significant effect on roosting habitat for this species.

Access to Foraging Habitat:

M. australis is essentially a coastal species with foraging associated with well timbered forest canopies in a broad range of habitats including rainforests, wet and dry sclerophyll forest, and *Melaleuca* swamps (Strahan 1995; Churchill 1998). Little Bent-wing Bats prefer foraging beneath well timbered canopies, flying rapidly with considerable manoeuvrability between the shrub and canopy layers in search of crane flies, ant, moths, and wasps (Churchill 1998). The open nature of the investigation area indicates that it would provide sub-optimal foraging habitat for this species.

Therefore, while the potential loss of 2.9 hectares of habitat as a result of the proposed action represents an incremental loss of habitat for a local population, the proposed action in itself is unlikely to place a local population at risk of extinction.

Access to breeding partners:

Whilst roost locations for this species are poorly known it is likely that access to breeding partners would not be inhibited by the proposal and that in the regional context access to breeding partners would not be restricted. Within NSW mating occurs in late May to early June after which implantation is delayed until August. After hibernation females migrate large distances in order to give birth to a single young in December within maternity caves (DEH 2004). Throughout this period males are generally absent and often undertake a much smaller migration to summer roost locations. Juvenile Bentwing bats disperse from maternity caves between February and March (Dwyer 1995) and once young become independent females leave the colony.

Given the breeding patterns of this species, the proposed action is unlikely to have a significant impact on breeding.

Regional habitat:

Estimating the amount of habitat available within the region is problematic. Limitations, notwithstanding, based on a sub-regional circular range of 30 km (diameter) from the study area there are 41,033 remnants ranging in size from <1 hectare to 3,058 hectares. In total these remnants make up over 100,013 hectares of remnant vegetation at the sub-regional scale. However the mean size of these remnants are relatively small (m= 2.4), which emphasises the pressures of clearing in the region.

Within the sub-regional area there are seven state forests (13,724 hectares) and fourteen reserves under DEC jurisdiction (7,287 hectares). Thus, within the sub-regional area 14% of potential habitat occurs within state forest while 7% occurs within land administered by DEC.

The removal of approximately 2.9 hectares (0.003% of the regional habitat) of vegetation from the investigation area is not likely to be considered a significant affect given the regional distribution of this species and the amount of available habitat.

Security of habitats:

The security of these remnants within the regional landscape are of concern given that 79% the foraging habitat is in private ownership and has the potential to be developed. A further 14% occurs within state forest. While this habitat would be potentially more secure than that in private ownership, commercial timber operations are a threat to the long term security. Approximately 7% of remnant vegetation within the sub-regional area occurs within land administered by DEC and is considered to be secure.

The limited information available on roost location is of concern given that the only known maternity cave for Bent-wing bats is located at Willi Willi caves, Kempsey. However, the discovery of Little Bent-wing bats at Balickera Tunnel (Ecotone 2000) suggests that an alternative maternity/roost site potentially occurs within the region given that Little Bent-wing bats are thought to fly only 60km from their maternity/roost cave (Dwyer, 1968 – cited in Ecotone report). As both bats are often found using the same maternity cave it is likely that *M. schreibersii oceanensis* would also be found within this cave.

Thus the insecurity of habitat within the region needs to be considered, especially areas which may contain suitable roost caves which need to be protected in order to ensure the longevity of this species.

Geographical genetics:

Kunz (2003) suggests that species which undertake regional migration and undergo periods of hibernation such as *M. australis* generally have polygamous mating systems

and uncooperative social behaviour which leads to the formation of communal nurseries (Wilkinson 1987).

Mating takes place in late autumn or early winter (Dwyer 1995). Females are fertilised at this time but implantation of the fertilised ovum does not take place until shortly before the females emerge from hibernation in August (Hoye and Spence 2004).Females occupy the over-wintering roosts until September when they migrate back to maternity roosts to give birth, often covering at least 70 km in a single night (Hoye and Spence 2004). The annual roost pattern for males is quite different. Up to fifty percent of the male population is present at the maternity roost during the breeding season with the remainder forming male colonies at roost sites used for other purposes at other times of the year (Hoye and Spence 2004).

Fragmentation of habitats alone is not ubiquitous with the isolation of genetic material, or the corresponding reduction of a local or meta-population range. The most important determinant of which species are retained in isolated patches appears to be the interaction of patches with the surrounding habitat matrix (Debinski & Holt 2000). Habitat islands can occur as a part of habitat matrix that includes fragmented remnants or as part of landscapes comprised largely of continuous vegetation.

Cardinal & Christidis (2000) also recognise that many natural cave systems have been disturbed by humans and that barriers between the Bent-wing bat populations in Queensland and Victoria are becoming less due to human intervention. Human created infrastructure, such as mines and other artifical roosts are now reducing gaps between the populations thus making it easier for individuals from geographically distinct areas to intermingle.

Detailed study of reproduction, survival, and dispersal is the only way to determine this and identify effective management solutions.

A7.17 – s Large Bent-wing Bat

Bats are known to spend over half their lives within their roosting environment (Kunz, 1982) suggesting that the protection of roosting habitats are extremely important to the management and conservation of bat species, especially cave-dwelling species such as *Miniopterus schreibersii oceanensis* which occupy habitat limited structures such as caves and mining tunnels.

M. schreibersii oceanensis exhibits a biomodal activity pattern indicative of most bats, where they leave the cave around sunset to feed and return to the roost between 2400 – 0100 to digest before leaving again after an hour to forage until dawn (Codd *et al.* 2001). Hoye (2000) estimated whilst they are highly mobile they generally forage within a radius of 20km from their roost site in a night.

While little information has been provided about the activities of bats within their roosting environments, a study by Codd *et al.* (2003) reported that within their cave-dwelling environment *M. schreibersii oceanensis* spent an average of 62% of its time at rest (not moving), 16% grooming(scratching, licking, preening) and 22% of the time active (head raised, alert, stretching). The study also identified that the time of day, location of the chamber, clustering of bats and their location on the cave wall all influenced the observed patterns of activity, however the relationships between these factors are difficult to determine.

Female *M. schreibersii oceanensis* undertake a regional migration in spring where they form maternity colonies in certain caves each year, whilst males undertake a much smaller migration to summer roost locations. It is speculated that this migration is undertaken as a reflection of resource requirements of the sexes. As females have higher energetic requirements during pregnancy and lactation (Kunz *et al.* 1995; Kurta *et al.* 1989; Speakman and Racey 1987) the benefits obtained from moving to high resource abundant areas may outweigh the costs of migration (Kunz 2003), further to this by establishing maternity roosts, a favourable temperature for maternity related activities can be established (Baundinette *et al.* 1994). Males with lower energetic demands are thought to accept lower resource densities in order to reduce migratory costs.

M. schreibersii oceanensis colonise in large numbers mainly in caves but also within man made structures such as bridge culverts, drains and buildings (DEH 2004; Hoye and Spence 2004). They are known to travel large distances between different roosts according to changing seasonal needs with winter roosting sites being located in cooler caves to aid in hibernation (Strahan 2000). As a result of migratory habits of this species, defining a local population is nearly impossible.

Roost Habitat:

For a subterranean roost to be considered significant it must have at least two of the following (DEH 2004):

- Mines or caves that are nearly horizontal tunnels ranging from several metres to deep interconnecting complex passageways;
- The presence of standing water or a damp floor;
- A domed area where temperature and humidity can be elevated through accumulation of heat or by retaining heat;
- High humidity;
- Be deep enough to have a fully dark area with constant temperatures; and
- Restricted airflow by partial collapse of entrance.

There are only a few known nursery sites for this species which are widespread throughout the region with females showing some fidelity for these sites (Hoye and Spence 2004). Nursery caves are large but must contain specific conditions of high temperature and humidity to be suitable. They are often large, dome-shaped chambers which allow them to house large numbers of juvenile bats and to retain warmed air created from bat activities.

Over-wintering roosts are generally cooler which assists bats to enter extended periods of torpor through periods of low food availability (Hoye and Spence 2004).

No potential roosting habitat was recorded within the study area during the survey period and as a result the proposed action is unlikely to have a significant effect on roosting habitat for this species.

Access to Foraging Habitat:

M. schreibersii oceanensis is essentially a coastal species with foraging associated with major drainage systems (DEH 2004). They are insectivorous and show a preference for foraging in well timbered valleys above the tree canopy (Dwyer 1995).

Thus, the proposed action involves the net loss of approximately 2.9 hectares of foraging habitat for this species. However, given its preference for foraging over well timbered forest, most of the potential foraging habitat within the investigation area would be considered sub-optimal. While the loss of habitat as a result of the proposed action represents an incremental loss of habitat for a local population, this proposed action in itself is unlikely to place a local population at risk of extinction.

Access to breeding partners:

Whilst roost locations for this species are poorly known it is likely that access to breeding partners would not be inhibited by the proposal and that in the regional context access to breeding partners would not be restricted. Within NSW mating occurs in late May to

early June after which implantation is delayed until August. After hibernation females migrate large distances in order to give birth to a single young in December within maternity caves (DEH 2004). Throughout this period males are generally absent and often undertake a much smaller migration to summer roost locations. Juvenile Bent-wing bats disperse from maternity caves between February and March (Dwyer 1995) and once young become independent females leave the colony.

Given the breeding patterns of this species, the proposed action is unlikely to have a significant impact on breeding.

Regional Habitat:

Estimating the amount of habitat available within the region is problematic. Limitations, notwithstanding, based on a sub-regional circular range of 30 km (diameter) from the study area there are 41,033 remnants ranging in size from <1 hectare to 3,058 hectares. In total these remnants make up over 100,013 hectares of remnant vegetation at the sub-regional scale. However the mean size of these remnants are relatively small (m= 2.4), which emphasises the pressures of clearing in the region.

Within the sub-regional area there are seven state forests (13,724 hectares) and fourteen reserves under DEC jurisdiction (7,287 hectares). Thus, within the sub-regional area 14% of potential habitat occurs within state forest while 7% occurs within land administered by DEC.

The removal of approximately 2.9 hectares (0.003% of the regional habitat) of vegetation from the investigation area is not likely to be considered a significant affect given the regional distribution of this species and the amount of available habitat.

Security of Habitats:

The security of these remnants within the regional landscape are of concern given that 79% the foraging habitat is in private ownership and has the potential to be developed. A further 14% occurs within state forest. While this habitat would be potentially more secure than that in private ownership, commercial timber operations are a threat to the long term security. Approximately 7% of remnant vegetation within the sub-regional area occurs within land administered by DEC and is considered to be secure.

The limited information available on roost location is of concern given that the only known maternity cave for Bent-wing bats is located at Willi Willi caves, Kempsey. However, the discovery of Little Bent-wing bats at Balickera Tunnel (Ecotone 2000) suggests that an alternative maternity/roost site potentially occurs within the region given that Little Bent-wing bats are thought to fly only 60km from their maternity/roost cave (Dwyer, 1968 – cited in Ecotone report). As both bats are often found using the same maternity cave it is likely that *M. schreibersii oceanensis* would also be found within this cave.

Thus the insecurity of habitat within the region needs to be considered, especially areas which may contain suitable roost caves which need to be protected in order to ensure the longevity of this species.

Geographical Genetics:

Kunz (2003) suggests that species which undertake regional migration and undergo periods of hibernation such as *M. schreibersii oceanensis* generally have polygamous mating systems and uncooperative social behaviour which leads to the formation of communal nurseries (Wilkinson 1987).

Mating takes place in late autumn or early winter (Dwyer 1995). Females are fertilised at this time but implantation of the fertilised ovum does not take place until shortly before the females emerge from hibernation in August (Hoye and Spence 2004). Females occupy the over-wintering roosts until September when they migrate back to maternity roosts to give birth, often covering at least 70 km in a single night (Hoye and Spence 2004). The annual roost pattern for males is quite different. Up to fifty percent of the male population is present at the maternity roost during the breeding season with the remainder forming male colonies at roost sites used for other purposes at other times of the year (Hoye and Spence 2004).

Fragmentation of habitats alone is not ubiquitous with the isolation of genetic material, or the corresponding reduction of a local or meta-population range. The most important determinant of which species are retained in isolated patches appears to be the interaction of patches with the surrounding habitat matrix (Debinski & Holt 2000). Habitat islands can occur as a part of habitat matrix that includes fragmented remnants or as part of landscapes comprised largely of continuous vegetation.

Interestingly the mitochondrial DNA and morphology of *M. schreibersii* has recently been studied by Cardinal & Christidis (2000) resulting in the identification of three geographically distinct forms of this bat within Australia. They argue that because there was only a 3-4% difference between their mitochondrial sequence they should not be regarded as different species as they do not approach the 10% divergence typical of interspecies differentiation.

Cardinal & Christidis (2000) also recognise that many natural cave systems have been disturbed by humans and that barriers between the Eastern Bent-wing bat populations in Queensland and Victoria are becoming less due to human intervention. Human created infrastructure, such as mines and other artifical roosts are now reducing gaps between the populations thus making it easier for individuals from geographically distinct areas to intermingle.

Detailed study of reproduction, survival, and dispersal is the only way to determine this and identify effective management solutions.

A7.18 – Eastern Free-tail Bat

Mormopterus norfolkensis is a tree-dwelling (Allison and Hoye 1995) insectivorous bat which is often found in dry eucalypt forest and coastal woodlands, although individuals have also been captured within riparian zones, wet sclerophyll forest and rainforest (Allison and Hoye 1995). They forage above the canopy or in unobstructed corridors in open areas (Allison and Hoye 1995) on either winged or wingless ants (Allison 1989). All authenticated records of this species occur to the east of the Great Dividing Range (Ecotone 1996).

The habitat requirements of *M. norfolkensis* are not very well known or understood. They are tree dwelling bats (Allison and Hoye 1995) which roost together in small colonies in hollows or under loose bark (Australian Museum 2004b).

This species has been recorded in the ecotone between cleared corridors and eucalypt forest/woodland and in forest/woodland habitats often in the vicinity of open water (Ecotone 1996). Thus, it is expected that forested land and the cleared land adjacent to bushland constitutes important habitat for this species and specific foraging activity may be concentrated over small areas of open water, such as dams and creeks in forest (Ecotone 1996).

Seldom has more than one individual been captured from the locations where the species is known to occur, suggesting population densities, even in suitable areas, are low (EEC 1996). These factors make it nearly impossible to determine the extent of any local population; low population densities may suggest that the local population would cover a large geographical area.

Regional Habitat:

Estimating the amount of habitat available within the region is problematic. Limitations, notwithstanding, based on a sub-regional circular range of 30 km (diameter) from the study area there are 41,033 remnants ranging in size from <1 hectare to 3,058 hectares. In total these remnants make up over 100,013 hectares of remnant vegetation at the sub-regional scale. However the mean size of these remnants are relatively small (m= 2.4), which emphasises the pressures of clearing in the region.

Within the sub-regional area there are seven state forests (13,724 hectares) and fourteen reserves under DEC jurisdiction (7,287 hectares). Thus, within the sub-regional area 14% of potential habitat occurs within state forest while 7% occurs within land administered by DEC.

Location and amount of roosting habitat within the sub-regional area is largely unknown and due to the low population densities apparently exhibited by this species, it would be nearly impossible to quantify this. The proposed action would result in the removal of approximately 2.9 hectares of foraging and potential roost habitat for this species which equates to less than 0.01% of the habitat available within the sub-regional area. As such,

it is considered unlikely that the proposal in itself, would significantly compromise the viability of a local population.

Security of Habitats:

The security of these remnants within the regional landscape are of concern given that 79% the foraging habitat is in private ownership and has the potential to be developed. A further 14% occurs within state forest. While this habitat would be potentially more secure than that in private ownership, commercial timber operations are a threat to the long term security. Approximately 7% of remnant vegetation within the sub-regional area occurs within land administered by DEC and is considered to be secure.

Thus the insecurity of habitat within the region needs to be considered, especially areas which may contain suitable roost caves which need to be protected in order to ensure the longevity of this species.

Access to Breeding Partners:

Little is known of the reproductive cycle of *M. norfolkensis*, but the capture of a number of females and no males at one site indicates that there may be some sexual segregation at certain times of year (Allison and Hoye 1995). Inspection of potential roosting/breeding hollows would be undertaken prior to removal of such habitat. With such measures in place it is considered unlikely that the proposed action would disrupt the breeding cycle of this species such that a viable local population would be placed at risk of extinction.

A7.18 –Greater Broad-nosed Bat

Scoteanax rueppellii is an insectivorous bat which is predominantly coastal (altitudes under 500 metres) and less than 100km inland (Hoye & Richards, 1995). It is found in a variety of habitats ranging from woodlands, moist and dry eucalypt forest and rainforest (Hoye & Richards, 1995). They prefer open habitats in which they can fly straight and direct and are known to utilise artificial openings in forests, with their favoured habitats being river and creek corridors (Hoye & Richards, 1995). The Greater Broad-nosed Bat is described as being structurally similar to *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) but has a dark reddish-brown fur above with a lighter undersurface, it has relatively long ears with the keel deflected posteriorly (Hoye & Richards, 1995). The key distinguishing feature is the two upper incisors on each side.

The National Action Plan for Bats (DEH 1999) recommended the following actions in order to improve the knowledge on Greater Broad-nosed Bats:

- Ensure protection of populations throughout the range of the species.
- Carry out ecological research to determine:
    - habitat requirements;
    - roost and maternity site selection, particularly winter and maternity roosts in the northern, central and southern sections of its distribution;
    - the sensitivity of roosts to disturbance;
    - key foraging areas and to ascertain the effectiveness of current forestry management practices in protecting these areas.
    - population dynamics; and
    - threatening processes.

Access to Foraging Habitat:

Greater Broad-nosed Bat has a preference for moist gullies in mature coastal forest or rainforest on the eastern side of the Great Dividing Range (Churchill 1998). They have also been found in gullies associated with open woodland and wet and dry sclerophyll forest (Churchill 1998).

Greater Broad-nosed Bat feeds on slow flying prey such as moths and a variety of beetles, including ground beetles, chafers and leaf beetles (Churchill 1998). These are hawked within 20m of the ground along rows of trees lining creeks and the edges of otherwise cleared paddocks (Churchill 1998).

Prey species are generally inactive below 10°C which makes energy expenditure an important component of the life cycle of hollow dwelling bats such as the Greater Broad-nosed Bat. The activity patterns of prey species often makes foraging a waste of time for this species during cold winter nights, therefore they enter into torpor to save energy.

Bats found to roost in exposed locations under bark and in fissures were found (Turnbill 2005) to enter into periods of continuous torpor during winter only becoming active for a few hours at dusk and only foraging on especially warm nights.

Given the habitat preferences of this species, the investigation area would be considered as sub-optimal habitat. Therefore, the proposed action is unlikely to disrupt the foraging aspects of this species life cycle such that a viable local population would be placed at risk of extinction.

Roosting Habitat:

Individuals have been recorded roosting in tree hollows, cracks and fissures in the trunk and boughs of stags, and under exfoliating bark. Maternity sites have not been documented for this species (DEH, 1999). However, a recent study on the north coast of NSW by Campbell (2001) found that *Scoteanax rueppellii* were found to roost exclusively in *Melaleuca quinquenervia* or *Melaleuca stypheloides*. Roost trees were mature trees which had been affected by fire, they were tall and thin DBH's ranging from 12 to 22 cm and roost hollows approximately 8 m high. Roost habitat occurred in a *Melaleuca* swamp woodland habitat (Wallum) in areas of low relief. The understorey vegetation changed considerably from sedgeland to wet heath, but roost habitats remained constant.

A radio-tracking study undertaken by Turnbill (2005) investigated the roost requirements of hollow-dwelling and bark-dwelling bats to gain an understanding of roost requirements. Turnbill (2005) found that hollow dwelling bats prefer utilising large, old or dead trees, but can also roost under bark, fissures and switch between roosts almost daily. During winter had preference for roosting on north-western aspects to take advantage of solar heating. Females were found to require large hollows in spring/summer to accommodate maternity colonies of 10 to 100 bats which provided a warm stable environment, whilst males were solitary throughout this period. Maternity colonies were also found to move between ten or more different tree roosts but show strong fidelity to a restricted roosting area.

Campbell (2001) also studied the behaviour of the Greater Broad-nosed Bat through radio-tracking and incidental observation during the study. The study suggests that the Greater Broad-nosed Bat has high site fidelity with one bat occupying the same roost for 6 days. The study also suggests that Greater Broad-nosed Bat forage within proximity of their roost with the largest distance from capture point to roost site being 2 km, although loss of radio contact suggested that they do travel over much larger distances. While this data was not sufficient to draw definitive results it highlighted patterns of foraging and roost behaviour and habitat relationships which has management implications.

Potential roosting habitat was not observed within the study area during the survey period. Therefore, the proposed action is unlikely to disrupt the breeding and roosting aspects of this species life cycle such that a viable local population would be placed at risk of extinction.

Regional Habitat:

Estimating the amount of habitat available within the region is problematic. Limitations, notwithstanding, based on a sub-regional circular range of 30 km (diameter) from the study area there are 41,033 remnants ranging in size from <1 hectare to 3,058 hectares. In total these remnants make up over 100,013 hectares of remnant vegetation at the sub-regional scale. However the mean size of these remnants are relatively small (m= 2.4), which emphasises the pressures of clearing in the region.

Within the sub-regional area there are seven state forests (13,724 hectares) and fourteen reserves under DEC jurisdiction (7,287 hectares). Thus, within the sub-regional area 14% of potential habitat occurs within state forest while 7% occurs within land administered by DEC.

Location and amount of roosting habitat within the sub-regional area is largely unknown and due to the low population densities apparently exhibited by this species, it would be nearly impossible to quantify this. The proposed action would result in the removal of approximately 2.9 hectares of foraging and potential roost habitat for this species which equates to less than 0.003% of the habitat available within the sub-regional area. As such, it is considered unlikely that the proposed action in itself, would significantly compromise the viability of a local population.

Security of Habitats:

The security of these remnants within the regional landscape are of concern given that 79% the foraging habitat is in private ownership and has the potential to be developed. A further 14% occurs within state forest. While this habitat would be potentially more secure than that in private ownership, commercial timber operations are a threat to the long term security. Approximately 7% of remnant vegetation within the sub-regional area occurs within land administered by DEC and is considered to be secure.

Thus the insecurity of habitat within the region needs to be considered, especially areas which may contain suitable roost caves which need to be protected in order to ensure the longevity of this species.

A7.19 - Eastern False Pipistrelle

The Eastern False Pipistrelle inhabits sclerophyll forests on the eastern side of the Great Dividing Range (Churchill 1998).

Roosting Habitat:

They generally roost in tree hollows in colonies of 3 to 36 individuals however they have been recorded roosting in caves at Jenolan and are sometimes found in old wooden buildings (Churchill 1998).

No potential roosting habitat was identified within the investigation area during the survey period and as such it is unlikely that the proposed action would disrupt this aspect of the species life cycle such that a viable local population would be placed at risk of extinction.

Foraging Habitat:

Eastern False Pipistrelle preys on a variety of flying invertebrates within or just below the tree canopy (Churchill 1998). They tend to fly fast and straight with sudden darting changes in course to attack potential prey (O'Neil and Taylor 1986; Churchill 1998).

Given that this species has a preference for foraging in well timbered areas, the investigation area is considered to provide only sub-optimal foraging habitat. Therefore, the proposed action is unlikely to disrupt the foraging aspects of the life cycle of this species such that a viable local population would be placed at risk of extinction.

It is virtually impossible to estimate the local population of any microchiropteran bat species based on the existing data. Most microchiropteran bats are highly mobile and can travel large distances between roost sites and foraging areas, although some have a restricted foraging range around their roost or maternity tree. Without detailed genetic data or banding recovery data it is not possible to know the extent of interactions between individuals and, therefore, the extent of the local populations.

A7.20 - s Yellow-bellied Sheath-tailed Bat

Little is known of the ecology of this species. This can be attributed to a combination of its rarity throughout its range and the difficulty in capturing individuals (Rhodes and Hall, 1997). Therefore, it is virtually impossible to estimate a local population of this species based on the existing data. It is a highly mobile species and without detailed genetic data or banding recovery data it is not possible to know the extent of interactions between individuals and, therefore, the extent of the local populations.

Roosting Habitat:

This species roosts in tree hollows and tend to be solitary for most of the year (Churchill 1998); however, colonies of up to 29 individuals have been recorded (see Rhodes and Hall 1997).

No potential roosting habitat for this species was observed within the investigation area during the survey period and as such the proposed action is unlikely to disrupt this aspect of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Foraging Habitat:

This species preys on airborne invertebrates (largely beetles and moths) generally above the tree canopy (Churchill 1998). It has been recorded feeding over chenopod shrubland were no trees were present however it apparently prefers to stay close to treed areas (DLWC Threatened Species Profile).

Given the foraging preferences of this species, the investigation area is considered to provide sub-optimal habitat. Therefore, the proposed action is unlikely to disrupt the foraging aspects of the life cycle of this species such that a viable local population would be placed at risk of extinction.

Appendix 8:
Assessment pursuant to EPBC Act

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Table A8.1 - Assessment for Grey-Headed Flying Fox

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the action is unlikely to result in a long-term decrease in the size of a population.
2. Whether the action would reduce the area of occupancy of the species.	No, the removal of 2.9 ha of potential foraging habitat comprising of forested areas within map units 3a,3b, 4, 5 and 6 would not significantly reduce the area of occupancy of this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the action would not result in the fragmenting of an existing population.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Grey-headed Flying Fox and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	No, the action would not disrupt the breeding cycle of a population, where a species is identified as occurring or likely to occur it is recommended that clearing take place outside of its known breeding period where possible.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline. Grey-headed Flying Fox is a highly mobile species which forages over a large range and as such the removal of 2.9 ha of potential foraging habitat is not considered to be significant.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action is unlikely to result in invasive species becoming established in 'endangered' species habitats.
8. Whether the action would interfere with the recovery of the species.	The action is unlikely to interfere with the recovery of the species.

Table A8.2 - Assessment for Green and Golden Bell Frog

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	Yes. The action could potentially disrupt foraging habitat and the dispersal abilities of a local population which could ultimately lead to a decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	Yes. The action could potentially reduce the area of occupancy for the local population of this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the action would not result in the fragmenting of an existing population.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Green and Golden Bell Frog and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	Yes. The action could potentially disrupt the dispersal abilities of the local population and could therefore potentially disrupt the demography and breeding dynamics of the local population.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Yes. The proposed action could potentially modify or remove foraging habitat for this species and could potentially further isolate the 2HD swamp breeding population. This could result in a decline of the species.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action is unlikely to result in invasive species becoming established in 'endangered' species habitats.

Table A8.2 - Assessment for Green and Golden Bell Frog

Factor	Response
8. Whether the action would interfere with the recovery of the species.	The Draft Recovery Plan for Green and Golden Bell Frog (DEC 2005) advocates a program that: • increases the security of key GGBF populations by way of preventing the further loss and favouring in-situ protection and management of GGBF habitat at key populations as well as secure opportunities for increasing the protection of these habitat areas; • ensure extant GGBF populations are managed to eliminate or attenuate the operation of factors that are known or discovered to be detrimentally affecting the species; • implement habitat management initiatives informed through a coordinated monitoring program; • establish self sustaining and representative colonies of 'at risk' captive populations of the GGBF for the primary purpose of maintaining 'insurance' colonies for re-establishment and supplementation; and • through educational programs and involvement increase the level of regional and local awareness of the conservation status of the GGBF and provide opportunity for community participation in the implementation of this recovery plan. Only four populations of this species occur in the Hunter region (DEC 2005). The proposed action could result in decreased security for the population occurring in the study area by potentially disrupting foraging habitat, dispersal ability and breeding dynamics. Therefore, the proposed action could interfere with the recovery of this species.

Table A8.3 - Assessment for Painted Snipe

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, it is unlikely that the proposed action would result in the long-term decrease in the population size of the Painted Snipe.
2. Whether the action would reduce the area of occupancy of the species.	No, the action is unlikely to result in a reduced area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the action would not fragment an existing population into two or more populations
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Painted Snipe and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	This species breeds mainly in the Murray-Darling region (Marchant and Higgins 1993). Therefore, the action would not disrupt the breeding cycle of a population.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action is unlikely to result in invasive species becoming established in 'endangered' species habitats.
8. Whether the action would interfere with the recovery of the species.	The action is unlikely to interfere with the recovery of the species.

Table A8.4 - Assessment for Latham's Snipe

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Latham's Snipe and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	This species breeds in northern Japan and the east Asian mainland (Higgins and Davies 1996). Therefore, the action is would not disrupt the breeding cycle of this species..
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.5 - Assessment for Great Egret

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Great Egret and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Great Egret forms breeding colonies, often in association with cormorants, ibises and other egrets (Australian Museum 2003b) normally between October and December. The Shortland Wetlands is an important site for breeding colonies of this species (The Wetlands Centre 2005). No such colonies have been identified utilising the investigation area and as such the proposed action is unlikely to disrupt the breeding cycle of this species.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.6 - Assessment for Cattle Egret

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Cattle Egret and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Cattle Egret forms breeding colonies, often in association with cormorants, ibises and other egrets (Australian Museum 2003b) normally between October and December. The Shortland Wetlands is an important site for breeding colonies of this species (The Wetlands Centre 2005). No such colonies have been identified utilising the investigation area and as such the proposed action is unlikely to disrupt the breeding cycle of this species. No such colonies have been identified utilising the investigation area and as such the proposed action is unlikely to disrupt the breeding cycle of this species.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.7 - Assessment for Glossy Ibis

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Glossy Ibis and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Glossy Ibis breeds in colonies mostly in the Macquarie Marshes region in NSW (Pizzey and Knight 1997). No breeding colonies are known to utilise the investigation area and as such the proposed action is unlikely to disrupt the breeding cycle of this species.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.8 - Assessment for White-bellied Sea Eagle

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for White-bellied Sea Eagle and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The White-bellied Sea Eagle breeds throughout its range building a large nest in tall live tree, on the ground on islands or on remote coastal cliffs (Pizzey and Knight 1997). No nests were located in the investigation area and further to this there are no ideal nesting habitats within the investigation area. As such, the action is unlikely to disrupt the breeding cycle of this species.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.9 - Assessment for Fork-tailed Swift

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Fork-tailed Swift and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Fork-tailed Swift is a non-breeding migrant to Australia. Therefore, the proposed action is unlikely to disrupt the breeding cycle of this species.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.10 - Assessment for Swamp Harrier

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Swamp Harrier and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Swamp Harrier breeds from September to February building a low nest out of grasses, sticks or rushes in tall grass, grain crops or other dense , low vegetation (Pizzey and Knight 1997). This species was not recorded during the survey period and is not considered to be currently nesting within the investigation area. Therefore, the proposed action is unlikely to disrupt the breeding cycle of this species.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.11 - Assessment for Tawny Grassbird

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under the s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Tawny Grassbird and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Tawny Grassbird breeds from August to December building a nest in rank grass in coastal heaths, rank grasses, canegrass, cumbungi swamps, grassy dunes and crops (Pizzey and Knight 1997). This species was recorded within the investigation area during the surveys and as such is likely to be breeding within the investigation area. However, there is an extensive area of habitat surrounding the investigation area which would also be used for breeding by the local population. Therefore, the proposed action is unlikely to significantly disrupt the breeding cycle of the local population.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.12 - Assessment for Little Grassbird

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Little Grassbird and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Little Grassbird breeds from August to December or opportunistically after rain building a nest of cupped grass in grass, reeds and low shrubs (Pizzey and knight 1997). This species was identified within the investigation area during the survey period and would potentially be breeding within the investigation area. However, there is an extensive area of habitat surrounding the investigation area which would also be used for breeding by the local population. Therefore, the proposed action is unlikely to significantly disrupt the breeding cycle of the local population.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.13 - Assessment for Clamorous Reed Warbler

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Clamorous Reed Warbler and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Clamorous Reed Warbler breeds from September to December building a deep cup nest from reed-sheaths woven around reed stems or willow strands (Pizzey and Knight 1997). This species was observed within the investigation area during the survey period and potentially breeds within the investigation area. However, there is an extensive area of habitat surrounding the investigation area which would be utilised for breeding by the local population. Therefore, it is considered unlikely that the proposed action would disrupt the breeding cycle of the local population.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.14 - Assessment for Golden-headed Cisticola

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Golden-headed Cisticola and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Golden-headed Cisticola breeds from September to March building a small dome nest of fine grass, plant-down, and sown together with spider web in a low shrub, reeds or tussock grass (Pizzey and Knight 1997). This species was observed within the investigation area during the survey period and potentially breeds within the investigation area. However, there is an extensive area of habitat surrounding the investigation area which would be utilised for breeding by the local population. Therefore, it is considered unlikely that the proposed action would disrupt the breeding cycle of the local population.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.15 - Assessment for Masked Lapwing

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Masked Lapwing and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Masked Lapwing breeds from June to October laying eggs in a small scrape on the ground which is generally situated away from groundcover (Pizzey and Knight 1997). This species was heard observed nesting on the northern end of the existing SH23 adjacent to the Sandgate roundabout. While the proposed action would result in the removal of a small area of breeding habitat for this species, Masked Lapwing is considered to be secure in the local area and as such the proposed action is unlikely to disrupt the breeding cycle of the local population.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.16 - Assessment for Whistling Kite

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Whistling Kite and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	The Whistling Kite builds a large nest in a tall tree (Pizzey and Knight 1997). No nests were observed within the investigation area and as such the proposed action is unlikely to disrupt the breeding cycle of the local population.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Table A8.17 - Assessment for Nankeen Kestrel

Factor	Response
1. Whether the action would lead to a long-term decrease in the size of a population.	No, the proposed action would result in the long-term decrease in the size of the population.
2. Whether the action would reduce the area of occupancy of the species.	No, the proposed action would not reduce the area of occupancy for this species.
3. Whether the action would fragment an existing population into two or more populations.	No, the proposed action would not fragment an existing population into two or more populations.
4. Whether the action would adversely affect habitat critical to the survival of a species.	Under s.207A of EPBC Act, Critical Habitat may be registered for any nationally listed threatened species or ecological community. When adopting a Recovery Plan the Federal Minister for the Environment must consider whether to list habitat identified in the Recovery Plan as being critical to the survival of the species or ecological community. No such habitat has been listed for Nankeen Kestrel and as such the proposed action would not adversely affect critical habitat.
5. Whether the action would disrupt the breeding cycle of a population.	Nankeen Kestrel nests in a variety of sites including tree hollows, caves, ledges on the outsides of buildings and occasionally on the ground (Pizzey and Knight 1997). A Nankeen Kestrel was observed foraging over the reed swamp in the investigation area during the survey period but was not observed to be nesting within the investigation area. The species is considered to be secure in the local area and given that it was not observed to be nesting within the investigation area the proposed action is unlikely to disrupt the breeding cycle of the local population.
6. Whether the action would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No, the action would not modify the availability or quality of habitat to the extent that a species is likely to decline.
7. Whether the action would result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*.	The action may result in the introduction of invasive species however mitigation measures such as thorough cleaning of machinery, equipment, shoes, and clothing etc. would ensure no invasive seed species enter the disturbed area. The action would not create favourable conditions for invasive species, such as the addition of nutrients etc.
8. Whether the action would interfere with the recovery of the species.	The action would not interfere with the recovery of the species.

Appendix 9:
Noxious Weeds and Management

Table A9 - Noxious weeds present within the investigation area and appropriate management actions.

Common Name	Scientific Name	Category	Removal Technique	Requirements under the Noxious Weed Act 1993
TREES/SHRUBS				
Bitou Bush	*Chrysanthemoides monilifera subsp. rotundata*	W3	Crown seedlings, cut and paint	Private Landholders must prevent the spread and reduce the numbers and distribution of W3 weeds
Small and Large-leaved Privet	*Ligustrum spp.*	W4B	Crown remove all roots, Cut and paint	The weed must not be sold, propagated or knowingly distributed and any existing weed must be prevented from flowering and fruiting.
Weeping Willow	*Salix spp*	W4G	Crown seedlings, cut and paint	The weed must not be sold, propagated or knowingly distributed.
Green Cestrum	*Cestrum parqui*	W3	Crown seedlings, cut and paint	Private Landholders must prevent the spread and reduce the numbers and distribution of W3 weeds
Prickly Pear	*Opuntia spp*	W4F	Crown	The weed must not be sold, propagated or knowingly distributed. Any biological control or other control program directed by a LCA must be implemented.
HERBS/FORBS/GRASSES/VINES				
Crofton Weed	*Ageratina adenophora*	W2	Hand pull, crown before fruiting	Private landholders must fully and continuously suppress and destroy all W2 noxious weeds
Pampas Grass	*Cortadieria selloana*	W2/W3	Dig out, cut and paint	Private landholders must fully and continuously suppress and destroy all W2 noxious weeds
Blackberry	*Rubus fruticosus* agg.	W3	Selective spraying, burn with follow up	Private Landholders must prevent the spread and reduce the numbers and distribution of W3 weeds
Spread / reproduction: S = seed, V = vegetative, W = wind, A = animals, G = residential areas and gardens				

Weed removal techniques listed in Table A9 are described below.

Crown/Hand Pull

This method is suitable for herbaceous plants and small trees and shrubs that are not significantly rooted into the ground. Crowning involves the use of a small knife or hand trowel to remove the stem and connected roots (the crown) from the ground. Care needs to be taken not to leave any significant stems or roots in the ground that will regrow, particularly with certain species.

Cut and Paint

This ideal for larger shrubs and trees that are too large to be hand pulled, but small enough to be cut with a hand saw or large secateurs. Simply cut the tree or shrub close to the ground (1-5cm) and using a small squeeze bottle immediately (within 20 seconds) apply 100% Glyphosate to cut area. The activity of Glyphosate is greatly reduced if it is contaminated with soil or other debris. Care should be taken not to contaminate the Glyphosate when applying. A dye should be mixed with the Glyphosate so previously poisoned plants can be easily identified.

Drill/Frill and Fill

This technique is useful for larger trees that can not be removed with a hand saw or secateurs, such as large Camphor Laurel trees. With this method the tree is left standing. An electric drill or small hand axe can be used to bore holes or cut frills into the cambium layer where sap flows just under the bark layer of the tree trunk, holes should be approximately 2-10 cm deep depending on the size of the tree. The holes or cuts should be at a steep angle approximately 45°, taking care not to go too deep into heartwood at regular intervals around the trunk (i.e. 3-5cm). Using a small squeeze bottle of Glyphosate the holes or frills should be filled immediately. This method requires two people, one to drill and one to fill, to ensure that the Glyphosate is being applied as soon as possible. The result of this method leaves a standing dead tree that can be utilised by fauna for habitat.

Cut and Roll

This technique is used for weedy ground covers such as Wandering Dew and some grass and twining species. The method involves cutting the plants connections to the ground and rolling the vegetation and bagging it. Care should be taken to remove all nodes that the plant may regrow from.

Weeding Techniques

It is very important that the weeding activities do not contribute to the further opportunities for weeds to colonise and spread. Weeding activities need to focus on minimal impact techniques so that soil, fauna habitat and native vegetation are disturbed as little as possible. Adequate methods need to be employed depending on the reproductive mechanism of the local weed species (i.e. bag seeds, disposing of vegetation).

Soil disturbance provides weed species with an opportunity to germinate or colonise an area. Care should be taken by all bush regenerators to not disturb the soil profile when removing weeds and any soil that is disturbed from weeding activities (i.e. digging out rhizomes) the area should be mulched or planted with local natives. Areas where weeds are relatively dense, care needs to be taken not to over-clear an area, so that follow up work is not extensive and significant areas of fauna habitat are not removed before areas can regenerate. Some weed species (Wild Tobacco) can be used as a nurse plant for native plantings and to provide cover to minimise weed germination.

When using Glyphosate care needs to only kill target weed species. Glyphosate can translocate through the soil affecting native plants and polluting waterways, therefore Glyphosate should only be applied by a qualified person who has received appropriate training for using chemicals.

Appendix 10:
Policy and Guidelines for Fish Friendly Water Crossings

fishnote

NOVEMBER 2003

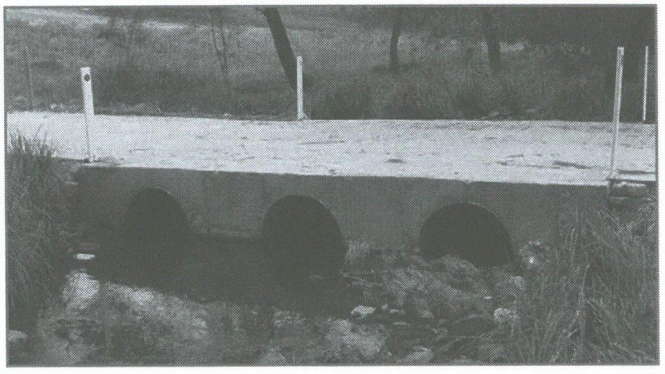
NSW FISHERIES

NSWF 1181

Policy and Guidelines for Fish Friendly Waterway Crossings

This Fishnote provides a summary of the specific legislation and policy requirements that must be observed by those intending to plan, design and construct waterway crossings in NSW.

Waterway crossings such as bridges, roads, causeways, culverts and similar structures have an impact on fish and aquatic habitats. Habitats can be damaged during the construction of waterway crossings by the removal of riparian and in-stream vegetation as well as disturbance to the bed and bank of the waterway. Other impacts can include the creation of long-term barriers to fish movement, bed and bank erosion and continuing pollution from erosion and sedimentation.



This Fishnote should be used in conjunction with:

- "Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings" (Fairfull and Witheridge 2003)
- Policy and Guidelines for Aquatic Habitat Management and Fish Conservation (NSW Fisheries 1999).

These documents are available from NSW Fisheries offices or website at www.fisheries.nsw.gov.au.

Fairfull and Witheridge (2003) provides a comprehensive overview of the best way to plan, design, construct and maintain waterway crossings to minimise impacts on fish passage and aquatic habitats and must be followed in NSW.

Comprehensive engineering guidelines for the design and construction of "fish and fauna friendly" waterway crossings are found in Witheridge (2002). Both documents were developed with the input of a national steering committee of experts in the field of road design, construction and fish passage.

Other factors should also be considered in addition to providing fish passage, such as public safety, social and budgetary constraints, and therefore each crossing must be assessed on a case-by-case basis.

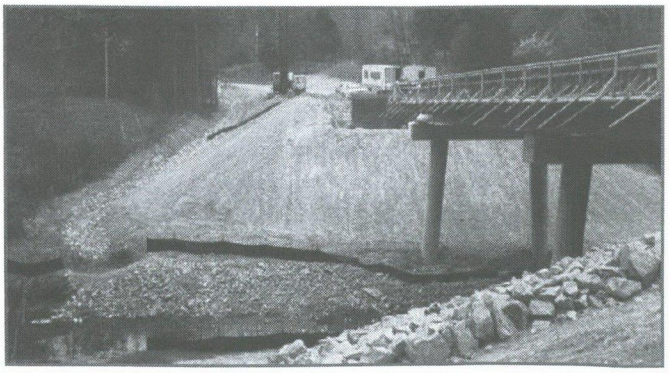
Legislation

The activity of constructing waterway crossings may require approval under Part 7 (Division 3) of the Fisheries Management Act 1994 (FM Act) to dredge and/or reclaim. Dredging works may be required to construct the footings or foundations for the crossing. Reclamation works could include the construction and replacement of pylons and abutments for bridges, creation of in-stream construction pads to access the works or the placement of material in a waterway to construct temporary or permanent waterway crossings.

Generally, a local government authority or individual will require a permit to carry out any dredging or reclamation work unless the works are authorised by another public authority (other than a local government authority). Part 7 (Division 3) requires that a public authority must notify the Minister for Fisheries before it carries out or authorises the carrying out of any such works and must consider any matters raised by the Minister.

Waterway crossings constructed in tidal waters may also require a permit under Part 7 (Division 4) of the FM Act if the construction is likely to harm marine vegetation such as seagrass, mangroves or marine macroalgae (seaweeds).

Consideration must also be given to potential impacts of the crossing design and construction on threatened species, populations, ecological communities or their habitat (including 'critical habitat') listed under the FM Act.



Environmental assessment and planning for any new road works, waterway crossings or maintenance programs for existing structures requires the completion of an '8 part test'. The '8 part test' (a series of eight questions) must be completed in order to assess the significance of the impact of the proposed works on listed threatened species, populations or ecological communities. If the '8 part test' indicates a significant impact(s) then a Species Impact Statement (SIS) may also be required. Further information on threatened species is provided on NSW Fisheries website at www.fisheries.nsw.gov.au.

A permit may also be required under s.219 of the FM Act for any works, which may result in the temporary or permanent blockage of fish passage within a waterway. Such blockages can include silt fencing across waterways for sediment and erosion control and bunding and dewatering works during construction of crossings.

A permit may by required under s.37 of the FM Act to undertake any sampling of fish or other aquatic macroinvertebrates (e.g. for environmental assessment or monitoring purposes).

Permits may also be required under Part 5 (clauses 112-115) of the Fisheries Management (General) Regulation 2002 for any works which may involve the use of explosives, electrical devices or other dangerous substances within waters.

Waterway crossing design and construction must also be consistent with Habitat Protection Plans (HPP) gazetted under Part 7 (Division 1) of the FM Act. In particular, HPP No.1 outlines NSW Fisheries requirements for the management of 'snags' (large woody debris or boulders) and HPP No.2 outlines requirements for the management of seagrasses, which may be present on the construction site.

If you are planning to construct a waterway crossing in NSW it is recommended that you contact your nearest regional NSW Fisheries staff (see contact list) to discuss your proposal. They can provide you with advice on permit and approval requirements.

The permit application form for dredging and reclamation, harm to marine vegetation, blockage of fish passage and use of explosives, electrical devices or other dangerous substances within a waterway can be found on the NSW Fisheries website at www.fisheries.nsw.gov.au under the "Aquatic Habitats" section.

Policy for waterway crossings

The following policies apply to waterway crossings in NSW:

(a) Waterway crossings must be designed and constructed in accordance with Fairfull and Witheridge (2003). This document can be obtained from NSW Fisheries offices or from the Department's website at www.fisheries.nsw.gov.au.

(b) For any waterway crossing proposal, an aquatic habitat and fish assessment should be undertaken (see Table 1).

(c) When proactively rehabilitating existing waterway crossings to improve fish passage, efforts should focus on those crossings located at the lowest end of the catchment where the numbers and diversity of fish species is generally greatest.

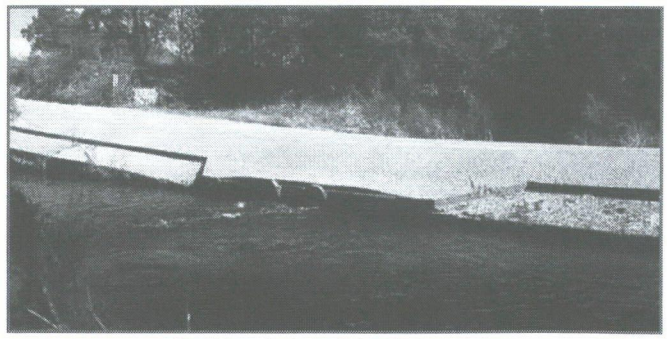
(d) The construction of waterway crossings will generally not be permitted if the work involves harm to marine vegetation (in particular mangroves and seagrass), unless rehabilitation or mitigation measures can compensate the harm in line with NSW Fisheries Policy and Guidelines for Aquatic Habitat Management and Fish Conservation (NSW Fisheries 1999).

(e) Fish passage must not be restricted at any time, unless the appropriate permit has been granted by NSW Fisheries. If a project requires fish passage to be temporarily blocked (e.g. construction of bunds, installation of silt fences across a waterway), and no feasible alternative exists, then NSW Fisheries must be informed and a permit obtained before the works are commenced. The timing of the works should also be determined so as to minimise the interference with the possible migration of fish within the waterway.

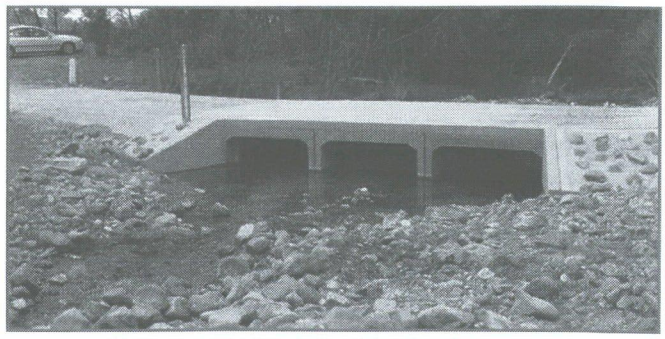
(f) Spawning grounds, such as gravel beds in areas where salmon or trout are likely to occur, must not be dredged or removed from within a waterway unless approval has been granted by NSW Fisheries.

(g) Generally, where a woody snag is in the site of the proposed waterway crossing, lopping should be considered as the first priority for the management of the snag. Where lopping will not solve the problem, re-alignment should be considered as the next possible management option, followed by relocation. Removal of a snag is the least desirable alternative and should only be adopted as a last resort. Local councils and other public authorities are required to notify NSW Fisheries of any proposed works, which involve the lopping, realignment, relocation or removal of snags.

(h) Where aquatic habitats are designated "critical habitat" under Part 7A of the FM Act, then the waters of that habitat must automatically be designated a Class 1 waterway (see Table 1 in Fairfull and Witheridge (2003)), and will be subject to the preferred engineering solutions outlined. A SIS must also be prepared for the works.



- Road crossing restricting fish passage -



- Same road crossing designed to allow fish passage -

(i) Where a project is identified as being in the potential range of a listed threatened species, population or ecological community under the FM Act, and the area has not been declared a "critical habitat", the following should apply:
  (i) if the determining/consent authority determines that the project will not have a significant impact after considering an '8 part test', then the proposed water way crossing(s) will be accepted, subject to compliance with this Fishnote, and any other relevant approvals, including those required from NSW Fisheries.
  (ii) if the determining/consent authority determines that the project will have a significant impact via the '8 part test', then the proposed project should be modified where possible (e.g. causeway crossing changed to a culvert crossing, culvert changed to a bridge crossing or new site selected) and the '8 part test' reapplied. If the modified project still results in a significant impact, then the waterway will be classified as a Class 1 waterway (see Table 1 in Fairfull and Witheridge (2003)) and the preferred engineering solutions outlined in Table 1 will apply. A SIS must also be prepared for the project.
  (iii) if the determining/consent authority determines that the project will have a significant impact via the '8 part test' (even after the completion of step ii above), the waterway will be classified as a Class 1 waterway (see Table 1 in Fairfull and Witheridge (2003)) and the preferred engineering solutions outlined in Table 1 will apply. A SIS must also be prepared for the project.

(j) Where a road project is likely to involve the loss of aquatic habitat, NSW Fisheries will request that habitat rehabilitation or environmental compensation be used to mitigate the damage.

(k) All possible care should be taken to ensure that sediment from road works does not enter any water ways. Sediment and erosion control plans should be developed and implemented and copies made available to NSW Fisheries on request.

(l) In order to minimise sedimentation, fill or excavated material must not be stockpiled in flood prone areas. Particular care should be taken in siting stockpiles and dumps. Sites should be situated either above mean high water mark in tidal areas, or be secure from a 1 in 10 year flood level and have effective sediment control works to contain any runoff.

(m) In the case of emergency waterway crossing repair works, NSW Fisheries should be notified of the proposed emergency repair works prior to their commencement. Basic information, such as the location of the works, classification of the waterway where the works are to be completed (i.e. Table 1 in Fairfull and Witheridge (2003)), the need for the works and proposed construction methods can be outlined either by phone or facsimile to your nearest NSW Fisheries office, (see contact list). NSW Fisheries will generally be able to issue a dredging and reclamation permit within 24 hours of notification via facsimile. The permit will be issued subject to the receipt of full documentation (in line with this document) and relevant permit fees as soon as possible after the emergency works have been completed. As most emergency works are of a temporary nature, the full documentation should also address how the structure will be permanently repaired (where relevant).

Guidelines for waterway crossings

The following guidelines apply to waterway crossings in NSW:

(a) Sediment to be used in dredging or reclamation should be tested for contaminants prior to any works (see ANZECC (2000)). Contaminated fill or dredge spoil containing toxic substances, such as heavy metals, organochlorines, acid sulphate soils, dinoflagellates, etc., must not be dredged or used in reclamation.

(b) Dredging or reclamation works should aim to have no net impact on the receiving watercourse. As a minimum, water quality assessments should include analysis of dissolved oxygen, pH, turbidity, temperature, nutrients and salinity and should take into account the existing water quality status of the receiving water course.

(c) Sediment controls along drainage lines should be left in place to control sediment entering a waterway after the construction phase is completed and until the site has been fully stabilised.

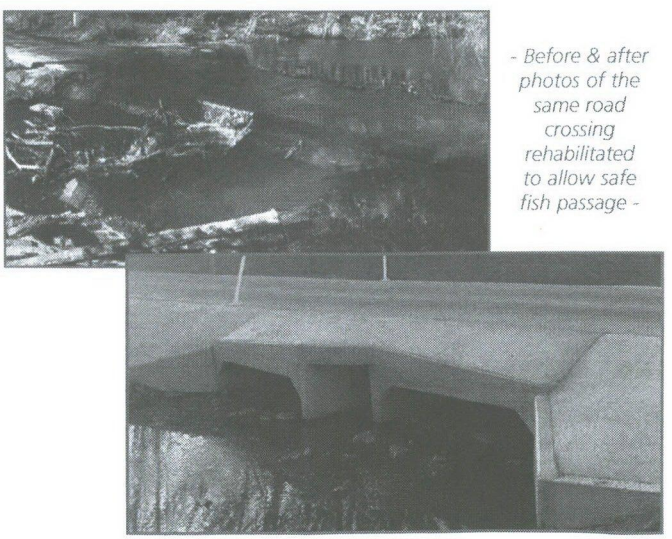
References

Australia and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (ANZECC) (2000) Australia and New Zealand Guidelines for Fresh and Marine Water Quality: Volume 1 - The Guidelines. Australia and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand.

Fairfull, S. and Witheridge, G. (2003) Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW Fisheries, Cronulla, 16 pp.

NSW Fisheries (1999) Policy and Guidelines Aquatic Habitat Management and Fish Conservation. (Eds. A. Smith and D. Pollard) NSW Fisheries, Cronulla.

Witheridge, G. (2002) Fish Passage Requirements for Waterway Crossings - Engineering Guidelines. Catchment and Creeks Pty Ltd, Brisbane.



- Before & after photos of the same road crossing rehabilitated to allow safe fish passage -

Table 1 - Aquatic habitat and fish assessment requirements for waterway crossings

The Department of Infrastructure, Planning and Natural Resources has released a document entitled, "*Guidelines for Assessment of Aquatic Ecology in EIA*" (1998) which should be referenced to assess aquatic flora and fauna impacts during the preparation of environmental assessment documentation under Parts 4 or 5 of the *Environmental Planning and Assessment Act 1979*.

The aim of an aquatic assessment should be to define the presence of aquatic habitat within both the study site and regional area, and upstream or downstream of any proposed waterway crossing sites. Some points to consider in assessing aquatic habitats include:

- the characteristics of the watercourse (e.g. Is it a gully, intermittent stream or major river? Does it have deep pools or in-stream gravel beds? Is it a wetland? Does the waterway interconnect with other waterways or wetlands upstream or downstream?)
- the flow regime of the watercourse (e.g. Is it an intermittent or permanently flowing stream? What is the water velocity of the flow?)
- what is the water quality like? (e.g. discolouration, sedimentation, turbidity, pH, dissolved oxygen, nutrients?)
- what are the types of land uses along the waterway? (e.g. agricultural, urban, aquaculture)
- is riparian vegetation present or absent? (i.e. Are the species native or exotic? What condition are they in?)
- is in-stream vegetation present or absent? (i.e. Are the species native or exotic? What condition are they in?)
- are there wetlands nearby? (e.g. in-stream or off-stream)
- what is the substrate type? (e.g. rock, sand, gravel, alluvial substrates)
- the presence of refuge areas (e.g. Are there wetlands nearby which could be interlinked by the waterway during flow? Are there pools of water above or below the crossing which could be fish habitat?)
- the presence of spawning areas (e.g. Are gravel beds, riparian vegetation, snags (large woody debris or boulders) present?)
- the presence of natural or artificial barriers to fish passage both upstream and downstream (e.g. weirs, dams, waterfalls or cascades, other waterway crossings)
- the types of fish or other aquatic species likely to inhabit the area (based on their known distribution range within the scientific literature)
- whether any threatened aquatic species are present
- whether the area has been declared a "critical habitat"
- the timing of construction (i.e. Will construction coincide with a migratory season for fish?)

In most cases, in areas where fish and/or other aquatic fauna are well documented, and no threatened species are recorded, a site inspection and desktop review of the study site and regional area may be the only assessment required, and may preclude the need for a detailed scientific aquatic survey. However, this decision must be justified in the environmental assessment by the proponent or determining authority. Consultation with NSW Fisheries staff is also advised during the planning phase to determine the required level of assessment.

When do I need to undertake an aquatic survey?
NSW Fisheries recommends that a detailed aquatic survey should only be undertaken:

(a) where the project is on a Class 1 or 2 water course (see Table 1 in Fairfull and Witheridge (2003)), or where an '8 part test' has identified that there may be a significant impact on a listed threatened species under the FM Act and an SIS is required;
(b) where the project area crosses through, over or within a "critical habitat" and an SIS is required; and;
(c) only after direct consultation with staff from NSW Fisheries. A permit must be obtained from NSW Fisheries prior to any aquatic fauna sampling.

Contact list for regional NSW Fisheries staff who can assist you with inquiries:

Region	*Catchments Covered by the Region*	*Postal Address*	*Phone*	*Fax*
Upper North West	Namoi, Gwydir, Barwon-Darling	NSW Fisheries Office of Conservation PO Box W47, Tamworth NSW 2340	(02) 6765 4591	(02) 6762 1993
North West	Bogan, Macquarie, Castlereagh	NSW Fisheries Office of Conservation PO Box 99, Wellington NSW 2820	(02) 6845 4439	(02) 6845 4452
Central West	Murrumbidgee, Lachlan	NSW Fisheries Office of Conservation PO Box 182, Narrandera NSW 2700	(02) 6959 9028	(02) 6959 2935
South West	Murray, Lower Darling	NSW Fisheries Office of Conservation Unit 3/556 Macauley Street, Albury NSW 2640	(02) 6042 4208	(02) 6021 0113
North East and Border Rivers	The Border Rivers and the coastal catchments from Queensland border to Macleay River	NSW Fisheries Office of Conservation PO Box 154, Ballina NSW 2478	(02) 6686 2018	(02) 6686 8907
Central	Coastal catchments from Hastings to Georges River	Office of Conservation Fisheries NSW Private Bag 1, Nelson Bay NSW 2315	(02) 4982 1232	(02) 4982 2306
South East	Coastal catchments from Wollongong Coast to Victorian border	Office of Conservation Fisheries NSW PO Box 456, Nowra NSW 2541	(02) 4423 2080	(02) 4423 2007