ECOLOGICAL MONITORING PROGRAM

Warrell Creek to Urunga upgrade

JUNE 2013

Benchmark
Environmental Management

Warrell Creek to Urunga Pacific Highway Upgrade Ecological Monitoring Program

Stage 1: Nambucca to Urunga

Prepared for:
NSW Roads and Maritime Services

June 2013

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WARRELL CREEK TO URUNGA PACIFIC HIGHWAY UPGRADE

STAGE 1 ECOLOGICAL MONITORING PROGRAM

(Nambucca Heads to Urunga Section Chainage 19500 - 41300)

June 2013

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1 Introduction

In June 2003, planning commenced on the upgrade of the Pacific Highway between Warrell Creek to Urunga, south of Coffs Harbour (WC2U). The project involves an upgrade of the existing highway to four lane divided highway from the existing Allgomera deviation, south of Warrell Creek, to the Waterfall Way at Raleigh.

Project approval was granted on 19 July 2011, under Part 3A of the Environmental Planning and Assessment Act 1979. The project was identified as a critical infrastructure project by the NSW State Government, designed to improve safety, traffic efficiency and increase capacity along the Pacific Highway. It forms part of the overall program for upgrading the Pacific Highway. The proposed upgrade extends over approximately 42 kilometres, which has been divided into two stages:

Stage 1 - Nambucca Heads to Urunga section (chainage 19500-41300); and
Stage 2 - Nambucca Heads to Warrell Creek section (chainage 19500-000).

The construction of the WC2U upgrade project will involve the disturbance of existing structures, native vegetation, and native fauna habitat(s) in the vicinity of the works. It will also involve the removal of up to 255 Ha of native vegetation.

As part of the Proposal's approval, the development of an Ecological Monitoring Program (EcMP) is required for each stage to address the Minister for Planning and Infrastructure's Condition of Approval (MCoA) B10. To satisfy MCoA B10 the ecological monitoring programs involve preconstruction, construction and post construction phases.

Benchmark Environmental Management (BEM) was contracted by the NSW Department of Roads and Maritime Services (RMS) to prepare the EcMP for Stage 1 of the WC2U upgrade project in accordance with MCoA B10, which states that:

Prior to the commencement of any construction work that will result in the disturbance of any native vegetation, the Proponent shall develop an Ecological Monitoring Program to monitor the effectiveness of the mitigation measures implemented as part of the project. The program shall be developed in consultation with OEH and prepared by a suitably qualified ecologist and shall include but not necessarily be limited to:

(a) an adaptive monitoring program to assess the effectiveness of the mitigation measures identified in condition B1 to B6, B7(b), B7(d), B21(c) and B31(b) and allow amendment to the measures if necessary. The monitoring program shall nominate appropriate and justified monitoring periods and performance targets against which effectiveness will be measured. The monitoring shall include operational road kill surveys to assess the effectiveness of fauna crossing and exclusion fencing implemented as part of the project;

(b) mechanism for developing additional monitoring protocols to assess the effectiveness of any additional mitigation measures implemented to address additional impacts in the case of design amendments or unexpected threatened species finds during construction (where these additional impacts are generally consistent with the biodiversity impacts identified for the project in the documents listed under condition A1);

(c) monitoring shall be undertaken during construction (for construction-related impacts) and from opening of the project to traffic (for operation/ongoing impacts) until such time as the effectiveness of

mitigation measures can be demonstrated to have been achieved over a minimum of five successive monitoring periods (i.e. 5 years) after opening of the project to traffic, unless otherwise agreed to by the Director General. The monitoring period may be reduced with the agreement of the Director General in consultation with OEH, depending on the outcomes of the monitoring;

(d) provision for the assessment of the data to identify changes to habitat usage and if this can be attributed to the project;

(e) details of contingency measures that will be implemented in the event of changes to habitat usage patterns directly attributable to the construction or operation of the project; and

(f) provision for annual reporting of monitoring results to the Director General and OEH, or as otherwise agreed by those agencies. The Program shall be submitted for the Director General's approval prior to the commencement of any construction work that will result in the disturbance of any native vegetation. Unless otherwise agreed, the Program shall be submitted to the Director General for approval no later than 6 weeks prior to the commencement of any construction that will result in the disturbance of any native vegetation.

There are 39 mitigation measures relevant to the EcMP preparation for Stage 1 of the WC2U upgrade project, which are listed in *Table 1.1*. The mitigation measures have been grouped into seven categories:

1. Pre-clearing and clearing procedures;
2. Fauna underpass structures and exclusion fencing;
3. Widened vegetated medians;
4. Nestbox installation;
5. Landscape rehabilitation
6. Protection of in-situ threatened flora populations; and
7. Establishment of translocation areas.

Table 1.1: Mitigation measures relevant to EcMP preparation for Stage 1 of the WC2U upgrade project.

Source	Mitigation Measure	Relevant Section of EcMP
MCoA B1	The Proponent shall implement the fauna and waterway crossings identified in the documents listed under condition A1(d) at the locations and in accordance with the minimum design dimensions identified in the documents listed under condition A1(d), unless otherwise agreed to by the Director General.	Section 2.2 and 3.3
MCoA B2	As part of detailed design, the Proponent shall further investigate design refinements to improve fauna connectivity between Chainages 19150 and 19820.	Section 2.2 and 3.3
MCoA B4	The Proponent shall in consultation with OEH, ensure that the design of the project as far as feasible and reasonable, incorporates provision for glider crossings (such as widened medians and maintenance or enhancement of habitat within the medians and corresponding carriageway boundaries) where the alignment crosses areas of recognised glider habitat.	Section 2.3 and 3.4
MCoA B6	Prior to the commencement of any construction work that will result in the disturbance of any native vegetation (or as otherwise agreed to by the Director General), the Proponent shall in consultation with OEH prepare and submit for the approval of the Director General a Nest Box Plan to provide replacement hollows for displaced fauna consistent with the requirements of SoC F7. The plan shall detail the number and type of nest boxes to be installed which must be justified based on the number and type of hollows removed (based on detailed pre-construction surveys), the density of hollows in the area to be cleared and adjacent forest, and the availability of adjacent food resources. The plan shall also provide details of maintenance protocols for the nest boxes installed including responsibilities, timing and duration.	Section 2.4 and 3.5
MCoA B7(b)	If investigation under Condition B7(a) reveals translocation of impacted plants is feasible, includes details of a translocation plan for the plants consistent with the Australian Network for Plant Conservation 2"d Ed 2OO4: Guidelines for the Translocation of NSW Government Department of Planning and lnfrastructure 6 Threatened Species in Australia, including details of ongoing maintenance such as responsibilities, timing and duration;	Section 2.7 and 3.8
MCoA B7(d)	Includes detail of mitigation measures to be implemented during construction to avoid and minimise impacts to areas identified to contain these species, including excluding construction plant, equipment, materials and unauthorised personnel.	Section 2.6 and 3.7
MCoA B31(b)	A Construction Flora and Fauna Management Plan to detail how construction impacts on ecology will be minimised and managed.	Section 2.1 and 3.2
MCoA B31(b)(i)	Undertake pre-construction surveys to verify the construction boundaries/footprint of the project based on detailed design and to confirm the vegetation to be cleared as part of the project.	Section 2.1.1 and Section 3.2.2
MCoA B31(b)(iii)	Prepare a Giant Barred Frog management plan, in the case that this species or its habitat is identified to occur in the project corridor or its vicinity.	Section 2.2.1; Section 3.3.2
MCoA B31(b)(iv)	Prepare a micro-bat management strategy, in the case that micro bats or evidence of roosting are identified during pre-construction surveys. The strategy shall detail measures to avoid, minimise and mitigate impacts to these species and identified roost sites, including short and long term management measures.	Section 2.1.1; Section 3.4
MCoA B31(b)(v)	Develop general work practices to minimise the potential for damage to native vegetation (particularly EECs) not proposed to be cleared as part of the project and native fauna during construction.	Section 2.1

Source	Mitigation Measure	Relevant Section of EcMP
MCoA B31(b)(vi)	Develop specific procedures to deal with EEC/threatened species anticipated to be encountered within the project corridor including re-location, translocation and/or management and protection measures.	EcMP
RSOC F1	Clearing of native vegetation (including endangered ecological communities) will be restricted to the minimum area necessary for construction.	Section 2.1 and 3.2
RSOC F2	A qualified ecologist will identify any vegetation (including *Marsdenia longiloba*) to be retained and to be clearly delineated on work plans within the construction corridor. Erection of flagging/fencing on-site prior to any construction works, which is to remain in place for the full construction period, will clearly delineate this vegetation.	Section 2.1 and 3.2
RSOC F3	Threatened species directly impacted by the Proposal will be translocated to a suitable location outside the impact zone. A further visual inspection will be conducted post clearance to identify threatened species which may be indirectly impacted outside the cleared zone. Landscape planting to commence along the road boundary as soon as possible during construction.	Section 2.7 and 3.8
RSOC F4	Plantings of rusty plum (*Amorphospermum whitei*) in areas of suitable habitat adjacent to the Proposal will follow from seed collection and propagation.	Section 2.7 and 3.8
RSOC F6	A suitably qualified ecologist will undertake pre-clearance surveys for threatened species including frogs. Searches will include nests and hollow bearing trees. Re-location of fauna species at risk of injury found in pre-clearance surveys or during construction will be in suitable habitat as close as possible to the area in which they were found. Immediately prior to clearing an inspection will confirm that the sites subject to pre-clearance surveys remain free of fauna.	Section 2.1 and 3.2
RSOC F7	Where feasible and reasonable the identification and distribution of natural and artificial habitat features and resources (such as hollow-bearing trees, hollow logs, nest boxes and bush rocks) will occur along the Proposal. This relocation will limit injury to fauna and damage to existing vegetation. A nest box plan will be developed for the Proposal.	Section 2.1 and 3.2
RSOC F8	Retention of mature trees in the median at locations identified in the environmental assessment will provide a stepping stone for gliders. Protection of these trees will occur (F2), and lopping and pruning is not to occur without expert advice.	Section 2.3 and 3.4
RSOC F9	Provision of fauna crossings will be as identified in the environmental assessment. All fauna crossings will be confirmed with the EPA and I&I (Fisheries) during the detailed design phase.	Section 2.2 and 3.3
RSOC F11	Erection of fauna exclusion fencing (e.g. floppy-top fencing) along the Proposal at appropriate locations will direct fauna movement towards fauna-crossing structures.	Section 2.2 and 3.3
EA Ch10 – Section 10.5.1.1	Revegetation/rehabilitation of the site should be conducted progressively during the construction phase to ensure the use of collected topsoil and seed and to develop different successional stages of rehabilitation.	Section 2.5 and 3.6
EA Ch10 – Section 10.5.1.1	A weed management plan is to be prepared as part of the flora and fauna management sub plan, outlining weed management actions to be carried out during construction to prevent the spread of weeds and plant pathogens.	Section 2.5 and 3.6
EA Ch10 – Section 10.5.1.2	A suitably qualified ecologist will undertake searches in the construction footprint for native fauna immediately prior to clearing activities. Searches will include nests and large hollow-bearing trees and target habitats of hollow dwelling species, Koalas and frogs. During the proposed clearing works, an experienced wildlife handler should be present to retrieve any displaced fauna and release the fauna into adjacent habitats safe from construction work.	Section 2.1 and 3.2

Source	Mitigation Measure	Relevant Section of EcMP
EA Ch10 – Section 10.5.1.2	Re-survey immediately prior to construction to identify nest locations for Osprey, Black-necked Stork and brolga. The location of the identified Osprey nest will be checked to confirm if it is present before clearing commences.	Section 2.1 and 3.2
EA Ch10 – Section 10.5.1.2	Provide dedicated and incidental fauna crossing structures at key locations for forest fauna species identified to target the range of large, medium and smaller species present such as Yellow-bellied Glider, Koala and Giant Barred Frog.	Section 2.2 and 3.3
EA Ch10 – Section 10.5.1.2	A fauna rescue framework for clearing has been developed by the RMS in consultation with the EPA and will be used as a basis for developing a protocol for the handling and translocation of fauna during construction.	Section 2.1 and 3.2
EA Ch10 – Section 10.5.1.2	Nest boxes are to be installed, where required, in accordance with specialist advice and in consultation with the EPA, prior to construction, to replace hollow resources that are proposed to be removed.	Section 2.4 and 3.5
EA Ch10 – Section 10.5.1.2	Bridges at Warrell Creek, Nambucca River, Deep Creek and the Kalang River and culverts identified in this environmental assessment as having a potential role in fauna crossing, will be designed to facilitate fauna movements	Section 2.2 and 3.3
EA Ch10 – Section 10.5.1.2	Strategies will be developed to deal with incidents involving individual animals during construction activities in consultation with the EPA officers, WIRES and/or other relevant local wildlife carer groups.	Section 2.1 and 3.2
EA Ch10 – Section 10.5.2	Native and locally indigenous plants will be used in the landscaping and disturbed areas will be progressively revegetated.	Section 2.5 and 3.6
EA Ch10 – Section 10.5.2	Weeds in areas disturbed by construction activities will be managed for a minimum of two years after construction completion.	Section 2.5 and 3.6
EA Ch10 – Section 10.5.3	Widening of the median at important locations.	Section 2.3 and 3.4
EA Ch10 – Section 10.5.3	Widening of the median at important locations.	Section 2.3 and 3.4
EA Ch10 – Section 10.5.3	Provision of dedicated, combined and incidental fauna underpass structures.	Section 2.2 and 3.3
EA Ch10 – Section 10.5.3	Exclusion fencing will be installed around the crossing structures to prevent access to the carriageway for up to 500 metres either side.	Section 2.2 and 3.3
EA Ch10 – Section 10.5.4	Development of a rehabilitation and weed control strategy as part of the construction environmental management plan, with specific mitigation measures for control of the spread of weeds and habitat rehabilitation, particularly along roadside verges, adjacent to culvert entrances and bridge pylons.	Section 2.5 and 3.6
EA Ch10 – Section 10.5.4	A protocol will be developed for weed infested areas to ensure that all potential weed propagules from soil and vegetative material are appropriately disposed of.	Section 2.5 and 3.6

Source	Mitigation Measure	Relevant Section of EcMP
EA Ch10 – Section 10.5.5	Roadside verges will be rehabilitated adjacent to culvert entrances and bridge pylons.	Section 2.5 and 3.6

The aim of the EcMP, as stated in Revised Statement of Commitment F13, is to assess the effectiveness of fauna and flora impact mitigation measures. The Contractor must address the requirements of this EcMP in design, construction and maintenance of the Project Works, Temporary Works and Maintenance Works where relevant.

The EcMP addresses the requirements of MCoA B10 in five chapters. Chapter one states the aim of the EcMP and identifies those responsible for its implementation. Chapter two identifies which proposed mitigation measures are to be subject to monitoring. Chapter three provides a detailed description of the monitoring methods recommended for each proposed mitigation measure. Chapter four identifies potential contingencies that may be applied if any of the mitigation measures prove to be insufficient. Chapter five specifies the reporting requirements.

2 Mitigation measures requiring monitoring

A meeting with the RMS, EPA and BEM was held at the Coffs Harbour EPA office 26 September 2012 to devise an agreed scope for the Stage 1 EcMP. It was agreed that the EcMP for Stage 1 will focus on all seven groups of mitigation measures proposed as part of the Warrell Creek to Urunga Pacific Highway Upgrade project (Stage 1):

1. Pre-clearing and clearing procedures;
2. Fauna underpass structures and exclusion fencing;
3. Widened vegetated medians
4. Nestbox installation;
5. Landscape rehabilitation
6. Protection of in-situ threatened flora populations; and
7. Establishment of translocation areas.

A description of each proposed mitigation measure nominated for monitoring is provided below.

2.1 Pre-clearing and clearing procedures

The Revised Statement of Commitments (RSoC) and WC2U upgrade project Environmental Assessment (EA) include several procedures to be undertaken during the construction phase of the project aimed at reducing the incidence of wildlife mortality during the clearing process. The procedures include:

- RSoC F1 - Clearing of native vegetation, including Endangered Ecological Communities (EECs) will be restricted to the minimum area necessary for construction;

- RSoC F2 - A qualified ecologist will identify any vegetation (including *Marsdenia longiloba*) to be retained and to be clearly delineated on work plans within the construction corridor. Erection of flagging/fencing on-site prior to any construction works, which is to remain in place for the full construction period, will clearly delineate this vegetation;

- RSoC F6 - A suitably qualified ecologist will undertake pre-clearance surveys for threatened species including frogs. Searches will include nests and hollow bearing trees. Re-location of fauna species at risk of injury found in pre-clearance surveys or during construction will be in suitable habitat as close as possible to the area in which they were found. Immediately prior to clearing an inspection will confirm that the sites subject to pre-clearance surveys remain free of fauna;

- RSoC F7 - Where feasible and reasonable the identification and distribution of natural and artificial habitat features and resources (such as hollow-bearing trees, hollow logs, nest boxes and bush rocks) will occur along the Proposal. This relocation will limit injury to fauna and damage to existing vegetation. A nest box plan will be developed for the Proposal;

- EA Chapter 10 Section 10.5.1.2 - A suitably qualified ecologist will undertake searches in the construction footprint for native fauna immediately prior to clearing activities. Searches will include nests and large hollow-bearing trees and target habitats of hollow dwelling species, koalas and frogs. During the proposed clearing works, an experienced wildlife handler should be present to retrieve any displaced fauna and release the fauna into adjacent habitats safe from construction work;

- EA Chapter 10 Section 10.5.1.2 - Re-survey immediately prior to construction to identify nest locations for Osprey, Black-necked Stork and brolga. The location of the identified Osprey nest will be checked to confirm if it is present before clearing commences;

- EA Chapter 10 Section 10.5.1.2 - A fauna rescue framework for clearing has been developed by the RMS in consultation with the EPA and will be used as a basis for developing a protocol for the handling and translocation of fauna during construction; and

- EA Chapter 10 Section 10.5.1.2 - Strategies will be developed to deal with incidents involving individual animals during construction activities in consultation with the EPA officers, WIRES and/or other relevant local wildlife carer groups.

Although not specified in the EA or RSoCs, vegetation containing hollow-bearing trees will be cleared using a staged clearing process developed in consultation with EPA. Furthermore, information on tree hollow characteristics will be collected during the staged clearing process to enable the quantification of actual tree hollows removed during construction. The resulting information will be used to assess the adequacy of the proposed nest box quantities specified in the project Nest Box Management Plan and as required to comply with MCoA No. B6.

2.1.1 Pre-clearing surveys

Prior to commencement of clearing operations the project ecologist will identify all areas within the project corridor that contain vegetation to be retained (including EECs) and suitable habitat for hollow-dependent fauna, koalas and threatened frog species.

Delineation of clearing boundaries

Targeted surveys will be undertaken to delineate the boundaries of vegetation (including EECs) to be retained within the project corridor. The clearing boundaries will then be subject to geodetic survey to enable accurate placement of protective fencing and inclusion on constraints mapping.

Habitat resource surveys

A large proportion of potential hollow-bearing trees within the WC2U upgrade corridor were mapped and marked by Lewis Ecological Surveys (LES) between December 2011 and March 2012. However, further surveys will be conducted up to seven days prior to commencement of clearing to re-mark potential habitat trees, detect additional habitat trees (e.g. trees containing nests, hollows, fissures, termitaria and dreys), hollow logs, ground nests, dens and large rocks within the clearing limits. Suitable release sites for fauna that may be encountered during clearing will be identified during the pre-clearing surveys. Activity levels at the known osprey nest will also be assessed during the pre-clearing surveys.

Habitat resources identified during the pre-clearing surveys will be marked with bright coloured flagging tape and numbered with bright coloured spray paint. The location of each habitat resource will be recorded using a handheld GPS (UTM WGS 84). Details of additional habitat resources will then be forwarded to the relevant project Environmental Officer for inclusion on sensitive area mapping.

Hollow-dependent fauna surveys

Spotlighting surveys to detect hollow-dependent fauna will be conducted within areas of forest habitat containing potential hollow-bearing trees. These surveys will be completed up to seven days prior to clearing operations.

Koala surveys

Surveys for koalas will involve spotlighting within areas of suitable habitat on the night prior to clearing operations. Diurnal visual searches will also be conducted in areas of suitable habitat immediately prior to commencement of clearing operations to detect any koalas that enter the area overnight. Vegetation within a 50 metre radius of any tree containing a residing koala will be retained until the koala has vacated habitat within the clearing limits.

Frog surveys

Targeted surveys for threatened frogs were undertaken by LES in late 2011. The surveys detected two threatened frog species within the project corridor, green-thighed frog (*Litoria brevipalmata*) and giant barred frog (*Mixophyes iteratus*) (LES 2012a). Management strategies for both of these species have been prepared by LES.

Frog surveys within suitable microhabitats will also be conducted either the night prior to or immediately prior (ie. less than two hours) to commencing clearing operations depending on the seasonal timing of proposed clearing operations. Nocturnal surveys, consisting of spotlighting searches and call playback census, will be conducted during warmer months (October to May) when frogs are generally more active. Frog surveys conducted during the colder months will be limited to active daytime searches (15 minutes per hectare) immediately prior to commencing clearing operations.

Subject to the results of further surveys to be conducted at Boggy Creek and McGraths Creek, additional targeted surveys for the giant barred frog may be required at these sites up to five days prior to clearing. Refer to the giant barred frog management strategy (LES 2012b) for more detail.

Active searches will involve turning of rocks and logs, raking of debris and peeling of decorticating bark. Captured individuals will be held temporarily in a plastic bag with a small amount of water (1 frog per bag) and relocated in areas of suitable habitat adjacent to the clearing footprint.

All field survey, capture and release tasks will be conducted in accordance with the NPWS (2001) hygiene protocol for the control of disease in frogs.

Microbat surveys and management

Bridge and culvert structures along the WC2U upgrade corridor were surveyed by LES in December 2011 and October 2012 to identify sites used for roosting by microbats. Nine of the 69 structures surveyed contained evidence of microbat use, while 22 of the structures were considered to contain suitable roosting habitat for microbats (LES 2013). Consequently, a microbat management strategy has been prepared by LES.

Final pre-clearing visual searches

A final pre-clearing visual search will be undertaken by the project ecologist immediately prior (ie. less than two hours) to commencement of clearing operations to ensure that the areas to be cleared are as free of fauna as possible.

All captured fauna will be released into adjacent or proximate areas of suitable habitat beyond the project clearing limit.

2.1.2 Clearing process

Staged clearing

Following the completion of the pre-clearing surveys described in *Section 2.1.1*, tree removal will be staged, with non-habitat trees being removed first, then the potential habitat trees being removed with a swivel head harvester at least 48 hours later to enable resident hollow-dependent fauna time to evacuate the tree prior to felling. A suitably qualified, licensed and experienced ecologist and a suitable licensed and experienced wildlife carer will be present to observe the removal of each potential habitat tree. The wildlife carer will manage any injured or displaced fauna residing in felled trees. The ecologist will inspect each felled tree to record tree hollow characteristics and any evidence of habitation.

The project ecologist will be responsible for the relocation and release of any displaced fauna once the health of captured individuals has been confirmed by the wildlife carer. The reporting requirements for the tree clearing phase of the project are provided in *Section 3.2.2.*

Incidental fauna management

A suitably licensed and experienced wildlife handler will be made available to attend the project site during clearing operations to ensure rapid treatment and management of any displaced fauna detected incidentally by clearing operators or project personnel.

2.2 Fauna underpasses and exclusion fencing

Requirements for fauna underpasses as part of the WC2U upgade project are stipulated in MCoAs B1, B2 and B3. Relevant RSoCs and EA mitigation measures include:

- RSoC F9 - Provision of fauna crossings will be as identified in the environmental assessment. All fauna crossings will be confirmed with the EPA and I&I (Fisheries) during the detailed design phase;

- RSoC F11 - Erection of fauna exclusion fencing (e.g. floppy-top fencing) along the Proposal at appropriate locations will direct fauna movement towards fauna-crossing structures.

- Chapter 10 Section 10.5.1.2 - Provide dedicated and incidental fauna crossing structures at key locations for forest fauna species identified to target the range of large, medium and smaller species present such as Yellow-bellied Glider, Koala, Giant Barred Frog and Green-thighed Frog;

- Chapter 10 Section 10.5.1.2 – all bridges on the project and culverts identified as having a potential role in fauna crossing will be designed to facilitate fauna movements;

- Chapter 10 Section 10.5.3 - Provision of dedicated, combined and incidental fauna underpass structures; and

- Chapter 10 Section 10.5.3 - Exclusion fencing will be installed around the crossing structures to prevent access to the carriageway for up to 500 metres either side.

A total of 25 fauna underpass structures are proposed for Stage 1 of the WC2U upgrade project (*Table 2.1*). These will consist of 16 sites with box culverts, six bridge sites, two sites with pipe culverts and one site with a bibo arch.

Table 2.1: Underpass structures proposed for Stage 1 of the WC2U upgrade project.

Chainage	Structure	Dimensions	Underpass Length (m)
19820	Box Culvert	5 x 2400 x 2100	97 + 30
20800	Bridge	n/a	96
21740	Bridge	n/a	122
23040	Bridge	n/a	n/a
24305	Box Culvert	2700 x 900	n/a
25255	Box Culvert	2700 x 2400	42 + 37
26535	Box Culvert	4 x 3600 x 1200; Plus 1 x 3600 x 2400	18 + 52
27848	Pipe Culvert	4 x 1200	n/a
28275	Pipe Culvert	2 x 1800	n/a
28565	Box Culvert	3600 x 3000	53
29650	Bridge	n/a	100
30855	Box Culvert	2100 x 900	110
31510	Bridge	n/a	n/a
31750-930	Box Culvert	2400 x 2400	50 + 50
32930	Arch	4 x 9m	62
33395	Box Culvert	3000 x 2400	n/a
33940	Box Culvert	2400 x 1200	n/a
34450	Box Culvert x 3	3600 x 2400; 3600 x 3600; 3000 x 3000	68
34780	Box Culvert	3600 x 2100	56
35095	Box Culvert	23 x 3600 x 3000	50
36905	Box Culvert	2 x 2400 x 1200	53
37950	Bridge	n/a	n/a
38330	Box Culvert	2 x 3000 x 1500	28 + 37
39990	Box Culvert	17 x 3300 x 2100	n/a
40500	Box Culvert	9 x 3000 x 2100	48 + 17

The purpose of the fauna underpasses and associated fauna exclusion fencing will be to maintain the viability of local populations of terrestrial fauna by facilitating wildlife movement between proximate areas of habitat either side of the Upgrade corridor, thus maintaining genetic variation and providing opportunities for species dispersal and recolonisation. Where possible, the fauna underpass structures will also be designed to accommodate use by several threatened fauna species including the spotted-tailed quoll (*Dasyurus maculatus*), brush-tailed phascogale (*Phascogale tapoatafa*), giant barred frog (*Mixophyes iteratus*) and koala (*Phascolarctos cinereus*).

In addition, MCoA B2 requires the RMS to further investigate design refinements to improve fauna connectivity between chainages 19150 and 19820. If this process delivers an improved fauna connectivity structure within Stage 1 of the project, the additional structure will be included in the monitoring program.

2.3 Widened vegetated medians

MCoA B4 states "*The Proponent shall in consultation with OEH, ensure that the design of the project as far as feasible and reasonable, incorporates provision for glider crossings (such as widened medians and maintenance or enhancement of habitat within the medians and corresponding carriageway boundaries) where the alignment crosses areas of recognised glider habitat*". Furthermore, RSoCs and EA mitigation measures relevant to the provision of widened medians include:

- RSoC F8 - Retention of mature trees in the median at locations identified in the environmental assessment will provide a stepping stone for gliders. Protection of these trees will occur (F2), and lopping and pruning is not to occur without expert advice; and

- Chapter 10 Section 10.5.3 - Widening of the median at important locations.

The purpose of the widened vegetated medians will be to maintain habitat connectivity for glider species known or likely to occur in the locality in order to maintain genetic variation and to provide opportunities for dispersal and recolonisation. Threatened glider species targeted by the mitigation measure include the squirrel glider (*Petaurus norfolcensis*) and yellow-bellied glider (*Petaurus australis*).

The vegetated medians will consist of strips of retained tall sclerophyll forest vegetation (minimum 40 metres wide), which will extend up to 900 metres in length. Continuous lengths of wildlife exclusion fencing will be installed either side of the Upgrade corridor in this locality to limit potential use of the vegetated median by ground-based fauna, thus minimising the incidence of road-strike mortalities.

2.4 Nest box installation

The relevant EA mitigation measure is contained in Chapter 10 Section 10.5.1.2 - *Nest boxes are to be installed, where required, in accordance with specialist advice and in consultation with the EPA, prior to construction, to replace hollow resources that are proposed to be removed*.

The purpose of nest box installation is to implement nest boxes as a compensatory mechanism for the loss of den, roost and nest resources (LES 2012c). A Nest Box Management Plan (NBMP) has been prepared by LES in accordance with MCoA B6, which states *"prior to the commencement of any construction work that will result in the disturbance of any native vegetation (or as otherwise agreed to by the Director General), the Proponent shall in consultation with OEH prepare and submit for the approval of the Director General a Nest Box Plan to provide replacement hollows for displaced fauna consistent with the requirements of SoC F7. The plan shall detail the number and type of nest boxes to be installed which must be justified based on the number and type of hollows removed (based on detailed pre-construction surveys), the density of hollows in the area to be cleared and adjacent forest, and the availability of adjacent food resources. The plan shall also provide details of maintenance protocols for the nest boxes installed including responsibilities, timing and duration"*.

A total of 303 nest boxes are to be installed along the Upgrade corridor between chainage 19.600 and 39.000. Detailed descriptions of nest box locations, nest box types and target species for each area are provided in the NBMP (LES 2012c). At least 60 percent of the nest boxes are to be installed prior to or during clearing works to provide alternative shelter for hollow-dependent fauna displaced during the clearing phase. The remaining nest boxes will be installed once the abundance of actual tree hollows removed has been confirmed by the clearing phase monitoring.

2.5 Landscape rehabilitation

Relevant EA mitigation measures include:

- Chapter 10 Section 10.5.1.1 - Revegetation/rehabilitation of the site should be conducted progressively during the construction phase to ensure the use of collected topsoil and seed and to develop different successional stages of rehabilitation;
- Chapter 10 Section 10.5.1.1 - A weed management plan is to be prepared as part of the flora and fauna management sub plan, outlining weed management actions to be carried out during construction to prevent the spread of weeds and plant pathogens;
- Chapter 10 Section 10.5.2 - Native and locally indigenous plants will be used in the landscaping and disturbed areas will be progressively revegetated;
- Chapter 10 Section 10.5.2 - Weeds in areas disturbed by construction activities will be managed for a minimum of two years after construction completion;
- Chapter 10 Section 10.5.4 - Development of a rehabilitation and weed control strategy as part of the construction environmental management plan, with specific mitigation measures for control of the spread of weeds and habitat rehabilitation, particularly along roadside verges, adjacent to culvert entrances and bridge pylons;
- Chapter 10 Section 10.5.4 - A protocol will be developed for weed infested areas to ensure that all potential weed propagules from soil and vegetative material are appropriately disposed of;
- Chapter 10 Section 10.5.5 - Roadside verges will be rehabilitated adjacent to culvert entrances and bridge pylons.

In order to comply with MCoA B21(c) the contractor will prepare and implement an Urban Design and Landscape Plan (UDLP) for the project, which will include locations along the project corridor directly or indirectly impacted by the construction of the project (e.g. temporary ancillary facilities, access tracks, watercourse crossings, etc.) which are proposed to be actively rehabilitated, regenerated and/ or revegetated to promote biodiversity outcomes and visual integration. The UDLP will provide details of species to be replanted, including their appropriateness to the area and considering existing vegetation and habitat for threatened species.

2.6 Protection of in-situ threatened flora populations

The relevant mitigation measure for the protection of in-situ threatened flora species is stipulated in MCoA B7(d), which states *"the Proponent shall in consultation with the OEH develop a management plan for these species which includes detail of mitigation measures to be implemented during construction to avoid and minimise impacts to areas identified to contain these species, including excluding construction plant, equipment, materials and unauthorised personnel".*

In situ threatened flora located within the road reserve outside the construction footprint will be protected during highway construction and operation by a range measures directed at maintaining species and their habitat in good condition. Detailed descriptions of the proposed mitigation and management measures are provided in the threatened plant species management plan prepared by Benwell (2012), and include:

- implementation of safeguards during clearing and construction - no-go zones, fencing and signage, toolbox sessions, tagging and marking and population mapping; and

- protection from edge effects - sedimentation fencing, shade/dust screening, landscaping, revegetation and weed control.

2.7 Establishment of translocation areas

The relevant mitigation measure for the establishment of translocation areas for threatened flora species is stipulated in MCoA B7(b), which states *"the Proponent shall in consultation with the OEH develop a management plan for these species which, if investigation under Condition B7(a) reveals translocation of impacted plants is feasible, includes details of a translocation plan for the plants consistent with the Australian Network for Plant Conservation 2"d Ed 2OO4: Guidelines for the Translocation of NSW Government Department of Planning and lnfrastructure 6 Threatened Species in Australia, including details of ongoing maintenance such as responsibilities, timing and duration".*

An additional mitigation measure relevant to the establishment of translocation areas is provided in RSoC F4 - *Plantings of rusty plum (Amorphospermum whitei) in areas of suitable habitat adjacent to the Proposal will follow from seed collection and propagation*.

This mitigation measures is also described in RSoC F3 - *Threatened species directly impacted by the Proposal will be translocated to a suitable location outside the impact zone. A further visual inspection will be conducted post clearance to identify threatened species which may be indirectly impacted outside the cleared zone. Landscape planting is to commence along the road boundary as soon as possible during construction*.

Within Stage 1 of the WC2U upgrade project translocations are proposed for four threatened flora species directly impacted by the Upgrade, *Amorphospermum whitei, Marsdenia longiloba, Tylophora woollsii* and *Dendrobium melaleucaphilum* (Benwell 2012). In addition, translocations are proposed for two rare flora species directly impacted by the Upgrade, *Goodenia fordiana* and *Artanema fimbriatum*.

The primary aims of the proposed translocations are to:

- save and re-establish those individuals of significant flora directly impacted by construction; and

- improve the prospective viability of the translocated population by propagating and introducing additional individuals (Benwell 2012).

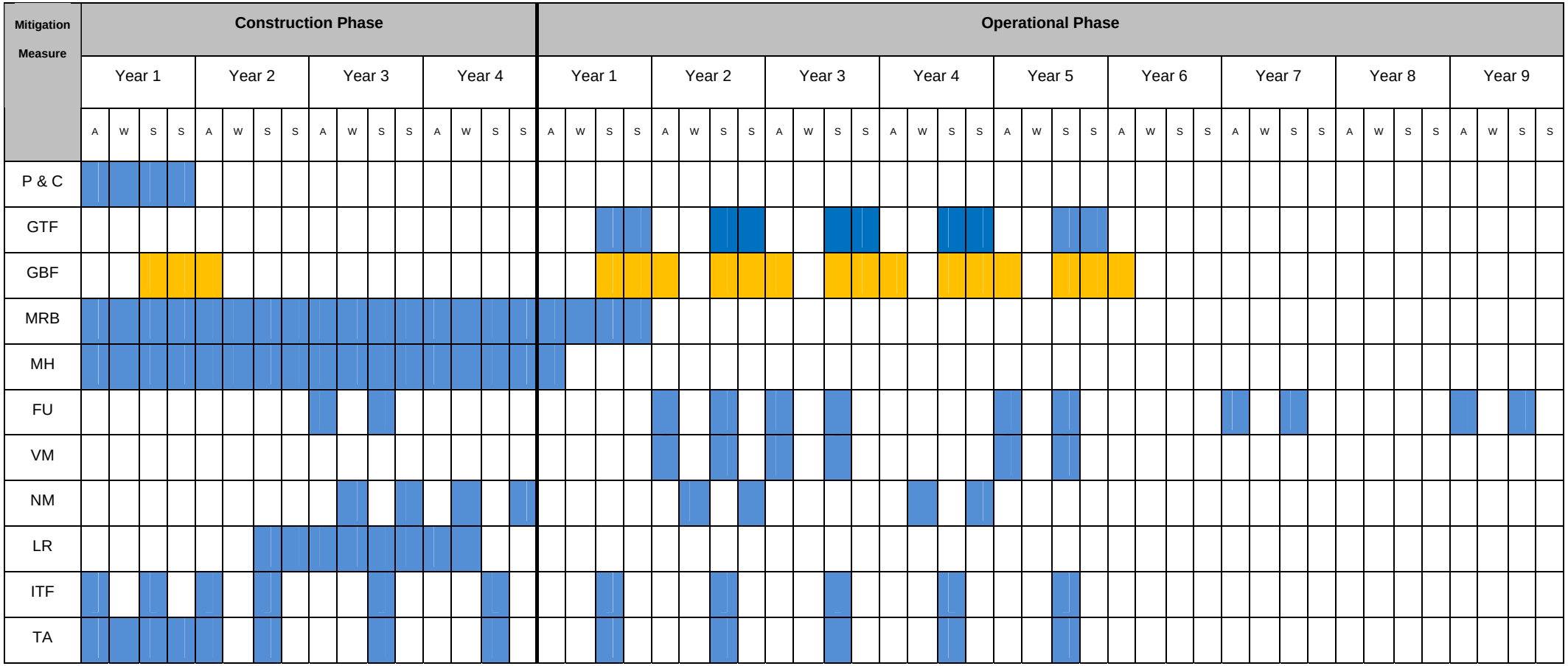
Details of the proposed translocation areas and procedures are provided in the Draft Warrell Creek to Urunga Upgrade Threatened Species Management Plan (Benwell 2012).

3 Monitoring methods

3.1 Timing and duration of monitoring

Details of the timing and duration of monitoring for each mitigation measure are provided in the following sections and summarised in *Table 3.1*.

Table 3.1: Summary of the timing and duration of monitoring events for each proposed mitigation measure. P & C =pre-clearing and clearing procedures; GTF = green-thighed frog monitoring; GBF = giant barred frog monitoring; MRB = microbat roost box monitoring; MH = microbat habitat monitoring; FU = fauna underpass and exclusion fence monitoring; VM = vegetated medians; NM = nestbox monitoring; LR = landscape rehabilitation monitoring; ITF = in-situ threatened flora population monitoring; TA = translocation area monitoring.



Note: Orange Shading indicates timing of monitoring only if the Giant Barred Frog is detected during future surveys. A; W; S; S - Autumn; Winter; Spring; Summer.

3.2 Pre-clearing and clearing procedures

3.2.1 Timing of monitoring

Surveys for delineating clearing limit boundaries, identifying habitat resources and detecting hollow-dependent fauna, koalas and frogs will be completed shortly prior to the commencement of clearing operations. Wildlife rescue and tree hollow inspection procedures will be undertaken in conjunction with the second clearing stage, which involves the felling of potential habitat trees.

3.2.2 Monitoring procedure

The results of the targeted vegetation boundary delineation surveys (refer to *Section 2.1.1*) will be incorporated into the project constraints mapping, which will be submitted in annual reporting to the RMS and OEH.

Monitoring of other pre-clearing and clearing procedures will consist of data collection and reporting tasks that will culminate in the production of a detailed clearing report to be submitted to the RMS and OEH upon completion of the clearing phase of the project. Information contained within the clearing report will include:

- a habitat tree register – to present the tree hollow data collected from habitat trees removed during clearing operations. The information will be analysed and compared with the potential tree hollow data contained in the NBMP prepared by LES (2012d) to ensure that an adequate supply of nest boxes has been installed to mitigate the impacts of tree hollow removal;
- detailed descriptions of methods used during the pre-clearing and clearing procedures;
- results of pre-clearing and clearing procedures including lists of fauna species displaced by clearing, species captured, species released and any wildlife mortalities resulting either directly or indirectly from the clearing operations;
- discussion of the pre-clearing and clearing procedures in terms of their effectiveness and any problems encountered that relate to the methods employed; and
- any recommended modifications to the pre-clearing and/or clearing procedures that may be adopted during future clearing operations.

The types of information to be collected during each pre-clearing and clearing procedure are provided in *Table 3.2*.

Table 3.2: Information to be collected during each pre-clearing and clearing procedure.

Mitigation/Management Procedure	Required Information
Habitat Resource Surveys	Sampling date; observers; start/finish chainages; sampling start/finish times; threatened flora observations; additional habitat resources; GPS locations for observations.
Hollow-dependent Fauna Surveys Stag Watching (optional technique)	Sampling date; observers; habitat tree number; tree location; tree species; sampling start/finish times, prevailing weather conditions; hollow-dependent fauna species and abundances observed; location and characteristics of occupied hollow(s) on the subject tree.
Spotlighting	Sampling date; observers; start/finish chainages; sampling start/finish times, prevailing weather conditions; fauna species and abundances observed; fauna behaviour (ie. foraging, emerging from hollow, moving through site); habitat type occupied by observed fauna; GPS locations of fauna observations.
Koala Surveys	Sampling date; observers; start/finish chainages; sampling start/finish times, GPS locations of observed koalas; koala sex and age; species and DBH of occupied trees; method of site marking used; management procedure applied.
Frog Surveys	Sampling date; observers; location; sampling start/finish times, prevailing weather conditions; frog species and abundances observed/captured; release date, release time; GPS location of release point; habitat type at release point.
Habitat Tree Removal	Habitat tree number; removal date; observers; removal method (e.g. sawn, pushed, hard or soft impact); tree hollow characteristics (e.g. hollow type, entrance diameter, hollow depth, evidence of fauna usage); species breeding status and condition of fauna captured/observed; release date; GPS location of release point; habitat type at release point; release method.
Final Pre-clear Searches	Sampling date; observers; start/finish chainages; sampling start/finish times; fauna observations and captures; GPS locations for observation and release points.
Habitat Tree Removal	Date; tree number; tree species; trunk diameter; hollow type; entrance diameter and depth; chamber shape; hollow height; evidence of fauna use; captures; mortalities; injuries; age; breeding status; release point details.

3.2.3 Potential indicators of success

Potential indicators of success for the pre-clearing and clearing procedures will include:

- low rates of fauna injury and mortality resulting from clearing operations, particularly of threatened fauna species;
- successful capture and release of fauna displaced by clearing operations; and
- accurate quantification of tree hollow resources being removed.

3.3 Threatened frog population monitoring

3.3.1 Green-thighed frog

Timing of monitoring

Monitoring will be undertaken on five occasions, commencing in the first year of the operational phase and finishing five years post-construction. The monitoring events will be at least 10 to 12 months apart but ultimately dependant on rainfall events. Monitoring will commence once the vegetation on the edges of the constructed ponds is considered sufficient (>20% groundcover).

Monitoring methods

Monitoring of the green-thighed frog population will consist of two main components:

1. Monitoring of constructed breeding ponds; and
2. Monitoring the integrity of frog fences.

Monitoring will be undertaken on a rainfall event basis when 24 hour rainfall totals exceed 75mm or a cumulative total of 150mm over a 72 hour period. Such rainfall events will be monitored via 'on site' weather stations which are to be programmed to generate a sms message to the field survey team phone, and alternatively, the Bureau of Meteorology (BOM) website and specifically the Nambucca Heads Bowling Club (Station No. 059024). Further details of monitoring methods are provided in the green-thighed frog management strategy prepared by a LES (2012a).

Potential indicators of success

Performance indicators of success will be based on either the:

- Continued presence of Green-thighed Frogs at breeding ponds;
- Green-thighed Frogs calling from the edge of the constructed ponds; or
- The presence of tadpoles, juveniles or metamorphs during follow up surveys.

3.3.2 Giant barred frog

No Known habitat for the giant barred frog has been identified within the Nambucca Heads to Urunga section of the upgrade project. However, additional targeted surveys for the species will be undertaken at Boggy Creek (chainage 62765) and McGraths Creek (chainage 71965) in spring and summer prior to the commencement of clearing works. If the species is detected at either of these sites then monitoring of these populations will consist of:

- Frog surveys conducted during spring, summer and autumn along a one kilometre transect per site. Captured individuals will be PIT tagged to record re-captures during subsequent surveys. Data to be recorded per individual will include location, sex and breeding condition, snout-vent length, weight and general condition; and
- Tadpole surveys using bait traps (20 traps per transect) and opportunistic dip netting.

If the species is detected then a monitoring event will be undertaken at the time of detection (ie. collection of baseline data), followed by five annual monitoring events commencing with the post-

construction phase of the project. Further details of monitoring methods are provided in the giant barred frog management strategy prepared by a LES (2012b).

Potential indicators of success

Performance indicators of success will be based on either the:

- Continued presence of giant barred frog along any part of the 1 km transect. This approach compensates for the mobile habits of this species and the shifting patterns of seasonal habitat use;
- The recapture of one or more giant barred frog following their relocation from the clearing footprint (if this occurs); or
- The presence of tadpoles, metamorphs or juveniles frogs during follow up surveys post construction (LES (2012b).

3.4 Microbat monitoring

3.4.1 Timing of monitoring

Microbat roost boxes will be monitored quarterly, commencing six months after installation, for a period of five years. Microbat habitat monitoring will be conducted once prior to construction and monthly during construction. Inspection of riparian zones to assess impacts on flyway function will also be conducted once post-construction.

3.4.2 Monitoring procedures

Microbat roost boxes

The microbat boxes will be inspected quarterly to determine species presence/absence, an estimate or count of numbers and breeding activity. Information will also be collected as to the roost identification number, date and time of the inspection. Bat box inspections will commence six months after installation and finish one year post-construction (*Table 3.1*).

Habitat monitoring

Habitat monitoring will focus on inspections of the riparian zone to assess whether flyways have been constricted as part of construction works. Therefore, on either side of the construction corridor a photo point will be installed and a visual assessment be undertaken to gauge whether the flyway has been maintained or is in need of corrective actions (i.e. vegetation management).

Monitoring of water quality will also be undertaken on both the upstream and downstream sides of the construction works. This monitoring will be undertaken on a monthly cycle in accordance with the Construction Environmental Management Plan (CEMP) and collect the following parameters: turbidity; total suspended solids; conductivity and pH at both upstream and downstream points.

3.5 Fauna underpasses and exclusion fencing

Subject to the availability of suitable control sites, monitoring of the fauna underpasses and exclusion fencing will employ a Before-After Control Versus Impact (BACI) design. The BACI design allows for

monitoring to occur on treated and untreated sites both before and after the subject mitigation measures have been installed or implemented (McComb *et al*. 2010).

Of the 25 fauna underpass sites proposed for Stage 1 of the WC2U upgrade project, seven sites have been selected for monitoring (*Table 3.3*). An additional site between chainage 19500 and 19820 may be added subject to the outcome of proposed design refinements to improve fauna connectivity in this area. The selection criteria for fauna underpass monitoring include a continuous underpass length greater than 90 metres (excludes bridges and arches) and/or location of the structure within an area of suitable habitat for one or more of the target threatened species (ie. koala, brush-tailed phascogale, spotted-tailed quoll or giant barred frog). It was agreed with EPA that bridge underpasses will not require monitoring given that such structures have been demonstrated to provide effective fauna movement on other similar road projects.

Table 3.3: Proposed fauna underpass structures suitable for monitoring.

Chainage	Structure	Underpass Length (m)	SQ	BtP	K	GBF
26535	Box Culvert	18 + 52			x	
28565	Box Culvert	53	x	x	x	
30855	Box Culvert	110	x	x	x	
31750-930	Box Culvert	50 + 50	x	x	x	
32930	Arch	62	x	x	x	
33395	Box Culvert	n/a	x	x	x	
34450	Box Culvert	68	x	x	x	

3.5.1 Control Site Selection

The BACI monitoring design requires the use of control sites to enable monitoring to occur on treated and untreated sites both before and after management has occurred (McComb *et al*. 2010). However, there are several logistical challenges to be overcome in selecting suitable control sites:

- locating suitably undisturbed yet comparable habitat within 10 kilometres of the project;
- obtaining approval from landholders and maintaining approval with any subsequent changes in land ownership; and
- ensuring that management at control sites does not change significantly over the 8 to 10 year monitoring period (e.g. timber harvesting and fire regimes).

Consequently, an assessment of potential control sites will be undertaken in consultation with EPA prior to commencement of baseline monitoring. Where feasible, control sites will be incorporated into the monitoring program. Ideally, the minimum number of control sites required will be that sufficient to represent each of the threatened fauna species targeted by the underpass and exclusion fencing mitigation measures.

3.5.2 Timing of monitoring

The timing of fauna underpass/exclusion fence monitoring has been selected to coincide with the breeding seasons and likely dispersal periods of threatened fauna species targeted by the underpass structures (*Table 3.4*). Fauna movements are expected to be more frequent and extensive during the breeding seasons and dispersal periods due to expansion of home ranges and movement of juveniles away from natal areas. Therefore, these periods are likely to represent peaks in fauna movement, resulting in higher rates of fauna underpass usage, hence higher detection rates and sample sizes.

Table 3.4: Breeding seasons and likely dispersal periods of threatened fauna species targeted by the fauna underpass structures.

Scientific Name	Common Name	Breeding Season	Likely Dispersal Periods
Dasyurus maculatus	Spotted-tailed Quoll	Late May to early August (Belcher *et al*. 2008).	Spring and summer.
Phascogale tapoatafa	Brush-tailed Phascogale	Mid May to early July (Soderquist & Rhind 2008). Males expand home ranges during breeding season (Soderquist & Rhind 2008).	Mid-summer (Soderquist & Rhind 2008).
Phascolarctos cinereus	Koala	Spring and summer (Martin *et al*. 2008).	Spring and summer.

The monitoring will commence after the vegetation clearing phase of the project has been completed, but before the underpass structures become operational. The impacts resulting from vegetation clearing are not relevant to assessing the effectiveness of fauna underpass or exclusion fence mitigation measures. Therefore, it will be necessary to collect the baseline monitoring data after the vegetation clearing phase in order to eliminate or control this variable so that its effects cannot be confused or confounded with those of the independent variable (ie. impacts of underpasses and exclusion fencing) (Hayek 1994).

Monitoring events will be undertaken in autumn and spring each year for a minimum of one year during the construction phase and five predominantly non-consecutive years during the operational phase of the project (*Table 3.1*). The autumn monitoring events will be conducted over eight weeks each year, preferably commencing in mid-March and finishing in mid-May. The spring monitoring events will also be conducted over eight weeks each year, preferably commencing in mid-September and finishing in mid-November.

3.5.3 Fauna census techniques

Monitoring of the selected fauna underpasses will involve sampling within each underpass structure and its entrances, in retained habitats adjacent to the fauna underpass and in the areas isolated by exclusion fencing leading into the underpass structures. Monitoring should involve the use of several fauna census techniques including:

- sand pad sampling (eight sampling nights per sand pad per monitoring event);
- hairtube sampling (minimum 20 sampling nights per hairtube per monitoring event);
- detection with automated cameras (minimum 40 sampling nights per camera per monitoring event);
- scat and track searches; and
- use of artificial groundcover (e.g. corrugated iron or plywood sheeting).

Due to the potential risk of inundation, the use of automated cameras is not recommended at combined drainage/fauna underpass structures.

Fauna underpass structures

Sand pads will be established several metres inside each underpass entrance. Each sand pad will be at least one metre wide and extend across the entire width of the underpass structure.

Hairtubes will be attached to fauna furniture within each underpass structure at various heights where possible to sample both ground-based and arboreal fauna. Hairtubes will be baited with a combination of vegetarian and meat baits.

Automated cameras will be installed near the centre of each fauna underpass structure (excluding combined structures) to detect mainly medium to large fauna species and their direction of movement. Smaller fauna species capable of moving beneath the camera detection beam will be sampled by other census techniques including hairtubes, sand pads and scat and track searches.

Each fauna underpass structure will be carefully searched for fauna scats, hair and tracks each time the sand pads are inspected.

If the underpass "fauna furniture" does not include logs or rocks to provide suitable shelter for small ground mammals, reptiles and frogs, then artificial groundcover will be placed in the underpass to sample these faunal groups. The artificial groundcover will be installed at the beginning of each monitoring event and checked when conducting sand pad inspections.

Adjacent forest habitat

Forest habitat adjacent to the fauna underpass entrances will be surveyed to assess the range of fauna species occurring in the proximity of each underpass structure. The results will then be compared with the underpass monitoring results to identify which species present in the immediate area are not utilising the underpass structure.

The sampling area in forest adjacent to each underpass entrance shall cover at least one hectare where possible. The census techniques will include spotlighting, arboreal and ground-based trapping (using cage and box traps), pitfall trapping, hairtube sampling, timed diurnal and nocturnal active searches (e.g. under fallen logs, litter, decorticating and fallen bark and rocks) and scat and track searches.

Fauna underpass exclusion fencing

Monitoring of areas isolated by the wildlife exclusion fencing leading into the fauna underpasses will be undertaken. The purpose of the monitoring is to assess the effectiveness of the exclusion fencing design in protecting smaller less mobile fauna species such as frogs, reptiles and small mammals from road strike mortality whilst funnelling them into the underpass structures. Limiting the sampling to within 200 metres either side of the underpass structure should be sufficient to accommodate the predominantly small home ranges of the target species (ie. smaller less mobile fauna). Monitoring techniques will include the use of sand pads (possibly in conjunction with drift fencing), hairtubes, timed diurnal active searches (e.g. under fallen logs, litter, decorticating and fallen bark and rocks) and scat, track and road mortality searches. Monitoring will also include an inspection of the exclusion fencing to assess fence condition, structural integrity, overhanging vegetation and vine growth.

The road mortality searches will involve careful inspections of roadside areas, not just the immediate road surface, to detect the remains of vertebrate fauna that have been struck by vehicles but have been able to move off the road surface before dying.

3.5.4 Potential indicators of success

Potential indicators of success for the fauna underpass and exclusion fence monitoring will include:

- low rates of use of fauna underpasses and adjacent habitats by feral predators;
- high levels of fauna underpass use by a wide variety of native fauna species;
- evidence of use by dispersing individuals and different age cohorts;
- use by cover-dependent species and species with low mobility; and

- low incidences of fauna road strike mortality.

3.6 Widened vegetated medians

3.6.1 Timing of monitoring

The timing of monitoring for the widened vegetated medians has been selected to coincide with the breeding seasons and likely dispersal periods of threatened glider species targeted by the mitigation measure (*Table 3.5*). As explained in *Section 3.5.2*, these periods are likely to represent peaks in glider movement, resulting in increased usage of the vegetated median.

Table 3.5: Breeding seasons and likely dispersal periods of threatened glider species targeted by the widened vegetated medians.

Scientific Name	Common Name	Breeding Season	Likely Dispersal Periods
Petaurus australis	Yellow-bellied Glider	Variable depending on habitat characteristics (Tyndale-Biscoe 2005). However, breeding in NSW generally occurs between July and September (Tyndale-Biscoe 2005).	When young are 12 to 24 months of age (Goldingay 2008).
Petaurus norfolcensis	Squirrel Glider	Young are born between April and November, with a peak during winter (Van der Ree & Suckling 2008).	When young are 12 to 18 months of age (Van der Ree & Suckling 2008).

Monitoring of the vegetated medians will commence during the second autumn of the operational phase of the Upgradeproject. Monitoring will be undertaken over six weeks each season on years 2, 3 and 5 of the operational phase (*Table 3.1*). Additional years of monitoring may be required if the vegetated median is found to be ineffective and requires modification or supplementation with alternative glider crossing structures.

3.6.2 Fauna census techniques

Monitoring of the vegetated median will involve sampling within the vegetated median and within retained habitat either side of the Upgrade corridor. Monitoring will involve the use of several fauna census techniques including:

- hairtube sampling;
- spotlighting surveys; and
- trapping.

Hairtube sampling

Hairtube sampling will be conducted for six weeks each monitoring event, with wafers and baits being replaced every two to three weeks. Hair samples will be sent to an appropriately qualified/experienced specialist for identification.

Hairtube transects, each containing 20 hairtubes (spaced 25 to 30 metres apart), will be established in retained forest habitat either side of the Upgrade corridor at each vegetated median site. One hairtube transect, containing 20 hairtubes (spaced 25 metres apart), will be established in each vegetated median.

Each hairtube will be attached to the main trunk of a mature Eucalypt at approximately six metres above the ground, and baited with a mixture of honey, oats and peanut butter. The main trunk above the hairtube will be sprayed with a mixture of honey and water upon installation to provide an additional attractant for gliders.

Spotlighting surveys

Spotlighting surveys will be conducted by two observers walking at one kilometre per hour on three occasions during each season. At each vegetated median site spotlighting transects (minimum 500 metres long), will be established in retained forest habitat either side of the Upgrade corridor and within the vegetated median (three transects in total). All fauna detected by spotlight will be identified to species, behaviour noted and located recorded using a GPS. If gliders are detected, they should be observed until their direction of movement can be ascertained.

Trapping and radio tracking

Spotlighting and hair tube sampling cannot always determine whether gliders occupying vegetated medians are residents of the median or traversing the road corridor. Consequently, upon the identification of target gliders in Year 2 of the operational phase, trapping and radio tracking will be undertaken in Year 3 to confirm glider movement across the highway via vegetated medians.

Transects of 10 large Elliot traps will be mounted on brackets approximately six metres high up the trunk of a tree and at 50 metre intervals. One transect will be located in the centre of each median for a period of four nights. Traps will be baited with a mixture of peanut butter, honey and oats. A honey solution will be sprayed up the tree trunk as an attractant. Traps will be checked early each morning and any trapped gliders will be processed and released on site at dusk.

Captured gliders will be weighed, sexed and assigned to age classes based on tooth condition, ventral fur colour and breeding status and fitted with a radio transmitter (Hyder Consulting 2012). A telemetry receiver will be used to locate the gliders, which will be radio-tracked at least one night a week for the following four weeks. The location of each radio-tracked individual will be recorded between two and four times per night and at least once each day. The GPS coordinates of each location will be recorded, along with the microhabitat being used and observed behaviour. Tagged individuals will be trapped and transmitters removed at the end of the monitoring period.

3.6.3 Potential indicators of success

Potential indicators of success for the vegetated median monitoring will include:

- evidence of regular use of median vegetation by the target glider species;
- evidence of use by dispersing individuals and different age cohorts; and
- use by glider species other than threatened species e.g. sugar glider and greater glider.

3.7 Nest box monitoring

3.7.1 Timing of monitoring

LES (2012d) has proposed that nestbox monitoring will take place in winter 12 months after the installation period, followed by a summer census to account for seasonal variation in the use of the nest

boxes. Winter and summer monitoring events will be conducted in years three and four of the construction phase as well as years two and four of the operational phase (*Table 3.1*).

During each monitoring event, the following information should be collected for each nest box using a field proforma:

- inspection dates, weather conditions (i.e. rain, wind, cloud cover, ambient temperature) and time each box was inspected;
- nest box number;
- is the nest box currently occupied by native fauna, if yes, what species;
- if no, are there signs of use and can the species be identified or assigned to a group (i.e. bats, birds);
- has the nest box been used by a pest species (i.e. european bees, common myna, termites);
- is there any deterioration of the nest box;
- is there any maintenance required; and
- has the surrounding landscape changed (i.e. clearing, partial clearing).

Factors to be considered as part of the maintenance schedule include:

- the need to remove exotic pests species such as common mynas, common starling and european bees;
- replacement of fallen, damaged or degraded nest boxes;
- repositioning or relocation of dysfunctional nest boxes;
- checking each box is not holding water or leaking; and
- removing excess nesting material as this may impede access over time.

3.7.2 Potential indicators of success

Potential indicators of success for the nest box mitigation measure will include:

- low rates of nest box occupancy by feral species;
- use of nest boxes by a wide variety of hollow-using native fauna species;
- species use of nest boxes is consistent with the species targeted by the nest box design; and
- high level of nest box durability, with minimal maintenance requirements.

3.8 Landscape rehabilitation

At the time of EcMP preparation no Landscape Rehabilitation Plan has been prepared for the WC2U project. Therefore, in the absence of such a plan, the objectives for monitoring landscape rehabilitation areas will be based on those applied to similar previous road projects (RTA undated), which will include:

- Plant species must be representative of each of the structural strata (tree, shrub and herb layer) of the target vegetation community;
- All of the species identified with positive or unique fidelity to the target vegetation community;
- At least 50% of the vascular plant species should be representative of the target vegetation community; with a community frequency of 25% or greater;
- Sufficient cover of native herbs established at a density which is sufficient to ensure continuous plant coverage by completion of the landscaping maintenance period;

- Weed species comprise no greater than 5% of all plant species per restored area with exception of 15% in riparian vegetation communities; and
- Weed cover is less than 5% per restored area.

The area to be rehabilitated within the WC2U upgrade project will most likely consist of several target vegetation types and implementation of several rehabilitation methods. Therefore, a minimum of one sampling site will be established within each stratification unit (ie. combination of target vegetation type and rehabilitation method). Additional sampling sites will be established in most of the stratification units to sample responses to variations in microclimate, topographic position and aspect. The intensity of sampling effort will be determined in accordance with the recommended number of sampling sites per stratification unit provided in *Table 3.6*.

Table 3.6: Recommended number of sampling sites depending on stratification unit size.

Size of Stratification Unit (ha)	Minimum Number of Sampling Sites Required
0-2	1
>2-20	3
>20-50	4
>50-100	5

A combination of transect and plot-based sampling techniques will be applied at each sampling site to enable recording of the structural and floristic data required to meet the monitoring objectives.

A 50 metre long tape transect will be established at each sampling site. Foliage projective cover will be recorded at 0.5 metre intervals to enable a quantitative measure of foliage cover of both native and introduced flora species.

A sampling plot will be established at each sampling site to record the condition and composition of vegetation. The dimensions of the sampling plot will be determined by preparing a species-area curve within each target vegetation type. All plant species within the sampling plot will be recorded, along with a visual estimate of vegetative cover for each species using the Braun-Blanquet 1-5 rating system.

A photopoint will also be established at each sampling site to record long-term gross changes in vegetation structure and composition.

Landscape rehabilitation monitoring will commence six months after the establishment of rehabilitation sites. Monitoring will then be conducted every three months for a two year period initially. The need for additional monitoring will be determined following analysis of the monitoring data.

A general traverse of all Landscape Rehabilitation Areas during the baseline sampling and at subsequent six monthly intervals (ie. every second monitoring event) will be conducted to detect and assess incidences of weed encroachment at the broader landscape level.

3.9 In-situ threatened flora populations

3.9.1 Timing of monitoring

The recommended timing for monitoring of in-situ threatened flora populations is as follows: collection of baseline data upon installation of protective barriers, 6-monthly intervals for two years and then once a year thereafter for five years post-construction (*Table 3.1*). The monitoring program will then be reviewed and a strategy developed for further monitoring if required.

3.9.2 Monitoring procedure

Monitoring of in-situ threatened flora populations will aim to assess the effectiveness of protective measures and provide feedback to management on any need for corrective measures if required (Benwell 2012). Each specimen within the in-situ populations will be tagged with an ID code, which will be written on flagging tape and attached to the plant. A map of each in-situ population will be prepared showing the position of all plants (with identification number). The maps can be used to relocate individuals if tags are dislodged or interfered with. The following data are to be recorded for each in-situ specimen:

Identification

- genus;
- species and subspecies;
- plant identification number; and
- location.

Plant condition

- general condition – score on a scale of 0 to 5, where 0 is dead and 5 is excellent;
- leaf condition –healthy/unhealthy, colour, vigour;
- flower/fruit – flower/fruit presence;
- length of new shoots – average length of new shoots (eyeball estimate) and abundance of shoots (many/few etc);
- disease symptoms – evidence of disease;
- recruitment; and
- evidence of any other damage or disturbance.

Site conditions

- plant community canopy height and cover;
- weed abundance and composition;
- climatic events (eg. drought, unusually cold winter temperatures etc);
- maintenance carried out – when and what kind of maintenance carried out at the site since the last monitoring; and
- any other ecological impacts.

3.9.3 Potential indicators of success

Potential indicators of success for the protection of in-situ threatened flora populations will include:

- no net loss of plant abundance within each in-situ population;
- no reduction in population extent;
- no reduction in reproductive vigour;
- good quality habitat successfully restored around each in-situ population site;
- maintenance carried out each year as described in the threatened flora management plan prepared by Benwell (2012); and
- threatening processes including weed invasion controlled or eradicated.

3.10 Translocation areas

3.10.1 Timing of monitoring

Monitoring of the translocations will be conducted as follows: every three months for the first year; every six months in the second year and once a year thereafter for five years post-construction.

3.10.2 Monitoring procedure

Monitoring of translocation areas will aim to record information that can be used to evaluate the success of the translocations and identify causes of survival or mortality. Transplanted individuals will be tagged with the ID code allocated during the targeted survey. This will be written on flagging tape and attached to the plant. A map of each translocation area will be prepared showing the position of all translocated plants (with identification number). The maps can be used to relocate individuals if tags are dislodged or interfered with. Enhancement individuals will also be tagged with flagging tape and numbered and recorded when planted out. The following data are to be recorded for each translocated individual:

Identification

- genus;
- species and subspecies;
- identifier – unique plant number;
- translocation – transplant/cutting/seedling;
- place of origin – original site or source location; easting, northing & description; and
- date – date of monitoring.

Plant condition

- condition when planted – good root-ball, minimal root-ball, bare rooted;
- height – initial height (also later dates as required);
- number of stems – number of stems at transplanting;
- diameter – initial diameter (also later dates as required);
- general condition – score on a scale of 0 to 5, where 0 is dead and 5 is excellent;
- leaf condition – healthy/unhealthy, colour, vigour;
- bark condition – bark damage, healing;
- flower/fruit – flower/fruit presence;
- recent shoot growth – average length of new shoots or recent foliage growth (eyeball estimate) and abundance of new shoot growth (many/few etc);

- insect grazing – evidence of insect grazing;
- mammal grazing - evidence of mammal grazing;
- disease symptoms – evidence of disease;
- recruitment – evidence of recruitment; and
- evidence of any other damage or disturbance.

Site conditions

- plant community canopy height and cover;
- weed abundance and composition;
- climatic events (eg. drought, unusually cold winter temperatures etc);
- maintenance carried out – when and what kind of maintenance carried out at the site since the last monitoring; and
- any other ecological impacts.

3.10.3 Potential indicators of success

Potential indicators of success for the translocation plan will include:

- for each translocated species, at least 60% of the transplants and enhancement introductions are surviving after the first year and 50% after five years;
- flowering/seeding occurs in transplanted individuals (unless saplings);
- representatives from a range of individuals from the local population are established;
- the new or enhanced populations have similar growth characteristics to the natural populations;
- good quality habitat successfully restored in and surrounding the recipient site;
- maintenance carried out each year as described in the threatened flora management plan prepared by Benwell (2012); and
- threatening processes including weed invasion controlled or eradicated.

4 Potential contingency measures

The MCoA B10(d) requires the formulation of potential contingency measures that will be implemented in the event of changes to habitat usage patterns directly attributable to the construction or operation of the project.

The type(s) of potential contingency measures available in the event that a mitigation measure is ineffective in preventing impacts on habitat usage patterns by native fauna will vary depending on the nature, location and/or magnitude of the impact. Consequently, this monitoring program provides only a basic list of potential contingency measures that may be applicable to the broader range of potential problems associated with each mitigation measure. The contingency measures are provided in *Table 4.1.*

Table 4.1: Potential problems and contingencies associated with each proposed mitigation measure.

Mitigation Measure	Potential Problems	Potential Contingency Measures
Clearing Procedures	• high rates of fauna injury and mortality resulting from clearing operations; • poor success at capturing and releasing affected fauna.	• review clearing procedures; • increase habitat tree retention times; • increase staff numbers.
Fauna Underpasses/Exclusion Fencing	• high rates of feral predator activity; • low levels of native fauna movement and species diversity in underpasses; • no use of underpasses by cover-dependent species or species with low mobility; • high rates of fauna road mortality.	• modify habitat structure near underpass entrances; • modify underpass “fauna furniture”; • modify or add potential groundcover resources; • modify exclusion fencing design, location or extent depending on the species and location of mortalities.
Vegetated Median	• no evidence of use of the median vegetation by the target glider species.	• install alternative crossing structures (e.g. glider poles and/or rope bridges)
Nest Box Installation	• high rates of nest box occupancy by feral species; • nest boxes used by a limited number of native fauna species; • species use is incompatible with nest box type; • poor nest box durability.	• modify nest box designs to exclude undesirable species or relocate affected nest boxes to more appropriate habitat; • review the selection and abundance of nest box designs; • identify causes of nest box failure and modify nest box design or construction accordingly.
Microbat Roost Boxes	• low use of nest boxes by target species.	• modify nest box design and/or location; • assess the occurrence of alternative roost sites in the vicinity to determine need for supplementary nest boxes.
Frog Monitoring	• absence of green-thighed frogs; • ponds not holding water for a sufficient time to enable tadpoles to reach metamorphosis; • ponds holding water for too long and representing unsuitable habitat; • exotic fish fauna recorded in breeding ponds.	• conduct additional target surveys to confirm continued presence of green-thighed frogs; • modify breeding pond design to ensure appropriate water regime and vegetation structure.

Mitigation Measure	Potential Problems	Potential Contingency Measures
Translocation Areas	• unsatisfactory survival rates for transplanted individuals; • no flowering/seeding occurs in transplanted individuals; • the new or enhanced populations have different growth characteristics to the natural populations; • threatening processes including weed invasion are inadequately controlled.	• increase number of enhancement plantings; • review site characteristics at translocation sites that potentially impact on plant fertility; • extend the duration and/or frequency of monitoring to observe any impacts of different growth characteristics; • review and modify weed management measures.

5 Reporting and Review

The results of the pre-clearing and clearing procedures monitoring will be compiled, analysed and discussed in a report, which will be submitted to the project Environmental Manager upon completion of the construction phase of the Upgrade project. A copy of the report will also be submitted to the Director-General of Planning and OEH.

Monitoring results for all other mitigation measures will be compiled, analysed and discussed in annual reports, which will be submitted to the Director-General of Planning, EPA and OEH. The annual reporting will include review and updating of the EcMP to account for any changes in detailed design, inclusion of additional management plans and identification of control sites.

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