

16. Terrestrial ecology

The environmental features of the study area vary as the route progresses from south to north. Accordingly the terrestrial ecology characteristics of the route are quite diverse and species composition varies from south to north.

The broad ecological features of the area can be described commencing in the south as coastal plain, passing into forested and wetland areas prior to progressing into pastureland and scattered woodlands.

Corindi Beach is located to the east of the highway in this section. North of Corindi Beach, the route passes through the agricultural setting of the Corindi River floodplain. As the route approaches the Dirty Creek Range, the environment becomes more forested and then the route climbs into the steep and heavily forested Dirty Creek Range dominated by eucalypt forests. The route then passes along the comparatively flat section where there is pastureland present within the predominantly forested area north to Wells Crossing.

Three Endangered Ecological Communities identified by the *NSW Threatened Species Conservation Act 1995* are found in numerous places along the route, and a number of Endangered Ecological Communities are impacted.

Twenty six threatened fauna species listed under the *Threatened Species Conservation Act 1995* and two threatened fauna species under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* were recorded in the study area from field survey or the Department of Environment and Climate Change Wildlife Atlas. One threatened flora species that is listed under both the *Threatened Species Conservation Act 1995* and *Environmental Protection and Biodiversity Conservation Act 1999* was recorded.

Further details regarding the terrestrial ecology are provided in the Terrestrial Ecology Report working paper.

16.1 Field investigations

Field investigations have been undertaken at different stages of the project development to ascertain the ecological constraints and to inform the requirements for the concept design. Initial preliminary surveys were undertaken at the route development stage, and further targeted surveys were undertaken where the developed route options deviated from the existing highway alignment.

Following the announcement of the Preferred Route by the Minister for Roads on 28 August 2006, the strategy for the advanced terrestrial ecology field investigations was formulated in order to comply with the Department of Environment and Climate Change's "Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities. Working Draft 2004". Two separate seasonal field investigation surveys were planned. Targeted field investigations were undertaken in early spring 2006 and late summer 2007 to satisfy the requirements of the Department of Environment and Climate Change Guidelines. The seasonal variation of species that can be detected, and in particular fauna species that seasonally migrate into and out of ecosystems, were accounted for by undertaking the field studies at these times.

The findings from the advanced terrestrial ecology field investigations have been incorporated into the Advanced Terrestrial Ecology Assessment Report and data collected has been mapped into the Geographical Information System platform to inform the concept design process.

16.2 Potential impacts during construction

The construction of the highway upgrade has the potential to impose impacts on the ecological characteristics and biodiversity integrity of the affected area if appropriate management measures are not implemented.

The construction of the highway has the potential to impose impacts on:

- Endangered ecological communities.
- Threatened species.
- Terrestrial and aquatic fauna habitat.
- Terrestrial and aquatic flora species.
- Water quality.
- Fauna movement corridors.

16.3 Potential impacts during operation

The route selection process was undertaken with the aim of minimising the impact on the environment by making informed decisions with information gathered during initial fieldwork and through an environmentally sensitive approach to selecting the ultimate alignment. The effectiveness of the measures proposed during the concept and detailed designs will determine the level and nature of ongoing impacts of the operation of the highway. The concept design strategy has been to formulate design measures aimed at further minimising the highway upgrade's impact on the ecological integrity and environmental characteristics of the area.

Management measures may require revision post-construction if it is found that impacts to the area's biodiversity, ecology and natural environment are unacceptable.

The operation of the highway has the potential to impose impacts on:

- Terrestrial fauna in the form of vehicle strikes if fauna crossings are not adequately implemented and maintained.
- Aquatic and amphibian fauna where waterway crossings are blocked, impeded or significantly altered.
- Flora species in terms of limiting propagation and colonisation opportunities for native species.
- Fauna in the form of degraded water quality.
- Adjoining habitats in the form of degraded water quality.

16.4 Recommended terrestrial flora and fauna mitigation measures prior to and during construction

More detailed mitigation and management measures will be developed during the environmental assessment, as a result of the conditions of approval, and the subsequent detailed design for the project. Detailed management and mitigation measures will be formulated and documented in a Construction Environmental Management Plan.

The flora and fauna mitigation measures that have been incorporated into the concept design have been formulated to provide performance-based outcomes. This approach differs from rigid design criteria. Performance-based approaches are less prescriptive in the way in which a desirable outcome is to be achieved, but more targeted in determining the performance requirements for the desired outcome.

This approach is consistent with the approach being adopted by the NSW Department of Planning for the environmental assessment under Part 3A of the Environmental Planning and Assessment Act for major transport infrastructure projects. It is anticipated that the Woolgoolga to Wells Crossing Project would be subject to a Part 3A Assessment (or the equivalent) at the time of progression to the environmental assessment phase.

The terrestrial ecology outcomes that have been addressed by the approach taken in developing the concept design are:

- Minimise impact on endangered ecological communities.
- Minimise impact on threatened flora and fauna species.
- Minimise impact on key habitat areas.
- Minimise impact key fauna movement corridors.
- Minimise impact on aquatic ecosystems.
- Ensure the location and sizing of fauna crossings are such that fauna species are not disadvantaged or threatened by their usage.
- Provide adequate passage for fauna species across the upgraded highway, and ensure that fauna is not channelled onto adjoining roads such as the old highway or busy service roads.
- Key recommendations from the outcomes of the concept design, environmental assessment phase and subsequent approvals, will allow the development of a Revegetation Plan to accompany the Construction Environmental Management Plan and provide a suitable and maintainable revegetation strategy.

16.4.1 Pre-construction

In order to target and address the required outcomes, the concept design has included the consideration of:

- Appropriate location and sizing of fauna crossings.
- Appropriate accommodation of fauna crossings in key fauna movement corridors and key fauna habitat.
- Indicative locations of fauna fencing.
- General arrangements for amphibian-friendly culvert designs.

- Minimisation of intrusion into sensitive ecosystems such as endangered ecological communities, SEPP 14 wetlands, key fauna habitat and key fauna movement corridors.
- Minimisation of intrusion into nature reserves, national parks and state conservation areas.
- Adequate assessment of the loss of hollow-bearing trees and potentially examine hollow replacement strategies.

Immediately prior to construction it is recommended that a qualified ecologist traverse the path to locate and safely remove fauna and threatened flora species from the construction path.

A Flora and Fauna Management Plan would also be formulated for incorporation into the Construction Environmental Management Plan.

16.4.2 During construction

The performance objectives of the environmental management and mitigation measures that have been developed and incorporated into the concept design will be further developed and documented in the Construction Environmental Management Plan. An environmental representative is to be appointed to monitor compliance with the environmental protection measures contained within the Construction Environmental Management Plan.

Environmental controls to be developed in the Construction Environmental Management Plan, and monitored by the environmental management representative, will include procedures to ensure that during construction the performance objectives can at minimum be met.

It is also recommended that a qualified ecologist be available to identify and safely relocate fauna and threatened flora species at the commencement of land clearing.

16.5 Indicative terrestrial flora and fauna management measures during operation

The primary mitigation and management measures that will be in place for the operational phase of the project will be those that have been developed in the concept design, and those that will be further expanded and refined during the detailed design phase. These measures include:

- Fauna crossing size and locations. A condition of approval may include the monitoring of these fauna crossings for adequacy and performance.
- Fauna fencing.
- Water quality and sedimentation ponds.

Based on the information gathered from the advanced terrestrial ecology field surveys and the information provided by stakeholders such as the Department of Environment and Climate Change, the Community Liaison Group and Ecological Focus Group forums, the management and mitigation provisions take into account the following:

- Known locations of threatened and/or endangered species.
- Vicinity of key fauna habitat.
- Local hydrological conditions.
- Known fauna movement corridors.
- Distance to adjoining fauna crossings.

The locations of proposed drainage culverts have formed the platform for the siting of fauna crossings. However, a number of purpose-specific fauna crossings have been proposed where there is an identified fauna movement corridor, where there is key fauna habitat that is severed by the route or where the vertical alignment allows for stand-alone fauna crossings in areas where there is a significant distance to adjoining crossings.

A summary of the provisions proposed for fauna movement across the upgraded highway are provided in Table 16-1. A summary of the proposed cattle and fauna fencing is also provided in Table 16-2.

Notes:

- BC = box culvert.
- RCP = reinforced concrete pipe.

Dimensions are in metres: number of cells by width by height eg 2 x 3 m x 3 m = two 3 m wide by 3 m high.

Fauna underpasses are to be designed to adopt the principles of the Department of Environment and Client Change and Department Primary Industry - Fisheries guidelines. Principles include allowing for dry passage for terrestrial fauna, allowing for line of sight through crossing and allowing for potential fish passage in drainage lines.

Generally the culverts shown in Table 16-1 also function as drainage lines, however Culverts 27F, 29F, 31F, 36BF, 61F and 61F1 are for Fauna movements only.

Table 16-1 Indicative fauna underpass structures

Location	Chainage	Structure*	Comments / species targeted
Culvert 6 Arrawarra, south of Darlington Beach Resort	2730	3.3 m x 1.8 m box culvert	Opposite Wedding Bells State Forest, which is key habitat and just north of a key fauna movement corridor.
Culvert 7 Approx 450m north of Sherwood Creek Road	2800	2 x 3 m x 1.8 m box culverts	Opposite Wedding Bells State Forest which is key habitat and a key fauna movement corridor.
Culvert 11 South of Kangaroo Trail Road and the northern boundary of Wedding Bells State Forest. Corindi Treatment Plant	4100	2 x 3 m x 2.4 m box culverts	Key habitat and movement corridor both to the west and south.

Location	Chainage	Structure*	Comments / species targeted
Culvert 11F Approx 300m north of Kangaroo Trail Road	4820	3 m x 2.7 m box culvert	Key habitat to the west, likely macropod crossing.
Corindi Creek Bridge	5507 to 5592	285 m Bridge	Bridge with fauna passage under. Fauna required to travel a total of 36 m beneath two bridge carriageways and median.
M4 floodplain bridge – Corindi Creek Floodplain	6025 to 6305	Floodplain bridge approx 3.5 m height	Floodplain bridge to be used for farm vehicles.
M6 floodplain culvert – Corindi Creek Floodplain	6420	2 x 2.7 m x 1.2 m box culverts + 1x 3 m x 3 m box culvert	Floodplain crossing likely used by macropods and others. Sub-regional fauna movement corridor located to the west.
Culvert 24 Approx 1200m south of Section C	8185	Bridge or arch structure with minimum 4.3 m clearance. Drainage for creek included	Culvert combined with property access and cattle underpass on a rural property. Small pockets of Swamp Sclerophyll Forest on Coastal Floodplain, both Endangered Ecological Communities, are located in the vicinity also. Key habitat and fauna movement corridors are to the west.
Culvert 27F West of Bottlebrush Drive.	8770	3 m x 3 m box culvert	Located within a key sub-regional fauna movement corridor and within a small pocket of the Swamp Sclerophyll Forest on Coastal Floodplain Endangered Ecological Community.
Culvert 28A Commencement of Section C	9465	3 m x 3 m box culvert	Located within a key sub-regional fauna movement corridor.
Culvert 29 F North of blueberry farms	10,535	3 m x 3 m box culvert	Located just west of a key sub-regional fauna movement corridor.
Culvert 31F	11,000	3 m x 3 m box culvert	Located just north of the blueberry farmland and where the old and new alignments merge. To the north of the existing alignment is a remaining pocket of Endangered Ecological Community and key habitat.
Culvert 33A North of Range Road	12,120	3 m x 3 m box culvert. Adjoining service road will need re-grading	Located within a key sub-regional fauna movement corridor.

Location	Chainage	Structure*	Comments / species targeted
Culvert 35A Vicinity of Dundoo Creek	12,820	3 m x 3 m box culvert	Located within a key sub-regional fauna movement corridor and within a small pocket of Subtropical Coastal Floodplain Forest, an Endangered Ecological Community.
Culvert 36F South of The Siding and Falconers Lane	13,815	3 m x 3 m box culvert	Located within a key regional fauna movement corridor and adjacent to key habitat.
Culvert 37 Just north of Falconers Lane	14,380	3 m x 3 m box culvert	Located within a key regional fauna movement corridor and adjacent to key habitat.
Culvert 39 Vicinity of Boneys Creek and McPhillips Road	14,940	3 m x 3 m box culvert	Located within a key regional fauna movement corridor and adjacent to key habitat.
Culvert 40 Boneys Creek	15,370	2 x 3m x 3m box culverts to be extended	Located within a key regional fauna movement corridor and adjacent to key habitat and within a small pocket of Subtropical Coastal Floodplain Forest, an Endangered Ecological Community.
Culvert 41	15,890	3 m x 3 m box culvert	Located adjacent to key habitat and in between two pockets of Endangered Ecological Communities. Newfoundland State Forest is adjacent. Just south of the Halfway Creek Duplication.
Culvert 42	16,100	2 x 1.35 m reinforced concrete pipes	Although concrete pipes, this crossing should be suitable for fauna passage, particularly in dry times. Just south of the Halfway Creek Duplication.
Halfway Creek Duplication 16,150 to 19,400 No works to be carried out			
Culvert 52	21,240	3 m x 2.4 m box culvert	Located on the north-eastern edge of the Swamp Sclerophyll Forest on Coastal Floodplain Endangered Ecological Community, and just east of a key regional fauna movement corridor.
Culvert 53	21,700	2 m x 2.4 m box culvert	Located within a key regional fauna movement corridor and adjacent to a pocket of Swamp Sclerophyll Forest on Coastal Floodplain Endangered Ecological Community.

Location	Chainage	Structure*	Comments / species targeted
Culvert 56	22,710	4 x 3 m x 2.4 m box culverts to be extended	Located just to the west of a key regional fauna movement corridor and adjacent to two Endangered Ecological Communities - Swamp Sclerophyll Forest on Coastal Floodplain and Subtropical Coastal Floodplain Forest.
57 - Wells Crossing Bridge	22,785	Wells Crossing Bridge	Wells Crossing bridge with fauna passage under. Fauna required to travel a total of 36m beneath two bridge carriageways and median.
Culvert 58	22,925	3 m x 1.8 m box culvert	Located just to the west of a key regional fauna movement corridor and just north of two Endangered Ecological Communities - Swamp Sclerophyll Forest on Coastal Floodplain and Subtropical Coastal Floodplain Forest.
Culvert 59	23,335	3m x 3m box culvert	Located just to the west of a key regional fauna movement corridor.
60 Bridge	24,435	Bridge	Bridge with fauna passage under.
Culvert 61F	25,185	3 m x 1.8 m box culvert	Located within key habitat and within a key sub-regional fauna movement corridor. Is also located just north of a pocket of Swamp Sclerophyll Forest on Coastal Floodplain Endangered Ecological Community.
Culvert 61F1	25,800	3 m x 1.8 m box culvert	Located within key habitat and within a key sub-regional fauna movement corridor.
Culvert 62	26,650	3 m x 1.8 m box culvert. Regrade required.	Located within key habitat and within a key sub-regional fauna movement corridor.
Culvert 63	26,690	3 m x 1.8 m box culvert. Regrade required.	Located within key habitat and within a key sub-regional fauna movement corridor.

Table 16-2 Indicative proposed fauna and cattle fencing

Location (side of highway)	Chainage	Length	Type
West	1700 – 11,400	9700 m	Fauna fencing
East	1700 – 11,350	9650 m	Fauna fencing
East	3500 – 11,400	7850 m	Cattle fencing
West	3500 – 16,275	12,775 m	Cattle fencing
East	11,400 – 12,350	950 m	Cattle fencing
East	11,400 – 15,250	3800 m	Fauna fencing
West	11,650 – 16,275	4675 m	Fauna fencing
West	19,000 – 22,375	3375 m	Fauna fencing
West	19,000 – 23,750	4750 m	Cattle fencing
East	19,500 – 27,400	7900 m	Fauna fencing
East	19,500 – 20,600	1100 m	Cattle fencing
East	21,550 – 27,400	5850 m	Cattle fencing
West	22,800 – 27,400	4600 m	Fauna fencing
Total – fauna fencing		43,700 m	
Total – cattle fencing		33,275 m	