



Map Projection: Transverse Mercator
Horizontal datum: GDA 1984
Vertical datum: AHD 1984
Scale: 1:5,000

North Arrow

LEO END

- Fire Trail
- Road
- Channel
- Stage 1 Dam Wall
- Stage 1 Dam FSL

Vegetation Communities

- Foot Hills Grey Gum - Broad Leaved Mangrove
- Hardwood Plantation
- Northern Wet Tallowood - Blue Gum Forest
- Par National

Riparian Vegetation

- Wet Tallowood - Tallowood Forest
- Temperate Forest
- Wet Tallowood - Tallowood Forest
- Preliminary Road Design

Job Number: 22-1-1133
Revision: A
Date: 08 OCT 2023

Nambucca Shire Council
Bouraville Off River Storage

Extent of
Vegetation Clearing

Figure 10

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10.4.3 Disrupt the breeding cycle, dormancy period and roosting behaviour

The breeding cycle, dormancy period, roosting and foraging behaviour of each species is likely to be affected by the Proposal, particularly within the proposed inundation area.

The Proposal is likely to disrupt the breeding cycle of most native species those species, which rely upon the habitat of the proposed inundation area, through the direct removal of breeding habitat (e.g. hollow trees for birds and microchiropteran bats). Although it is difficult to gauge, removal of these resources would reduce the number of available breeding resources within the study area. Furthermore, the Proposal is likely to be undertaken throughout the year during all seasons and during the breeding seasons of all species that utilise the study area if uncontrolled clearing were to occur. It is proposed that clearing occur over a 3 month period. This would provide threatened and non-threatened species time to relocate into adjacent habitats.

The Proposal could disrupt the dormancy period (e.g. native burrowing frogs) and disrupt the roosting behaviour of many native fauna (e.g. forest owls) by directly removing habitat including diurnal roosting sites through the study area (e.g. habitat trees, fallen timber).

It is likely that all of these resources would be removed from the proposed inundation area over the life of the Proposal. Removal of these sites would reduce the overall availability of harbourage within the study area.

Foraging behaviour for all species that utilise the resources of the study area, particularly the proposed works area (e.g. Sooty Owl and Koala) would be disrupted. The majority of these resources would be removed or modified over the life of the Proposal within the proposed works area. The overall total foraging area would be removed from the proposed works area and reduced within the study area.

10.4.4 Impacts on Migration and Dispersal Ability

The impact upon the migration and dispersal ability of native flora and fauna like most of the other impacts is species specific. Species, which are less mobile (e.g. reptiles and amphibians), residents (e.g. some birds) or species whereby the habitat forms an important component of the overall habitat area and/or important habitat linkages are those that would most likely be impacted.

The size and shape of existing vegetation and habitats within the study area would be altered. Aside from the direct impacts of the inundation area the construction of roads and additional infrastructure (e.g. power) is likely to create or exacerbate internal vegetation and habitat fragmentation and edge effects.

The inundation of the off-river storage would reduce the opportunities for movement of wildlife along and across Bowra Creek. It is unlikely that a similar riparian ecosystem would be re-established below the inundation area as the environmental flow characteristics of the inundation area, and the seasonal fluctuation in water levels would not facilitate a similar riparian ecology as pre-inundation.

Connectivity of vegetation immediately surrounding the inundation area and existing links and connectivity with more extensive vegetation in State Forests and Conservation Areas in the



wider locality would be maintained. It is also unlikely to impose a significant barrier to more mobile species such as microbats and forest owls.

10.4.5 Disruption of Pollination Cycle and Seed Dispersion

The dispersal ability, pollination cycle and seed bank of the native flora of the proposed inundation area would be reduced through the direct removal of vegetation and inundation. The Proposal would disrupt the recruitment of native plant species within the proposed inundation area. Furthermore, excessive dust from the proposed activities could potentially disrupt the pollination cycle and ability of native plants to regenerate (i.e. germination, revegetation and re-colonisation of existing plants). Mitigation measures to suppress excessive dust are referred in Section 11.1.5

10.4.6 Introduction of Weeds and Feral Pest Species

The Proposal has the potential to create favourable conditions for introduced weed species within the study area, which could potentially lead to an increase of existing weed populations. It is also likely that the Proposal could exacerbate existing impacts relating to feral animals. This may potentially occur where increased grassland habitats at the off-river storage embankment that may be favourable to Rabbits. Also the areas around the off-river storage that may become more open as seasonal variations dictate the maximum and minimum water levels of the off-river storage this may provide open areas that could make predation of native fauna by Foxes or feral Dogs easier.

Weed control measures should primarily focus on preventing the spread of the noxious weed Giant Parramatta Grass (*Sporobolus indicus*) and to a lesser extent the environmental weed Fireweed (*Senecio madagascariensis*) along private property access roads, access tracks through paddocks and along the pipeline route where surface soils are disturbed in paddocks through the installation of the pipeline and groundwater bores.

A detailed weed audit (see Appendix D) was undertaken to determine the extent and type of existing weed infestations across the private and Council owned properties where proposed works such as pipeline infrastructure and access roads are likely to be located. The Weed Audit would be instrumental in establishing noxious, environmental and agricultural weed control measures prior to and after the proposed activities, as it provides details on the types of weeds identified and their location in regards to allocated property numbers and Lot numbers.

The potentially cleared land adjoining the upper limit of the inundation area, as well as areas associated with infrastructure such as the off-river storage embankment, access roads, pipeline routes and borefields, would potentially provide bare soil and make conditions favourable for invasive noxious weeds such as Lantana, Small-leaf Privet, Camphor Laurel and Giant Parramatta Grass. Where practical these weeds should be removed from site or controlled by means of herbicide applications to help prevent or minimise their re-occurrence.

Revegetation of this zone would be required as soon as possible after land clearing and infrastructure activities to reduce soil erosion. It would be important to re-establish groundcover in the form of native grasses, so as to provide competition against invasive noxious weeds. This would also provide some foraging habitat for native fauna.

The increased perimeter of the inundation area and the large variance between the maximum fill level of the off-river storage and dry season condition fill level would create conditions favourable to feral animals, such as Foxes and feral Dogs that may lay in waiting for native fauna accessing the waters edge through open exposed areas. The greater availability of permanent water in the area would also favour feral species, such as Foxes and feral Dogs that rely on water more so than some native species and may begin become permanent residents in the vegetation surrounding the inundation area. As previously noted, the opportunities created in the short term for other pest species, notably *Gambusia* would expand and would continue to do so over the life cycle of the off-river storage. However it must be noted that *Gambusia* was not identified in Bowra Creek and the off-river storage is to be filled with groundwater from the borefield, thus significantly reducing the likelihood of *Gambusia* establishing/ migrating in the storage.

10.4.7 Other impacts

Noise pollution as a result of vehicles, machinery and blasting may deter native fauna from utilising the study area and immediate surrounding areas as habitat. The Proposal could affect the migration and dispersal ability of native fauna particularly in relation to noise and vehicular movements. The Proposal may result in increased noise pollution which has the potential to disrupt the breeding cycle and the foraging and roosting behaviour of some native fauna species.

10.5 Instream Environment and Aquatic Flora and Fauna

10.5.1 Barrier to Aquatic Fauna

The storage embankment would affect fish and turtle passage along Bowra Creek during periods of high rainfall. The species most affected would be those with migratory or highly mobile characteristics. Whilst barriers to fish and turtle movement can have major impacts on communities by dividing populations (upstream and downstream) and disrupting migration and life cycle stages, the location of the embankment on an ephemeral waterway is unlikely to result in these impacts. Given the characteristics of Bowra Creek, the provision of a fish ladder is not considered necessary.

It is not envisaged that any additional obstructions would be installed as part of construction activities that would typically limit the passage of native fauna.

The existing obstruction to aquatic fauna where the existing pipeline river crossing is located along the Nambucca River would be alleviated through the provision of a fish ladder, thus allowing the migration of aquatic fauna species above and below the existing obstruction.

10.5.2 Impacts of Groundwater Extraction on the Upper Estuary

Hydrological analyses undertaken by Bishop (2005/06) found that percentile flow limits would perform badly in protecting plant beds (i.e. no protection would be provided by the 95%ile flows, and only two months would be protected with the 90%ile flows). The extent of potential impacts that would occur when extractions continue into the percentile period would be positively related to the volume of water extracted. Bishop goes on to say that cease to pump limits based on



monthly 80%ile flows would perform better than those based on monthly 90 and 95%ile flows and that additional modelling would be required to better understand these impacts.

The environmental flow rules developed subsequent to Bishop's work were agreed to in-principle by the then DPI and DIPNR.

In recognition of Bishop investigations, it is proposed that 'cease to pump limits' be based on monthly 95%ile flows with on-going adaptive management monitoring of river levels, flow rates macrophytes and macroinvertebrates be undertaken during the detailed design phase to ensure that changes to the downstream riparian and aquatic ecosystem are minimised, managed and do not impact on their current habitat values. Site specific assessment criteria, based on the 95th percentile levels from available historical data, can be used as early warning triggers that there may be impacts to the riparian vegetation. If statistical trend analysis suggests that there are upward trends in concentrations of toxicants and stressors, modifications would be made to the scheme and/or flow rules.

The implementation of an Adaptive Management Framework has been described in Chapter of 4 and the associated monitoring is provided in Chapter 24 of the EIS. The potential impact of not having environmental flow rules would be the reduction of aquatic habitats for native flora and fauna, alterations to temperature regimes, restrictions to fauna migration and subsequent disruptions to breeding cycles of both aquatic flora and fauna and increased potential for mortality.

10.5.3 Inundation Area Habitat Alteration

The inundation area would provide an extensive aquatic habitat and thereby logically increase the availability of overall aquatic habitat. This habitat would retain very little of the characteristics of the existing environment. The primary impact within the inundation area would be the change in environmental flow regime from a high energy, high flow environment with high seasonal variability in flow and volume, to a low energy relatively still waterbody with seasonal variability limited to inundation levels. The alteration of the environmental flows would result in a relatively rapid (immediately following the construction and finalization of the off-river storage dam embankment) impact on these habitat values. The alteration to existing aquatic habitats within the inundation area would be irrevocable whilst the off-river storage remains.

10.5.4 Downstream Bowra Creek Environmental Flows

Changes in environmental flows downstream would result from water being farmed from the inundation area and the natural curtailing of seasonal variability in flow regimes characteristic of the current environmental flows. Many of the potential impacts can be ameliorated through incorporation of a controlled water release program that has been derived from an environmental flow study. This controlled release program may sustain environmental flows at a level that is commensurate with maintaining habitat quality downstream of the inundation area. In order to comply with the Water Management Act by explicitly allowing for the maintenance of environmental flows in Nambucca River past the extraction zone, the following "in-principle" extraction rules have been adopted:

- ▶ Do not pump between dusk to dawn when flow at the gauging station after extraction by upstream irrigators is between 80ML/d to 120ML/d during January to September and 40ML/d to 120ML/d during October to December;
- ▶ Stop pumping to distribution system to meet existing demands when the flow at the gauging station reaches the 95%ile flow corresponding to that month;
- ▶ Stop pumping to distribution system to meet future growth demands and to fill the off-river storage (ORS) when the flow at the gauging station reaches the 90%ile flow corresponding to that month;
- ▶ The upstream irrigators and town water supply are allowed to extract up to 60% of the total daily flow provided other constraints are satisfied;
- ▶ When off-river storage (ORS) is drawn-down to say 60% and the water supply is subject to level 4 and above restrictions, the previous rules are relaxed with pumping to water supply ceasing at 95%ile flow corresponding to that month; and
- ▶ Upstream irrigators are to cease pumping when the previous day's affected flow at the gauging station reaches the annual 95%ile flow, which is about 10ML/d.

10.5.5 Changes in Water Quality

The water quality of the Nambucca River and Bowra Creek are currently largely within ANZECC/ARMCANZ (2000) Guidelines for Freshwater Aquatic ecosystem health. This has potential to change in the inundation waters with increased depth due to stratification. Reduced flows downstream have the potential to greatly increase the impacts of nutrient enrichment of Bowra Creek. Changes in downstream water quality from an off-river storage typically include increases in water temperature, nutrient load, turbidity, dissolved gases, and concentration of heavy metals and minerals (including those that are naturally occurring). An increased frequency of discharges of water containing toxic algae may affect the fish and aquatic invertebrate community downstream of the off-river storage.

Cold water pollution may also be an issue for some fauna. While platypuses are well adapted to cold conditions, they require a greater intake of food to regulate their body temperature in cold water and low water temperatures may also affect macroinvertebrate productivity. Furthermore, water temperature is a reproductive cue for fish with breeding occurring at a particular temperature or within a particular range. Many native fish would not breed in colder water.

Low oxygen water from the off-river storage releases can be toxic to benthic macroinvertebrates on which the platypus feeds. Bishop and Harris (1990) suggested that the raising of the storage could result in such toxic effects downstream, possibly including fish kills.

The construction of the off-river storage embankment would cause an increase in nutrient loads within the storage. One of the potential ecological impacts associated with poor water quality within water bodies is the occurrence of algal blooms (cyanobacteria). This potentially toxic alga could be released to Bowra Creek downstream of the off-river storage. The potential causes of algal blooms relate the following:

- ▶ Depth and stratification of the off-river storage;

- ▶ Water clarity;
- ▶ Accumulation of nutrients from both natural sources such as leaf litter and adjoining land uses such as livestock grazing; and
- ▶ Low abundance of macrophytes, which would otherwise compete with the algae for nutrients.

Potential ecological impacts associated with blue-green algal blooms include toxic poisoning of aquatic biota such as waterbirds and fish, and adverse impacts on aquatic vegetation and macroinvertebrates.

There is also the possibility of an increase in trace metals in the lower levels of the storage and the possibility of these being transferred downstream. A study undertaken in Tasmania (Munday *et al.* 2002), found elevated levels of persistent pesticide residues and PCBs (polychlorinated biphenyls) in platypi but not at levels, which have produced reproductive or immune system depression in other species. It is known, however, that trace metals can affect the reproductive success of fish and can bio-accumulate in macroinvertebrate communities.

The implementation of an Adaptive Management Framework has been described in Chapter 4 and the associated monitoring is provided in Chapter 24 of the EIS.

10.5.6 Increased Invasion by Pest Species

Gambusia has been identified in Bowra Creek and is an immediate and severe threat to aquatic habitats in the area. This species prefers lakes and slow moving streams thus the inundation would create conditions conducive to the establishment of populations of Gambusia. However it must be noted that Gambusia was identified in Bowra Creek and because the storage is to be filled with groundwater from the borefield and the construction of the off-river storage embankment would occur within the ephemeral part of Bowra Creek and creating a physical barrier, the likelihood of Gambusia migrating into and establishing in the storage is significantly reduced. Appropriate mitigation measures associated with monitoring the potential impacts of this species are provided in Section 11.1.7.

10.5.7 Siltation

Increases in silt load and turbidity in Bowra Creek downstream of the off-river storage are likely to occur as a result of construction work. This could potentially result in a reduced food supply and loss of large-particle substrates and deep-water habitats for fish, as well as effects of suspended solids on native fish. The benthic substrates of Bowra Creek and its tributaries are largely coarse sand and fine gravel, which are re-suspended during flow events. Sediment released during construction and/or operation of the off-river storage could result in the filling of interstitial spaces in the rough substrates (gravel, cobbles and boulders) in which macroinvertebrate food species are found.

The inundation area would to a large degree prevent the re-suspension of sediments below the off-river storage embankment under normal seasonal conditions (non-flood events) consequently having an adverse impact on the benthic substrates and their dependent macroinvertebrate communities. The lack of significant flows immediately below the inundation area would result in sediments settling out of suspension (or not being suspended at all) resulting in increased sediment deposition and changes in channel morphology. These impacts



lessen with distance from the off-river storage embankment and may be ameliorated through controlled releases from the inundation area during low flow periods.

Turbidity can also affect the light availability to macrophytes resulting in reduced productivity and supply of organic material to the stream food web.

10.5.8 Changes in Downstream Morphology of Riverbed and Banks

The off-river storage would reduce the magnitude and frequency of flood events and a likely impact of this would be the reduction of channel width of Bowra Creek downstream of the inundation area. This has the potential to provide habitat favourable to invasive flora (Parrots Feather) and fauna (Gambusia) and would compromise the habitat potential for native aquatic species as environmental conditions change.

10.5.9 Potential Changes to Habitats in the off-river storage as a Result of Water Level Fluctuations

The rise and fall in water level resulting from water extraction can influence the physical nature of the substrate within the littoral zone of the off-river storage. For example, off-river storage near full storage level may contain a high proportion of rocky substrate or woody debris, whilst substrate at a lower level may be predominantly sand or silt. Thus, as water levels fall the habitat changes from rock to silt, a change that may well result in shifts in species assemblages as mobile species migrate to areas closer to being their preferred habitat.

10.5.10 Inundation of Riffle Habitats

Inundation of the headwater of Bowra Creek would result in the loss of shallow riffles and run zones that occur periodically along this ephemeral creek. These zones are regions of high productivity, which are lost when a waterbody is impounded. Many types of macroinvertebrates and microscopic organisms are confined to riffles, and these are highly productive areas providing a food supply for other components of the aquatic system.

10.5.11 Reduced Flood Events

The flora and fauna populations of the catchment are adapted to annual flood events. The construction of the off-river storage would not only alter flows but also reduce the magnitude and frequency of these flood events. These impacts lessen with distance from the off-river storage dam embankment as tributaries contribute to flood events.

10.5.12 Long-term Flow Alteration below Inundation Area

Flow variations are important to the lifecycles of resident fish and turtle populations. Flow variation can result in exposed sand banks becoming available for turtle nesting and alter water temperature – a key trigger in the promotion of hormonal changes for fish prior to breeding. The area's communities are adapted to the seasonal flows of the catchment and changes to the existing regime would impact on the abundance and diversity of fauna populations. The incorporation of a controlled release program from the off-river storage to maintain environmental flows would be the key element in mitigating long-term impacts on the river environment below the off-river storage.



Further details of the environmental flow rules in regards to impacts below the off-river storage are available in Chapter 4 of the EIS.

10.5.13 Changes in Flooding and Flow Regime Downstream of the off-river storage

River regulation produces a much more constant flow of water. This constancy has had ecological impacts such as aiding the spread of non-native fish species. The practice of capturing water in winter and releasing it in summer has overturned the normal flow pattern in southern regulated rivers. Seasonal patterns in flow and water temperature are key factors influencing several native fish species to mature and spawn, and are critical for their growth. Flow and temperature patterns also control the diversity of aquatic invertebrate animals and other fauna.

This impact would also result in a change in the distribution of riparian vegetation along the banks of Bowra Creek below the off-river storage. This change in vegetation community distribution would occur gradually in response to the new flooding and flow regimes. However, changes may be partly offset by increased visitation to the off-river storage by fauna species that prefer off-river storage and lagoon conditions.

Additionally if storage releases are not appropriately controlled and sudden high volume releases were to occur bank instability and erosion along Bowra Creek below the off-river storage would be likely, especially if the structural characteristics of riparian vegetation were to change due to changed flow conditions. Monitoring of the transparent operation of the storage should ensure that this does not occur or is minimised.

10.5.14 Groundwater Extraction and Potential Impacts on Riparian Vegetation Structural Characteristics and Bank Stability

The extraction of groundwater from the aquifer associated with the borefields have the potential in the long-term to reduce flow rates and surface water levels and increase groundwater depths in the Nambucca River and South Creek. This may potentially lead to the gradual change in the structural characteristics of riparian vegetation communities.

Hydrological analyses undertaken by Bishop (2005/06) found that percentile flow limits would perform badly in protecting plant beds (i.e. no protection would be provided by the 95%ile flows, and only two months would be protected with the 90%ile flows). The extent of potential impacts that would occur when extractions continue into the percentile period would be positively related to the volume of water extracted. Bishop goes on to say that cease to pump limits based on monthly 80%ile flows would perform better than those based on monthly 90 and 95%ile flows and that additional modelling would be required to better understand this.

It must be noted that the majority of riparian vegetation is comprised of introduced species such as Camphor Laurel, Small-leaf Privet and Lantana, which are expected to be tolerant of reduced flow rates and surface water levels and increased groundwater depths.

However, in light of the findings from the Bishop investigations, it is proposed that 'cease to pump limits' be based on monthly 95%ile flows with on-going monitoring of river levels and flow rates to be undertaken as part of an on-going adaptive management framework to ensure that changes to the downstream riparian and aquatic ecosystem as a result of the Proposal are minimised, managed and does not impact on their current habitat values. Site specific



assessment criteria, based on the 95th percentile levels from available historical data, can be used as early warning triggers that there may be impacts to the riparian vegetation. If statistical trend analysis suggests that there are upward trends in concentrations of toxicants and stressors, modifications would be made to the scheme and/or flow rules.

The implementation of an Adaptive Management Framework has been described in Chapter of 4 and the associated monitoring is provided in Chapter 24 of the EIS.

10.5.15 Interrelationship between Groundwater, Streamflow and the Aquatic and Riparian Environment

There exists the potential for imbalances between the interrelationships between groundwater, streamflow and the aquatic and riparian environment characteristics, due to the extraction of groundwater from the borefield reducing the aquifer and thus altering this interrelationship. The environmental flow rules designed for the extraction of groundwater and the transparent operation of the off-river storage should maintain the interrelationship/ balance between groundwater, streamflow and the aquatic and riparian environment to a level close to what is presently occurring naturally. Therefore potential impacts upon these characteristics are minimal and are unlikely to have adverse effects upon the existing ecology.

Further details of the environmental flow rules in regards to impacts below the off-river storage are available in Chapter 4 of the EIS.

10.5.16 Likely Changes and Impacts on Flora and Fauna adjacent to the Stored Waterbody

When the storage is filled with water, the ground surrounding the perimeter of the stored waterbody would become laden with increased amounts of groundwater. This would potentially impact upon the floristic characteristics of existing vegetation communities, where some species may perish and others may begin to appear or dominate. Also the water level of the inundation area would fluctuate and only those species tolerant of such fluctuations are likely to persist over the long-term.

The primary risk associated with increased groundwater would be the potential for weeds or natives that may be more tolerant of such conditions becoming invasive. This may then potentially impact on the diversity of flora species where water levels may fluctuate throughout the seasons and alter the habitat values for native fauna, due to a reduced level of biodiversity; however the extent of this occurring may only be limited to this thin area around the perimeter of the off-river storage.

10.5.17 Seasonal Clearing of Vegetation

If vegetation were to be cleared during periods of wet weather soil erosion and sedimentation of waterways is likely. The clearing of vegetation in all areas should be responsive to wet weather during the wetter months of the year between March and May. During the remainder of the year erosion and sediment control measures should alleviate soil erosion and sedimentation of waterways.

10.5.18 Dispersion Capacity of Local Clays

The clay soils of the inundation area are moderately dispersive and can be appropriately managed to minimise dispersion through application of gypsum, sediment control measures and methods of vegetation clearing (leaving tree stumps etc) and potential impacts upon aquatic flora and fauna downstream of the off-river storage embankment. Potential impacts may be associated with increased suspension of fine sediments in the lower reaches of Bowra Creek restricting light penetration and reducing water quality that may potentially impact upon the photosynthesis of aquatic flora and make conditions unfavourable to aquatic fauna.

10.6 Groundwater Dependant Ecosystems

10.6.1 Background

A groundwater dependent ecosystem is an ecosystem where the species composition and natural ecological processes are determined by groundwater (Department of Land and Water Conservation, 2002), and is therefore reliant on groundwater for at least some of its water requirements. Examples of groundwater dependent ecosystems include wetlands and red gum forests, some terrestrial vegetation communities, ecosystems in streams fed by groundwater, limestone cave systems, springs, and hanging valleys and swamps. For such ecosystems, access to groundwater can be critically important to the maintenance of ecosystem viability and biodiversity.

Surface groundwater dependent ecosystems can be considered in two classes. The first class is reliant on the surface expression of groundwater and includes swamps, wetlands and rivers, while the second class relies on the availability of groundwater below the surface but within the rooting depth of the vegetation (Eamus, 2009). The riparian vegetation along Nambucca River, South Creek and Bowra Creek could be considered as being first class dependant ecosystems.

The dependency upon groundwater of these ecosystems varies, with obligate and facultative dependent ecosystems recognised. For an obligate groundwater dependent ecosystem, groundwater forms a critically important water source in the hydrological regime of the ecosystem. However the term 'obligate' does not mean that the ecosystem is totally dependent upon, or requiring of, continuous access to groundwater (Howe and Prichard, 2007). Facultative groundwater dependence refers to an ecosystem where the presence or absence of groundwater is not crucial to the presence of species within an ecosystem. For facultative groundwater dependent ecosystems, other environmental factors such as landscape position, geology, hydrology, and climate, are of greater importance to the species composition of the ecosystem.

With respect to obligate and facultative groundwater dependent ecosystems, surface ecosystems, such as those ecological communities in the inundation area, generally have dynamic water requirements with some dependence on surface water and soil water and are not often totally dependent upon groundwater (Howe and Prichard, 2007). On this basis it can be inferred that any groundwater dependent ecosystems occurring within the inundation area would only be partially dependent upon groundwater (or 'facultative groundwater dependent ecosystems') with groundwater supplementing water gained from soil water.

Figure 11 below depicts the facultative groundwater dependant ecosystems of the study area.

10.6.2 Potential Impacts to Groundwater Dependent Ecosystems

Although it is not possible with the available information to confidently determine the degree of dependence of the vegetation communities in the inundation area upon groundwater, such that a relationship between the community and the groundwater can be established, potential impacts of the Proposal upon vegetation communities (ecosystems) likely to be at least partially dependent upon groundwater are inferred from the literature as well as the existing groundwater environment and likely impacts upon groundwater as described in the EIS.

In general, the recognised threats to groundwater dependent ecosystems (Sinclair Knight Merz, 2001) include:

- ▶ Groundwater resource development;
- ▶ Changes in land use – particularly from native vegetation to agriculture or agriculture or native vegetation to plantation forestry;
- ▶ Activation of acid sulphate soils in coastal areas by drainage, dredging or groundwater extraction;
- ▶ Dewatering or water resource development associated with mining; and
- ▶ Commercial, urban or recreational developments.

Key potential impacts to groundwater dependant ecosystems related to these threats include alteration of the water regime experienced by groundwater dependent ecosystems resulting in changes in the structure, function and/or composition of the ecosystem (Sinclair Knight Merz, 2001) as well as the potential for detrimental changes to the groundwater quality to impact upon the vegetation. It is noted that impacts associated with lowered water tables upon groundwater dependant ecosystems can take place over an extended time and can lead to decline in growth, recruitment and enable invasion by exotic species (Eamus, 2009).

The activities (besides clearing) that could have potential impacts upon groundwater dependent ecosystems include:

- ▶ Cutting through areas of higher elevation;
- ▶ Construction of embankments over low-lying areas; and
- ▶ Potential risks associated with construction activity including fuel spills.

Impacts associated with these include:

- ▶ Groundwater drawdown;
- ▶ Groundwater impedance; and
- ▶ Groundwater quality impacts, including groundwater acidification or contamination.

Vegetation dieback may be the potential impact upon groundwater dependant ecosystems and would become apparent over the long-term as the off-river storage is operating and as the environmental flow rules are applied.

The environmental flow rules should alleviate any potential impacts upon groundwater dependant ecosystems of the study area in particular riparian vegetation. Any noticeable impacts upon groundwater dependant ecosystems in the study area would be reflected in the operation of the environmental flow rules and changes could be made accordingly.

10.6.3 Groundwater Drawdown

Despite the operation of flow rules, the extraction of groundwater from the aquifer associated with the borefields may over the long-term reduce flow rates and surface water levels and increase groundwater depths in the Nambucca River and South Creek. This may potentially lead to the gradual change in the floristic characteristics of riparian vegetation communities. This may then lead to riverbank instability if some riparian species were to begin to die off.

It must be noted that the majority of riparian vegetation is comprised of introduced species such as Camphor Laurel, Small-leaf Privet and Lantana, which are expected to be tolerant of reduced flow rates and surface water levels and increased groundwater depths.

Ongoing monitoring of river levels and flow rates would be necessary to ensure that changes to the riparian vegetation are minimal, manageable and do not impact on their current habitat values. This would be most important if extraction regimes are to change.

Excavation within the inundation area could also contribute to localised drawdown through drainage of groundwater from within the storage and from the altered recharge regime. However as these areas are within the upper part of the catchment where the groundwater is at depth, it is not expected that groundwater dependent ecosystems would be impacted as a result of this activity.

Drawdown of the alluvial aquifers may also occur along the floodplain areas as part of the borefield collection pipeline system. This could occur as a result of dewatering during trenching construction. The potential for groundwater drawdown to the degree that the groundwater table is significantly lowered is considered to be minor. As such floodplain, wetland, riparian and aquatic communities are not likely to be impacted. In addition, as these vegetation communities are unlikely to be solely dependant upon groundwater for their environmental water requirements, any temporary or localised impacts associated with dewatering are not likely to result in any long term impacts to these communities.

10.6.4 Groundwater Impedance

Constructing hard compacted surfaces across the Bowra Creek could potentially result in localised impedance to shallow groundwater flow. This may result in localised higher water table on the up-gradient side of the embankment, and lower on the other. With respect to groundwater dependent ecosystems, this could increase the availability of water on the side where flows are impounded, while a reduction of groundwater availability may occur on the side where groundwater has been impeded. This is only likely to be a localised effect, and only likely to occur where groundwater flow occurs within a few metres of ground surface, and should be adequately catered for by typical drainage facilities associated with construction. Again, as the communities are unlikely to be solely dependant upon groundwater for environmental water requirements, then minimal impact is expected. It is also of note that much of the Bowra Creek

catchment has been subject to clearing through forest operations and agriculture and is likely to have been previously subjected to groundwater changes.

10.6.5 Groundwater Quality Impacts

Potential impacts associated with groundwater quality could result from activation of saline waters due to drawdown of groundwater in the floodplain, or from fuel or chemical spills that could occur during construction.

- ▶ In relation to activation of saline waters, it is considered that only minor impacts to the groundwater level would result from the Proposal, this is unlikely.
- ▶ Localised fuel or chemical spills, while having potential for impacts upon groundwater and riparian systems, may be mitigated. As such they are considered unlikely to significantly impact upon groundwater dependent ecosystems.

Chapter 11 Groundwater discusses the existing groundwater environment in the study area, identifies likely impacts as a result of the Proposal, and proposes management measures to reduce these impacts.

10.7 Key Threatening Processes relevant to Proposal

A threatening process is defined under the FM Act and TSC Act as 'a process that threatens, or that may threaten, the survival or evolutionary development of a species, population or ecological community'. Threatening processes that adversely affect threatened species, populations or ecological communities, or possibly cause others that are not currently threatened; to become threatened are listed as key threatening processes (KTPs) under the TSC, FM and EPBC Acts. KTPs relevant to the Proposal are discussed in Table 28.

The proposed mitigation measures to minimise the potential of exacerbating each of the KTPs include:

- ▶ Weed control in particular Lantana;
- ▶ Environmental Flow Rules;
- ▶ Provision of a protection area;
- ▶ Placement of removed hollow trees and logs into protection area;

The provision of fish passage where applicable.

Table 28 Key Threatening Processes Relevant to Proposal

Key Threatening Process	Relevance to proposal
Invasion of native plant communities by exotic perennial grasses	There exists the potential for the spread of Giant Parramatta Grass (<i>Sporobolus fertilis</i>) along the pipeline route, borefields, upgraded roadsides and the off-river storage embankment. This species has been already recorded within the study area.

Invasion, establishment and spread of <i>Lantana camara</i>	There exists the potential for the spread of <i>Lantana (Lantana camara)</i> along the pipeline route, upgraded roadsides, the off-river storage embankment and around the perimeter of the inundation area. This species has been already recorded within the study area.
Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands.	The off-river storage would inundate the upper reaches of Bowra Creek resulting in that portion of the creek becoming an artificial lake. Transforming this ephemeral first order stream into a stationary water body. The lower reach of Bowra Creek would have reduced flows as a result of the storage's construction. The groundwater that would be extracted from the proposed borefields would impact on the flow rates of the Nambucca River and South Creek.
Clearing of native vegetation	Approximately 64.06 ha of native vegetation is to be removed from within the inundation area, embankment footprint and upgraded access roads, and 1.49 ha from the location of proposed riverbank stabilisation works. A total of 80.71 ha from within the study area.
Loss of Hollow-bearing Trees	Some hollow bearing trees would be removed from the proposed works area at specific locations as part of proposed road upgrade works along Bobo Road to allow access for large vehicles into the study area. The majority of road upgrade activities would be occurring in association with tight corners. It is at these locations where the removal of hollow bearing trees is inevitable as part of cut and fill road construction practices.
Removal of dead wood and dead trees	All dead wood and debris would be removed prior to the inundation of the storage area.
Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams	Bowra Creek would have a substantial permanent instream structure constructed that would permanently inundate the upper reach of the creek and would result in permanently altering the natural flow regimes of the creek.
Degradation of native riparian vegetation along NSW water courses	The riparian vegetation along Bowra Creek, Nambucca River and South Cree is in poor to moderate condition. All are already considered degraded in regards to healthy viable native riparian vegetation. The upper reach of Bowra Creek would be permanently inundated and altered. Some of the riparian vegetation along Nambucca River and South Creek is to be minimally impacted as part of riverbank restoration works and may benefit the long-term persistence of this vegetation and thus reducing the impact of this KTP.
Removal of large woody debris from New South Wales rivers and streams	Large woody debris would be removed prior to inundation of the storage area. It is not anticipated that any large woody debris would be removed along the Nambucca River or South Creek in association with proposed pipeline routes.



10.8 Significance of Potential Impacts

10.8.1 TSC Act listed Threatened Species and EECs

Section 5A of the EP&A Act lists seven factors that must be taken into account in the determination of the significance of potential impacts of a Proposal on 'threatened species, populations or ecological communities (or their habitats)' listed under the TSC Act. The Assessment of Significance (AoS) '7-part test' is used to determine whether a Proposal is 'likely' to cause 'a significant effect' on threatened biota and thus whether a Species Impact Statement (SIS) is required to accompany the DA.

The AoS is to be applied to each species, population and ecological community that was recorded during the survey within the study area or is likely to exist or utilise habitat within the study area (see Section 7.3).

Flora

The findings of the 8-part tests undertaken by Connell Wagner and Biosis in regards to threatened flora species that may potentially occur in the locality determined that no significant impacts upon threatened flora were considered likely in regards to the proposed activities.

No threatened flora was identified during the current survey, however 7-part tests have been undertaken for four threatened species that could potentially occur based on known distributions and the habitats present within the study area.

A summary of the potential impacts and proposed mitigative measures for relevant threatened species and the conclusions of the 7-part tests is provided in Table 29. See Appendix C for the completed AoS. It is unlikely that the proposal would result in 'a significant effect' on any threatened flora species in light of the mitigation measures provided in Section 11.1.

Fauna

The findings of the 8-part tests undertaken by Connell Wagner and Biosis in regards to threatened fauna species that may potentially occur in the locality determined that no significant impacts upon threatened fauna were considered likely in regards to the proposed activities.

An AoS was completed for the 14 threatened fauna species identified in Table 30, seven of which were recorded and seven that were considered likely to occur. See Appendix C for the completed AoS. It is unlikely that the proposal would result in 'a significant impact' on any threatened fauna species in light of the mitigation measures provided in Section 11.

Table 29 Summary of AoS for threatened flora species

Species	Potential Impact	Description	Proposed Mitigation Measures	Significant Impact
Rusty Plum	Loss of habitat	The removal of vegetation communities in which this species could potentially occur.	The vegetation surrounding the inundation area (that comprises the same vegetation communities as would be cleared as a result of the Proposal) is to be acquired by NSC from NSW Forests. This area would be retained and conserved as a protection area to the proposal. The proposed protection area would ensure that existing or potential habitat for this species in the immediate locality of the dam would be conserved into the future.	Significant impact unlikely
Tylophora	Loss of habitat	The removal of vegetation communities in which this species could potentially occur.	The vegetation surrounding the inundation area (that comprises the same vegetation communities as would be cleared as a result of the Proposal) is to be acquired by NSC from NSW Forests. This area would be retained and conserved as a protection area to the proposal. The proposed protection area would ensure that existing or potential habitat for this species in the immediate locality of the dam would be conserved into the future.	Significant impact unlikely
Minute Orchid	Loss of habitat	The removal of vegetation communities in which this species could potentially occur.	The vegetation surrounding the inundation area (that comprises the same vegetation communities as would be cleared as a result of the Proposal) is to be acquired by NSC from NSW Forests. This area would be retained and conserved as a protection area to the proposal. The proposed protection area would ensure that existing or potential habitat for this species in the immediate locality of the dam would be conserved into the future.	Significant impact unlikely
Leafless Tongue Orchid	Loss of habitat	The removal of vegetation communities in which this species could potentially occur.	The vegetation surrounding the inundation area (that comprises the same vegetation communities as would be cleared as a result of the Proposal) is to be acquired by NSC from NSW Forests. This area would be retained and conserved as a protection area to the proposal. The proposed protection area would ensure that existing or potential habitat for this species in the immediate locality of the dam would be conserved into the future.	Significant impact unlikely
River-flat Eucalypt Forest on Coastal Floodplains EEC	Loss of community	The removal of riparian vegetation that resembles this EEC as part of Riverbank Stabilisation Works.	Retain as many of the dominant tree species that occur in this EEC if vegetation that resembles this EEC are identified in areas where riverbank stabilisation works are proposed to occur.	Significant impact unlikely

Table 30 Summary of AoS for threatened fauna species

Species	Potential impact	Description	Proposed Mitigation Measures	Significant Impact
Forest Owls (Barking, Masked, Sooty and Powerful Owls)	The Barking, Masked and Sooty Owls were recorded in the study area, whilst the Powerful Owl has the potential to occur in the locality. Loss of habitat	The potential removal of stags and hollow bearing trees from the study area that may provide roosting and breeding habitat. The potential for reducing some foraging habitat that is considered of lower foraging value to these species in comparison to habitat in surrounding lands.	Identify and flag stags and hollow bearing trees to be removed as part of the proposed activities. Pre-clearance surveys of identified stags and hollow bearing trees prior to removal. Inspect any fallen stags and hollow bearing trees for forest owl nests prior to removal. Undertake appropriate measures in case these species become injured as the result of felling stags or hollow bearing trees. The protection area comprising of 122.58 ha is of suitable habitat for the forest Owls and is to be conserved and excluded from logging practices.	Significant impact unlikely
Glossy Black Cockatoo	This species has the potential to occur in the locality. Loss of habitat	The potential removal of stags and hollow bearing trees from the study area that may provide roosting and breeding habitat. The potential for reducing some foraging habitat that is considered of lower foraging value to this species in comparison to habitat in surrounding lands.	Identify and flag stags and hollow bearing trees to be removed as part of the proposed activities. Pre-clearance surveys of identified stags and hollow bearing trees prior to removal. Undertake appropriate measures in case these species become injured as the result of felling stags or hollow bearing trees. The protection area comprising of 122.58 ha is of suitable habitat for the Glossy Black Cockatoo and is to be conserved and excluded from logging practices.	Significant impact unlikely
Wompoo Fruit-dove	This species has the potential to occur in the breeding locality within rainforest vegetation. Loss of habitat	The potential removal of potential foraging and breeding habitat for the Wompoo Fruit-dove in the study area is considered unfavourable to the species because there is limited rainforest vegetation that is structurally modified. As this species is highly mobile and able to	The potential foraging and breeding habitat for the Wompoo Fruit-dove in the study area is considered unfavourable to the species because there is limited rainforest vegetation that is structurally modified. As this species is highly mobile and able to	Significant impact unlikely

Species	Potential impact	Description	Proposed Mitigation Measures	Significant Impact
Koala	One Koala was recorded in the study area. Loss of habitat and potential for mortality of Koalas as a result of land clearing.	The potential removal of viable breeding habitat in the study area. The potential removal of foraging habitat associated with Koala feed trees that are scattered throughout the study area.	relocate into more favourable rainforest habitats no specific mitigation measures are considered necessary and the 122.58 ha of a protection area may potentially provide an immediate refuge for the species. Identify and flag Koala feed trees during pre-clearance surveys and inspect flagged trees prior to felling. If Koalas are identified undertake the appropriate protocols to limit the potential risk of injury or mortality to individuals of this species. Undertake appropriate measures in case this species become injured as the result of felling trees. The identified clearing practices should assist in the safe relocation of Koalas. The protection area comprising of 122.58 ha is of suitable habitat for the Koala and is to be conserved and excluded from logging practices.	Significant impact unlikely
Grey-headed Flying-fox	This species has the potential to occur in the study area where proposed land clearing activities are to take place. Loss of habitat	No Grey-headed Flying-fox roosting camps were identified in the study area where proposed land clearing activities are to take place. The potential loss of some foraging habitat that is of lower value to the species in comparison to surrounding habitats.	As this species is highly mobile and able to relocate into more favourable foraging habitats no specific mitigation measures are considered necessary and the 122.58 ha of a protection area may potentially provide an immediate refuge for the species.	Significant impact unlikely

Species	Potential impact	Description	Proposed Mitigation Measures	Significant Impact
Spotted-tail Quoll	<p>This species has the potential to occur in the outcrops from the study area that may provide denning and breeding habitats.</p> <p>Loss of habitat and potential for mortality of Spotted-tail Quolls as a result of land clearing.</p>	<p>The potential removal of hollow logs and rocky outcrops from the study area that may provide denning and breeding habitats.</p> <p>The potential for reducing foraging habitat that is considered of lower foraging value to these Spotted-tail Quolls in comparison to habitat in surrounding lands.</p>	<p>Identify and flag any hollow logs and rocky outcrops that may provide potential denning and breeding habitat during pre-clearance surveys and inspect flagged sites prior to land clearing.</p> <p>Relocate any hollow logs and large rocks into the protection area to provide potential denning and breeding habitat.</p> <p>The identified clearing practices should assist in the safe relocation of Spotted-tail Quolls.</p> <p>Control any potential feral pests (Foxes and feral Dogs) that may potentially occur in the study area.</p> <p>The protection area comprising of 122.58 ha is of suitable habitat for the Spotted-tail Quoll and is to be conserved and excluded from logging practices.</p>	Significant impact unlikely
Eastern Bentwing-bat, Little Bentwing-bat and Golden-tipped Bat.	<p>These microbat species were recorded in the study area.</p> <p>Loss of habitat and the potential for mortality of individuals as a result of land clearing.</p>	<p>The Eastern Bentwing-bat and Little Bentwing-bat primarily occupy cave/mine shaft habitats where breeding colonies roost and may on occasion roost in stags or hollow-bearing trees of the study area.</p> <p>The Golden-tipped Bat may potentially roost in abandoned hanging bird nests typically associated with dense riparian vegetation.</p> <p>The potential loss of foraging habitat that is considered of lower foraging value to these species in comparison to habitat in surrounding lands.</p> <p>The potential loss of some flyways along existing fire trails that may potentially be removed; however the high mobility of these species and the continuation of the flyways in the broader study area would ameliorate these impacts.</p>	<p>Identify and flag stags, hollow-bearing trees and hanging bird nests to be removed as part of the proposed activities.</p> <p>Pre-clearance surveys of flagged stags, hollow-bearing trees and hanging bird nests prior to removal.</p> <p>Inspect any fallen stags and hollow-bearing trees for microbats prior to removal.</p> <p>Undertake appropriate protocols to handle and relocate any microbats found in stags, hollow-bearing trees and hanging bird nests.</p> <p>In the case of the Golden-tipped Bat, provide bat boxes in the protection area for any individuals that need to be relocated from hanging bird nests.</p> <p>Undertake appropriate measures in case these species become injured as the result of felling stags or hollow-bearing trees.</p> <p>The protection area comprising of 122.58 ha is of</p>	Significant impact unlikely



Species	Potential impact	Description	Proposed Mitigation Measures	Significant Impact
Giant Barred Frog and Southern Barred Frog	<p>These frog species have the potential to occur in the locality.</p> <p>Loss of habitat and the potential for mortality of individuals as a result of land clearing.</p>	<p>The potential removal of viable breeding habitat in the study area.</p> <p>The potential removal of foraging habitat in dense moist forested gullies.</p> <p>The potential of individuals of these frog species being present in the study area where suitable habitat may be available is unlikely because of past logging and land clearing practices.</p>	<p>suitable habitat for the Micro-bat species and is to be conserved and excluded from logging practices.</p> <p>If any individuals of these species are found during pre-clearance surveys or land clearing activities, care should be taken to relocate them into dense moist gullies that may occur along drainage lines in the study area.</p> <p>The protection area comprising of 122.58 ha is of suitable habitat for the Giant Barred frog and Southern Barred Frog and is to be conserved and excluded from logging practices.</p>	Significant impact unlikely



Endangered Ecological Communities

As detailed in Section 6.3 the riparian vegetation of the Nambucca River and South Creek is not considered to comprise the River-flat Eucalypt Forest on Coastal Floodplains EEC as determined by the Scientific Committee. However, a precautionary approach has been taken and an assessment of significance has been prepared with respect to this community (refer to Appendix C).

A similar riparian community was also recorded at various locations on the upper slopes of Bowra Creek catchment. These areas of vegetation are not considered to constitute 'floodplain' ecosystems and hence are not considered to constitute this EEC.

No other EECs listed under the TSC or EPBC Acts were recorded in the study area.

10.9 EPBC Act Matters of National Environmental Significance

The assessments of significance were carried out in accordance with EPBC Act guidelines.

In January 2007, the Commonwealth and NSW governments signed a Bilateral Agreement which allows DEWHA to accredit the assessment regimes under Part 3A, Part 4 and Part 5 of the EP&A Act for assessment purposes under the EPBC Act. The Bilateral Agreement applies only to proposals that the Commonwealth Environment Minister has determined are controlled actions under the EPBC Act, with the exception of nuclear actions (DoP 2007).

A number of EPBC Act listed threatened species have previously been recorded or are predicted to occur in the locality. The NSW Wildlife Atlas (DECC, 2008) also revealed records of EPBC Act listed threatened species previously recorded in the locality. EPBC Act listed threatened species are discussed in Section 7.3, along with TSC Act listed biota, and described in detail in Appendix C.

The matters of national environmental significance (NES) listed under the EPBC Act of potential relevance to the study area are:

- ▶ Threatened fauna species (e.g. Spotted-tail Quoll, Giant Barred Frog);
- ▶ Threatened flora species (e.g. Minute Orchid, Tylophora); and
- ▶ Migratory species (e.g. Rufous Fantail, Cattle Egret).

No world heritage properties, national heritage places, Ramsar sites or threatened ecological communities are relevant to the study area. A detailed assessment of the significance of these impacts on threatened species is provided in Appendix C.

10.9.1 Assessment under EPBC Act Significance Guidelines

The assessments of significance were carried out in accordance with EPBC Act guidelines.

In January 2007, the Commonwealth and NSW governments signed a Bilateral Agreement which allows DEWHA to accredit the assessment regimes under Part 3A, Part 4 and Part 5 of the EP&A Act for assessment purposes under the EPBC Act. The Bilateral Agreement applies only to proposals that the Commonwealth Environment Minister has determined are controlled actions under the EPBC Act, with the exception of nuclear actions (DoP 2007).

A number of EPBC Act listed threatened species have previously been recorded or are predicted to occur in the locality. The NSW Wildlife Atlas (DECC, 2008) also revealed records of EPBC Act listed threatened species previously recorded in the locality. EPBC Act listed threatened species are discussed above, along with TSC Act listed biota, and described in detail in Appendix A.

The matters of national environmental significance (NES) listed under the EPBC Act of potential relevance to the study area are:

- ▶ Threatened fauna species (e.g. Spotted-tail Quoll, Giant Barred Frog);
- ▶ Threatened flora species (e.g. Minute Orchid, Tylophora); and
- ▶ Migratory species (e.g. Rufous Fantail, Cattle Egret).

No world heritage properties, national heritage places, Ramsar sites or threatened ecological communities are relevant to the study area.

10.9.2 Potential Impacts on Nationally Listed Threatened Species

No threatened flora species listed under the EPBC Act were recorded at the site; however ten threatened species are known or predicted to occur in the locality. These species are presented in Appendix A, along with an assessment of their habitat requirements and likelihood of occurring at the site. The likelihood of occurrence revealed that three species might possibly occur in the study area, Leafless Tongue Orchid, Minute Orchid and Tylophora. Targeted surveys of the inundation area did not locate any individuals of these species, nor any evidence that important habitat occurs at the site (Biosis, 2005). Therefore the Proposal is unlikely to have a significant impact on any EPBC Act listed flora species as was determined whilst undertaking the 7-part tests for each of these species.

No threatened fauna species listed under the EPBC Act was recorded at the site during the current study. Fourteen species have been previously recorded in the locality of which six may utilise habitat at the site (refer Appendix C). Based on the results of this and other assessments four EPBC Act listed fauna species are likely to occur at the site and potentially be affected by the Proposal:

- ▶ Spotted-tail Quoll;
- ▶ Giant Barred Frog;
- ▶ Southern Barred Frog; and
- ▶ Grey-headed Flying-fox.

The outcome of the EPBC Act AoS is that the Proposal is not likely to have a significant impact on any nationally listed threatened species, which may occur at the site in concurrence with the proposed management measures listed in Section 11.

10.9.3 Potential Impacts on Migratory Species

The study area provides habitat for a number of EPBC Act listed migratory bird species including the Rufous Fantail and Cattle Egret, which were observed during field surveys. Native



vegetation and aquatic habitat at the site are likely to be used by a range of terrestrial, wetland and marine migratory species on a periodic basis.

The habitat to be removed is 80.71 ha in total, inclusive of open grasslands and riparian vegetation associated with access roads and off-river storage embankment infrastructure. Therefore the habitats to be removed are not considered to constitute critical or important habitat for any listed species under the migratory bird provisions of the EPBC Act, because the habitat values of these vegetation communities is considered moderate to poor in relation to surrounding lands and any migratory species that may potentially use the study area as a habitat resource may only do so on a transient basis.

Further, modification of the habitat through inundation is unlikely to make it unsuitable for occupation by the majority of migratory species. Migratory waterbirds are likely to occupy the site during inundation periods, such as the White-bellied Sea Eagle. The Proposal is also unlikely to create a barrier to migration, increase the risk of injury or mortality or otherwise impact on migratory species. Therefore the Proposal is unlikely to impose "a significant effect" on any of the listed migratory fauna species, which could possibly occur in the study area on occasion, in particular the Rufous Fantail and Cattle Egret.

11. Impact Mitigation and Management

The management of adverse impacts arising from the Proposal has been addressed according to the hierarchy of avoidance; mitigation and offsetting of residual impacts. In order to minimise impacts a Construction Environmental Management Plan (CEMP) is to be developed for the Proposal.

To avoid and mitigate impacts on the biodiversity values of the study area a range of impact mitigation and environmental management measures would be implemented during the following stages of the Proposal:

- ▶ Prior to the commencement of the Proposal (i.e. pre-construction);
- ▶ During the Proposal (i.e. during construction); and
- ▶ After the Proposal (i.e. the post-construction/operational phase).

Disturbance and removal of areas of native vegetation and habitat is unavoidable during the construction phase. However, a range of measures would be implemented to prevent further disturbance and minimise adverse impacts on retained native vegetation and habitat and resident fauna.

These mitigation measures would be detailed in a Flora and Fauna Management Plan which would comprise sub-plans of the CEMP as described below.

11.1 Proposed Mitigation Measures

Upon completion of the above recommendations the following mitigation measures should be implemented:

- ▶ Mitigation measures to be undertaken prior to commencement of Proposal (e.g. pre-clearance surveys);
- ▶ Mitigation measures to be undertaken during the Proposal (e.g. clearly marking areas to be cleared); and
- ▶ Mitigation measures to be undertaken after the Proposal has been completed (e.g. the provision of a protection area and environmental monitoring of the study area).

These measures should be implemented to ensure that any unforeseen potential impacts that may occur upon any threatened biota that are known to occur or may potentially occur, or their habitats that are known to occur or could potentially occur within the study area. These measures would also ensure that the impacts upon other native flora and fauna and the general environment of the study area would also be minimised.

11.1.1 Mitigation Measures prior to commencement of Proposal

Preparation of Environmental Management Plans

A CEMP and Operational Environmental Management Plan (OEMP) should be prepared for the Proposal and should include:

- ▶ An Erosion and Sediment and Control Plan (ESCP) should be developed and implemented before, during and after the works to protect soils and prevent erosion after rainfall events and wind erosion, particularly for works along the steeper slopes and where moderately dispersive soils are identified. Sediment and erosion control structures, which conform with the relevant guidelines, should be installed in stages as vegetation is cleared and appropriately installed where major infrastructure is to be located e.g. dam embankment and access roads;
- ▶ A Weed Management Plan (WMP) should be developed in the design stage of the off-river storage and initiated prior to works commencing for implementation before, during and after the works are completed to prevent the spread of introduced species and declared noxious plants recorded within the study area. The WMP would encompass the areas where infrastructure is to be upgraded or developed along the pipeline route, borefield locations, access road upgrades and the dam embankment. Due to under riverbed boring for the pipeline being undertaken, it is not envisaged that riparian vegetation along Nambucca River or South Creek would be adversely impacted. Therefore revegetation and rehabilitation works for these areas is not considered necessary;
- ▶ A Flora and Fauna Management Plan (FFMP) comprising of sub-plans to provide protocols/management strategies to minimise adverse impacts on retained native vegetation and habitat and resident fauna (e.g. pre-clearing and clearing surveys), these are described in more detail below; and

11.1.2 Protocols to Protect Vegetation prior to Clearing

- ▶ Areas of native vegetation that needs to be cleared would be clearly marked on maps and identified with parawebbing or flagging tape in the field to ensure that clearing does not occur beyond the area necessary for the Proposal; and
- ▶ Locating the construction compounds and materials stockpiles in areas that are currently cleared or disturbed wherever possible. This would reduce the need to clear additional areas of natural vegetation.

11.1.3 Protocols to Protect Fauna prior to Clearing

Pre-clearance Survey

It is recommended that a pre-clearance survey be conducted prior to the commencement of any of the proposed activities to identify and flag Koala habitat trees, hollow bearing trees, stags, rocky outcrops, large hollow logs and hanging bird nests, preferably by a qualified ecologist.

A two staged approach should be used to undertake for the pre-clearance surveys as specified below.

Stage 1 – prior to commencement of clearing

Inspection of clearing areas to identify and mark habitat features (large trees with obvious hollows, rocky outcrops, large logs, hanging bird nests etc.) that would need special attention during clearing and to identify features suitable for placement into the protection area to maintain habitat resources (e.g. large rocks and logs).

Stage 2 – surveys during clearing

- ▶ Inspection for Koalas and follow protocols relating to Koalas if one is found;
- ▶ Banging of habitat trees, careful felling and inspection of hollows once felled (protocols for this are described below);
- ▶ Inspection of hanging bird nests for Golden-tipped bats;
- ▶ Adhere to protocols for removing fauna e.g. bats, temporarily holding and releasing at dusk to be developed in consultation with DECCW and detailed in fauna management sub-plan of CEMP;
- ▶ Inspection of other habitat features ahead of clearing e.g. rocky outcrops and large hollow logs for Spotted-tail Quolls or other denning fauna; and
- ▶ Make sure that any fauna that is disturbed are encouraged to move into areas of retained habitat, dealing with injured animals if required in accordance with injured animal protocols.

Habitat inspection and relocation

Habitat inspection of the clearance zone to identify any logs, rocks or other fauna habitats considered suitable for relocation into nearby habitat areas. Habitat suitable for relocation marked with paint to be relocated to protection area. Any felled trees and limbs that were considered suitable for habitat relocation including limbs with hollows, cracks and fissures and shedding bark. Other limbs without these attributes currently may also be used for habitat relocation, as fissures would form in time as these felled limbs decay.

11.1.4 Protocols to Protect Fauna during clearing

A suitably qualified ecologist must be on site during the removal of Koala habitat trees, hollow bearing trees, stags, rocky outcrops, large hollow logs, hanging bird nests and other significant habitat components (as identified in the pre-clearance surveys), to ensure all items are checked. Any injured fauna as a result of the clearing activities must be attended to by a member of WMRES or by a local veterinarian. Protocols relating to certain species are outlined in the following sections.

Vegetation Clearing Protocols

The vegetation clearing protocols would include:

- ▶ Hollow logs, leaf litter and woody debris and large boulders that provide refuge for native fauna identified during the pre-clearing surveys would be removed during construction would be redistributed into the protection area. This would minimise the removal of dead wood from the locality, which has been listed on the TSC Act as a key threatening process;
- ▶ Vegetation clearing would commence from the dam embankment and work upslope through the inundation area;
- ▶ Trees should be felled away from retained vegetation where possible to reduce the incidence of unnecessary impacts to adjacent vegetation;
- ▶ Fallen timber in the form of hollow bearing trees or stags should be gently lowered during felling and carefully placed into the edge of adjacent forest that is to be retained, whilst avoiding access by heavy machinery into this 'no go' area (i.e. area beyond the cleared

storage perimeter). This practice would ensure that additional habitat is provided or maintained for any threatened fauna potentially relocating. This should be completed under supervision by an ecologist or appropriately qualified person;

- ▶ Ensure an experienced ecologist or wildlife handler is present to manage and retrieve any displaced wildlife during clearing activities. The handling protocols are detailed below for uninjured and injured fauna;
- ▶ Relocating displaced fauna to similar habitat at the closest available secure location; and
- ▶ Exposed surface soil should be stabilised as soon as possible to avoid potential erosion (by mulching, covering or replanting with native grass species where appropriate).

Fauna monitoring during clearing

Vegetation or other habitat features identified as potentially harbouring fauna would be monitored by an ecologist during clearing activities.

Removal of Hollow-bearing Habitat Trees and Large Hollow Logs

Particular attention would be given to those trees with substantial hollows or large hollow logs identified during the initial pre-clearing site investigation as potential habitat for native fauna. Adjacent non-habitat trees and other surrounding vegetation would be removed 24 hrs prior to habitat tree removal providing fauna with an opportunity to exit the tree to minimise the potential for unnecessary mortality or injury during tree felling activities and stress associated with handling.

The following steps would be taken before clearing of vegetation surrounding identified habitat trees and logs:

- ▶ Surrounding vegetation would be inspected by an ecologist for the presence of native fauna, including searches for Koalas;
- ▶ Where a Koala is detected a temporary vegetation clearing exclusion zone of a minimum of 30 m radius must be established around it, until the Koala vacates the tree;
- ▶ Where other fauna are encountered they would be captured and released into adjoining secure habitat or gently encouraged to leave the construction area and directed into adjoining habitat; and
- ▶ Where no fauna species are detected clearing of vegetation surrounding habitat trees and logs can proceed. The clearing activities would be monitored by an ecologist to detect any fauna observed to be at risk.

The following protocols would be implemented for the removal of identified hollow-bearing trees and hollow logs:

- ▶ Hollow-bearing trees or trees thought to harbour fauna would be felled, and large hollow logs removed, under the supervision of two wildlife specialists. These specialists would have appropriate permits and animal-handling equipment. The local veterinarian would also be contacted and informed of the impending clearing activities;
- ▶ Prior to felling or removal, clearing machinery would be used to gently shake or 'bang' the habitat tree or log for a period of 2-3 minutes (dependant on tree health and structural integrity) to encourage any resident fauna to vacate hollows. Sticks, poles or other similar

hand-held objects would also be used to hit the trunk of the tree or log at various points, to encourage animals to vacate the tree/log. The tree or log would be observed for at least 5 minutes prior to completing the next action; and

- ▶ After the observation period, each tree would be felled at the base. Once it has been deemed safe to inspect each tree by the excavator operator, hollows in felled trees would be inspected for fauna that may be present (uninjured, injured or deceased).

Inspection of Rocky Outcrops

Rocky outcrops identified during the pre-clearing surveys would be inspected prior to clearing by a wildlife specialist for the presence of sheltering fauna. Any fauna detected would be captured and released in adjoining areas of suitable habitat or encouraged to vacate the construction area and directed into adjoining habitats.

Uninjured captured individuals

Uninjured captured individuals would either be:

- ▶ Released immediately into adjoining retained habitat outside of the Construction Area, particularly for diurnal species (e.g. <150 m away); or
- ▶ Temporarily retained in captivity until dusk, then released at the nearest suitable location away from the area being cleared (e.g. <150 m away), particularly for nocturnal species.

Injured and deceased individuals

If injured or deceased animals are found, then the local veterinarian or WIRES representative should be contacted.

Stockpiling of hollow logs and branches and rocks

Hollow-bearing branches, logs, tree trunks and large rocks identified during the pre-clearing surveys would be stockpiled for placement in the protection area.

11.1.5 Mitigation Measures during construction of the Proposal

- ▶ Any infrastructure and machinery required for the proposed activities should be positioned to avoid retained native vegetation (e.g. adjacent vegetation outside designated clearing areas);
- ▶ *Noxious and environmental weeds should be controlled through a WMP included in the CEMP;
- ▶ Drainage and runoff should be controlled in such a way as that no foreign substrates or materials leave the site;
- ▶ Exposed surface soil should be stabilised as soon as possible to avoid potential erosion (by mulching, covering or replanting with native species);
- ▶ Excessive dust should be suppressed via watering dust generating soil or stock piles; and
- ▶ *The avoidance of soil disturbance in or near remnants, such as ripping planting lines and road grading.

* - Mitigation measures to be also undertaken after the proposed works are complete.

11.1.6 Timing of Clearing

The colder months of the year represent a time when fauna may be in torpor, less active and less willing to relocate.

In general, for all species, and particularly hollow dependent species, they are generally less likely to survive if you move them in winter because some are in torpor and for others it may be more difficult to find foraging resources and new territory or roosting habitat.

Key times to avoid where possible would be breeding times for Owls, however the only large hollow bearing trees or stags are located along Bobo Road and protocols have been provided to reduce the possibility of any potential impacts upon these trees that would be marked during the pre-clearance survey.

The Bentwing-bats breed in caves or similar areas so clearing is unlikely to significantly impact their breeding colonies. Additionally protocols have been provided to reduce the possibility of any potential impacts upon any Bentwing-bats that may be roosting in stags or hollow bearing trees that would be marked during the pre-clearance survey.

The mitigation measures and protocols prescribed above should reduce the potential impact upon any of the threatened fauna species that have been recorded or are considered likely to occur, as well as any non-threatened fauna species that may be present when clearing takes place.

Table 31 depicts the seasonal flowering or breeding periods of the threatened flora and fauna species recorded or considered likely to occur in the study area.

Table 31 Flowering or Breeding Periods of Threatened Species Occurring or likely to Occur in the Study Area

Species	Seasonal Flowering or Breeding Periods											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barking Owl												
Masked Owl												
Sooty Owl												
Powerful Owl												
Glossy Black Cockatoo												
Wompoo Fruit-dove												
Koala												
Golden-tipped Bat												
Little Bentwing-bat												
Eastern Bentwing-bat												
Spotted-tail Quoll												

	Seasonal Flowering or Breeding Periods											
Grey-headed Flying-fox												
Southern Barred Frog												
Giant Barred Frog												
Rusty Plum												
Tylophora												
Minute Orchid												
Leafless Tongue Orchid	*	*	*	*	*	*	*	*	*	*	*	*

* Indicates unknown flowering period of species

Green indicates the flowering/ breeding periods for the threatened flora and fauna species occurring or likely to occur in the study area.

11.1.7 Mitigation Measures Post Proposal Construction

The amelioration measures to be undertaken after the Proposal include:

- ▶ Exposed surface soil should be stabilised progressively as soon as possible to avoid potential erosion (by mulching, covering or replanting with native grass species); and
- ▶ The transparently operated storage as specified in the Water Quality Report component of the EIS should be implemented through a spillway system and controlled release of water to ensure ecological processes are sustained and that adequate flows to maintain habitat for aquatic biota is provided along Bowra Creek;
- ▶ Initial detailed monitoring assessments of the transparently operated storage should be conducted for the downstream sections of Bowra Creek below the inundation area. These assessments would serve as a benchmark for determining the long-term effectiveness of the transparent release of water from the off-river storage to sustain the environmental flow below the inundation area;
- ▶ Monitor aquatic weeds, particularly Parrots Feather *Myriophyllum aquaticum*, and develop a removal management plan to ensure the ongoing control of aquatic weed species that may be introduced by waterbirds or humans; and
- ▶ Monitor for Gambusia and develop a removal management plan if the species is identified.

11.1.8 Provision of Protection Area

There is the potential for direct and indirect impacts on biodiversity values as a consequence of the Proposal. While many of these impacts can be adequately mitigated or managed, there are impacts associated with certain aspects of the Proposal where measures to avoid and mitigate are not possible. These impacts are called residual impacts. The primary residual impact associated with the Proposal would be the loss of native vegetation in the inundation area,

including known and potential habitat for threatened flora and fauna species listed under the TSC and EPBC Acts.

To address the residual impacts of the Proposal, NSC have nominated a potential protection area that would be conserved in perpetuity and contribute to the long term conservation of biodiversity in the locality. The proposed protection area has been devised in cooperation with the existing landowner (Forests NSW) and comprises 122.58 ha of native vegetation above and surrounding the proposed inundation area where current logging activities would cease. It contains vegetation communities representative of those that are to be removed from the inundation area and provides for an offset ratio of approximately 1.88 : 1 as detailed in Table 32.

The protection area is designed to account for any potential direct, indirect or residual impacts upon threatened species that may be associated with the Proposal that may not be adequately controlled through the proposed mitigation measures. The proposed protection area aims to offset the vegetation to be removed, as a whole, and is not able to offset each vegetation community at the same ratio that the whole protection area does. To achieve such outcome, corresponding vegetation communities of the right size to accommodate the same ratio would need to be identified further a field and purchased by NSC. This could be considered impractical, expensive and difficult to manage.

The protection area has not been designed to offset each vegetation community to be removed at the same ratio as is to be retained (i.e. 1:1). The emphasis is on the long-term protection of habitat for threatened and non-threatened species and the removal of the vegetation clearing KTP, associated with logging practices, from the vegetation to be retained. This is not considered to be significant regards to the vegetation communities identified being only able to support certain threatened or non-threatened species.

The structurally modified state of each vegetation community to be cleared is unlikely to be considered species specific habitat. The species recorded or considered likely to occur or may possibly occur in the vegetation to be cleared are considered likely to breed, forage and/or roost in all of the vegetation communities identified. This then applies to the vegetation communities associated with the proposed protection area.

Table 32 Protection Area including Retained Vegetation

Native vegetation communities to be cleared in the inundation area	Native vegetation communities to be retained in land acquired from DI&I	Total area (ha) to be retained as protection area	Total area (ha) to be cleared
<ul style="list-style-type: none"> ▶ Foothills Grey Gum – Broad Leaved Mahogany; ▶ Northern Wet Tallowwood – Blue Gum; ▶ Wet Bloodwood – Tallowwood (Temperate Rainforest); ▶ Wet Flooded Gum – 	<ul style="list-style-type: none"> ▶ Foothills Grey Gum – Broad Leaved Mahogany; ▶ Northern Wet Tallowwood – Blue Gum; ▶ Wet Bloodwood – Tallowwood (Temperate Rainforest); ▶ Wet Flooded Gum – 	122.58	65.05

Native vegetation communities to be cleared in the inundation area	Native vegetation communities to be retained in land acquired from DI&I	Total area (ha) to be retained as protection area	Total area (ha) to be cleared
Tallowwood; and ► Hardwood Plantation.	Tallowwood; and ► Hardwood Plantation.		
RATIO of Cleared Vegetation to Retained Vegetation		1.88 : 1	

Note: all figures determined through GIS analysis based upon overstorey vegetation cover.

The protection area is at a ratio of approximately 1.88 : 1 as detailed in Table 32. In the protection area, fallen limbs, leaf litter and dead trees should be retained insitu for habitat purposes.

Firebreaks must be located outside the protection area area wherever possible or along existing fire trails within the inundation area, as shown in Figure 12. The way in which fuel loads are to be managed in the protection area is dependant on the use and approval of fuel reduction.

12. Conclusion

The main objectives of this assessment were to review, verify and supplement previous relevant studies; survey, identify and report on existing aquatic and terrestrial flora and fauna communities; provide a qualitative summary of the environmental values of the study area; assessment to identify the extent of potential impact to flora and fauna values; and provide management advice and tools to mitigate these impacts.

12.1 Key findings

The proposed inundation area is comprised of structurally modified native vegetation and hardwood plantations that have undergone significant past disturbances associated with logging activities. Subsequent weed invasion has been instrumental in modifying the structure of this vegetation resulting in reduced habitat values for threatened flora and fauna.

Numerous exotic plant species were observed during field surveys. Several noxious weeds were recorded in varying populations (Camphor Laurel, Lantana, Small-leaf Privet, Broad-leaf Privet, Weeping Willow, Giant Parramatta Grass, Crofton Weed and Mistflower). Feral dogs were recorded as well as Hares.

Fourteen species of fauna listed under the TSC, FM and/ or EPBC Acts were confirmed as occurring within the study area. The fauna of conservation significance includes six mammal species (Koala, Spotted-tail Quoll, Grey-headed Flying-fox, Eastern Bentwing-bat, Golden-tipped Bat and Little Bentwing-bat), eight bird species (Masked Owl, Barking Owl, Sooty Owl, Powerful Owl, Glossy Black Cockatoo and Wompoo Fruit-dove), including two migratory birds (Rufous Fantail and Cattle Egret). The 7-part tests concluded that no significant impact is likely on these species as a result of the Proposal. Therefore a Species Impact Statement is not deemed necessary. No significant impacts are considered likely on the threatened species or migratory birds listed under the EPBC Act and therefore no referral to the Commonwealth Minister in relation to the EPBC Act is necessary.

Three threatened flora species listed under the TSC or EPBC Acts were considered likely to occur in the study area including Minute Orchid, Leafless Tongue Orchid, Rusty Plum and Tylophora.

No threatened aquatic fauna or EECs were recorded or assessed as likely to occur within the study area. Therefore no assessments of significance were undertaken for these entities.

The 7-part Tests concluded that no significant impact is likely on these species as a result of the proposed action. Therefore no Species Impact Statements are deemed necessary. No referral to the Commonwealth Minister in relation to the EPBC Act is necessary.

The key impacts associated with the Proposal include habitat loss, sedimentation and weed invasion. In order to minimise these key impacts it has been recommended that an Environmental Management Plan be developed for the Proposal. This plan would include the management of all proposed mitigation measures as outlined in this report.



12.2 Concluding Statement

This Working Paper addresses the terrestrial and aquatic ecology impacts associated with the construction of an off-river storage at Bowraville, NSW (the Proposal) and has been prepared as a technical document to support the Environmental Assessment. The objective of the Working Paper is to provide an ecological assessment of the impact of the Proposal pursuant to Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The working paper also provides an assessment of the significance of impacts on 'Matters of National Environmental Significance' pursuant to the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). As a result of this assessment, particular areas where mitigation may be required have been identified and ameliorative measures have been proposed so as to minimise the impacts of the Proposal.

There is the potential for a number of direct and indirect impacts to occur on biodiversity values as a consequence of the Proposal. While many of these impacts have been adequately minimised or managed, there are some impacts that cannot be adequately mitigated. To address these residual impacts of the Proposal, the NSC has prepared a biodiversity offset strategy. This strategy would complement the specific mitigation measures incorporated into the Proposal and which would be implemented during the construction and operational phases to further mitigate residual impacts and contribute to the maintenance and improvement of local and regional biodiversity values.

An assessment of the potential significance of impacts on threatened species has been prepared in accordance with section 5A of the EPA Act. The significance assessments have concluded that there is unlikely to be a significant impact on threatened species provided that proposed mitigation and management measures are developed and implemented.

The Proposal is unlikely to have a significant impact on any other threatened or migratory species listed under the EPBC Act, provided that adequate mitigation and management measures are developed and implemented in consultation with the relevant authorities. Provided such measures are implemented, the Proposal is unlikely to constitute a controlled action as defined under the EPBC Act.

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Appendix A Threatened Species Identified during Database Searches

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
Amphibians					
<i>Litoria aurea</i>	Green and Golden Bell Frog	V	E	<p>This frog is typically found in small, coastal, or near coastal populations, which are widely separated and isolated. This species inhabits marshes, dams and streambanks, particularly those containing bulrushes (<i>Typcha</i> spp.) or spike rushes (<i>Eleocharis</i> spp.). Preferred habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (<i>Gambusia holbrooki</i>), have a grassy area nearby and diurnal sheltering sites available; Sometimes in highly disturbed areas. This species is active by day and usually breeds in summer when conditions are warm and wet.</p>	<p>Unlikely. Preferred habitat for this species was not available in the inundation area. This species is known to utilise disturbed areas and farm dams, but typically prefers spots adjacent to extensive wetlands. This larger wetland habitat is not available along the pipeline route.</p>
<i>Litoria booroolongensis</i>	Booroolong Frog	E	E	<p>This species is predominantly found along the western-flowing streams of the Great Dividing Range. They live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Adults occur on or near cobble banks and other rock structures within stream margins. They shelter under rocks or amongst vegetation near the ground on the stream edge. Sometimes they bask in the sun on exposed rocks near flowing water during summer. Breeding occurs in spring and early summer.</p>	<p>No. This species preferred habitat was not present in the study area</p>

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Mixophyes balbus</i>	Southern Barred Frog	V	E	This is the only <i>Mixophyes</i> species that occurs in south-east NSW and in recent surveys it has only been recorded at three locations south of Sydney. This species is typically found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. This species breeds in streams during summer after heavy rain.	Likely. This species preferred habitat is available within the study area and a species with similar habitat preferences has been found in the area. See <i>M. iteratus</i>
<i>Mixophyes iteratus</i>	Giant Barred Frog	E	E	This species is found in north-eastern NSW, particularly the Coffs Harbour-Dorrigo area. Giant Barred Frogs forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m. They breed around shallow, flowing rocky streams from late spring to summer. When not breeding the frogs disperse hundreds of metres away from streams.	Likely. This species preferred habitat is available within the study area and a State Forest fauna survey has identified this species in the northwest portion of the Viewmont State Forest.
Bats					
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	This bat is found mainly in areas with extensive cliffs and caves. It is generally rare with a very patchy distribution in NSW. It roosts in caves, near their entrances, crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (<i>Hirundo ariel</i>), frequenting low to mid-elevation dry open forest and woodland close to these features. It breeds from November to January in roof domes in sandstone caves and remain loyal to the same cave over many years. They typically forage in well-timbered areas containing gullies and are likely to hibernate through the coolest months.	Unlikely. This species preferred roosting habitat (caves) was not present on the study area.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Myotis papuensis</i>	Golden-tipped Bat		✓	<p>The Golden-tipped Bat is distributed along the east coast of Australia in scattered locations from the Cape York Peninsula to southern NSW. It is found in rainforest and adjacent sclerophyll forest and roosts in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests located in rainforest gullies on small first and second order streams. It would fly up to two km from roosts to forage in rainforest and sclerophyll forest on upper-slopes. This bat is a specialist feeder on small web-building spiders.</p>	Yes. This species was positively identified during anabat analysis.
<i>Myotis australis</i>	Little Bentwing-Bat		✓	<p>This species is found in coastal northeastern NSW in moist eucalypt forest, rainforest or dense coastal banksia scrub. Little Bentwing-bats roost in caves, tunnels and sometimes tree hollows during the day, and at night forage beneath the canopy of densely vegetated habitats.</p>	Yes. This species was positively identified during anabat analysis.
<i>Myotis schreibersii oceanensis</i>	Eastern Bentwing Bat		✓	<p>Eastern Bentwing Bats occur along the east and northwest coasts of Australia. Caves are the primary roosting habitat for this species, but they also use derelict mines, storm-water tunnels, buildings and other man-made structures. This species forms discrete populations centred on a maternity cave annually in the spring and summer. At other times of the year, populations disperse within about a 300 km range of the maternity cave. This species hunts in forested areas above the tree tops.</p>	Yes. This species was positively identified during anabat analysis.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Mormopterus norfolkensis</i>	Eastern Freetail-Bat		✓	The Eastern Freetail-bat is found along the east coast in southern NSW. It occurs in dry sclerophyll forest and woodland east of the Great Dividing Range and roosts mainly in tree hollows, but would also roost under bark or in man-made structures.	Unlikely. Several microbat species with similar foraging habitats were recorded during anabat surveys. Although there were a minimal amount of tree hollows for roosting.
<i>Myctophilus bifax</i>	Eastern Long-eared Bat		✓	In NSW, this species appears to be confined to the coastal plain and nearby coastal ranges, with a few records further south around Coffs Harbour. This species prefers lowland subtropical rainforest and wet and swamp eucalypt forest, extending into adjacent moist eucalypt forest. Coastal rainforest and patches of coastal scrub are particularly favoured. It roosts in hollows in trees and also in the hanging foliage of palms, in dense clumps of foliage of rainforest trees and under bark.	Unlikely. Coffs Harbour is typically this species southern distribution limit.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	✓	✓	Grey-headed Flying Foxes are found within 200 km of the eastern coast of Australia. They occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Their roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water and in vegetation with a dense canopy. Annual mating commences from January to October or November. They travel up to 50 km to forage and feed on the nectar and pollen of Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.	Yes. Grey-headed flying foxes (GHFF) have been recorded in the inundation area and there is an active GHFF camp adjacent to NR5.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
Birds					
<i>Ardea alba</i>	Great Egret	M		This species is common throughout Australia, with the exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands (Morcombe, 2003).	Unlikely. This species preferred habitat is not available in the study area.
<i>Ardea ibis</i>	Cattle Egret	M		This species is most widespread in south-eastern Australia from Bundaberg, Queensland to Port Augusta, South Australia. The Cattle Egret is found in grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Will also forage at garbage dumps, and is often seen with cattle and other stock (Morcombe, 2003).	Yes. This species was observed during the fauna survey in the paddocks and along the waterways.
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo		✓	The species is uncommon although widespread throughout suitable forest and woodland habitats. It is dependent on large hollow-bearing eucalypts for nest sites. This species typically inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of she-oak species, particularly Black She-oak (<i>Allocasuarina littoralis</i>), Forest She-oak (<i>A. torulosa</i>) or Drooping She-oak (<i>A. verticillata</i>) occur. In the Riverina area, it inhabits open woodlands dominated by Belah (<i>Casuarina cristata</i>) and feeds almost exclusively on the seeds of several species of she-oak (<i>Casuarina</i> and <i>Allocasuarina</i> species).	Possible. This species preferred breeding habitat does not exist in the study area as there were minimal hollow-bearing trees for nesting, however foraging resources were identified <i>Allocasuarina torulosa</i> and <i>A. littoralis</i> .

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Climacteris picumnus victorae</i>	Brown Treecreeper (eastern subspecies)		V	<p>The Brown Treecreeper is endemic to eastern Australia. It is found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range. It mainly inhabits woodlands dominated by stringy barks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species. It is also found in mallee and River Red Gum (<i>Eucalyptus camaldulensis</i>) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses. It is typically not found in woodlands with a dense shrub layer. Fallen timber is an important habitat component for foraging. It has also been recorded in similar woodland habitats on the coastal ranges and plains. It is typically found foraging on trunks and branches of trees and amongst fallen timber. Hollows in standing dead or live trees and tree stumps are essential for nesting.</p>	No. This species has been recorded in the vicinity, but its preferred habitat was not available within the study area. The majority of the inundation area has a dense shrub layer of Lantana.
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork		E	<p>This species is widespread across coastal northern and eastern Australia, becoming increasingly uncommon further south into NSW. Some birds may move long distances and can be recorded well outside their normal range. It inhabits permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands. It can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries. It feeds in shallow, still water on a variety of prey and breeds in early summer in the south. A large nest, up to 2 m in diameter, is made in a live or dead tree, in or near a freshwater swamp.</p>	Unlikely. This species preferred habitat is not available in the study area.



Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	M		White-bellied Sea-Eagles are a common sight in coastal and near coastal areas of Australia. are normally seen perched high in a tree, or soaring over waterways and adjacent land (Morcombe 2003).	No. This species preferred habitat was not available within the study area.
<i>Hirundapus caudacutus</i>	White-throated Needletail	M		White-throated Needletails often occur in large numbers over eastern and northern Australia. White-throated Needletails are aerial birds and for a time it was commonly believed that they did not land while in Australia. It has now been observed that birds would roost in trees (Morcombe, 2003).	No. This species preferred habitat was not available within the study area.
<i>Lathamus discolor</i>	Swift Parrot	E	E	In NSW, this species mostly occurs on the coast and southwest slopes. It migrates to the Australian southeast mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations. There preferred feed trees include winter flowering species such as Swamp Mahogany (<i>Eucalyptus robusta</i>), Spotted Gum (<i>Corymbia maculata</i>), Red Bloodwood (<i>C. gummifera</i>), Mugga Ironbark (<i>E. sideroxylon</i>), and White Box (<i>E. albens</i>). Commonly used lerp infested trees include Grey Box (<i>E. microcarpa</i>), Grey Box (<i>E. moluccana</i>) and Blackbutt (<i>E. pilularis</i>).	No. This species preferred habitat was not available within the study area.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Merops ornatus</i>	Rainbow Bee-eater	M		This species is widespread in Australia, except in desert areas, and breeds throughout most of its range. The Rainbow Bee-eater is most often found in open forests, woodlands and shrublands, and cleared areas, usually near water. It would be found on farmland with remnant vegetation and in orchards and vineyards. It would use disturbed sites such as quarries, cuttings and mines to build its nesting tunnels (Morcombe, 2003).	Unlikely. This species preferred habitat was not available within the study area.
<i>Monarcha melanopsis</i>	Black-faced Monarch	M		The Black-faced Monarch is found along the coast of eastern Australia, becoming less common further south. This species is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	Unlikely. This species preferred habitat was not available within the study area.
<i>Monarcha trivirgatus</i>	Spectacled Monarch	M		The Spectacled Monarch is found in coastal north-eastern and eastern Australia, including coastal islands. It prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	Unlikely. This species preferred habitat was not available within the study area.
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	M		The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. It is typically found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	Unlikely. This species preferred habitat was not available within the study area.



Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Ninox connivens</i>	Barking Owl		✓	<p>The Barking Owl has declined across much of its distribution across NSW and now occurs only sparsely. It is most frequently recorded on the western slopes and plains and is rarely recorded in the far west or in coastal and escarpment forests. This species inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as <i>Acacia</i> and <i>Casuarina</i> species, or the dense clumps of canopy leaves in large <i>Eucalypts</i>. Territories range from 30 to 200 hectares and birds are present all year. Nests in hollows of large, old eucalypts including River Red Gum (<i>Eucalyptus camaldulensis</i>), White Box (<i>Eucalyptus albens</i>), Red Box (<i>Eucalyptus polyanthemus</i>) and Blakely Red Gum (<i>Eucalyptus blakelyi</i>). Breeding occurs during late winter and early spring.</p>	<p>Yes. This species was heard during call-playback surveys.</p>

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Ninox strenua</i>	Powerful Owl		V	<p>In NSW, this species is widely distributed throughout the eastern forests from the coast inland to the tablelands. The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine (<i>Syncarpia glomulifera</i>), Black She-oak (<i>Allocasuarina littoralis</i>), Blackwood (<i>Acacia melanoxylon</i>), Rough-barked Apple (<i>Angophora floribunda</i>), Cherry Ballart (<i>Exocarpus cupressiformis</i>) and a number of eucalypt species. As most prey species require hollows and a shrub layer, these are important habitat components for the owl. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. Nesting occurs from late autumn to mid-winter, but is slightly earlier in north-eastern NSW (late summer - mid autumn).</p>	<p>Likely. This species has been recorded within a 10 km radius of the study area. Foraging habitat for this species was identified in the study area.</p>
<i>Pandion haliaetus</i>	Osprey		V	<p>This species is uncommon to rare or absent from closely settled parts of south-eastern Australia. It favours coastal areas, especially the mouths of large rivers, lagoons and lakes. This species breeds from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.</p>	<p>No. This species preferred habitat was not available within the study area.</p>

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Ptilinopus magnificus</i>	Wompoo Fruit-dove		V	This species is rarely recorded south of Coffs Harbour. Three subspecies are recognised, with the most southerly in NSW and south-eastern Queensland. It occurs in or near rainforest, low elevation moist eucalypt forest and brush box forests. This species feeds on a diverse range of tree and vine fruits and is locally nomadic, following ripening fruit. Some of its feed trees rely on this species to distribute their seeds. It breeds in spring and early summer and is most often seen in mature forests, but is also found in remnant and regenerating rainforest.	Possible. This species has been recorded in the northwest portion of Viewmont State Forest during a forestry survey.
<i>Rhipidura rufifrons</i>	Rufous Fantail	M		The Rufous Fantail is found in northern and eastern coastal Australia. It is typically found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats or urban areas.	Yes. This species was observed in the inundation area during the recent survey.
<i>Rostratula australis</i>	Australian Painted Snipe	V		This species occurs across Australia, the areas of most sensitivity to the species are those wetlands where the birds frequently occur and are known to breed. The Australian Painted Snipe is usually found in shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled. It is a cryptic bird that is hard to see and often overlooked. It nests on the ground amongst tall reed-like vegetation near water, and feeds near the water's edge and on mudflats.	No, this species preferred habitat was not available within the study site.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Tyto novaehollandiae</i>	Masked Owl		V	<p>This species is recorded in most of NSW, excluding the most arid northwestern corner. The Masked Owl lives in dry eucalypt forests and woodlands from sea level to 1100 m. This species is a forest owl, but often hunts along the edges of forests, including roadsides. Pairs have a large home-range of 500 to 1000 hectares. This owl roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.</p>	Yes. This species was heard during call playback and spotlighted during nocturnal surveys.
<i>Tyto tenebrosa</i>	Sooty Owl		V	<p>This species occurs along the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. It occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. This species roosts by day in the hollow of a tall forest tree or in heavy vegetation and hunts at night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum (<i>Pseudocheirus peregrinus</i>) or Sugar Glider (<i>Petaurus breviceps</i>). This species nests in very large tree-hollows.</p>	Yes. This species was heard during call playback surveys.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E	E	In NSW, the distribution of this species is very patchy and mainly confined to two main breeding areas and surrounding fragmented woodlands. In some years non-breeding flocks converge on flowering coastal woodlands and forests. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. This species are occasionally seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast.	No. This species preferred habitat was not available within the study area.
Marsupials					
<i>Dasyurus maculatus</i>	Spotted-tail Quoll	E	V	In NSW, this species distribution has contracted significantly and it is now only found on the east coast. It has been recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. They are mostly nocturnal, although would hunt during the day. They spend most of the time on the ground, although they are excellent climbers. They use "latrine sites", often on flat rocks among boulder fields and rocky cliff-faces. They usually traverse their large home range along densely vegetated creek lines.	Likely. This species preferred habitat was identified within the study area.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Phascolarctos cinereus</i>	Koala	✓	✓	In NSW, this species mainly occurs on the central and north coasts with some populations in the western region where they inhabit eucalypt woodlands and forests. This species feeds on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area it would select preferred browse species. They spend most of their time in trees, but would descend and traverse open ground to move between trees.	Yes. This species was heard during the night.
<i>Potorous tridactylus</i>	Long-nosed Potoroo	✓	✓	In NSW, this species is generally restricted to coastal heaths and forests east of the Great Dividing Range, with an annual rainfall exceeding 760 mm. It inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. The fruit-bodies of hypogaeous (underground-fruited) fungi are a large component of the diet of the Long-nosed Potoroo. They often dig small holes in the ground in a similar way to bandicoots. They are mainly nocturnal, hiding by day in dense vegetation, but may venture out during the day in winter.	Unlikely. This species preferred habitat was not available within the study area.
Reptiles					
<i>Emydura macquarii</i> (Bellinger River Form)	Bellinger River Emydura	✓	✓	This turtle species is very rare and has a restricted distribution in the upper Bellinger River above Thora. It prefers long, deep pools in broad reaches of the upper Bellinger River. Fallen timber (snags) in the river is typically used as basking sites.	No. This species habitat was not within the study area.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Hoplocephalus stephensi</i>	Stephens' Banded Snake		V	This species is found on the coast and ranges from Southern Queensland to Gosford in NSW. It prefers rainforest and eucalypt forests and rocky areas up to 950 m in altitude. Stephens' Banded Snake is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day.	Unlikely. This species preferred habitat was not available within the study area.
Rodents					
<i>Pseudomys oralis</i>	Hastings River Mouse	E	E	This species has a patchy distribution along the east side of the Northern Tablelands and great escarpment of northeast NSW. It occupies a variety of dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs. Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops. Nests may be in either gully areas or ridges and slopes.	No. This species habitat was not within the study area.

Note: All species distribution and habitat information was adapted from the Department of Environment and Climate Change webpage - Threatened Species, Species Populations and Ecological Communities of NSW, URL: http://www.threatenedspecies.environment.nsw.gov.au/speciesprofile/home_species.aspx, unless referenced otherwise.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
Plants					
<i>Acacia chrysotricha</i>	Newry Golden Wattle		E	This species is restricted to an area south of Bellingen on the NSW north coast. This is an understorey species found on rainforest edges and in wet or dry eucalypt forest in steep narrow gullies on quartzite soils. Newry Golden Wattle is relatively short-lived. The seeds, which remain in the soil, require heat from fire to induce germination. Too-frequent fire may lead to a decline in the population, as gradual exhaustion of the soil-borne seed bank would result, with no replacement of adult plants over time.	Unlikely. Unsuitable habitat found on site due to logging and weed infestation.
<i>Amorpha sperrum whitei</i>	Rusty Plum		V	This species is a small to medium tree to 20 m high with a very fluted or irregular trunk. It occurs on the coast and adjacent ranges from northern NSW into southern QLD. This species prefers rainforest and adjacent understorey of moist eucalypt forest. Threats include clearing, timber harvesting, and weed invasion, particularly Lantana.	Possible. Suitable habitat found on site.
<i>Anthraxon hispidus</i>	Hairy Jointgrass		V	This species is a creeping grass with branching, erect to semi-erect purplish stems. A moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps. It occurs over a wide area in southeast QLD, and on the northern tablelands and north coast of NSW, but is never common.	Unlikely. Little to no suitable habitat found on site. Competitive grass species occur where suitable habitat exists.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Cryptostylus hunteriana</i>	Leafless Tongue Orchid	V		<p>This species is known historically from a number of localities on the NSW south coast. It is typically found in heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (<i>Eucalyptus sclerophylla</i>), Silvertop Ash (<i>E. sieberi</i>), Red Bloodwood (<i>Corymbia gummifera</i>) and Black Sheoak (<i>Allocasuarina littoralis</i>). It appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (<i>C. subulata</i>) and the Tartan Tongue Orchid (<i>C. erecta</i>). Little is known about the ecology of the species. It is leafless and is expected to have limited photosynthetic capability and probably depends upon a fungal associate to meet its nutritional requirements from either living or dead organic material. In addition to reproducing from seed, it is also capable of vegetative reproduction and thus forms colonies, which can become more or less permanent at a site.</p>	Possible. Suitable habitat found on site.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Cynanchum elegans</i>	White-Flowered Wax Plant	E	E	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree <i>Leptospermum laevigatum</i> – Coastal Banksia <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> coastal scrub; Forest Red Gum <i>Eucalyptus tereticornis</i> aligned open forest and woodland; Spotted Gum <i>Eucalyptus maculata</i> aligned open forest and woodland; and Bracelet Honey myrtle <i>Melaleuca armillaris</i> scrub to open scrub. Flowering occurs between August and May, with a peak in November.	No. Unsuitable habitat found on site.
<i>Hicksbeachia pinnatifolia</i>	Monkey Nut	V	V	This species is found in coastal areas of north-east NSW from the Nambucca Valley north to south-east Queensland. Its preferred habitat includes subtropical rainforest, moist eucalypt forest and Brush Box forest.	Unlikely. Unsuitable habitat found on site due to logging and weed infestations including Lantana.
<i>Marsdenia longiloba</i>	Clear Milkvine	V		This species is a slender climber of the milk vine group that is distributed on scattered sites on the north coast of NSW north from Barrington Tops. Habitat is subtropical/warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops. Threats include loss of habitat through land clearing, small populations, introduced weeds, grazing and trampling of plants by cattle and the use of herbicides.	Unlikely. Due to logging and weed infestations.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Parsonsia dorrigoensis</i>	Milky Silkpod	E	V	Milky Silkpod is found only within NSW, with scattered populations in the north coast region between Kendall and Woolgoolga. Found in subtropical and warm-temperate rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils. Typically flowers in summer. Little is known of the species' reproductive biology. Appears to be able to withstand, and maybe even favour, light to moderate physical disturbance.	Unlikely. Due to logging and weed infestations including Lantana, as well as unsuitable soil type found on site.
<i>Quassia</i> sp.	Moonee Quassia		E	Shrubby layer below tall moist eucalypt forest and tall dry eucalypt forest, including forest edges, mostly at lower altitudes.	No. The study area does not contain appropriate habitat. Not known from the immediate locality.
<i>Taeniophyllum muelleri</i>	Minute Orchid	V		This species is epiphytic, favouring littoral rainforest, subtropical rainforest, wet sclerophyll forests and riparian (stream-side) areas. Flowering occurs during winter and spring (June to October).	Possible. Suitable habitat found on site.
<i>Thesium australe</i>	Austral Toadflax	V	V	This species occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (<i>Themeda australis</i>). Austral Toadflax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia.	No. This species habitat was not within the study area.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
<i>Tylophora woolfsii</i>	Tylophora	E	E	The Cryptic Forest Twiner is found from the NSW north coast and New England Tablelands to southern Queensland, but is very rare within that range. It is known on the Tablelands from the Bald Rock and Boonoo Boonoo areas north of Tenterfield. This species grows in moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins. Flowering occurs in summer and autumn, usually between January and March but sometimes as late as November.	Possible. Suitable habitat found on site.
Endangered Ecological Communities					
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions			EEC	Coastal Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. It is frequently found as a zone on the landward side of mangrove stands. Characteristic plants include <i>Baumea juncea</i> , <i>Juncus kraussii</i> , <i>Sarcocornia quinqueflora</i> , <i>Sporobolus virginicus</i> , <i>Triglochin striata</i> , <i>Isolepis nodosa</i> , <i>Samolus repens</i> , <i>Selliera radicans</i> , <i>Suaeda australis</i> and <i>Zoysia macrantha</i> . Occasionally mangroves are scattered through the saltmarsh. Tall reeds may also occur, as well as salt pans. This community occurs in the intertidal zone along the NSW coast.	This community was not present in the study area. Too far from the coast.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions			EEC	<p>Associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years. Typically occurs on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes but may also occur in backbarrier landforms where floodplains adjoin coastal sandplains. Generally occur below 20 m elevation on level areas. They are dominated by herbaceous plants and have very few woody species. Known from along the majority of the NSW coast.</p>	This community was not present in the study area.
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions			EEC	<p>An open forest which characterises the gentle slopes of depressions and drainage flats on the Hunter Valley floor. The most common canopy tree species are <i>Eucalyptus tereticornis</i> (Forest Red Gum) and <i>E. punctata</i> (Grey Gum). Other frequently occurring canopy species are <i>Angophora costata</i>, <i>Corymbia maculata</i>, <i>E. crebra</i> and <i>E. moluccana</i>. The mid-storey is open and characterised by sparse shrubs such as <i>Breynia oblongifolia</i>, <i>Leucopogon juniperinus</i>, <i>Daviesia ulicifolia</i> and <i>Jacksonia scoparia</i>. The ground cover typically comprises grasses and herbs. Occurs from Muswellbrook to the Lower Hunter in the Sydney Basin and North Coast bioregions. It has been recorded from the Maitland, Cessnock, Port Stephens, Muswellbrook and Singleton local government areas, but may occur elsewhere in these bioregions. Less than 500 ha or about 27% of the community remains.</p>	This community was not present in the study area. Although some flora species were present.



Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		CE	EEC	Littoral Rainforest is generally a closed forest, the structure and composition of which is strongly influenced by its proximity to the ocean. The plant species of this community are predominantly rainforest species. Several species have compound leaves, and vines may be a major component of the canopy. These features differentiate littoral rainforest from forest or scrub, but while the canopy is dominated by rainforest species, scattered emergent individuals of sclerophyll species, such as <i>Angophora costata</i> , <i>Banksia integrifolia</i> , <i>Eucalyptus botryoides</i> and <i>Eucalyptus tereticornis</i> occur in many stands. Littoral Rainforest occurs only on the coast and is found at locations in the NSW North Coast Bioregion, Sydney Basin Bioregion and South East Corner Bioregion. Littoral Rainforest is very rare and occurs in many small stands.	This community was not present in the study area.
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions		EEC		Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions is an ecological community of subtropical rainforest and some related, structurally complex forms of dry rainforest. Lowland Rainforest, in a relatively undisturbed state, has a closed canopy, characterised by a high diversity of trees whose leaves may be mesophyllous and encompass a wide variety of shapes and sizes. Typically, the trees form three major strata: emergents, canopy and sub-canopy which, combined with variations in crown shapes and sizes results in an irregular canopy appearance. The trees are taxonomically diverse at the genus and family levels, and some may have buttressed roots. The Hawkesbury River notionally marks the southern limit of Lowland Rainforest in the NSW North Coast and Sydney Basin bioregions.	This community was not present in the study area. The temperate rainforest identified on site is too disturbed to be classified as this EEC.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion			EEC	Lowland Rainforest on Floodplain is a rainforest community which now occurs only as small remnants in scattered localities on the NSW north coast, with less than 1,000ha in total thought to remain. Larger stands of the community typically have a dense canopy, which blocks most light from reaching the ground, creating cool, moist conditions within. Lowland Rainforest on Floodplain supports a rich diversity of plants and animals. Typical tree species in the community include figs (<i>Ficus macrophylla</i> , <i>F. obliqua</i> and <i>F. watkinsiana</i>), palms (<i>Archontophoenix cunninghamiana</i> and <i>Livistona australis</i>), Silky Oak (<i>Grevillea robusta</i>), Black Bean (<i>Castanospermum australe</i>) and Brush Cherry (<i>Syzygium australe</i>). The NSW north coast.	This community was not present in the study area. The rainforest identified on site is too disturbed and does not fit the species composition of this EEC.
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions			EEC	Montane Peatlands and Swamps comprise a dense, open or sparse layer of shrubs with soft-leaved sedges, grasses and forbs. It is the only type of wetland that may contain more than trace amounts of <i>Sphagnum</i> spp., the hummock peat-forming mosses. Small trees may be present as scattered emergents or absent. The Montane Peatlands and Swamps EEC is currently known from parts of the Local Government Areas of Armidale Dumaresq, Bega Valley, Bellingen, Blue Mountains, Bombala, Cooma-Monaro, Eurobodalla, Gloucester, Greater Argyle, Guyra, Hawkesbury, Lithgow, Oberon, Palerang, Severn, Shoalhaven, Snowy River, Tenterfield, Tumbarumba, Tumut, Upper Lachlan and Wingecarribee but may occur elsewhere in these bioregions.	This community was not present in the study area.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions			EEC	<p>As the name suggests, this EEC is found on the river flats of the coastal floodplains. It has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include <i>Eucalyptus tereticornis</i> (forest red gum), <i>E. amplifolia</i> (cabbage gum), <i>Angophora floribunda</i> (rough-barked apple) and <i>A. subvelutina</i> (broad-leaved apple). Known from parts of the Local Government Areas of Port Stephens, Maitland, Singleton, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Parramatta, Penrith, Blue Mountains, Fairfield, Holroyd, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Palerang, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions.</p>	Possible. This community may potentially occur in the study area.



Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
Themeda grassland on seaciffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions			EEC	<p><i>Themeda australis</i> is the dominant species in the Themeda Grassland on seaciffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregion ecological community. <i>Themeda australis</i> is an extremely widespread species, but in this community it may have a distinctive appearance, being prostrate and having glaucous leaves. These features are retained in cultivation and the form is believed to be genetically distinct. Scattered shrubs occur in many stands, most frequently <i>Pimelea linifolia</i>, <i>Banksia integrifolia</i> and <i>Westringia fruticosa</i>. Themeda Grassland on seaciffs and coastal headlands is found on a range of substrates in the NSW North Coast, Sydney Basin and South East Corner bioregions.</p>	This community was not present in the study area.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion			EEC	<p>This sub-tropical forest occurs on the coastal floodplains of the North Coast of NSW. It has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include <i>Eucalyptus tereticornis</i> (forest red gum), <i>E. siderophloia</i> (grey ironbark), <i>Corymbia intermedia</i> (pink bloodwood) and, north of the Macleay floodplain, <i>Lophostemon suaveolens</i> (swamp turpentine). Other trees may be scattered throughout at low abundance or locally common at few sites, particularly where there is an influence from lithic substrates upslope. These include <i>Eucalyptus moluccana</i> (grey box), <i>E. propinqua</i> (grey gum), <i>E. seeana</i> (narrow-leaved red gum), <i>Angophora subvelutina</i> (broad-leaved apple), <i>E. robusta</i> (swamp mahogany), <i>Eucalyptus resinifera</i> subsp. <i>hemilampra</i> (red mahogany), <i>E. acmenoides</i> (white mahogany), <i>Angophora woodsiana</i>, <i>A. paludosa</i> and rainforest trees such as <i>Ficus</i> spp. (figs) and <i>Cupaniopsis</i> spp. (tuckeroos). A layer of small trees may be present, including <i>Allocasuarina torulosa</i> (forest oak), <i>Alphitonia excelsa</i> (red ash), <i>Glochidion ferdinandi</i> (cheese tree), <i>Callistemon</i> spp., <i>Melaleuca</i> spp. and <i>Casuarina glauca</i> (swamp oak).</p> <p>Subtropical Coastal Floodplain Forest is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, but may occur elsewhere in this bioregion.</p>	<p>This community was not present in the study area. The rainforest identified on site is too disturbed and does not fit the species composition of this EEC.</p>

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		EEC	<p>This community is found on the coastal floodplains of NSW. It has a dense to sparse tree layer in which <i>Casuarina glauca</i> (swamp oak) is the dominant species northwards from Bermagui. Other trees including <i>Acmena smithii</i> (lilly pilly), <i>Glochidion</i> spp. (cheese trees) and <i>Melaleuca</i> spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Hawkesbury, Baulkham Hills, Hornsby Lane Cove, Blacktown, Auburn, Parramatta, Canada Bay, Rockdale, Kogarah, Sutherland, Penrith, Fairfield, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions.</p>	This community was not present in the study area.

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions			EEC	<p>This swamp community has an open to dense tree layer of eucalypts and paperbarks although some remnants now only have scattered trees as a result of partial clearing. The trees may exceed 25 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality where the tree stratum is low and dense. For example, stands dominated by <i>Melaleuca ericifolia</i> typically do not exceed 8 m in height. The community also includes some areas of fernland and tall reedland or sedgeland, where trees are very sparse or absent. The most widespread and abundant dominant trees include <i>Eucalyptus robusta</i> (swamp mahogany), <i>Melaleuca quinquenervia</i> (paperbark) and, south from Sydney, <i>Eucalyptus botryoides</i> (bangalay) and <i>Eucalyptus longifolia</i> (woollybut). This community is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, Lake Macquarie, Wyong, Gosford, Hornsby, Pittwater, Warringah, Manly, Liverpool, Rockdale, Botany Bay, Randwick, Sutherland, Wollongong, Shellharbour, Kiama and Shoalhaven but may occur elsewhere in these bioregions.</p>	This community was not present in the study area.



Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Distribution and Habitat	Likelihood of Occurrence
White Box Yellow Box Blakely's Red Gum Woodland	White Box Yellow Box Blakely's Red Gum Woodland	CE	EEC	White Box Yellow Box Blakely's Red Gum Woodland is found on relatively fertile soils on the tablelands and western slopes of NSW and generally occurs between the 400 and 800 mm isohyets extending from the western slopes, at an altitude of c. 170m to c. 1200 m, on the northern tablelands (Beadle 1981). The community occurs within the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands and NSW South Western Slopes Bioregions.	This community was not present in the study area.

Notes: All species distribution and habitat information was adapted from the Department of Environment and Climate Change web page - Threatened Species, Species Populations and Ecological Communities of NSW, URL: http://www.threatenedspecies.environment.nsw.gov.au/species/home_species.aspx, unless referenced otherwise.



Appendix B

Flora and Fauna Species Lists



Flora Species Recorded in the Study Area

Common Name	Scientific Name	Family	Survey
Ferns			
Common Maidenhair	<i>Adiantum aethiopicum</i>	Adiantaceae	CW, BIO, GHD
Rough Maidenhair	<i>Adiantum hispidulum</i> var. <i>hispidulum</i>	Adiantaceae	CW, BIO, GHD
Gristle Fern	<i>Blechnum cartilagineum</i>	Blechnaceae	CW, BIO, GHD
Prickly Rasp Fern	<i>Doodia aspera</i>	Blechnaceae	CW, BIO
Rough Treefern	<i>Cyathea australis</i>	Cyatheaceae	CW, BIO, GHD
Bracken	<i>Pteridium esculentum</i>	Dennstaedtiaceae	CW, BIO, GHD
Common Ground Fern	<i>Calochlaena dubia</i>	Dicksoniaceae	CW
Shiny Shield Fern	<i>Lastreopsis acuminata</i>	Dryopteridaceae	CW
Umbrella Fern	<i>Sticherus flabellatus</i> var. <i>flabellatus</i>	Gleicheniaceae	CW, GHD
Screw Fern	<i>Lindsaea linearis</i>	Lindsaeaceae	CW, GHD
Elkhorn	<i>Platynerium bifurcatum</i>	Polypodiaceae	CW, BIO, GHD
Rock Felt Fern	<i>Pyrrosia rupestris</i>	Polypodiaceae	CW
Jungle Brake	<i>Pteris umbrosa</i>	Pteridaceae	CW
Burrawang	<i>Lepidozamia peroffskyana</i>	Zamiaceae	CW, BIO, GHD
Monocotyledons			
Settler's Flax	<i>Gymnostachys anceps</i>	Araceae	CW, GHD
Bangalow Palm	<i>Archontophoenix cunninghamiana</i>	Arecaceae	CW, BIO, GHD
Walking-stick Palm	<i>Linospadix monostachya</i>	Arecaceae	CW, BIO, GHD
Narrow-leaved Palm Lily	<i>Cordyline stricta</i>	Asteliaceae	CW, BIO, GHD
Aneilema	<i>Aneilema acuminatum</i>	Commelinaceae	CW
Native Wandering Jew	<i>Commelina cyanea</i>	Commelinaceae	CW, BIO, GHD



*Wandering Jew	<i>Tradescantia albiflora</i>	Commelinaceae	GHD
Tall Sedge	<i>Carex appressa</i>	Cyperaceae	CW, GHD
Cyperus	<i>Cyperus filipes</i>	Cyperaceae	CW
Cyperus	<i>Cyperus spp.</i>	Cyperaceae	CW, BIO
Cyperus	<i>Cyperus tetraphyllus</i>	Cyperaceae	CW
Gahnia	<i>Gahnia aspera</i>	Cyperaceae	CW, GHD
Red-fruit Saw-sedge	<i>Gahnia sieberiana</i>	Cyperaceae	CW, GHD
Native Yam	<i>Dioscorea transversa</i>	Dioscoreaceae	CW, BIO, GHD
Juncus	<i>Juncus spp.</i>	Juncaceae	CW, BIO, GHD
Spiny-headed Mat-rush	<i>Lomandra longifolia</i>	Lomandraceae	CW, BIO, GHD
Wombat Berry	<i>Eustrephus latifolius</i>	Lomandraceae	CW, BIO, GHD
Scrambling Lily	<i>Geitonoplesium cymosum</i>	Lomandraceae	CW, BIO, GHD
Snake Orchid	<i>Cymbidium suave</i>	Orchidaceae	CW, BIO
Ironbark Orchid	<i>Dendrobium aemulum</i>	Orchidaceae	CW
Paroo Lily	<i>Dianella caerulea</i> var. <i>caerulea</i>	Phormiaceae	CW, BIO
*Whisky Grass	<i>Andropogon virginicus</i>	Poaceae	CW, BIO, GHD
*Broad-leaved Carpet Grass	<i>Axonopus compressus</i>	Poaceae	CW, BIO, GHD
Tufted Hedgehog Grass	<i>Echinopogon caespitosus</i> var. <i>caespitosus</i>	Poaceae	CW, BIO, GHD
Wiry Panic	<i>Entolasia stricta</i>	Poaceae	CW, BIO, GHD
*Panic Veldtgrass	<i>Erharta erecta</i>	Poaceae	BIO
Blady Grass	<i>Imperata cylindrica</i> var. <i>major</i>	Poaceae	CW, BIO, GHD
Blown Grass	<i>Lachnagrostis filiformis</i>	Poaceae	GHD
*Perennial Ryegrass	<i>Lolium perenne</i>	Poaceae	BIO, GHD
Oplismenus	<i>Oplismenus imbecillis</i>	Poaceae	CW, BIO, GHD
*Paspalum	<i>Paspalum dilatatum</i>	Poaceae	CW, BIO, GHD
*Kikuyu Grass	<i>Pennisetum clandestinum</i>	Poaceae	CW, BIO, GHD
Kangaroo Grass	<i>Themeda australis</i>	Poaceae	CW, BIO, GHD



Spreading Rope-Rush	<i>Empodisma minus</i>	Restionaceae	BIO, GHD
White Supplejack	<i>Ripogonum album</i>	Ripogonaceae	CW, GHD
Prickly Supplejack	<i>Ripogonum discolor</i>	Ripogonaceae	CW, GHD
Harry Supplejack	<i>Ripogonum elseyanum</i>	Ripogonaceae	CW
Small Supplejack	<i>Ripogonum fawcettianum</i>	Ripogonaceae	CW
Sarsaparilla	<i>Smilax australis</i>	Smilacaceae	CW, BIO, GHD
Sweet Sarsaparilla	<i>Smilax glycyphylla</i>	Smilacaceae	CW, BIO, GHD
Native Ginger	<i>Alpinia caerulea</i>	Zingiberaceae	CW, BIO, GHD
Dicotyledons			
Pastel Flower	<i>Pseuderanthemum variable</i>	Acanthaceae	CW, BIO
*American Pennywort	<i>Hydrocotyle bonariensis</i>	Apiaceae	CW, GHD
*Moth Vine	<i>Araujia sericifera</i>	Apocynaceae	GHD
Common Silkpod	<i>Parsonsia straminea</i>	Apocynaceae	BIO, GHD
Elderberry Panax	<i>Polyscias sambucifolia</i>	Araliaceae	CW, BIO, GHD
*Crofton Weed	<i>Ageratina adenophora</i>	Asteraceae	CW, GHD
*Mistflower	<i>Ageratina riparia</i>	Asteraceae	CW
*Cobbler's Pegs	<i>Bidens pilosa</i>	Asteraceae	CW, BIO, GHD
Cassinia	<i>Cassinia spp.</i>	Asteraceae	CW, BIO, GHD
*Spear Thistle	<i>Cirsium vulgare</i>	Asteraceae	CW, BIO, GHD
*Tall Fleabane	<i>Conyza albida</i>	Asteraceae	CW, BIO, GHD
Star Cudweed	<i>Euchiton involucratus</i>	Asteraceae	BIO, GHD
Native Musk	<i>Olearia argophylla</i>	Asteraceae	CW
Sticky Daisy Bush	<i>Olearia elliptica</i>	Asteraceae	CW
White Dogwood	<i>Ozothamnus diosmifolius</i>	Asteraceae	CW, BIO, GHD
*Stinking Roger	<i>Tagetes minuta</i>	Asteraceae	CW, GHD
*Dandelion	<i>Taraxacum officinale</i>	Asteraceae	BIO, GHD



Pandorea	<i>Pandorea pandorana</i> <i>ssp. pandorana</i>	Bignoniaceae	CW, BIO, GHD
Koda	<i>Ehretia acuminata</i> var. <i>acuminata</i>	Boraginaceae	CW
*Japanese Honeysuckle	<i>Lonicera japonica</i>	Caprifolaceae	GHD
Forest Starwort	<i>Stellaria flaccida</i>	Caryophyllaceae	CW
Black Sheoak	<i>Allocasuarina littoralis</i>	Casuarinaceae	CW, BIO, GHD
Forest Oak	<i>Allocasuarina torulosa</i>	Casuarinaceae	CW, BIO, GHD
River Oak	<i>Casuarina</i> <i>cunninghamiana</i> subsp. <i>cunninghamiana</i>	Casuarinaceae	GHD
Celastrus	<i>Celastrus subspicata</i>	Celastraceae	CW
Narrow-leaved Orangebark	<i>Maytenus silvestris</i>	Celastraceae	CW, GHD
Berry Saltbush	<i>Einadia hastata</i>	Chenopodiaceae	BIO
Kidney Weed	<i>Dichondra repens</i>	Convolvulaceae	CW, BIO
Black Wattle	<i>Callicoma serratifolia</i>	Cunoniaceae	CW, BIO, GHD
Coachwood	<i>Ceratopetalum</i> <i>apetalum</i>	Cunoniaceae	CW, BIO, GHD
Twining Guinea Flower	<i>Hibbertia dentata</i>	Dilleniaceae	CW, GHD
Climbing Guinea Flower	<i>Hibbertia scandens</i>	Dilleniaceae	CW, BIO, GHD
Blueberry Ash	<i>Elaeocarpus reticulatus</i>	Elaeocarpaceae	CW, BIO, GHD
Lance Beard-heath	<i>Leucopogon</i> <i>lanceolatus</i> var. <i>lanceolatus</i>	Epacridaceae	CW
Tree Heath	<i>Trochocarpa laurina</i>	Epacridaceae	CW, BIO, GHD
Featherwood	<i>Polyosma cunninghamii</i>	Escalloniaceae	CW
Brush Bloodwood	<i>Baloghia inophylla</i>	Euphorbiaceae	CW, BIO, GHD
Coffee Bush	<i>Breynia oblongifolia</i>	Euphorbiaceae	CW, BIO, GHD
Brittlewood	<i>Claoxylon australe</i>	Euphorbiaceae	CW
Cheese Tree	<i>Glochidion ferdinandi</i> var. <i>ferdinandi</i>	Euphorbiaceae	CW, BIO, GHD
Red Kamala	<i>Mallotus philippensis</i>	Euphorbiaceae	CW
Bolwarra	<i>Eupomatia laurina</i>	Eupomatiaceae	CW, BIO



Twining Glycine	<i>Glycine clandestina</i>	Fabaceae (Fabiodeae)	CW
False Sarsaparilla	<i>Hardenbergia violacea</i>	Fabaceae (Fabiodeae)	CW, BIO
Prickly Shaggy Pea	<i>Podolobium ilicifolium</i> (syn. <i>Oxylobium ilicifolium</i>)	Fabaceae (Fabiodeae)	CW, BIO
Pultenaea	<i>Pultenaea vilosa</i>	Fabaceae (Fabiodeae)	CW
*White Clover	<i>Trifolium repens</i>	Fabaceae (Fabiodeae)	BIO, GHD
Two-veined Hickory	<i>Acacia binervata</i>	Fabaceae (Mimosoideae)	CW, BIO, GHD
Green Wattle	<i>Acacia irrorata</i>	Fabaceae (Mimosoideae)	CW, BIO, GHD
Maiden's Wattle	<i>Acacia maidenii</i>	Fabaceae (Mimosoideae)	CW, BIO, GHD
Blackwood	<i>Acacia melanoxylon</i>	Fabaceae (Mimosoideae)	CW, BIO, GHD
Germander Raspswort	<i>Gonocarpus teucrioides</i>	Haloragaceae	CW
*Parrots Feather	<i>Myriophyllum aquaticum</i>	Haloragaceae	GHD
Cockspur Flower	<i>Plectranthus parviflorus</i>	Lamiaceae	CW, BIO
*Camphor Laurel	<i>Cinnamomum camphora</i>	Lauraceae	CW, BIO, GHD
Jackwood	<i>Cryptocarya glaucescens</i>	Lauraceae	CW, BIO, GHD
Forest maple	<i>Cryptocarya rigida</i>	Lauraceae	CW
Endiandra	<i>Endiandra muelleri</i> ssp. <i>muelleri</i>	Lauraceae	CW, BIO
Hard Corkwood	<i>Endiandra sieberi</i>	Lauraceae	CW, GHD
White Bolly Gum	<i>Neolitsea dealbata</i>	Lauraceae	CW, GHD
Toothed Lobelia	<i>Lobelia dentata</i>	Lobeliaceae	CW, GHD
Whiteroot	<i>Pratia purpurascens</i>	Lobeliaceae	CW, BIO, GHD
Native Rosella	<i>Hibiscus heterophyllus</i> ssp. <i>heterophyllus</i>	Malvaceae	CW, BIO, GHD



*Paddy's Lucerne	<i>Sida rhombifolia</i>	Malvaceae	CW, BIO, GHD
Synoum	<i>Synoum glandulosum</i> <i>ssp. glandulosum</i>	Meliaceae	CW, BIO
Snake Vine	<i>Stephania japonica</i> var. <i>discolor</i>	Menispermaceae	CW, BIO, GHD
Anchor Vine	<i>Palmeria scandens</i>	Monimiaceae	GHD
Veiny Wilkiea	<i>Wilkiea huegeliana</i>	Monimiaceae	CW, BIO, GHD
Creek Sandpaper Fig	<i>Ficus coronata</i>	Moraceae	CW, BIO, GHD
Strangling Fig	<i>Ficus watkinsiana</i>	Moraceae	GHD
Brush Muttonwood	<i>Rapanea howittiana</i>	Myrsinaceae	CW, GHD
Muttonwood	<i>Rapanea variabilis</i>	Myrsinaceae	CW
Lilly Pilly	<i>Acmena smithii</i>	Myrtaceae	CW, BIO, GHD
Rose Myrtle	<i>Archirhodomyrtus</i> <i>beckleri</i>	Myrtaceae	CW
Python Tree	<i>Austromyrtus bidwoudii</i>	Myrtaceae	CW
Grey Myrtle	<i>Backhousia myrtifolia</i>	Myrtaceae	CW, BIO, GHD
Pink Bloodwood	<i>Corymbia intermedia</i>	Myrtaceae	CW, BIO, GHD
White Mahogany	<i>Eucalyptus acmenoides</i>	Myrtaceae	CW, BIO, GHD
Thick-leaved Mahogany	<i>Eucalyptus carnea</i>	Myrtaceae	CW, BIO, GHD
Dunn's White Gum	<i>Eucalyptus dunnii</i>	Myrtaceae	CW, GHD
Flooded Gum	<i>Eucalyptus grandis</i>	Myrtaceae	CW, BIO, GHD
Tallowwood	<i>Eucalyptus microcorys</i>	Myrtaceae	CW, BIO, GHD
Blackbutt	<i>Eucalyptus pilularis</i>	Myrtaceae	BIO, GHD
Small-fruited Grey Gum	<i>Eucalyptus prostrata</i>	Myrtaceae	CW, BIO, GHD
Sydney Blue Gum	<i>Eucalyptus saligna</i>	Myrtaceae	CW, BIO, GHD
Grey Ironbark	<i>Eucalyptus siderophloia</i>	Myrtaceae	CW, BIO, GHD
Forest Red Gum	<i>Eucalyptus tereticornis</i>	Myrtaceae	CW, BIO, GHD
Leptospermum	<i>Leptospermum</i> <i>polygalifolium</i> ssp. <i>polygalifolium</i>	Myrtaceae	CW, BIO, GHD
Brush Box	<i>Lophostemon confertus</i>	Myrtaceae	CW, BIO, GHD
Scrub Turpentine	<i>Rhodamnia rubescens</i>	Myrtaceae	CW, BIO, GHD



Syncarpia	<i>Syncarpia glomulifera</i> <i>ssp. glomulifera</i>	Myrtaceae	CW, BIO, GHD
Water Gum	<i>Tristaniaopsis laurina</i>	Myrtaceae	GHD
Weeping Lilly Pilly	<i>Waterhousea floribunda</i>	Myrtaceae	GHD
*Small-Leaf Privet	<i>Ligustrum sinense</i>	Oleaceae	CW, BIO, GHD
*Large-Leaf Privet	<i>Ligustrum lucidum</i>	Oleaceae	GHD
Large Mock-olive	<i>Notelaea longifolia</i>	Oleaceae	CW, BIO, GHD
Veined Mock-olive	<i>Notelaea venosa</i>	Oleaceae	CW
*White Passionflower	<i>Passiflora subpeltata</i>	Passifloraceae	CW, BIO, GHD
*Inkweed	<i>Phytolacca octandra</i>	Phytolaccaceae	CW, GHD
Common Apply-berry	<i>Billardiera scandens</i> <i>var. scandens</i>	Pittosporaceae	CW, BIO
Orange Thorn	<i>Pittosporum multiflorum</i>	Pittosporaceae	CW, BIO, GHD
Water Pepper	<i>Persicaria hydropiper</i>	Polygonaceae	BIO
Crinkle Bush	<i>Lomatia silaifolia</i>	Proteaceae	CW
Persoonia	<i>Persoonia spp.</i>	Proteaceae	CW
Persoonia	<i>Persoonia media.</i>	Proteaceae	GHD
Yellow Ash	<i>Emmenosperma</i> <i>alphitonioides</i>	Rhamnaceae	CW
Privet Pomaderris	<i>Pomaderris ligustrina</i> <i>ssp. ligustrina</i>	Rhamnaceae	CW
Pomaderris	<i>Pomaderris spp.</i>	Rhamnaceae	BIO, GHD
Molucca Raspberry	<i>Rubus moluccanus</i>	Rosaceae	CW, BIO
Green-Leaved Bramble	<i>Rubus nebulosus</i>	Rosaceae	GHD
Native Raspberry	<i>Rubus parvifolius</i>	Rosaceae	BIO, GHD
Rubus	<i>Rubus spp.</i>	Rosaceae	CW
Coast Canthium	<i>Canthium coprosmoides</i>	Rubiaceae	CW
Morinda	<i>Morinda jasminoides</i>	Rubiaceae	GHD
Hairy Psychotria	<i>Psychotria loniceroides</i>	Rubiaceae	CW



Hairy-leaved Doughwood	<i>Melicope micrococca</i> (syn <i>Euodia micrococca</i>)	Rutaceae	CW, GHD
Big Yellow Wood	<i>Sarcomelicope simplicifolia</i> ssp. <i>simplicifolia</i>	Rutaceae	CW, GHD
Sandfly Zieria	<i>Zieria smithii</i>	Rutaceae	CW
*Weeping Willow	<i>Salix babylonica</i>	Salicaceae	GHD
Native Tamarind	<i>Diploglottis cunninghamii</i>	Sapindaceae	CW, GHD
Large-leaf Hop-bush	<i>Dodonaea triquetra</i>	Sapindaceae	CW, BIO, GHD
Green Tamarind	<i>Elatostachys nervosa</i>	Sapindaceae	CW, GHD
Guioa	<i>Guioa semiglauc</i>	Sapindaceae	CW, BIO, GHD
Parahebe	<i>Parahebe</i> sp.	Scrophulariaceae	CW
Veronica	<i>Veronica</i> Spp.	Scrophulariaceae	CW
Corkwood	<i>Duboisia myoporoides</i>	Solanaceae	CW, GHD
*Wild Tobacco Bush	<i>Solanum mauritianum</i>	Solanaceae	CW, BIO, GHD
*Blackberry Nightshade	<i>Solanum nigrum</i>	Solanaceae	BIO, GHD
Brush Kurrajong	<i>Commersonia fraseri</i>	Sterculiaceae	CW
Lasiopetalum	<i>Lasiopetalum parviflorum</i>	Sterculiaceae	CW
Seringia	<i>Seringia arborescens</i>	Sterculiaceae	BIO
Wikstroemia	<i>Wikstroemia indica</i>	Thymelaeaceae	CW, BIO
Native Peach	<i>Trema tomentosa</i> var. <i>viridis</i>	Ulmaceae	GHD
Clerodendrum	<i>Clerodendrum tomentosum</i>	Verbenaceae	CW
*Lantana	<i>Lantana camara</i>	Verbenaceae	CW, BIO, GHD
*Purpletop	<i>Verbena bonariensis</i>	Verbenaceae	BIO, GHD
Ivy-leaved Violet	<i>Viola hederacea</i>	Violaceae	CW, BIO
Five-Leaved Water Vine	<i>Cissus hypoglauca</i>	Vitaceae	GHD
Water Vine	<i>Cissus antarctica</i>	Vitaceae	GHD
Brush Pepperwood	<i>Tasmannia insipida</i>	Winteraceae	CW

Notes:

BIO – Biosis (2005), CW – Connell Wagner (1997), GHD – GHD (2008), * Denotes Introduced Weed Species



Fauna Species Recorded in the Study Area

Common Name	Scientific Name	Family	Survey
Amphibians			
Lesueur's Frog	<i>Litoria lesueuri</i>	Hylidae	CW
Common Eastern Froglet	<i>Crinia signifera</i>	Myobatrachidae	BIO, CW, GHD
Eastern Banjo Frog	<i>Limnodynastes dumerilii</i>	Myobatrachidae	BIO, CW
Great Barred Frog	<i>Mixophyes fasciolatus</i>	Myobatrachidae	CW
Red-Backed Toadlet	<i>Pseudophryne coriacea</i>	Myobatrachidae	CW
Striped Marsh Frog	<i>Limnodynastes peronii</i>	Myobatrachidae	GHD
Southern Barred Frog	<i>Mixophyes iteratus</i>	Myobatrachidae	F
Tusked Frog	<i>Adelotus brevis</i>	Myobatrachidae	CW, GHD
Reptiles			
Eastern Water Dragon	<i>Physignathus lesueuri</i>	Agamidae	BIO, GHD
Jacky Lizard	<i>Amphibolurus muricatus</i>	Agamidae	CW
Southern Angle-headed Dragon	<i>Hypsilurus spinipes</i>	Agamidae	CW
Diamond Python	<i>Morelia spilota spilota</i>	Boidae	CW, GHD
Macquarie Turtle	<i>Emydura macquarii</i>	Chelidae	GHD
Black-bellied Swamp Snake	<i>Hemiaspis signata</i>	Elapidae	CW
Eastern Brown Snake	<i>Pseudonaja textilis</i>	Elapidae	CW
Red-bellied Black Snake	<i>Pseudechis porphyriacus</i>	Elapidae	CW, GHD
Yellow-faced Whip Snake	<i>Demansia psammophis</i>	Elapidae	BIO/CW
	<i>Calyptotis ruficauda</i>	Scinidae	CW
Copper-tailed Skink	<i>Ctenotus taeniolatus</i>	Scinidae	CW
Eastern Blue-tongued	<i>Tilqua scincoids</i>	Scinidae	CW, GHD
Garden Skink	<i>Lampropholis guichenoti</i>	Scinidae	BIO, CW, GHD
Grass Skink	<i>Lampropholis delicata</i>	Scinidae	CW, GHD



Common Name	Scientific Name	Family	Survey
Lace Monitor	<i>Varanus varius</i>	Varanidae	BIO/CW, GHD
Native Birds			
Crested Pigeon	<i>Ocyphaps lophotes</i>		BIO, GHD
Black-shouldered Kite	<i>Elanus axillaris</i>	Accipitridae	BIO
Pacific Baza	<i>Aviceda subcristata</i>	Accipitridae	BIO
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>	Aegotheidae	CW
Azure Kingfisher	<i>Alcedo azurea</i>	Alcedinidae	BIO
Australian Wood Duck	<i>Chenonetta jubata</i>	Anatidae	CW, GHD
Pacific Black Duck	<i>Anas superciliosa</i>	Anatidae	BIO, CW, GHD
White-throated Needletail	<i>Hirundapus caudacutus</i>	Apodidae	BIO
Cattle Egret	<i>Ardea ibis</i>	Ardeidae	BIO, CW, GHD
Nankeen Night Heron	<i>Nycticorax caledonicus</i>	Ardeidae	BIO
White-faced Heron	<i>Egretta novaehollandiae</i>	Ardeidae	BIO, CW, GHD
Australian Magpie	<i>Gymnorhina tibicen</i>	Artamidae	BIO, CW, GHD
Grey Butcherbird	<i>Cracticus torquatus</i>	Artamidae	BIO, CW, GHD
Pied Butcherbird	<i>Cracticus nigrogularis</i>	Artamidae	BIO, CW, GHD
Pied Currawong	<i>Strepera graculina</i>	Artamidae	BIO, CW, GHD
Galah	<i>Cacatua roseicapilla</i>	Cacatuidae	CW, GHD
Sulphur-crested Cockatoo	<i>Cacutua galerita</i>	Cacatuidae	CW, GHD
Yellow-tailed Black Cockatoo	<i>Calyptorhynchus funereus</i>	Cacatuidae	CW, GHD
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	Campephagidae	BIO/CW/GHD
Cicadabird	<i>Coracina tenuirostris</i>	Campephagidae	BIO, CW
White-winged Triller	<i>Lalage sueurii</i>	Campephagidae	BIO



Common Name	Scientific Name	Family	Survey
Masked Lapwing	<i>Vanellus miles</i>	Charadriidae	CW, GHD
Eastern Whipbird	<i>Psophodes olivaceus</i>	Cinclosomatidae	BIO, CW, GHD
White-throated Treecreeper	<i>Cormobates leucophaeus</i>	Climacteridae	BIO, CW
Brown Cuckoo-dove	<i>Macropygia amboinensis</i>	Columbidae	BIO, CW, GHD
Peaceful Dove	<i>Geopelia striata</i>	Columbidae	BIO, CW, GHD
White-headed Pigeon	<i>Columba leucomela</i>	Columbidae	BIO, CW
Wompoo Fruit-dove	<i>Ptilinopus magnificus</i>	Columbidae	F
Dollarbird	<i>Eurystomus orientalis</i>	Coraciidae	BIO, CW, GHD
Australian Raven	<i>Corvus coronoides</i>	Corvidae	BIO, CW, GHD
Torresian Crow	<i>Corvus orru</i>	Corvidae	BIO, CW
Common Koel	<i>Eudynamys scolopacea</i>	Cuculidae	BIO, CW
Pallid Cuckoo	<i>Cuculus pallidus</i>	Cuculidae	BIO, CW
Shining Bronze-cuckoo	<i>Chrysococcyx lucidus</i>	Cuculidae	CW
Mistletoebird	<i>Dicaeum hirundinaceum</i>	Dicaeidae	CW
Black-faced Monarch	<i>Monarcha melanopsis</i>	Dicruridae	BIO, CW
Grey Fantail	<i>Rhipidura fuliginosa</i>	Dicruridae	BIO, CW, GHD
Magpie-lark	<i>Grallina cyanoleuca</i>	Dicruridae	BIO, CW, GHD
Rufous Fantail	<i>Rhipidura rufifrons</i>	Dicruridae	CW, GHD
Spangled Drongo	<i>Dicrurus bracteatus</i>	Dicruridae	BIO, CW
Spectacled Monarch	<i>Monarcha trivirgatus</i>	Dicruridae	CW
Willie Wagtail	<i>Rhipidura leucophrys</i>	Dicruridae	BIO, CW, GHD
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	Halcyonidae	BIO, GHD



Common Name	Scientific Name	Family	Survey
Sacred Kingfisher	<i>Todiramphus sanctus</i>	Halcyonidae	BIO , CW
Fairy Martin	<i>Hirundo ariel</i>	Hirundinidae	CW
Welcome Sembankmentow	<i>Hirundo neoxena</i>	Hirundinidae	CW, GHD
Superb Fairy-wren	<i>Malurus cyaneus</i>	Maluridae	BIO , CW, GHD
Variegated Fairy-wren	<i>Malurus lamberti</i>	Maluridae	CW
Australian Brush-turkey	<i>Alectura lathamii</i>	Megrapodiidae	CW, GHD
Bell Miner	<i>Manorina melanophrys</i>	Meliphagidae	CW
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>	Meliphagidae	BIO
Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	Meliphagidae	CW
Lewin's Honeyeater	<i>Meliphaga lewinii</i>	Meliphagidae	BIO , CW
Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>	Meliphagidae	CW
Yellow-faced Honeyeater	<i>Lichenostormus Chrysops</i>	Meliphagidae	BIO/CW
Superb Lyrebird	<i>Menura novae-hollandiae</i>	Menuridae	CW, GHD
Olive-backed Oriole	<i>Oriolus sagittatus</i>	Oriolidae	CW
Golden Whistler	<i>Pachycephala pectoralis</i>	Pachycephalidae	BIO , CW
Grey Shrike-thrush	<i>Colluricincla hamonica</i>	Pachycephalidae	BIO , CW
Rufous Whistler	<i>Pachycephala rufiventris</i>	Pachycephalidae	BIO , CW
Brown Gerygone	<i>Gerygone mouki</i>	Pardalotidae	BIO , CW
Brown Thornbill	<i>Acanthiza pusilla</i>	Pardalotidae	BIO , CW
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>	Pardalotidae	BIO , CW
Large-billed Scrubwren	<i>Sericornis magnirostris</i>	Pardalotidae	CW
Striated Thornbill	<i>Acanthiza lineata</i>	Pardalotidae	BIO , CW
White-browed Scrubwren	<i>Sericornis frontalis</i>	Pardalotidae	BIO
White-throated Gerygone	<i>Greygona olivacea</i>	Pardalotidae	BIO
Yellow-throated Scrubwren	<i>Sericornis citreogularis</i>	Pardalotidae	CW/BIO



Common Name	Scientific Name	Family	Survey
Red-browed Finch	<i>Neochmia temporalis</i>	Passeridae	BIO, CW, GHD
Eastern Yellow Robin	<i>Eopsaltria australis</i>	Petroicidae	BIO, CW, GHD
Pale-yellow Robin	<i>Tregellasia capito</i>	Petroicidae	CW
Rose Robin	<i>Petroica rosea</i>	Petroicidae	CW
King Quail	<i>Coturnix chinensis</i>	Phasianidae	BIO
Tawny Frogmouth	<i>Podargus stigidus</i>	Podargidae	CW
Australian King-parrot	<i>Alisterus scapularis</i>	Psittacidae	CW, GHD
Crimson Rosella	<i>Platycercus elegans</i>	Psittacidae	CW, GHD
Eastern Rosella	<i>Platycercus eximius</i>	Psittacidae	BIO, CW
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	Psittacidae	CW, GHD
Scaly-breasted Lorikeet	<i>Trichoglossus chlorolepidotus</i>	Psittacidae	CW
Green Catbird	<i>Ailuroedus crassirostris</i>	Ptilonorhynchidae	BIO, CW, GHD
Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>	Ptilonorhynchidae	BIO, CW, GHD
Barking Owl	<i>Ninox connexa</i>	Strigidae	GHD
Southern Boobook	<i>Ninox novaeseelandiae</i>	Strigidae	BIO
Masked Owl	<i>Tyto novaehollandiae</i>	Tytonidae	GHD
Sooty Owl	<i>Tyto tenebricosa</i>	Tytonidae	CW, GHD
Silvereye	<i>Zosterops lateralis</i>	Zosteropidae	BIO, CW
Introduced Birds			
Rock Dove	<i>Columba livia</i>	Columbidae	CW, GHD
House Sparrow	<i>Passer domesticus</i>	Passeridae	CW
Common Myna	<i>Acridotheres tristis</i>	Sturnidae	BIO, GHD
Common Starling	<i>Sturnus vulgaris</i>	Sturnidae	CW
Native Mammals			



Common Name	Scientific Name	Family	Survey
Brown Antechinus	<i>Antechinus stuartii</i>	Dasyuridae	CW
Eastern Grey Kangaroo	<i>Macropus giganteus</i>	Macropodidae	CW, GHD
White-striped Mastiff-bat	<i>Nyctinomus australis</i>	Molossidae	CW
Bush Rat	<i>Rattus fuscipes</i>	Muridae	CW
Fawn-footed Melomys	<i>Melomys cervinipes</i>	Muridae	CW
Long-nosed Bandicoot	<i>Perameles nasuta</i>	Peramelidae	CW
Sugar Glider	<i>Petaurus breviceps</i>	Petauridae	CW
Common Brushtail Possum	<i>Trichosurus vulpecular</i>	Phalangeridae	CW, GHD
Mountain Brushtail Possum	<i>Trichosurus caninus</i>	Phalangeridae	CW
Koala	<i>Phascolarctos cinereus</i>	Phascolarctidae	CW, GHD
Greater Glider	<i>Petauroides volans</i>	Pseudocheiridae	F
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	Pteropodidae	CW
Eastern Horseshoe-bat	<i>Rhinolophus megaphyllus</i>	Rhinolophidae	CW
Chocolate Wattled Bat	<i>Chalinolobus morio</i>	Vespertilionidae	CW
Golden-tipped Bat	<i>Kerivoula papuensis</i>	Vespertilionidae	CW, GHD
Common Bent-wing Bat	<i>Miniopterus schreibersii</i>	Vespertilionidae	CW, GHD
Eastern Broad-nosed Bat	<i>Scotorepens orion</i>	Vespertilionidae	CW, GHD
Eastern Forest Bat	<i>Vespadelus pumilus</i>	Vespertilionidae	CW, GHD
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	Vespertilionidae	CW, GHD
Gould's Long-eared Bat	<i>Nyctophilus gouldi</i>	Vespertilionidae	CW, GHD
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	Vespertilionidae	CW, GHD
Little Bent-wing Bat	<i>Miniopterus australis</i>	Vespertilionidae	CW, GHD
Little Forest Bat	<i>Vespadelus vulturnus</i>	Vespertilionidae	CW
Introduced Mammals			
Black Rat	<i>Rattus rattus</i>	Muridae	CW
Brown Hare	<i>Lepus capensis</i>	Leporidae	CW
Cat (feral)	<i>Felis catus</i>	Felidae	CW, GHD



Common Name	Scientific Name	Family	Survey
Cattle (domestic)	<i>Bos Taurus</i>	Bovidae	BIO, CW, GHD
Fox	<i>Vulpes vulpes</i>	Canidae	CW
Horse (domestic)	<i>Equus caballus</i>	Equidae	BIO, CW, GHD
House Mouse	<i>Mus musculus</i>	Muridae	CW
Rabbit	<i>Oryctolagus cuniculus</i>	Leporidae	CW
Fish			
Long-finned eel	<i>Anguilla reinhardtii</i>	Ambassidae	DPI, EL, BIO
Short-finned eel	<i>Anguilla reinhardtii</i>	Anguillidae	EL
Dwarf flat-headed gudgeon	<i>Philypnodon sp.</i>	Eleotridae	EL
Cox's gudgeon	<i>Gobiomorphus coxii</i>	Eleotridae	DPI, EL
Firetail gudgeon	<i>Hypseleotris gailii</i>	Eleotridae	DPI, EL
Flat-headed gudgeon	<i>Philypnodon grandiceps</i>	Eleotridae	DPI, EL, BIO
Striped gudgeon	<i>Gobiomorphus australis</i>	Eleotridae	DPI, EL, BIO
Empire gudgeon	<i>Hypseleotris compressa</i>	Eleotridae	DPI, EL, BIO, GHD
Gudgeon	<i>Hypseleotris sp.</i>	Eleotridae	DPI, EL
Oxeye herring	<i>Megalops cypringoides</i>	Megalopidae	GHD
Crimson-spotted Rainbowfish	<i>Philypnodon sp.</i>	Melanotaenia	DPI, EL, BIO
Freshwater mullet	<i>Myxus petardi</i>	Myxus	DPI, EL, GHD
Sea mullet	<i>Myxus cephalus</i>	Myxus	DPI, EL
Eel-tailed catfish	<i>Tandanus tandanus</i>	Plotosidae	GHD
Pacific blue-eye	<i>Pseudomugil signifer</i>	Pseudomugilidae	DPI, EL, BIO, GHD



Common Name	Scientific Name	Family	Survey
Australian smelt	<i>Retropinna semoni</i>	Retropinnidae	EL
Bullrout	<i>Noteesthes robusta</i>	Scorpaenidae	DPI, EL
Yellowfin bream	<i>Acanthopagrus australis</i>	Sparidae	GHD
Introduced Fish			
Gambusia	<i>Gambusia holbrooki</i>	Poeciliidae	DPI, EL, BIO, GHD

Notes:

BIO – Biosis (2005)
CW – Connell Wagner (1997)
DPI – Department of Primary Industries (2005)
EL – The Ecology Lab (1998)
GHD – GHD (2008)
F – Forests NSW



Appendix C

Assessment of Significance

EPBC Act

TSC Act



Assessment of Significance (EPBC Act)

There are nine EPBC listed species that are considered as potentially occurring in the locality in terms of potentially suitable habitat, of which four are listed as vulnerable, three as endangered and two are migratory. These species included:

Vulnerable

- ▶ Leafless Tongue Orchid (*Cryptostylis hunteriana*);
- ▶ Minute Orchid (*Taeniophyllum muelleri*);
- ▶ Southern Barred Frog (*Mixophyes balbus*); and
- ▶ Grey-headed Flying-fox (*Pteropus poliocephalus*).

Endangered

- ▶ Giant Barred Frog (*Mixophyes iteratus*);
- ▶ Spotted-tail Quoll (*Dasyurus maculatus*); and
- ▶ Tylophora (*Tylophora woollsii*).

Migratory

- ▶ Rufous Fantail (*Rhipidura rufifrons*); and
- ▶ Cattle Egret (*Ardea ibis*).

The Leafless Tongue Orchid and Minute Orchid are both listed as vulnerable species and due to their similarities as cryptic plant species they would be assessed together.

None of the other EPBC listed species identified in the table in Appendix A were considered likely to occur or be significantly affected by the Proposal for some or all of the following reasons:

- ▶ Potential habitat does not occur on or near the site;
- ▶ Potential habitat is not impacted at all or significantly;
- ▶ Minimal potential to occur on site due to:
 - Disturbance history;
 - Isolation from other suitable habitats; and
 - Insufficient extent of habitats in remnants.
- ▶ Habitat loss due to the Proposal represents a negligible contraction of a marginally suitable fraction of a larger potential range.

No aquatic flora or fauna species or endangered ecological communities listed under the EPBC Act were recorded in the study area and their likelihood of occurrence was considered unlikely. Therefore no assessments of significance were undertaken for such species.



Vulnerable Species

Leafless Tongue Orchid (*Cryptostylis hunteriana*)

This species is known historically from a number of localities on the NSW south coast. It is typically found in heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*). It appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*). Little is known about the ecology of the species. It is leafless and is expected to have limited photosynthetic capability and probably depends upon a fungal associate to meet its nutritional requirements from either living or dead organic material. In addition to reproducing from seed, it is also capable of vegetative reproduction and thus forms colonies, which can become more or less permanent at a site.

Minute Orchid (*Taeniophyllum muelleri*)

This species is epiphytic, favouring littoral rainforest, subtropical rainforest, wet sclerophyll forests and riparian (stream-side) areas. Flowering occurs during winter and spring (June to October).

Significant Impact Criteria

The guidelines to the assessment of significance define an action as likely to have significant impact on a vulnerable species if it would:

a) Lead to a long-term decrease in the size of an important population of a species;

These species were not recorded in the study area; this may be due to their cryptic nature. It has therefore been assessed that they may possibly occur in the study area. In this regard a population of these species is considered unlikely to exist and a long-term decrease of an important population is unlikely.

b) Reduce the area of occupancy of an important population;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. This vegetation may possibly provide suitable habitat for populations of these species.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the connectivity of the study area and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.



The proposed vegetation clearing would have a significant impact upon the potential establishment of these species in the inundation area. Although the proposed works are going to clear viable habitat, it is assessed that there would be no negative impact on the long-term persistence and recovery of this species, due to the proposed 150.86 ha protection area.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

c) Fragment an existing important population into two or more populations;

The proposed action is unlikely to fragment populations of these species because of the connectivity of the surrounding lands.

d) Adversely affect habitat critical to the survival of a species;

The habitat in the study is not considered critical habitat for the survival of either of these species.

e) Disrupt the breeding cycle of an important population;

It is only a possibility that these species may occur in the study area, in that an important population may not exist. Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of these species. This is primarily due to the proposed 122.58 ha protection area.

f) Modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The existing habitat is structurally modified in regards to the preferred habitats for these species. The removal of this habitat is unlikely to result in the decline of these species, because it is only a possibility that they are likely to occur. The proposed protection area may help both of these species populations to increase in the broader study area.

g) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

There already exists a high level of weed infestation within the inundation area because of past logging practices. However the proposed 122.58 ha protection area surrounding the inundation area would be conserved and no logging would occur in this area, thus limiting the potential of the weed infestation to increase as a result of logging practices.

h) Introduce disease that may cause the species to decline; or

The potential for the introduction of a disease is likely, however mitigation measures to disinfect vehicles accessing the study area should reduce the likelihood of a disease that may be detrimental to these species from occurring.

i) Interfere with the recovery of the species.

These Orchid species have not been recorded in the study area, although they may possibly occur. The proposed 122.58 ha protection area that is to be conserved into the future may help both of these species to establish and persist in the study area.

Conclusion



Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Leafless Tongue Orchid or the Minute Orchid and therefore referral of the Proposal to the Environment Minister is not required.

Southern Barred Frog (*Mixophyes balbus*)

This species is typically found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range (DECC, 2009). Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor (DECC, 2009). This species breeds in streams during summer after heavy rain (DECC, 2009).

The Southern Barred Frog was not detected in the study area during the present study, however it is likely to occur within the study area.

a) Lead to a long-term decrease in the size of an important population of a species;

The Southern Barred Frog was not recorded during the field surveys undertaken for this assessment; however potential habitat for a population of the Southern Barred Frog is present within gullies supporting rainforest and moist gully forest within the inundation area.

It is considered unlikely that a local population of Southern Barred Frog would be adversely affected such that its population would decrease. It is considered unlikely that the Proposal would adversely affect any of the currently known populations of the species, as no DECC Atlas of NSW Wildlife records are located within the inundation area or locations of other infrastructure.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

b) Reduce the area of occupancy of an important population;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. This vegetation may possibly provide suitable habitat for a population of this Southern Barred Frogs.

This species has not been previously recorded within the study area; therefore the presence of an important population is unlikely. Additionally the availability of suitable habitat to support an important population is minimal and degraded in comparison to more viable habitat in surrounding lands.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest



(7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

c) Fragment an existing important population into two or more populations;

The proposed action is unlikely to fragment populations of this species because of the connectivity of the surrounding lands. The Southern Barred Frog is mobile and would be able to relocate into adjacent habitat. The Proposal would not impede movement of the species and would not fragment an important population. The proposed 122.58 ha protection area would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

d) Adversely affect habitat critical to the survival of a species;

The habitat in the study area is not considered critical habitat for the survival of this species.

e) Disrupt the breeding cycle of an important population;

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the Southern Barred Frog and the proposed vegetation clearing would not have a significant impact upon the long-term survival of the species.

f) Modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The existing habitat is of low quality in regards to the preferred habitats for the Southern Barred Frog. The removal of this habitat is unlikely to result in the decline of this species. Additionally the extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

No new species that affect the lifecycle of the species would be introduced. Mitigation measures to reduce the impact of invasive flora and fauna have been included in this report.

h) Introduce disease that may cause the species to decline; or

No new disease that would affect the lifecycle of the species would be introduced.

i) Interfere with the recovery of the species.



The proposed activities would not affect the movement of the Southern Barred Frog and is unlikely to impact upon foraging and breeding resources as the proposed 122.58 ha protection area would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Southern Barred Frog and therefore referral of the Proposal to the Environment Minister is not required.

Grey-headed Flying-fox (*Pteropus poliocephalus*)

Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water and in vegetation with a dense canopy. Site fidelity to camps is high with some camps being used for over a century. These camps can be made up of many thousands of animals. The GHFF eats fruit from a range of native and introduced species, particularly figs, and for this reason it is sometimes called a 'Fruit Bat' (DECC, 2008).

Annual mating commences in January and a single young is born each year. The young are usually born in September-November (DECC, 2008).

Individual camps may have tens of thousands of animals and are used for mating, birth and the rearing of young. Although they appear in large groups, numbers of Grey-Headed Flying Foxes are declining because of habitat clearing (Australian Museum, 2008).

This species would travel up to 50 km to forage. They feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines. They also forage in cultivated gardens and fruit crops and can inflict severe crop damage. This species is sensitive to the loss of key roosting resources, particularly winter and summer flowering species (DECC, 2008).

The GHFF was not detected on the study area during the present study; however it was recorded in previous studies.

a) Lead to a long-term decrease in the size of an important population of a species;

The GHFF was not recorded during the field surveys undertaken for this assessment, however potential foraging habitat for the species is present within the study area and the local population may seasonally use the site in greater numbers whilst certain Eucalypt species are flowering. A breeding colony was identified on the outskirts of Bowraville and as such forms the local population of the species.

It is considered unlikely that this local population would be adversely affected such that its population would decrease. It is considered unlikely that the Proposal would adversely affect any of the currently known populations of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive



vegetation corridor comprised of state forest and nature reserves.

b) Reduce the area of occupancy of an important population;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. This vegetation may possibly provide suitable foraging habitat for a population of GHFFs.

This species has been previously recorded within the inundation area and a viable breeding population is present in the locality. Any impacts to this population are unlikely as the population is far removed from the impacted areas.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

c) Fragment an existing important population into two or more populations;

The proposed action is unlikely to fragment populations of this species because of the connectivity of the surrounding lands. This species is mobile and would be able to relocate into adjacent habitat. The Proposal would not impede movement of the species and would not fragment an important population. The proposed 122.58 ha protection area would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

d) Adversely affect habitat critical to the survival of a species;

The habitat in the study area is not considered critical habitat for the survival of this species.

e) Disrupt the breeding cycle of an important population;

Due to the large amount of alternative breeding and foraging habitat within the locality, the area to be affected by the proposed action is not considered an important resource for the GHFF and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

f) Modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The existing habitat is of low quality in regards to the preferred habitats for this species. The removal of this habitat is unlikely to result in the decline of this species. Additionally the extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.



Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

No new species that affect the lifecycle of the species would be introduced. Mitigation measures to reduce the impact of invasive flora and fauna have been included in this report.

h) Introduce disease that may cause the species to decline; or

No new disease that would affect the lifecycle of the species would be introduced.

i) Interfere with the recovery of the species.

The proposed activities would not affect the movement of the GHFF and is unlikely to impact upon breeding and foraging resources as the proposed 122.58 ha protection area would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Grey-headed Flying-fox and therefore referral of the Proposal to the Environment Minister is not required.

Endangered

Giant Barred Frog (Mixophyes iteratus)

Giant Barred Frog is distributed along the coast and ranges from southeastern Queensland to the Hawkesbury River in NSW (DECC, 2009). Northeastern NSW, particularly the Coffs Harbour-Dorrigo area, is now a stronghold (DECC, 2009). The species forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m (DECC, 2009). They breed around shallow, flowing rocky streams from late spring to summer (DECC, 2009).

The Giant Barred Frog was not detected on the study area during the present study; however it is likely to occur within the study area.

a) Lead to a long-term decrease in the size of a population;

The Giant Barred Frog was not recorded during the field surveys undertaken for this assessment; however potential habitat for the species is present within gullies supporting rainforest and moist gully forest within the inundation area, as is evident in this species having been previously recorded in the study area. It is within these vegetation communities that



populations of the species may be distributed.

It is considered unlikely that a local population of Giant Barred Frog would be adversely affected such that its population would decrease. It is considered unlikely that the Proposal would adversely affect any of the currently known populations of the species, as no DECC Atlas of NSW Wildlife records are located within the inundation area or locations of other infrastructure.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

b) Reduce the area of occupancy of an important population;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. This vegetation may possibly provide suitable habitat for a population of this species.

This species has not been previously recorded within the study area; therefore the presence of an important population is unlikely. Additionally the availability of suitable habitat to support an important population is minimal and is structurally modified in comparison to more viable habitat in surrounding lands.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

c) Fragment an existing important population into two or more populations;

The proposed action is unlikely to fragment populations of this species because of the connectivity of the surrounding lands. This species is mobile and would be able to relocate into adjacent habitat. The Proposal would not impede movement of the species and would not fragment an important population. The proposed 122.58 ha protection area would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

d) Adversely affect habitat critical to the survival of a species;

The habitat in the study area is not considered critical habitat for the survival of this species.

e) Disrupt the breeding cycle of an important population;

The existence of alternative foraging and breeding resources within the wider study area and the poor habitat status of the study area means it is unlikely that the proposed action would have an adverse effect on the breeding cycle of the species. Due to the large amount of alternative breeding and foraging habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the Giant Barred Frog and the



proposed vegetation clearing would not have a significant impact upon the long-term survival of the species.

f) Modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The existing habitat is of low quality in regards to the preferred habitats for the Giant Barred Frog. The removal of this habitat is unlikely to result in the decline of this species. Additionally the extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;

No new species that affect the lifecycle of the species would be introduced. Mitigation measures to reduce the impact of invasive flora and fauna have been included in this report.

h) Introduce disease that may cause the species to decline; or

No new disease that would affect the lifecycle of the species would be introduced.

i) Interfere with the recovery of the species.

The proposed activities would not affect the movement of the Giant Barred Frog and is unlikely to impact upon foraging and breeding resources as the proposed 122.58 ha protection area would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Giant Barred Frog and therefore referral of the Proposal to the Environment Minister is not required.

Spotted-tail Quoll (*Dasyurus maculatus*)

The Spotted-tail Quoll is the largest and most arboreal of the quolls. It inhabits a variety of habitats including wet and dry sclerophyll forest, rainforest, vine thicket, woodland and coastal scrub and is known to deposit its scats on prominent high points in the landscape. This species



is solitary and typically occupies a home range of thousands of hectares. They normally travel several kilometres a night while foraging. The subject area provides foraging habitat, but little in the form of shelter due to the lack of large debris and tree hollows.

No Spotted-tail Quolls were recorded in the study area however they are likely to occur.

a) Lead to a long-term decrease in the size of a population;

The Spotted-tail Quoll was not recorded during the field surveys undertaken for this assessment; however potential foraging habitat for the species is present in the study area, as is evident in this species having been previously recorded within a 10 km radius of the study area.

It is considered unlikely that a local population of Spotted-tail Quoll would be adversely affected such that its population would decrease. It is considered unlikely that the Proposal would adversely affect any of the currently known populations of the species, as no DECC Atlas of NSW Wildlife records are located within the inundation area or locations of other infrastructure.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

b) Reduce the area of occupancy of an important population;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. This vegetation may possibly provide suitable habitat for a population of this species.

The Spotted-tail Quoll has not been previously recorded within the inundation area; therefore the presence of an important population is unlikely. Additionally the availability of suitable breeding habitat in the form of large debris and tree hollows to support an important population is minimal in comparison to more viable breeding habitat in surrounding lands.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

c) Fragment an existing important population into two or more populations;

The proposed action is unlikely to fragment populations of this species because of the connectivity of the surrounding lands. This species is mobile and would be able to relocate into adjacent habitat. The Proposal would not impede movement of the species and would not fragment an important population. The proposed 122.58 ha protection area would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

d) Adversely affect habitat critical to the survival of a species;



The habitat in the study area is not considered critical habitat for the survival of this species.

e) Disrupt the breeding cycle of an important population;

The existence of alternative feeding and breeding resources within the wider study area and the low habitat values of the study area mean it is unlikely that the proposed action would have an adverse effect on the breeding cycle of the species.

f) Modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The existing habitat is of low quality in regards to the preferred habitats for this species. The removal of this habitat is unlikely to result in the decline of the species. Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;

No new species that affect the lifecycle of the species would be introduced. Mitigation measures to reduce the impact of invasive flora and fauna have been included in this report.

h) Introduce disease that may cause the species to decline; or

No new disease that would affect the lifecycle of the species would be introduced.

i) Interfere with the recovery of the species.

The proposed activities would not affect the movement of the Spotted-tail Quoll and is unlikely to impact upon foraging and breeding resources as the proposed 122.58 ha protection area would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Spotted-tail Quoll and therefore referral of the Proposal to the Environment Minister is not required.

Tylophora (Tylophora woolfsii)

The Cryptic Forest Twiner is found from the NSW north coast and New England Tablelands to southern Queensland, but is very rare within that range. It is known on the Tablelands from the Bald Rock and Boonoo Boonoo areas north of Tenterfield. This species grows in moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins. Flowering occurs in summer and



autumn, usually between January and March but sometimes as late as November.

a) Lead to a long-term decrease in the size of a population;

This species was not recorded in the study area, however this may be due to its cryptic nature. It has therefore been assessed that it may possibly occur in the study area. In this regard a population of the species is considered unlikely to exist and a long-term decrease of an important population is unlikely.

b) Reduce the area of occupancy of an important population;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. This vegetation may possibly provide suitable habitat for a population of *Tylophora*.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The proposed vegetation clearing would have a significant impact upon the potential establishment of this species in the inundation area. Although the proposed works are going to clear viable habitat, it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area.

c) Fragment an existing important population into two or more populations;

The proposed action is unlikely to fragment populations of this species because of the connectivity of the surrounding lands. Additionally it is only a possibility that this species may occur in the study area.

d) Adversely affect habitat critical to the survival of a species;

The habitat in the study area is not considered critical habitat for the survival of this species.

e) Disrupt the breeding cycle of an important population;

It is only a possibility that this species may occur in the study area, in that an important population may not exist. Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area.

f) Modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The existing habitat is of low quality in regards to the preferred habitats for this species. The removal of this habitat is unlikely to result in the decline of this species, because it is only a possibility that they are likely to occur. The proposed protection area may help this species population to establish and persist in the broader study area.



g) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;

The possibility of invasive weed infestation is high, however mitigation measures to control and prevent weed infestation should improve the habitat for Tylophora after the proposed actions have taken place.

h) Introduce disease that may cause the species to decline; or

The potential for the introduction of a disease is likely, however mitigation measures to disinfect vehicles accessing the study area should reduce the likelihood of a disease that may be detrimental to this species from occurring.

i) Interfere with the recovery of the species.

Tylophora has not been recorded in the study area, although it may possibly occur. The proposed 122.58 ha protection area that is to be conserved into the future may help this species to persist and establish in the broader study area.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on Tylophora and therefore referral of the Proposal to the Environment Minister is not required.

Migratory

Two migratory species, Rufous Fantail and Cattle Egret were recorded in the study area and may regularly utilise the site as vagrants and as such would be assessed together.

Rufous Fantail (*Rhipidura rufifrons*)

The Rufous Fantail is found in northern and eastern coastal Australia. It is typically found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats or urban areas.

Cattle Egret (*Ardea ibis*)

This species is most widespread in south-eastern Australia from Bundaberg, Queensland to Port Augusta, South Australia. The Cattle Egret is found in grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Will also forage at garbage dumps, and is often seen with cattle and other stock (Morcombe, 2003).

The EPBC Assessment guidelines define an action as likely to have a significant impact on a migratory species, if it would:

a) Substantially modify (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat



of the migratory species.

An important habitat is considered:

- ▶ Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or;
- ▶ Habitat that is of critical importance to the species at particular life-cycle stages, or;
- ▶ Habitat utilised by a migratory species which is at the limit of the species range, or;
- ▶ Habitat within an area where the species is declining.

The site is not considered likely to constitute an *important area of habitat* on the basis of the following:

The site is not known breeding habitat for both of the above mentioned species and constitutes only a very small area of more extensive vegetation communities of greater habitat value on adjoining lands and in the broader locality. The site is not considered capable of supporting an ecologically significant population of either of these species (at most, only a small group or transient individuals).

While some migratory species occurring in the locality may be at the limits of their range, no such species were recorded in the study area. Additionally, similar habitat is known to occur in all directions from the study area.

b) Will the activity result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or

The proposed activities would not result in an invasive species that is harmful to a migratory species becoming established in an area of important habitat.

c) Will the activity seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species

No disruption on the lifecycle of any migratory bird is likely, as the site did not contain suitable potential breeding habitat for the two migratory species recorded. The loss of 79.71 ha of potential foraging habitat associated with the structurally modified proposed inundation area and related infrastructure is considered, amidst the large reserve system with in the region, is unlikely to significantly affect the foraging success of these migratory species.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on migratory species and therefore referral of the Proposal to the Environment Minister is not required.

Assessment of Significance (TSC Act)



Threatened species listed under the TSC Act recorded in the study area include:

- ▶ Barking Owl (*Ninox connivens*);
- ▶ Masked Owl (*Tyto novaehollandiae*);
- ▶ Sooty Owl (*Tyto tenebricosa*);
- ▶ Powerful Owl (*Ninox strenua*);
- ▶ Glossy Black Cockatoo (*Calyptorhynchus lathamii*);
- ▶ Wompoo Fruit-dove (*Ptilinopus magnificus*);
- ▶ Koala (*Phascolarctos cinereus*);
- ▶ Golden-tipped bat (*Kerivoula papuensis*);
- ▶ Little Bentwing-bat (*Miniopterus australis*); and
- ▶ Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*).

A further six threatened species (Spotted-tail Quoll, Grey-headed Flying-fox, Southern Barred Frog, Giant Barred Frog, Rusty Plum and Tylophora) are likely to occur based on the results of previous studies, known species ranges and habitat associations and habitat present in the study area.

No aquatic flora or fauna species listed under the TSC Act were recorded in the study area and their likelihood of occurrence was considered unlikely. Therefore no assessments of significance were undertaken for such species.

One EEC River-flat Eucalypt Forest on Coastal Floodplains has also undergone an assessment of significance because some of the riparian vegetation along Nambucca River and South Creek contains some elements that possibly resemble this EEC. Further detail is provided in a preamble for this EEC's AoS.

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek.



Threatened Species Recorded in the Study Area

Koala (*Phascolarctos cinereus*)

The Koala is the largest of Australia's arboreal mammals. Its home range size varies with quality of habitat, ranging from less than two hectares to several hundred hectares in size. Koalas typically inhabit eucalypt woodlands and forests where they feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area would select preferred browse species. They are generally inactive for most of the day, feeding and moving mostly at night. Koalas spend most of their time in trees, but would descend and traverse open ground to move between trees. This species is generally solitary, but has complex social hierarchies based on a dominant male with a territory overlapping several females and subordinate males on the periphery. Females breed at two years of age and produce one young per year (DECC, 2008).

One male Koala was recorded in the upper centre of the inundation area in close proximity to the camp site during a nocturnal survey.

- a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;***

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Koala due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

The study area contains two Koala feed trees listed under Schedule 2 of SEPP 44 site is not considered to constitute core Koala habitat due the level of past disturbances and weed infestation and therefore may not support a large population of Koalas. No evidence of Koala activity (scats and scratches) was noted during the site inspection, but one male Koala was heard during a nocturnal survey in the proposed inundation area. Due to their complex social hierarchy, territorial behaviour and the structurally modified condition of the site, the sole male Koala recorded may have a large home range that extends beyond the inundation area, therefore a low population density is probable, although it is more than likely a breeding population that is present.

The study area is considered to be a smaller component of the overall habitat used by this species as they often have large home ranges. This species would utilise the study area as a foraging resource, although the continuous vegetation communities in the surrounding study area are considered to be of greater foraging and breeding importance to this species as indicated by database search results (see Figure 5).



It is proposed that the vegetation immediately surrounding the inundation area occupying 122.58 ha would be acquired by NSC from Forests NSW as a protection area to the proposal. The protection area would be made into a conservation area for the long-term. Subsequently the koalas inhabiting this area would be protected from logging and any future development.

The Koala is mobile and would be minimally affected by the loss of vegetation due to the proposed off-river storage and related infrastructure. Additionally the Koala would be able to disperse into adjacent lands due good connectivity and that the off-river storage would not create a barrier to this movement.

The Proposal is likely to remove existing foraging habitat for a local Koala population, however due to structural modification resulting from past logging practices this habitat is less favourable than habitats in adjacent lands. It is therefore considered that the Proposal is unlikely to significantly affect breeding and foraging success, or dispersal of local Koalas.

It is therefore unlikely that the proposed action would have an adverse effect on the life cycle of the Koala such that a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There is no endangered population currently listed on the TSC Act within the study area.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to threatened species.

d) In relation to the habitat of a threatened species, population or ecological community:

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed comprises structurally modified vegetation due to past logging practices, monoculture plantings and weed infestation. There are two species of SEPP 44 listed



Koala feed trees located within the proposed inundation area along with other less significant feed trees, the Koala may utilise these trees opportunistically as a foraging resource. These existing feed trees are to be removed as part of the proposed action. The proposed 122.58 ha of protection area that is to be conserved would provide a long-term habitat resource for the Koala.

The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected because of the proposed protection area. The proposed off-river storage would not impose a barrier to movement for the Koala into adjacent lands. Higher than normal vehicle activity would be expected but not for the long-term, hence the threat of car strike in the local area would not be significantly increased as a result of the proposed activities.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be affected by the proposed action is not considered an important resource for the Koala and the proposed vegetation clearing would not have a significant impact upon the long-term survival of the species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

There is no critical habitat listed for this species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

There is a recovery plan for the Koala (NSW National Parks and Wildlife Service, 2003), which outlines specific objectives to help conserve the Koala and its habitat. Ten current threats to Koalas are identified. Habitat loss and fragmentation are considered to be the most important threats to this species in NSW. Although the proposed works are not consistent with the objectives of the recovery plan it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and has lower habitat values due to past disturbances and weed infestation resulting in structural modification. The area would not be fragmented due to the proposed works. Any areas to be revegetated would be planted with native tree species, including Koala food trees to avoid or reduce adverse impacts on the Koala.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation



that contains Koala feed trees. However the proposed protection area area of 122.58 ha aims to conserve the surrounding vegetation that does contain viable foraging and breeding habitat for the Koala and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Koala and therefore a Species Impact Statement is not required for this species.

Barking Owl (Ninox connivens)

Barking Owl is found throughout Australia except for the central arid regions and Tasmania (DECC 2008). The species inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses (DECC 2008). Denser vegetation is used occasionally for roosting (DECC 2008). Territories range from 30 to 200 hectares and birds are present all year (DECC 2008). During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as *Acacia* and *Casuarina* species, or the dense clumps of canopy leaves in large Eucalypts (DECC 2008). Breeding occurs during late winter and early spring, with eggs laid in nests in hollows of large, old eucalypts including River Red Gum (*Eucalyptus camaldulensis*), White Box (*Eucalyptus albens*), Red Box (*Eucalyptus polyanthemus*) and Blakely's Red Gum (*Eucalyptus blakelyi*) (DECC 2008).

One Barking Owl was heard calling and recorded after a call playback survey beyond the northern extent of the study area.

a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Barking Owl due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

This species preferred nesting trees were not identified as occurring within the inundation area but were identified along the access roads to be upgraded, however no hollows were identified as being large enough for the species to nest in. Therefore it is unlikely that a local population of the species nests or breeds within the study area.

However it may occasionally utilise the study area as a foraging resource, as some limited foraging resources are available, although the continuous vegetation communities in the surrounding study area are likely to be of greater foraging and breeding importance to this



species due to the presence of non-plantation forests that provide suitable mature hollow bearing trees. The Barking Owl is highly mobile and would be minimally affected by the loss of vegetation due to the proposed off-river storage and related infrastructure.

The Proposal is not considered likely to reduce the local Barking Owl population due to the low quality roosting and nesting habitat found in the inundation area and the availability of more favourable adjacent habitats, however suitable foraging habitat is present. Additionally the Barking Owl was recorded beyond the northern extent of the study area in the Viewmont State Forest. It is therefore considered that the Proposal is unlikely to significantly affect breeding and foraging success, or dispersal of local Barking Owls.

The existence of alternative foraging and breeding resources within the wider study area and the poor habitat status of the study area mean it is unlikely that the proposed action would have an adverse effect on the life cycle of the Barking Owl such that a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There is no endangered population currently listed on the TSC Act within the study area.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

d) In relation to the habitat of a threatened species, population or ecological community:

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation. Hollow bearing trees were identified along the proposed access roads that are to be upgraded, the majority of which do not have hollows sufficiently large enough to be utilised by the Barking Owl.

The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed. Additional vehicle activity



along the proposed access roads would be expected, but not for the long-term, hence the threat of car strike in the local area would not be significantly increased as a result of the proposed activities.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be affected by the proposed action is not considered an important resource for the Barking Owl and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

There is no critical habitat listed for this species on the register of critical habitat.

f) *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;*

There is a recovery plan for the Barking Owl (NSW National Parks and Wildlife Service, 2003), which outlines specific objectives to help conserve the Barking Owl and its habitat. Four current threats to Barking Owls are identified. Inappropriate forest harvesting practices that change forest structure and the removal of old growth hollow-bearing trees is the primary threat posed by the proposed action.

The potential removal of hollow bearing trees along the proposed access roads to be upgraded poses a minimal threat to the species, because the trees identified would not, at present, have hollows suitably large enough for Barking Owls to inhabit, although these trees may potentially provide suitably sized hollows in the future. This species was not identified within the study area because its preferred nesting habitat may not be present, but use of the site as a foraging resource is likely.

The expanse of adjacent lands, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7 200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The retention of woodland and open forest remnants, especially those containing hollow-bearing trees is one of the key strategies to recover the species. Although the proposed works are not consistent with this objective of the recovery plan it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

g) *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most



relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential future nesting sites in hollow bearing trees. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Barking Owl and therefore a Species Impact Statement is not required for this species.

Masked Owl (Tyto novaehollandiae)

Masked Owl occurs from the coast (where it is most abundant), to the western plains (DECC 2008). Overall records for this species fall within approximately 90% of NSW, excluding the most arid northwestern corner (DECC 2008). The species lives in dry eucalypt forests and woodlands from sea level to 1100 m, but often hunts along the edges of forests, including roadsides (DECC 2008). Pairs have a large home-range of 500 to 1000 hectares, and the species roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting (DECC 2008).

Two Masked Owls were visually recorded during a call playback survey beyond the northern extent of the study area. This is indicative of a viable population, however no additional records of this species within a 10 km radius of the study area.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Masked Owl due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

The inundation area has no stags, hollow bearing trees or caves that would provide potential nesting sites for a local population. Some stags and hollow bearing trees were identified along the proposed access roads that are to be upgraded, the majority of which, at present, would not have hollows sufficiently large enough to be utilised as roosting or nesting sites.

However it may occasionally utilise the study area as a foraging resource, as some limited foraging resources are available, although the continuous vegetation communities in the surrounding study area are considered to be of greater foraging and breeding importance to the species, because of a greater abundance of hollow bearing trees and foraging resources. The



Masked Owl is highly mobile and would be minimally affected by the loss of vegetation due to the proposed off-river storage dam and related infrastructure.

The Masked Owl is known to forage along access roads and the potential for increased road mortality during the construction phase is likely, particularly when trucking out cleared timber from the inundation area, albeit only a temporary activity.

The Proposal is not considered to reduce the local Masked Owl population due to the relatively low quality of the habitat found in the inundation area and the availability of more favourable adjacent habitats. Additionally the Masked Owl was recorded beyond the northern extent of the study area in the Viewmont State Forest. It is therefore considered that the Proposal is unlikely to significantly affect breeding and foraging success or dispersal of a local population of Masked Owls and as such a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There is no endangered population currently listed on the TSC Act within the study area.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

d) In relation to the habitat of a threatened species, population or ecological community:

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation. Hollow bearing trees were identified along the proposed access roads that are to be upgraded, the majority of which, at present, do not have hollows sufficiently large enough to be utilised by the Masked Owl.

The effectiveness of the study area as a movement corridor and habitat resource would not be



negatively affected due to its level of connectivity to large tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed. Additional vehicle activity along the proposed access roads would be expected, but not for the long-term, hence the threat of car strike in the local area would not be significantly increased as a result of the proposed activities.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the Masked Owl and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

There is no critical habitat listed for this species on the register of critical habitat.

f) *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;*

There is a recovery plan for the Masked Owl (DECC, 2006), which outlines specific objectives to help conserve the Masked Owl and its habitat. Five current threats to Masked Owls are identified. The two most relevant ones to this action are the loss of mature hollow-bearing trees and changes to forest and woodland structure, which leads to fewer such trees in the future and the clearing of habitat for grazing, agriculture, forestry or other development.

The potential removal of hollow bearing trees along the proposed access roads to be upgraded poses a minimal threat to the species, because the trees identified would not have hollows suitably large enough for Masked Owls to inhabit, although these trees may potentially provide suitably sized hollows in the future. The species was not identified within the study area because its preferred nesting habitat may not be present, but use of the site as a foraging resource is likely.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The retention of hollow bearing trees as well as large, mature trees that would provide hollows in the future is one of the key strategies to recover the species. Although the proposed works are not consistent with this objective of the recovery plan because of the removal of hollow bearing trees it is assessed that there would be no negative impact on the long-term persistence and recovery of the species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.



g) *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

There are currently 31 key threatening processes (KTP's) listed under the TSC Act. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential nesting sites in hollow bearing trees. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees as well as more suitable foraging habitat. In effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Masked Owl and therefore a Species Impact Statement is not required for this species.

Sooty Owl (Tyto tenebricosa)

The Sooty Owl occurs in the easternmost one-eighth of NSW, on the coast, coastal escarpment and eastern tablelands (DECC, 2008). The species occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests (DECC, 2008). The species roosts by day in the hollow of a tall forest tree or in heavy vegetation and hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum (*Pseudocheirus peregrinus*) or Sugar Glider (*Petaurus breviceps*) (DECC, 2008). Sooty Owls nest in very large tree-hollows (DECC, 2008).

The Sooty Owl was heard and recorded during a nocturnal survey within the inundation area, which is consistent with this species being recorded in the same general location by Connell Wagner in 1996.

a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Sooty Owl due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

The inundation area has no stags or hollow bearing trees that would provide potential nesting



sites for a population of this species, however some stags and hollow bearing trees were identified along the proposed access roads that are to be upgraded, the majority of which would not have hollows sufficiently large enough to be utilised as roosting or nesting sites.

The Sooty Owl does utilise the study area as a foraging resource, because it was recorded in the inundation area. However the extensive vegetation communities in the surrounding study area are considered to be of greater foraging, nesting and breeding importance to a population of this species. The Sooty Owl is highly mobile and would be minimally affected by the loss of vegetation due to the proposed off-river storage and related infrastructure and would be able to relocate into the adjacent lands.

The Proposal is not considered to reduce the local Sooty Owl population due to the low quality of the habitat found in the inundation area and the availability of more favourable adjacent habitats. It is unlikely to roost in the hollow bearing trees recorded along the proposed access roads that are elevated above the inundation area, because the trees identified would not have hollows suitably large enough for it to inhabit. Therefore the Sooty Owl recorded onsite may be roosting in hollow bearing trees located in the elevated parts of the study area. It is therefore considered that the Proposal is unlikely to significantly affect breeding and foraging success, or dispersal of a local population of Sooty Owls.

The existence of alternative foraging and breeding resources within the wider study area and the relatively poor habitat value of the study area mean it is unlikely that the proposed action would have an adverse effect on the life cycle of the Sooty Owl such that a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There is no endangered population currently listed on the TSC Act within the study area.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

d) In relation to the habitat of a threatened species, population or ecological community:

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***



- ***the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation. Hollow bearing trees were identified along the proposed access roads that are to be upgraded, the majority of which do not have hollows sufficiently large enough to be utilised by the Sooty Owl.

The Sooty Owl was recorded in the study area although the effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed. Additional vehicle activity along the proposed access roads would be expected, but not for the long-term, hence the threat of car strike in the local area would not be significantly increased as a result of the proposed activities.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be affected by the proposed action is not considered an important resource for the Sooty Owl and the proposed vegetation clearing would not have a significant impact upon the long-term survival of the species.

- e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);***

There is no critical habitat listed for this species on the register of critical habitat.

- f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;***

There is a recovery plan for the Sooty Owl (DECC, 2006), which outlines specific objectives to help conserve the Sooty Owl and its habitat. Four current threats to Sooty Owls are identified. The two most relevant ones to this action are the loss of mature hollow-bearing trees and changes to forest and woodland structure, which leads to fewer such trees in the future and the clearing of habitat for grazing, agriculture, forestry or other development. The potential removal of hollow bearing trees along the proposed access roads to be upgraded poses a minimal threat to the species, because the trees identified would not, at present, have hollows suitably large enough for Sooty Owls to inhabit, although these trees may potentially provide suitably sized hollows in the future.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The retention of hollow bearing trees as well as large, mature trees that would provide hollows in the future is one of the key strategies to recover the species. Although the proposed works are not consistent with this objective of the recovery plan it is assessed that there would be no



negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential nesting sites in hollow bearing trees.

However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Sooty Owl and therefore a Species Impact Statement is not required for this species.

Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)

Eastern Bentwing-bats occur along the east and north-west coasts of Australia (DECC 2008). The species is associated with a range of habitats, typically well-timbered areas where it forages above and below the tree canopy on small insects (DECC 2008). The species would utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (DECC 2008). This species has been reported utilising bushland remnants in urban areas and is estimated to forage within a 20 km radius in a single night (DECC 2008). Predators include owls, pythons, feral cats and foxes (DECC 2008).

Breeding is confined to caves with suitable temperature, humidity and physical dimensions to permit breeding (DECC 2008). The dependence of the Eastern Bentwing-bat upon relatively few nursery caves suggests that threats to the existence or structural integrity of these may place widespread populations in jeopardy (DECC 2008). Long migrations between roost sites, according to seasonal needs or reproductive status, have been recorded (DECC 2008).

With the onset of spring, adult female Eastern Bentwing-bats move from numerous widely scattered roosts to specific nursery caves which provide high temperature and humidity or have an internal conformation that retains air warmed by the bats activities (DECC 2008). Within nursery caves, young bats can be present at densities of up to 3 000 per square metre (DECC 2008). In New South Wales, mating occurs in late May and early June, just prior to winter (DECC 2008). Cool caves are utilised during the winter hibernation, when Eastern Bentwing-bats go into deep torpor, relying on body reserves of fat (DECC 2008). Bats in this state are particularly vulnerable to disturbance (DECC 2008).



The Eastern Bentwing-bat was identified during the current study via definite Anabat recordings at two locations within the study area. It was also recorded in the inundation area during a previous study.

a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Eastern Bentwing-bat due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

There are no known maternity roost caves within the study area that would support a local population of the species and a high proportion of the potential foraging habitat is in adjacent lands that have undergone less disturbances. The key habitat resource; caves and similar cave-like man-made structures for roosting occur beyond the limits of the study area and would be retained as potential roosting sites for a population of the species.

Whilst multiple trees with hollows are likely to be removed along the proposed access roads and potentially undetected small hollows within the inundation area, these features are only occasionally used by the Eastern Bentwing-bat and do not constitute primary roosting habitat for a population of this species, as they would be more likely to utilise caves which occur in the locality. The distribution of a population would be greatest around such caves and densities may decrease the greater the distance from them.

The existence of alternative foraging and breeding resources within the wider study area and the poor habitat status of the study area mean it is unlikely that the proposed action would have an adverse effect on the life cycle of the Eastern Bentwing-bat such that a viable local population of the species is likely to be placed at risk of extinction.

b) *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

There is no endangered population currently listed on the TSC Act within the study area.

c) *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- is likely to substantially and adversely modify the composition of the ecological***



community such that its local occurrence is likely to be placed at risk of extinction,

This factor does not apply to this species.

d) In relation to the habitat of a threatened species, population or ecological community:

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The Proposal would require the removal of an area of potential habitat, which is relatively small in comparison to the expanse of adjacent habitat. Therefore this area could not be regarded as significant habitat for the Eastern Bentwing-bat on a local or regional basis due to the level of past disturbances. The Proposal would not involve the removal or modification of critical roosting habitat or nursery/ hibernation caves for the Eastern Bentwing-bat.

The Eastern Bentwing-bat is a fast flying species that usually feeds above the canopy (Churchill 1998), and has been known to travel up to 65 km in a night (Ayers *et al.* 1996). Given the high mobility of this species and the study area's connectivity to adjacent more favourable vegetation it is unlikely that the proposed action would isolate the Eastern Bentwing-bat from other areas of habitat.

No known maternity caves are within the locality. The habitat to be removed may provide potential foraging habitat for this species; however, it is not considered that the removal of this already disturbed vegetation would have an impact on the long-term survival of the species. Vegetation clearance would not further isolate any area of habitat for this wide-ranging and highly mobile species. Compared to the remaining potential habitat within the study area and wider locality

Due to the large amount of alternative breeding and foraging habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the species and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

There is no critical habitat listed for this species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

DECC is yet to prepare a recovery plan for this species and does not currently list any Priorities Action Statements (PAS). There are no threat abatement plans applicable to this species.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest



(7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The retention of woodland and open forest remnants, especially those containing hollow-bearing trees is one of the key strategies to recover the species. Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential roosting sites in hollow bearing trees. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Eastern Bentwing-bat and therefore a Species Impact Statement is not required for this species.

Golden-tipped Bat (*Kerivoula papuensis*)

The Golden-tipped Bat is distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland to Bega in southern NSW (DECC 2008). The species is found in rainforest and adjacent sclerophyll forest, and roosts in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests located in rainforest gullies on small first- and second-order streams (DECC 2008). It is also known to roost beneath hanging moss on tree trunks and in dense foliage in rainforest close to creek lines. Golden-tipped Bats would fly up to two km from roosts to forage in rainforest and sclerophyll forest on upper-slopes, and is a specialist feeder on small web-building spiders (DECC 2008).

The Golden-tipped Bat was identified during the current study via definite Anabat recordings at one location within the study area.

a) In the case of a threatened species, whether the action proposed is likely to have



an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Golden-tipped Bat due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

Whilst multiple trees with hollows are likely to be removed along the proposed access roads, these features are not used by the Golden-tipped Bat and do not constitute primary roosting habitat for the species, as they would be more likely to utilise abandoned hanging bird nests, hanging moss on tree trunks and in dense foliage, which would occur in the locality. The distribution of a population of this species would be based upon the amount and location of abandoned hanging bird nests. Due to past disturbances and structural modification at the site, this distribution could be considered minimal and may only support a small population of the species.

The species roosts in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests located in rainforest gullies on small first and second order streams (DECC, 2008). Both bird species have been recorded in the study area during previous studies and the inundation area contains a first order stream. Therefore abandoned hanging bird nests would occur in the study area and are likely to be utilised by the Golden-tipped Bat as roosting sites.

Given the extent of viable habitat suitable for the Golden-tipped Bat and the presence of Yellow-throated Scrubwren and Brown Gerygone populations in the wider study area. It is considered unlikely that the proposed action would have an adverse effect on the life cycle of the Golden-tipped Bat such that a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There is no endangered population currently listed on the TSC Act within the study area.

- c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***
- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
 - is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.



d) *In relation to the habitat of a threatened species, population or ecological community:*

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The Proposal would require the removal of an area of potential habitat, which is relatively small in comparison to the expanse of adjacent habitat. Therefore this area could not be regarded as significant habitat for the Golden-tipped Bat on a local or regional basis due to the level of past disturbances.

The Proposal would involve the removal of roosting habitat that is in the form of abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests. Given the extent of viable habitat suitable for the Golden-tipped Bat and the presence of Yellow-throated Scrubwren and Brown Gerygone populations in the wider study area, it is considered unlikely that the study area would form an important component of habitat for the long-term survival of the species in the locality.

The habitat to be removed may provide potential foraging habitat for this species; however, it is not considered that the removal of this structurally modified vegetation would have an impact on the long-term survival of this species. The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the Golden-tipped Bat and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

There is no critical habitat listed for this species on the register of critical habitat.

f) *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;*

The Golden-tipped Bat is incorporated into The Action Plan for Australian Bats (DEWHA, 1999). One of the threats is that the majority of roosts that have been located so far, have been in the nests of the Yellow-throated Scrubwren and Brown Gerygone, it may be important to identify current threats facing these two rainforest bird species (DEWHA, 1999). As both of these



species are present within the study area, there may also be viable populations in the adjacent habitat that is of greater habitat value. In light of this, any Golden-tipped Bats that may become dislocated as a result of the action may be able to relocate successfully into adjacent habitats where viable Yellow-throated Scrubwren and Brown Gerygone populations are likely to occur.

DECC is yet to prepare a recovery plan for this species but does currently list 6 Priorities Action Statements (PAS). One PAS is to identify the effects of fragmentation on the species in a range of fragmented landscapes, e.g. genetic isolation, movement and persistence across a range of fragment sizes (DECC, 2009). The area to be cleared is not going to create fragmentation and would retain connectivity to adjacent habitat. There are no threat abatement plans applicable to this species.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential nesting sites in hollow bearing trees. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Golden-tipped Bat and therefore a Species Impact Statement is not required for this species.

Little Bentwing-bat (Miniopterus australis)

Little Bent-wing Bat is found in coastal northeastern NSW and eastern Queensland (DECC 2008). The species prefers moist eucalypt forest, rainforest or dense coastal banksia scrub (DECC, 2008). Little Bentwing-bats roost in caves, tunnels and sometimes tree hollows during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats (DECC 2008). The species often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters (DECC 2008).



The Little Bentwing-bat was identified during the current study via definite Anabat recordings at two locations within the study area. It was also recorded within the inundation area during a previous study.

- a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;***

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Little Bentwing-bat due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

There are no known maternity roost caves within the study area that would potentially support a population of the species and a high proportion of the potential foraging habitat is in adjacent lands that have undergone less disturbances. The key habitat resource; caves and similar cave-like man-made structures for roosting occur beyond the limits of the study area and would be retained.

Whilst multiple trees with hollows are likely to be removed along the proposed access roads, these features are only occasionally used by the Little Bentwing-bat and do not constitute primary roosting habitat for a population of this species, as they would be more likely to utilise caves which must occur elsewhere in the locality. However it may occasionally utilise the study area as a foraging resource, as some limited foraging resources are available, although the continuous vegetation communities in the surrounding study area are likely to be of greater foraging and breeding importance to this species due to the presence of non-plantation lands that would provide more favourable foraging and suitable hollow bearing trees.

The existence of alternative foraging and breeding resources within the wider study area and the poor habitat status of the study area mean it is unlikely that the proposed action would have an adverse effect on the life cycle of the Little Bentwing-bat such that a viable local population of the species is likely to be placed at risk of extinction.

- b) *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;***

There is no endangered population currently listed on the TSC Act within the study area.

- c) *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***
- is likely to have an adverse effect on the extent of the ecological community such***



that its local occurrence is likely to be placed at risk of extinction, or

- is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

This factor does not apply to this species.

d) *In relation to the habitat of a threatened species, population or ecological community:*

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*

The Proposal would require the removal of an area of potential habitat, which is relatively small in comparison to the expanse of adjacent habitat. Therefore this area could not be regarded as significant habitat for the Little Bentwing-bat on a local or regional basis due to the level of past disturbances. The Proposal would not involve the removal or modification of critical roosting habitat or nursery/ hibernation caves for the Little Bentwing-bat.

The Little Bentwing-bat feeds on insects under densely vegetated habitats and is known to stay within close proximity to colony sites (DECC, 2009). Given that no caves or tunnels exist in the study area suitable for a roosting colony and that very little densely vegetated habitats occur onsite, as well as the study area's connectivity to adjacent more favourable vegetation. It is unlikely that the proposed action would isolate the Eastern Bentwing-bat from other areas of foraging and roosting habitat. The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed.

The habitat to be removed may provide potential foraging habitat for this species; however, it is not considered that the removal of this structurally modified vegetation would have an impact on the long-term survival of the species. Vegetation clearance would not further isolate any area of favourable habitat for this species in comparison to the remaining potential habitat within the study area and wider locality.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the Little Bentwing-bat and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

There is no critical habitat listed for this species on the register of critical habitat.

f) *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;*



DECC is yet to prepare a recovery plan for this species but does currently list 25 Priorities Action Statements (PAS). One PAS is to protect significant roosting/ maternity sites of the species. This would be ensured as no caves or tunnels were identified in the study area. There are no threat abatement plans applicable to this species.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under *TSC* and *EPBC Acts*. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential roosting sites in hollow bearing trees. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Little Bentwing-bat and therefore a Species Impact Statement is not required for this species.

Endangered Ecological Community

River-flat Eucalypt Forest on Coastal Floodplains EEC

Preamble

The riparian vegetation in the study area has been substantially altered (both structurally and floristically) and degraded as a result of previous land management activities (logging, clearing and grazing) and is dominated by Camphor Laurel, Privet and Lantana with scattered native canopy trees. Areas of this vegetation along the Nambucca River, South Creek and lower reaches of Bowra Creek contain some elements that possibly resemble the *River-flat Eucalypt*



Forest on Coastal Floodplains EEC listed under the TSC Act. However, the riparian vegetation in these areas is not considered to constitute this EEC given:

- ▶ The vegetation, including canopy, understorey and groundcover strata, is dominated by exotic species;
- ▶ Native species, potentially indicative of the EEC, including Forest Red Gum and Flooded Gum, are only present as scattered and isolated individuals. The majority of the understorey was clear of vegetation due to livestock grazing and the remainder was comprised of exotic species, whilst no native understorey species typically associated with this EEC were present; and
- ▶ The study area is located well beyond the identified northern-most occurrence of the community in the Port Stephens LGA (Scientific Committee Determination (DEC, 2005)).

Whilst the riparian vegetation is not considered to comprise the River-flat Eucalypt Forest on Coastal Floodplains EEC as determined by the Scientific Committee, a precautionary approach has been taken and an assessment of significance has been prepared with respect to this community (refer to Appendix D). Given the relatively small area of highly modified and disturbed riparian vegetation to be impacted (approximately 1.49 ha), a significant impact on the community is considered highly unlikely even if it does occur in some areas.

A similar riparian community was also recorded at various locations on the upper slopes of Bowra Creek catchment. These areas of vegetation are not considered to constitute 'floodplain' ecosystems and hence are not considered to constitute this EEC.

The DEC profile of this EEC determines the distribution of this community as being as far north as the Port Stephens LGA, which is found in the northern extent of the Sydney Basin Bioregion. The study area is located in the Nambucca Shire LGA and is part of the North Coast Bioregion. Therefore the study area is located beyond the typical natural distribution for this EEC.

GHD has decided to take the precautionary approach and has undertaken an assessment of significance for this EEC, because where the riverbank stabilisation works are proposed to occur, impacting approximately 1.49 ha of riparian vegetation, is where this vegetation community is representative of this EEC due to the presence of Eucalypt canopy species that are typically associated with this EEC in the Sydney Basin Bioregion.

Background

As the name suggests, this EEC is found on the river flats of the coastal floodplains. It has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple) and *A. subvelutina* (broad-leaved apple). Known from parts of the Local Government Areas of Port Stephens, Maitland, Singleton, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Parramatta, Penrith, Blue Mountains, Fairfield, Holroyd, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Palerang, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions.



- a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;***

This factor does not apply to EECs.

- b) *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;***

This factor does not apply to EECs.

- c) *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***
- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
 - is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

The Proposal involves the removal of approximately 1.49 ha of structurally modified riparian vegetation along sections of the Nambucca River and South Creek where riverbank stabilisation works are proposed to take place. The riparian vegetation in these areas contain some elements resembling this EEC due to the presence of Eucalypt canopy species that are recognised as an element of this EEC. However due to past land uses associated with agriculture and land clearing this vegetation has become dominated by exotics resulting in a reduction of these elements that are now scattered along these thin riparian zones. Therefore it is considered unlikely that there would be any significant impacts upon the extent of this community, which may potentially resemble this EEC, in that it would be placed at risk of extinction.

The composition of this ecological community contains some elements of this EEC and has been structurally modified through weed infestation and land use practices and any additional modification is unlikely to place it at risk of extinction, as previous land use has already modified it substantially and only some elements remain i.e. scattered canopy species typically associated with this EEC.

- d) *In relation to the habitat of a threatened species, population or ecological community:***
- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
 - whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
 - the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the***



locality,

The Proposal involves the removal of approximately 1.49 ha of structurally modified riparian vegetation along sections of the Nambucca River and South Creek where riverbank stabilisation works are proposed to take place. The habitat value of this endangered community is already very low due to past disturbances associated with agricultural land use and weed infestation.

This community contains some elements resembling this EEC, which are scattered through thin riparian zones comprised of vegetation communities modified to varying degrees along the Nambucca River and South Creek. It is therefore not considered to be presently fragmented and is unlikely to be fragmented as part of the proposed riverbank stabilisation works and should remain connected to this thin riparian zone, as the works only occupy the lower riverbank in close proximity to the waters edge. In some regard this community, which contains some elements of this EEC, is already isolated in that it is located well beyond its typical bioregional distribution.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

There is no critical habitat listed on the register for this EEC in the north coast bioregion.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

Weed invasion is a threat to this endangered community. The vegetation to be cleared is primarily weed infested and the removal of these weeds may assist in the re-establishment of this community post riverbank stabilisation works, even though it is only considered to contain some elements of this EEC.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 1.49 ha of riparian vegetation along the lower riverbank in close proximity to the waters edge along the Nambucca River and South Creek where vegetation that contains some elements of this EEC occurs. However this vegetation is structurally modified through past land uses and weeds infestation and only contains some elements of this EEC; therefore the proposed action of riverbank stabilisation would not constitute being a KTP.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on this vegetation community that contains some elements of River-flat Eucalypt Forest on Coastal Floodplains EEC and therefore a Species Impact Statement is not required for this EEC.



Threatened Species Considered Likely to Occur

Spotted-tail Quoll (*Dasyurus maculatus*)

The Spotted-tail Quoll is the largest and most arboreal of the quolls. It inhabits a variety of habitats including wet and dry sclerophyll forest, rainforest, vine thicket, woodland and coastal scrub and is known to deposit its scats on prominent high points in the landscape. This species is solitary and typically occupies a home range of thousands of hectares. They normally travel several kilometres a night while foraging. The subject area provides foraging habitat, but little in the form of shelter due to the lack of large debris and tree hollows.

No Spotted-tail Quolls were recorded in the study area however they are likely to occur.

- a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;***

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Spotted-tail Quoll due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

The study area is considered to be a smaller component of the overall habitat used by this species as they often have large home ranges. This species would utilise the study area as a foraging resource, although the continuous vegetation communities in the surrounding study area are considered to be of greater foraging and breeding importance to this species. Additionally this species is typically solitary for the majority of its life and occupies a large home range. Therefore the importance of the study area for a local population is considered unlikely.

It is proposed that the vegetation immediately surrounding the inundation area occupying 122.58 ha that may be acquired by NSC from Forests NSW as a protection area to offset the proposal. The protection area would be made into a conservation area for the long-term and subsequently the Spotted-tail Quolls inhabiting this area would be protected from logging and any future development.

The Proposal is likely to remove existing foraging habitat for a local Spotted-tail Quoll population, however due to structural modification resulting from past logging practices this habitat is less favourable than habitats in adjacent lands. It is therefore considered that the Proposal is unlikely to significantly affect breeding and foraging success, or dispersal of local Spotted-tail Quolls.



It is therefore unlikely that the proposed action would have an adverse effect on the life cycle of the Spotted-tail Quoll such that a viable local population of the species is likely to be placed at risk of extinction.

- b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;***

There is no endangered population currently listed on the TSC Act within the study area.

- c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***
- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
 - is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

- d) In relation to the habitat of a threatened species, population or ecological community:***
- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
 - whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
 - the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation. The Spotted-tail Quoll is solitary and typically occupies a home range of thousands of hectares. They normally travel several kilometres a night and may occasionally utilise the area as a foraging resource. There was also a minimal amount of large log debris and tree hollows available for shelter within the study area. The study area would be revegetated where possible with local native species to reflect the natural conditions existing prior to development and improve other roadside vegetation areas that are currently degraded.

The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed. Additional vehicle activity along the proposed access roads would be expected, but not for the long-term, hence the threat of car strike in the local area would not be significantly increased as a result of the proposed activities.

Due to the large amount of alternative breeding and foraging habitat within the locality, the area to be affected by the proposed action is not considered an important resource for the Spotted-



tail Quoll and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

There is no critical habitat listed for this species or similar species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

There is no recovery plan for this species however there are 32 priority actions listed for this species within the priority action statement. High priority actions include habitat management (conservation of core quoll habitat) and monitoring and research (short and long term, tracking and disturbance thresholds). Although the proposed action is not consistent with some of the objectives of these priority actions it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 30 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential nesting sites in hollow bearing trees. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Spotted-tail Quoll and therefore a Species Impact Statement is not required for this species.



Grey-headed Flying-fox (*Pteropus poliocephalus*)

Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water and in vegetation with a dense canopy. Site fidelity to camps is high with some camps being used for over a century. These camps can be made up of many thousands of animals. The GHFF eats fruit from a range of native and introduced species, particularly figs, and for this reason it is sometimes called a 'Fruit Bat' (DECC, 2008).

Annual mating commences in January and a single young is born each year. The young are usually born in September-November (DECC, 2008).

Individual camps may have tens of thousands of animals and are used for mating, birth and the rearing of young. Although they appear in large groups, numbers of Grey-Headed Flying Foxes are declining because of habitat clearing (Australian Museum, 2008).

This species would travel up to 50 km to forage. They feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines. They also forage in cultivated gardens and fruit crops and can inflict severe crop damage. This species is sensitive to the loss of key roosting resources, particularly winter and summer flowering species (DECC, 2008).

The GHFF was not detected on the study area during the present study, however it was recorded in previous studies to the east of the study area. A large GHFF colony is located adjacent to the Bowraville Township.

a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Grey-headed Flying-fox (GHFF) due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

The GHFF was not detected on the study area during the present study and it is unlikely to camp or breed there given the lack of dense canopy cover and access to a permanent water body as is preferred for campsites. It is likely to forage opportunistically on the flowers of the Tallowwood, Turpentine, Ironbark and Bloodwoods located on and around the study area.

Although this species may utilise the study area as a foraging resource, the vegetation communities in the adjacent lands associated with Forests NSW are considered of greater foraging and breeding importance to this species. As a population and as individuals the GHFF is highly mobile species and would be minimally affected by the loss of native vegetation. It is also noted that within the broader study area there is a vast extent of native vegetation that contains similar vegetation communities as those contained within the study area that are in a less disturbed condition and more likely to sustain members of the viable local population identified on the Nambucca River in Bowraville Township.



The existence of alternative feeding and breeding resources within the broader study area and the limited resources provided by the study area mean it is unlikely that the action proposed would have an adverse effect on the life cycle of the GHFF such that a viable local population of the species is likely to be placed at risk of extinction.

- b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;***

There is no endangered population currently listed on the TSC Act within the study area.

- c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***
- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
 - is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

- d) In relation to the habitat of a threatened species, population or ecological community:***
- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
 - whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
 - the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;***

The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation.

The GHFF may utilise the subject area opportunistically as a foraging resource at certain times of the year as part of a much larger home range. There is low quality roosting habitat available due to the structurally modified nature of the inundation area. One GHFF was recorded within the inundation area during previous studies; however none were recorded during the present study. The minimal recording of the species in the inundation area is indicative of the level of disturbance and habitat values at the site.

The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed. The GHFF is highly nomadic and follows the fruiting season. Migratory movements can be up to hundreds of kilometres. The proposed action would not decrease the value of the study area as a potential



movement corridor, therefore no area of habitat is likely to become fragmented or isolated from other areas of habitat.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the GHFF and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

There is no critical habitat listed for this species or similar species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

An Action Plan for Australian Bats was completed in 1999. This Action Plan, which was prepared for Environment Australia, reviews the conservation status of 90 taxa of Australian bats including the GHFF. The major threat to this species according to the Action Plan is habitat loss. The complexity of the habitat requirements of the GHFF, particularly its requirement for multiple, geographically dispersed populations of food trees, leaves it vulnerable to population declines from land use decisions and management strategies. Although the proposed action is not consistent with the objectives of these priority actions it is believed that there would be no negative impact on the long-term persistence and recovery of this species due to the already disturbed state of the area to be cleared and the large amount of similar resources in the study area.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 30 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under *TSC* and *EPBC Acts*. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more



suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the GHFF and therefore a Species Impact Statement is not required for this species.

Powerful Owl (Ninox strenua)

In NSW, this species is widely distributed throughout the eastern forests from the coast inland to the tablelands. The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine (*Syncarpia glomulifera*), Black She-oak (*Allocasuarina littoralis*), Blackwood (*Acacia melanoxylon*), Rough-barked Apple (*Angophora floribunda*), Cherry Ballart (*Exocarpus cupressiformis*) and a number of eucalypt species. As most prey species require hollows and a shrub layer, these are important habitat components for the owl.

Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. Nesting occurs from late autumn to mid-winter, but is slightly earlier in north-eastern NSW (late summer - mid autumn).

The Powerful Owl has been previously recorded within a 10 km radius of the study area and was targeted whilst using call playback, however none were recorded during this study.

Previous studies also targeted the Powerful Owl with no success.

a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Powerful Owl due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

The inundation area has no stag or hollow bearing trees that would provide potential nesting sites, however some stags and hollow bearing trees were identified along the proposed access roads that are to be upgraded, the majority of which would not have hollows sufficiently large enough to be utilised as roosting or nesting sites.

This species preferred nesting trees were not identified as occurring within the inundation area but were identified along the access roads to be upgraded, however no hollows were identified



as being large enough for the species to nest in. Therefore it is unlikely that a local population of the species nests or breeds within the study area.

However it may occasionally utilise the study area as a foraging resource, as some limited foraging resources are available, although the continuous vegetation communities in the surrounding study area are likely to be of greater foraging and breeding importance to this species due to the presence of non-plantation lands that would provide suitable hollow bearing trees. The Powerful Owl is highly mobile and would be minimally affected by the loss of vegetation due to the proposed off-river storage and related infrastructure.

The Proposal is not considered to reduce the local Powerful Owl population due to the low quality of the habitat found in the inundation area and the availability of more favourable adjacent habitats. It is therefore considered that the Proposal is unlikely to significantly affect breeding and foraging success, or dispersal of local Powerful Owls.

The existence of alternative foraging and breeding resources within the wider study area and the relatively poor habitat status of the study area mean it is unlikely that the proposed action would have an adverse effect on the life cycle of the Barking Owl such that a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There is no endangered population currently listed on the TSC Act within the study area.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

d) In relation to the habitat of a threatened species, population or ecological community:

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation. Hollow bearing trees were identified along the proposed access roads that are to be upgraded, the majority of which do not have hollows sufficiently large enough to be utilised by the Powerful Owl.



The Powerful Owl is known to adapt to fragmented landscapes, although the effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed. Additional vehicle activity along the proposed access roads would be expected, but not for the long-term, hence the threat of car strike in the local area would not be significantly increased as a result of the proposed activities.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the Powerful Owl and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

There is no critical habitat listed for this species on the register of critical habitat.

f) *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;*

There is a recovery plan for the Powerful Owl (NSW National Parks and Wildlife Service, 2003), which outlines specific objectives to help conserve the Powerful Owl and its habitat. Four current threats to Powerful Owls are identified. Inappropriate forest harvesting practices that change forest structure and the removal of old growth hollow-bearing trees is the primary threat posed by the proposed action.

The potential removal of hollow bearing trees along the proposed access roads to be upgraded poses a minimal threat to the species, because the trees identified would not, at present, have hollows suitably large enough for Powerful Owls to inhabit, although these trees may potentially provide suitably sized hollows in the future. The species was not identified within the study area because its preferred nesting habitat may not be present, but use of the site as a foraging resource is likely.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The retention of woodland and open forest remnants, especially those containing hollow-bearing trees is one of the key strategies to recover the species. Although the proposed works are not consistent with this objective of the recovery plan it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent



lands and it has lower habitat values due to structural modification and weed infestation.

g) *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential nesting sites in hollow bearing trees. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Powerful Owl and therefore a Species Impact Statement is not required for this species.

Glossy Black Cockatoo (Calyptorhynchus lathami)

The Glossy Black Cockatoo is uncommon although widespread throughout suitable forest and woodland habitats. This species is dependent on large hollow-bearing eucalypts for nest sites. This species typically inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of she-oak species, particularly Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur. It feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species).

This species was not recorded during the recent study, however *Allocasuarina torulosa* and *A. torulosa* were both identified and are a foraging resource for the species and it has been previously recorded within a 10 km radius to the southeast of the study area.

a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Glossy Black Cockatoo due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

The inundation area has no stags or hollow bearing trees that would provide potential nesting sites, however some stags and hollow bearing trees were identified along the proposed access



roads that are to be upgraded, the majority of which would not, at present, have hollows sufficiently large enough to be utilised as roosting or nesting sites.

The Glossy Black Cockatoo may utilise the study area as a foraging resource, because it has been previously recorded within a 10 km radius of the study area. However the extensive vegetation communities in the surrounding study area are considered to be of greater foraging and in particular nesting and breeding importance to a population of this species, as the surrounding more elevated areas contain a greater abundance of *Allocasuarina* sp. that are important to the species. The Glossy Black Cockatoo is highly mobile and would be minimally affected by the loss of vegetation due to the proposed off-river storage and related infrastructure and would be able to relocate into the adjacent lands.

The Proposal is not considered to reduce the local Glossy Black Cockatoo population due to the low quality of the habitat found in the inundation area and the availability of more favourable adjacent habitats that contain a greater abundance of foraging resources i.e. *Allocasuarina* sp..

The existence of alternative foraging and breeding resources within the wider study area and the reduced habitat status of the study area mean it is unlikely that the proposed action would have an adverse effect on the life cycle of the Glossy Black Cockatoo such that a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There is no endangered population currently listed on the TSC Act within the study area.

- c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***
- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
 - is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

d) In relation to the habitat of a threatened species, population or ecological community:

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***



The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation. Hollow bearing trees were identified along the proposed access roads that are to be upgraded, the majority of which do not have hollows sufficiently large enough to be utilised by the Glossy Black Cockatoo.

The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat to be removed. Additional vehicle activity along the proposed access roads would be expected, but not for the long-term, hence the threat of car strike in the local area would not be significantly increased as a result of the proposed activities. Any resident Glossy Black Cockatoos would be able to relocate into adjacent lands that provide higher quality foraging and roosting habitats.

Due to the large amount of alternative breeding habitat and greater abundance of foraging habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the Glossy Black Cockatoo and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

There is no critical habitat listed for this species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

There is no recovery plan for the Glossy Black Cockatoo. Four current threats to Glossy Black Cockatoos are identified. The two most relevant ones to this action are the loss of mature hollow-bearing trees and changes to forest and woodland structure, which leads to fewer such trees in the future, and the clearing of habitat for development.

The potential removal of hollow bearing trees along the proposed access roads to be upgraded poses a minimal threat to the species, because the trees identified do not, at present, have hollows suitably large enough for Glossy Black Cockatoos to inhabit, although these trees may potentially provide suitably sized hollows in the future. The existing vegetation is already structurally modified so any changes to the forest structure at the site has already occurred due to logging practices with the subsequent invasion of noxious weeds throughout the understorey.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The retention of hollow bearing trees as well as large, mature trees that would provide hollows in the future is one of the key strategies to recover the species. Although the proposed works are not consistent with this objective of the recovery plan it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.



The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential nesting sites in hollow bearing trees. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Glossy Black Cockatoo and therefore a Species Impact Statement is not required for this species.

Wompoo Fruit-dove (*Ptilinopus magnificus*)

This species is rarely recorded south of Coffs Harbour. Three subspecies are recognised, with the most southerly in NSW and southeastern Queensland. It occurs in or near rainforest, low elevation moist eucalypt forest and brush box forests. This species feeds on a diverse range of tree and vine fruits and is locally nomadic, following ripening fruit. Some of its feed trees rely on this species to distribute their seeds. It breeds in spring and early summer and is most often seen in mature forests, but is also found in remnant and regenerating rainforest. Aspects of its behavior such as social behavior and structure, movements and breeding biology have not been well-studied.

This species was not recorded during the current study; however it may potentially occur on site at one time or another, as it was previously recorded within a 10 km radius of the study area by Forests NSW.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 4.66 ha of native vegetation along the proposed access roads and 14.23 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Wompoo Fruit-dove due to an expanse of native vegetation in adjacent lands that is of greater habitat value.



The study area may provide potential nesting sites for a population of this species, however the surrounding lands where pockets of rainforest exist that are not as structurally modified may be more favourable to this species. Additionally the Wompoo Fruit-dove is rarely recorded south of Coffs Harbour.

The Wompoo Fruit-dove is likely to utilise the study area as a foraging resource at certain times of the year as seasonal native fruits are ripening. These species are likely to be in short supply in the study area due to weed infestation and past logging practices. However the extensive vegetation communities in the surrounding study area are considered to be of greater foraging, nesting and breeding importance to a population of this species, because it is less intensively logged and has lower weed content. The Wompoo Fruit-dove is a highly mobile nomadic species that would be minimally affected by the loss of vegetation due to the proposed off-river storage and related infrastructure and would be able to relocate successfully into the adjacent lands.

The existence of alternative foraging and breeding resources within the wider study area and the relatively poor habitat status of the study area mean it is unlikely that the proposed action would have an adverse effect on the life cycle of the Wompoo Fruit-dove such that a viable local population of the species is likely to be placed at risk of extinction.

- b) *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;***

There is no endangered population currently listed on the TSC Act within the study area.

- c) *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***
- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
 - is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

- d) *In relation to the habitat of a threatened species, population or ecological community:***
- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
 - whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
 - the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation.



The Wompoo Fruit-dove has been recorded within a 10 km radius of the study area. The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed. The Wompoo Fruit-dove would be able to relocate into adjacent lands that provide higher quality foraging and breeding habitat.

Additional vehicle activity along the proposed access roads would be expected, but not for the long-term, hence the threat of car strike in the local area would not be significantly increased as a result of the proposed activities.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be affected by the proposed action is not considered an important resource for the Wompoo Fruit-dove and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

There is no critical habitat listed for this species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

There is no recovery plan for the Wompoo Fruit-dove. Three current threats to Wompoo Fruit-doves are identified (DECC, 2008). The two most relevant ones to this action are clearing, fragmentation and weed invasion of low to mid-elevation rainforest due to coastal development and grazing, and logging and roading in moist eucalypt forest with well-developed rainforest understorey.

The potential removal of some rainforest by means of clearing/ logging may reduce foraging resources in the study area. Although the proposed works are not consistent with the current threats it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves. Additionally the Wompoo Fruit-dove is a highly mobile and nomadic species and would be able to find foraging and breeding resources elsewhere.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study areas and provides extensive habitat linkages in the locality. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

The rainforest vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.



g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging habitat and potential nesting sites. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Wompoo Fruit-dove and therefore a Species Impact Statement is not required for this species.

Giant Barred Frog (*Mixophyes iteratus*)

Giant Barred Frog is distributed along the coast and ranges from southeastern Queensland to the Hawkesbury River in NSW (DECC, 2009). Northeastern NSW, particularly the Coffs Harbour-Dorrigo area, is now a stronghold (DECC, 2009). The species forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m (DECC, 2009). They breed around shallow, flowing rocky streams from late spring to summer (DECC, 2009).

The Giant Barred Frog was not detected in the study area during the present study; however it is likely to occur within the study area as it has been previously recorded to the northeast of the study area.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Giant Barred Frog due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

Giant Barred Frog was not recorded during the field surveys undertaken for this assessment; however potential habitat for the species is present within gullies supporting rainforest and moist gully forest within the inundation area. It is within these vegetation communities that populations of the species may be distributed.

It is considered unlikely that a local population of Giant Barred Frog would be adversely affected such that it would be placed at risk of extinction. It is considered unlikely that the Proposal



would adversely affect any of the currently known populations of the species, as no DECC Atlas of NSW Wildlife records are located within the inundation area or locations of other infrastructure.

The existence of alternative foraging and breeding resources within the wider study area and the relatively poor habitat status of the study area mean it is unlikely that the proposed action would have an adverse effect on the life cycle of the Giant Barred Frog such that a viable local population of the species is likely to be placed at risk of extinction.

b) *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

There is no endangered population currently listed on the TSC Act within the study area.

c) *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

d) *In relation to the habitat of a threatened species, population or ecological community:*

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation. There exists potential habitat for the species within gullies supporting rainforest and moist gully forest within the inundation area.

The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed. The inundation of the site would displace the Giant Barred Frog, however the upper reaches of the Bowra catchment containing rainforest may provide appropriate habitat for the species.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the Giant



Barred Frog and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

There is no critical habitat listed for this species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

DECC is yet to prepare a recovery plan for this species but does currently list 6 Priorities Action Statements (PAS). One PAS is to control weeds in riparian areas. Eight current threats to the Giant Barred Frog are identified. Changes in water flow patterns; either increased or decreased flows and habitat loss through vegetation clearance are the key ones relating to the proposed action. The water flow patterns below the off-river storage would be reduced, however 80 % of the environmental flow rate is to be maintained in the Nambucca River and lower reaches of Bowra Creek, this should provide viable habitat for the species.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study area and provides extensive habitat linkages in the locality that may be utilised by the species. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging and breeding habitat. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Giant Barred Frog and therefore a Species Impact Statement is not required for this species.



Southern Barred Frog (*Mixophyes balbus*)

This species is typically found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range (DECC, 2009). Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor (DECC, 2009). This species breeds in streams during summer after heavy rain (DECC, 2009).

The Southern Barred Frog was not detected in the study area during the present study; however it is likely to occur within the study area because viable foraging and breeding habitat exists.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Southern Barred Frog due to an expanse of native vegetation in adjacent lands that is of greater habitat value.

The Southern Barred Frog was not recorded during the field surveys undertaken for this assessment, however potential habitat for the species is present within gullies supporting rainforest and moist gully forest within the inundation area. It is within these vegetation communities that populations of the species may be distributed.

It is considered unlikely that a local population of Southern Barred Frog would be adversely affected such that it would be placed at risk of extinction. It is considered unlikely that the Proposal would adversely affect any of the currently known populations of the species, as no DECC Atlas of NSW Wildlife records are located within the inundation area or locations of other infrastructure.

The existence of alternative foraging and breeding resources within the wider study area and the poor habitat status of the study area mean it is unlikely that the proposed action would have an adverse effect on the life cycle of the Southern Barred Frog such that a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There is no endangered population currently listed on the TSC Act within the study area.



- c) ***In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***
- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
 - ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

- d) ***In relation to the habitat of a threatened species, population or ecological community:***

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- ***the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed comprises degraded vegetation due to past logging practices, monoculture plantings and weed infestation. There exists potential habitat for the species within gullies supporting rainforest and moist gully forest within the inundation area.

The effectiveness of the study area as a movement corridor and habitat resource would not be negatively affected due to its level of connectivity to larger tracts of forest that provide better foraging and breeding habitat than the habitat that is to be removed. The inundation of the site would displace the Southern Barred Frog, however the upper reaches of the Bowra catchment containing rainforest may provide appropriate habitat for the species.

Due to the large amount of alternative breeding and feeding habitat within the locality, the area to be effected by the proposed action is not considered an important resource for the Southern Barred Frog and the proposed vegetation clearing would not have a significant impact upon the long-term survival of this species.

- e) ***Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);***

There is no critical habitat listed for this species on the register of critical habitat.

- f) ***Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;***

DECC is yet to prepare a recovery plan for this species but does currently list 7 Priorities Action Statements (PAS). One PAS is to control weeds in known habitat for this species. Four current threats to the Southern Barred Frog are identified. Changes in water flow patterns; either increased or decreased flows and habitat loss through vegetation clearance are the key ones relating to the proposed action. The water flow patterns below the off-river storage would be reduced, however 80 % of the environmental flow rate is to be maintained in the Nambucca River and lower reaches of Bowra Creek, this should provide viable habitat for the species.



The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study area and provides extensive habitat linkages in the locality that may be utilised by the species. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area, which would maintain connectivity with an extensive vegetation corridor comprised of state forest and nature reserves.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the TSC Act. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains existing foraging and breeding habitat. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain hollow bearing trees and more suitable foraging habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Southern Barred Frog and therefore a Species Impact Statement is not required for this species.

Rusty Plum (*Amorhospermum whitei*)

This species is a small to medium tree to 20 m high with a very fluted or irregular trunk (DECC, 2009). It occurs on the coast and adjacent ranges from northern NSW into southern QLD (DECC, 2009). This species prefers rainforest and adjacent understorey of moist eucalypt forest (DECC, 2009). Threats include clearing, timber harvesting, and weed invasion, particularly Lantana (DECC, 2009).

The Rusty Plum was not detected in the study area during the present study, however it may possibly occur within the study area.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the



inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Rusty Plum.

Rusty Plum was not recorded during the field surveys undertaken for this assessment, however potential habitat for a population of the species is present within the Wet Bloodwood – Tallowood Forest (Temperate Rainforest) vegetation of the upper Bowra Creek catchment.

It is considered unlikely that a local population of Rusty Plums would be adversely affected such that it would be placed at risk of extinction. It is considered unlikely that the Proposal would adversely affect any of the currently known populations of the species, as no DECC Atlas of NSW Wildlife records are located within the inundation area or locations of other infrastructure.

The existence of less degraded habitats in the wider study area and the amount of Lantana infestation would impede the successful establishment or persistence of the species. Therefore it is unlikely that the proposed action would have an adverse effect on the life cycle of the Rusty Plum such that a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There is no endangered population currently listed on the TSC Act within the study area.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

d) In relation to the habitat of a threatened species, population or ecological community:

- the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed is comprised of already degraded vegetation due to past logging practices, monoculture plantings and weed infestation. There exists potential habitat for the



species within gullies supporting rainforest and moist gully forest within the upper catchment of the inundation area.

Due to the large amount of more suitable habitat within the wider study area, the area to be affected by the proposed action is not considered important habitat for the Rusty Plum. The proposed vegetation clearing would have a significant impact upon the potential establishment of the species in the inundation area.

e) *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

There is no critical habitat listed for this species on the register of critical habitat.

f) *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;*

DECC is yet to prepare a recovery plan for this species but does currently list 9 Priorities Action Statements (PAS). One high PAS is to protect areas of known habitat from timber harvesting and other land clearing. This would occur as part of the proposed protection area to retain and rehabilitate the vegetation surrounding the inundation area that may potentially be acquired by Council. Another high PAS is fire management. The maintenance of fire trails and firebreaks as proposed in the mitigation measures may help to protect the species from the occurrence of fire.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest (7,200 ha) strengthens the vegetation connectivity of the study area and potentially provides suitable habitats for the species if its seed were to be deposited by fauna. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts. The proposed action includes the clearing of 58.59 ha of native vegetation that contains a portion of habitat that is considered suitable for the presence and establishment of the species. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain similar habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to



this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the Rusty Plum and therefore a Species Impact Statement is not required for this species.

Tylophora (Tylophora woolfsii)

Tylophora is a cryptic forest twiner found on the NSW north coast and New England Tablelands to southern Queensland, but is very rare within that range (DECC, 2009). It is known on the Tablelands from the Bald Rock and Boonoo Boonoo areas north of Tenterfield (DECC, 2009). This species grows in moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins (DECC, 2009). Flowering occurs in summer and autumn, usually between January and March but sometimes as late as November (DECC, 2009).

The Tylophora was not detected in the study area during the present study.

a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

The Proposal involves the removal of 58.59 ha of structurally modified native vegetation in the inundation area that is heavily infested with noxious weeds throughout the understorey, 5.03 ha of native vegetation along the proposed access roads and 16.84 ha of pastureland and weed infested riparian vegetation at the proposed locations of the off-river storage embankment, access road upgrades and where proposed riverbank restoration works are located along the Nambucca River and South Creek. It is considered unlikely to constitute habitat critical for the maintenance of a local population of the Tylophora because the study area is south of the southern limit of the species.

Tylophora was not recorded during the field surveys undertaken for this assessment, however potential habitat for a population of the species is present within the Wet Bloodwood – Tallowood Forest (Temperate Rainforest) gullies of the upper Bowra Creek catchment.

It is considered unlikely that a local population of Tylophora would be adversely affected such that it would be placed at risk of extinction. It is considered unlikely that the Proposal would adversely affect any of the currently known populations of the species, as no DECC Atlas of NSW Wildlife records are located within the inundation area or locations of other infrastructure.

The existence of less degraded habitats in the wider study area and the poor habitat status of the study area, mean it is unlikely that the proposed action would have an adverse effect on the life cycle of Tylophora such that a viable local population of the species is likely to be placed at risk of extinction.

b) *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

There is no endangered population currently listed on the TSC Act within the study area.



- c) ***In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***
- ***is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
 - ***is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

This factor does not apply to this species.

- d) ***In relation to the habitat of a threatened species, population or ecological community:***

- ***the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- ***the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,***

The vegetation to be removed is comprised of already degraded vegetation due to past logging practices, monoculture plantings and weed infestation. There exists potential habitat for the species within gullies supporting rainforest and moist gully forest within the upper catchment of the inundation area, which would have a small portion removed as part of land clearing activities.

Due to the large amount of more suitable habitat within the wider study area, the area to be affected by the proposed action is not considered important habitat for *Tylophora*. The proposed vegetation clearing would have a significant impact upon the potential establishment of the species in the inundation area, although after the action is completed the retained vegetation in the protection area may allow this species to potentially re-establish and persist.

- e) ***Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);***

There is no critical habitat listed for this species on the register of critical habitat.

- f) ***Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;***

DECC is yet to prepare a recovery plan for this species but has identified 15 Priorities Action Statements (PAS). One high PAS is to integrate weed control works on public lands into regional works programs as appropriate. Another high PAS is fire management. The maintenance of fire trails and firebreaks as proposed in the mitigation measures may help to protect the species from the occurrence of fire.

The extensive adjacent land, which contains Viewmont State Forest (890 ha), Bollonolla Nature Reserve (650 ha), Bowraville Nature Reserve (80 ha) and the large Gladstone State Forest



(7,200 ha) strengthens the vegetation connectivity of the study area and potentially provides suitable habitats for the species if its seed were to be deposited by fauna. The presence of the two nature reserves could be considered as providing security for the long-term survival of the species.

Although the proposed works are going to clear viable habitat it is assessed that there would be no negative impact on the long-term persistence and recovery of this species. This is due to the proposed 122.58 ha protection area.

The vegetation to be cleared is small in comparison to vegetation associated with adjacent lands and it has lower habitat values due to structural modification and weed infestation.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

There are currently 31 key threatening processes (KTP's) listed under the *TSC Act*. The most relevant one to this proposal is the clearing of native vegetation which is listed as a KTP under *TSC* and *EPBC Acts*. The proposed action includes the clearing of 58.59 ha of native vegetation that contains a portion of habitat that is considered suitable for the presence and establishment of the species. However the proposed protection area of 122.58 ha aims to conserve the surrounding vegetation that does contain similar habitat and in effect the clearing of native vegetation KTP would be excluded from the protection area, as logging currently contributes to this KTP at this locality.

Conclusion

Based on consideration of the above factors it is concluded that the Proposal is unlikely to have a significant impact on the *Tylophora* and therefore a Species Impact Statement is not required for this species.



Appendix D

DEWHA Protected Matters Search



Australian Government

Department of the Environment, Water, Heritage and the Arts

Protected Matters Search Tool

You are here: [Environment Home](#) > [EPBC Act](#) > [Search](#)

25 July 2008 08:56

EPBC Act Protected Matters Report

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

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

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

Search Type: Point
Buffer: 10 km
Coordinates: -30.6265,152.86287



Report Contents: [Summary](#)
[Details](#)

- [Matters of NES](#)
- [Other matters protected by the EPBC Act](#)
- [Extra Information](#)

[Caveat](#)
[Acknowledgments](#)



This map may contain data which are
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Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are

proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see

<http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html>.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
<u>Threatened Species:</u>	24
<u>Migratory Species:</u>	15

Other Matters Protected by the EPBC Act

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

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

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

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at <http://www.environment.gov.au/epbc/permits/index.html>.

<u>Commonwealth Lands:</u>	1
Commonwealth Heritage Places:	None
<u>Places on the RNE:</u>	1
<u>Listed Marine Species:</u>	13
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

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

nominated.

State and Territory Reserves:	3
Other Commonwealth Reserves:	None
Regional Forest Agreements:	1

Details

Matters of National Environmental Significance

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
<u><i>Lathamus discolor</i></u> Swift Parrot	Endangered	Species or species habitat may occur within area
<u><i>Rostratula australis</i></u> Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
<u><i>Xanthomyza phrygia</i></u> Regent Honeyeater	Endangered	Species or species habitat likely to occur within area
Frogs		
<u><i>Litoria aurea</i></u> Green and Golden Bell Frog	Vulnerable	Species or species habitat may occur within area
<u><i>Litoria booroolongensis</i></u> Booroolong Frog	Endangered	Species or species habitat may occur within area
<u><i>Mixophyes balbus</i></u> Stuttering Frog, Southern Barred Frog (in Victoria)	Vulnerable	Species or species habitat likely to occur within area
<u><i>Mixophyes iteratus</i></u> Southern Barred Frog, Giant Barred Frog	Endangered	Species or species habitat likely to occur within area
Insects		
<u><i>Phyllodes imperialis</i> (southern subsp. - ANIC 3333)</u> a moth	Endangered	Species or species habitat likely to occur within area
Mammals		
<u><i>Chalinolobus dwyeri</i></u> Large-eared Pied Bat, Large Pied Bat	Vulnerable	Species or species habitat may occur within area
<u><i>Dasyurus maculatus maculatus</i> (SE mainland population)</u> Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	Endangered	Species or species habitat may occur within area
<u><i>Potorous tridactylus tridactylus</i></u> Long-nosed Potoroo (SE mainland)	Vulnerable	Species or species habitat may occur within area
<u><i>Pseudomys oralis</i></u> Hastings River Mouse	Endangered	Species or species habitat likely to occur within area
<u><i>Pteropus poliocephalus</i></u> Grey-headed Flying-fox	Vulnerable	Roosting known to occur within area
Reptiles		

Emydura signata
Bellinger River Emydura (Bellinger River,
NSW)

Vulnerable Species or species habitat likely to
occur within area

Plants

Arthraxon hispidus
Hairy-joint Grass

Vulnerable Species or species habitat likely to
occur within area

Cryptostylis hunteriana
Leafless Tongue-orchid

Vulnerable Species or species habitat may
occur within area

Cynanchum elegans
White-flowered Wax Plant

Endangered Species or species habitat likely to
occur within area

Hicksbeachia pinnatifolia
Monkey Nut, Bopple Nut, Red Bopple, Red
Bopple Nut, Red Nut, Beef Nut, Red Apple
Nut, Red Boppel Nut, Ivory Silky Oak

Vulnerable Species or species habitat likely to
occur within area

Marsdenia longiloba
Clear Milkvine

Vulnerable Species or species habitat likely to
occur within area

Parsonsia dorrigoensis
Milky Silkpod

Endangered Species or species habitat likely to
occur within area

Quassia sp. Moonee Creek (J.King s.n. 1949)
NSW Herbarium

Endangered Species or species habitat likely to
occur within area

Taeniophyllum muelleri
Minute Orchid, Ribbon-root Orchid

Vulnerable Species or species habitat may
occur within area

Thesium australe
Austral Toadflax, Toadflax

Vulnerable Species or species habitat likely to
occur within area

Tylophora woollii

Endangered Species or species habitat likely to
occur within area

Migratory Species [[Dataset Information](#)]

Status Type of Presence

Migratory Terrestrial Species

Birds

Haliaeetus leucogaster
White-bellied Sea-Eagle

Migratory Species or species habitat likely to
occur within area

Hirundapus caudacutus
White-throated Needletail

Migratory Species or species habitat may
occur within area

Merops ornatus
Rainbow Bee-eater

Migratory Species or species habitat may
occur within area

Monarcha melanopsis
Black-faced Monarch

Migratory Breeding may occur within area

Monarcha trivirgatus
Spectacled Monarch

Migratory Breeding likely to occur within area

Myiagra cyanoleuca
Satin Flycatcher

Migratory Breeding likely to occur within area

Rhipidura rufifrons
Rufous Fantail

Migratory Breeding may occur within area

Xanthomyza phrygia
Regent Honeyeater

Migratory Species or species habitat likely to
occur within area

Migratory Wetland Species

Birds

Ardea alba
Great Egret, White Egret

Migratory Breeding likely to occur within area

Ardea ibis
Cattle Egret

Migratory Species or species habitat may occur within area

Gallinago hardwickii
Latham's Snipe, Japanese Snipe

Migratory Species or species habitat may occur within area

Rostratula benghalensis s. lat.
Painted Snipe

Migratory Species or species habitat may occur within area

Migratory Marine Birds

Apus pacificus
Fork-tailed Swift

Migratory Species or species habitat may occur within area

Ardea alba
Great Egret, White Egret

Migratory Breeding likely to occur within area

Ardea ibis
Cattle Egret

Migratory Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [[Dataset Information](#)]

Status Type of Presence

Birds

Apus pacificus
Fork-tailed Swift

Listed - overfly marine area Species or species habitat may occur within area

Ardea alba
Great Egret, White Egret

Listed - overfly marine area Breeding likely to occur within area

Ardea ibis
Cattle Egret

Listed - overfly marine area Species or species habitat may occur within area

Gallinago hardwickii
Latham's Snipe, Japanese Snipe

Listed - overfly marine area Species or species habitat may occur within area

Haliaeetus leucogaster
White-bellied Sea-Eagle

Listed Species or species habitat likely to occur within area

Hirundapus caudacutus
White-throated Needletail

Listed - overfly marine area Species or species habitat may occur within area

Lathamus discolor
Swift Parrot

Listed - overfly marine area Species or species habitat may occur within area

Merops ornatus
Rainbow Bee-eater

Listed - overfly marine area Species or species habitat may occur within area

Monarcha melanopsis

Listed - Breeding may occur within area

Black-faced Monarch

overfly
marine
area

Monarcha trivirgatus
Spectacled Monarch

Listed - Breeding likely to occur within area
overfly
marine
area

Myiagra cyanoleuca
Satin Flycatcher

Listed - Breeding likely to occur within area
overfly
marine
area

Rhipidura rufifrons
Rufous Fantail

Listed - Breeding may occur within area
overfly
marine
area

Rostratula benghalensis s. lat.
Painted Snipe

Listed - Species or species habitat may occur
overfly within area
marine
area

Commonwealth Lands [[Dataset Information](#)]

Communications, Information Technology and
the Arts - Telstra Corporation Limited

Places on the RNE [[Dataset Information](#)]

Note that not all Indigenous sites may be listed.

Natural

Bowraville Nature Reserve NSW

Extra Information

State and Territory Reserves [[Dataset Information](#)]

Bollanolla Nature Reserve, NSW

Bowraville Nature Reserve, NSW

Jaaningga Nature Reserve, NSW

Regional Forest Agreements [[Dataset Information](#)]

Note that all RFA areas including those still under consideration have been included.

Lower North East NSW RFA, New South Wales

Caveat

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

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

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is

a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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

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

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

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

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

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

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

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

Acknowledgments

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

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection

- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

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

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This report has been prepared by GHD in response to a specific brief issued by Nambucca Shire Council and the Proposal for services presented by GHD. This report is intended for the sole use of the client. It has been prepared in accordance with the Terms of Engagement for the commission and on the basis of specific instructions and information provided by the client. The contents and conclusion of this report cannot be relied upon by any third party.

This report should not be altered, amended or abbreviated, issued in part or issued incomplete in any way without prior checking and approval by GHD.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	R. Harrison	C Grabham/ J Tipping	<i>J Tipping</i>	M Graver	M Graver	Sep 09

Appendix D

Construction and Operational Noise and Vibration Impact Assessment



CLIENTS | PEOPLE | PERFORMANCE

Nambucca Shire Council

Report on Bowraville Off-River Storage Scheme

Construction and Operational Noise and Vibration Impact Assessment

January 2009

Revision 0



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A Noise Monitoring Results

Glossary

dB	Decibel, which is 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a unit of sound.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels.
L_N	Statistical sound measurement recorded on the linear scale.
L_{AN}	Statistical sound measurement recorded on the "A" weighted scale.
L_{A10} (Time)	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{A10} (1 hour)	The L_{A10} level measured over a 1-hour period.
L_{A10} (18 hour)	The arithmetic average of the L_{A10} levels for the 18-hour period between 0600 and 2400 hours on a normal working day. It is a common traffic noise descriptor.
L_{Aeq} (Time)	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
L_{Aeq} (15 hr)	The L_{Aeq} noise level for the period 7 am to 10 pm.
L_{Aeq} (9 hr)	The L_{Aeq} noise level for the period 10 pm to 7 am.
L_{Aeq} (1 hr)	The L_{Aeq} noise level for a one-hour period. In the context of the NSW DECC <i>Environmental Criteria for Road Traffic Noise</i> , it represents the highest tenth percentile hourly A-weighted L_{eq} during the period 7 am to 10 pm, or 10 pm to 7 am, (whichever is relevant). If this cannot be defined accurately, the highest A-weighted L_{eq} noise level is used.
L_{A90} (Time)	The A-weighted sound pressure level that is exceeded for 90 per cent of the time over which a given sound is measured. This is considered to represent the background noise e.g. L_{A90} (15 min).
L_{Amax} (Time)	The maximum sound level recorded during a specified time interval.
L_{Amin} (Time)	The minimum sound level recorded during a specified time interval.
Rating Background Level (RBL)	<p>The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period. This is the level used for assessment purposes. It is defined as the median value of:</p> <ul style="list-style-type: none"> • All the day assessment background levels over the monitoring period for the day; • All the evening assessment background levels over the monitoring period for the evening; or • All the night assessment background levels over the monitoring period for the night.



Executive Summary

GHD was commissioned by Nambucca Shire Council (NSC) to undertake a noise and vibration impact assessment as part of an Environmental Impact Statement (EIS) for the proposed construction and operation of the Bowraville Off-River Storage Works.

The aim of this noise and vibration assessment has been to assess the level of impact from the construction and operation of the proposed project on the surrounding environment. Due to the nature of the proposed project, noise and vibration impacts during construction have the greatest potential for impact and is therefore the focus of this assessment.

This assessment has been conducted with consideration to the NSW Department of Environment and Climate Change's (DECC) *New South Wales Construction Noise Guidelines: Draft for consultation* (August 2008) (CNG), *Industrial Noise Policy* (INP) (EPA, 2000) and *Assessing Vibration: a technical guideline* (February 2006).

Long-term unattended noise monitoring indicated that the ambient noise environment around the proposed project site was generally low and influenced by typical rural noises, such as insects, birds and wildlife.

Assuming construction activities will primarily be undertaken between 7 am and 6 pm Monday to Friday, and 7 am to 1 pm Saturdays, construction noise impacts may exceed the 41 dB(A) construction noise goal at nearby residential receivers based on the conservative estimates made in this assessment.

Noise from the proposed pipeline construction has the greatest potential for impact due to the proximity of noise receivers to construction activity. However, given the mobile nature of construction activities, it is expected that noise receivers will only be exposed to elevated noise levels for relatively short periods.

GHD believe that with the general type of construction operations and the typical separation distance to nearby receivers, vibration impacts from general construction activities should be negligible. However, blasting, if it occurs may cause vibration impacts at nearby receivers.

Estimations of airblast overpressure indicates that the recommended peak noise level of 115 dB(L) may be reached at up to 1500 metres from the blast location. Estimations of ground vibration levels indicates that the 5 mm/sec recommended limit may be reached at up to 300 metres from the blast location. As attenuation loss from screening of local terrain features has not been taken into account, these estimations are considered to be conservative.

A preliminary analysis of the operational phase of the proposed project reveals that likely noise impacts would be comparable to the existing operational components of the water supply system and, with the application of the identified noise mitigation measures, are not expected to be significant.

Recommendations for noise mitigation measures have been provided in Section 5 of this report.



1. Introduction

GHD was commissioned by Nambucca Shire Council (NSC) to undertake a noise and vibration impact assessment as part of an Environmental Impact Statement (EIS) for the proposed construction and operation of the Bowraville Off-River Storage Works.

The Bowraville Off-River Storage Works involves the construction of an off-river water storage area on the head waters of Bowra Creek, expansion of the existing borefield along the Nambucca River and South Creek, construction of new collection tanks and high lift pumping station, and installation of approximately 1,500 to 2,000 m of pipeline to connect the collection tanks to the proposed off-river storage along with other related roads and power infrastructure. The majority of the study area is located in Viewmount State Forest.

The main objectives of the Bowraville Off-River Storage Works are to increase the capacity of water storage to meet future population growth and demand.

The aim of this noise and vibration assessment is to assess the level of impact from the construction and operation of the proposed project on the surrounding environment. Due to the nature of the proposed project, potential noise and vibration impacts during construction are the focus of this assessment, rather than operational impacts.

This assessment has been conducted with consideration to the NSW Department of Environment and Climate Change's (DECC) *New South Wales Construction Noise Guidelines: Draft for consultation*, (August 2008) (CNG), *Industrial Noise Policy* (INP) (EPA, 2000) and *Assessing Vibration: a technical guideline* (February 2006).

1.1 Scope of Works

The scope of works for this noise assessment comprised:

- ▶ Initial desk top review to identify key environmental noise catchment areas and noise sensitive receivers from aerial photography;
- ▶ Unattended noise monitoring for a period of one week. The monitoring was conducted using four environmental noise loggers and one weather station at noise receiver locations indicative of the local ambient noise environment;
- ▶ Attended noise measurements at the unattended noise logging locations to supplement the unattended measurements;
- ▶ Assessment and filtering of noise data to remove invalid data due to extraneous noise or adverse weather conditions;
- ▶ Based on monitoring results, determination of project specific noise and vibration goals for the construction and operation of the proposed storage with consideration to the abovementioned publications;



- ▶ Identification of the likely principal noise and vibration sources during construction and operation and their potential impacts on sensitive receptors; and
- ▶ One noise modelling scenario using Computer Aided Noise Abatement (CadnaA) software to predict sound pressure levels emanating from the construction works of the proposed storage.

1.2 Limitations

The purpose of the report is to provide an independent operational noise impact assessment for the proposed Bowraville Off-River Storage Works, NSW.

It is not the intention of the assessment to cover every element of the acoustical environment, but rather to conduct the assessment with consideration to the prescribed work scope.

The findings of the acoustic assessment represent the findings apparent at the date and time of the monitoring and the conditions of the area at that time. It is the nature of environmental monitoring that not all variations in environmental conditions can be accessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. Professional judgement must be exercised in the investigation and interpretation of observations.

In conducting this assessment and preparing the report, current guidelines for noise were referred to. This work has been conducted in good faith with GHD's understanding of the client's brief and the generally accepted consulting practice.

No other warranty, expressed or implied, is made as to the information and professional advice included in this report. It is not intended for other parties or other uses.



2. Existing Environment

2.1 Site Location

Bowraville is a small country town located on the Mid-North coast of NSW, approximately 17 km west of Nambucca Heads.

The study area is primarily located to the north of the Bowraville township, as shown in Figure 1.

2.2 Noise Receivers

As construction of the proposed project covers a significant area in the vicinity of Bowraville, with a variety of activities, there are a number of residential receivers that may be affected by noise. Noise receivers in the area have been identified as being primarily residential, with isolated rural dwellings as well as dwellings within the main township of Bowraville.

2.3 Existing Noise Environment

Attended and unattended noise monitoring was conducted by GHD in the area surrounding the proposed NSC storage dam and associated facilities in Bowraville, on the mid north coast of NSW. The purpose of noise monitoring was to determine the existing noise levels in the area, which will assist in setting construction and operational noise goals for the project.

Long-term unattended noise monitoring was undertaken between 18 September and 26 September 2008. Monitoring was undertaken at four residential properties surrounding the project area. Short-term attended noise monitoring was also undertaken at the same locations. Figure 1 shows an aerial image of the noise logger locations and the project site.

An environmental weather station was set-up at one of the noise monitoring locations to capture local weather conditions. The weather station was programmed to record wind speed, wind direction and rainfall on 15-minute intervals for the entire monitoring period.



2.3.1 Noise Monitoring Results

Unattended noise monitoring was undertaken using four Acoustic Research Laboratories (ARL) EL 215 environmental noise loggers. These loggers are capable of measuring continuous sound pressure levels and are able to record L_{A90} , L_{A10} , L_{Aeq} and L_{Amax} noise descriptors. The instruments were programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period.

Prior to deployment, the loggers were calibrated with a sound pressure level of 94 dB at 1kHz using a Bruel and Kjaer Type 4231 sound level Calibrator (serial number 2542101). At completion of the monitoring period, the loggers were retrieved and calibration was rechecked. The data collected by the loggers was downloaded and analysed, and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s, when rainfall occurred, or for when anomalous noise levels occurred.

Table 2-1 displays the detail of each noise logger.

Table 2-1 Unattended Noise Logger Details

Noise Logger	Logger 1	Logger 2	Logger 3	Logger 4
Monitoring Location	1549 Valla Road	122 Bellinghen Road	53 Borefield Road	42 North Arm Road
Logger Serial No.	194803	194539	194637	194688
Measurement Started	18/09/2008 14:00	18/09/2008 15:00	18/09/2008 17:00	18/09/2008 17:30
Measurement Ceased	26/09/2008 08:30	26/09/2008 09:30	26/09/2008 11:00	26/09/2008 11:30
Pre-measurement Calibration	94.2 dB(A)	93.8 dB(A)	93.7 dB(A)	93.6 dB(A)
Freq. Weighting	A	A	A	A
Time response	Fast	Fast	Fast	Fast

Figure 2 to Figure 5 show the location of each logger.



Figure 2 **Logger 1 - 1549 Valla Road**



Figure 3 **Logger 2 - 122 Bellingen Road**



Figure 4 **Logger 3 - 53 Borefield Road**



Figure 5 **Logger 4 - 42 North Arm Road**

Table 2-2 to Table 2-5 present a summary of the long-term noise monitoring data. Statistical noise results are also presented in graphical format in Appendix A. Shaded areas indicate noise data that has been excluded from the data set.

Table 2-2 Summary of Noise Monitoring Results – Logger 1 dB(A)

Logger	Background L _{A30} dB(A)			Ambient L _{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Thursday-18-Sep-08	-	42	29	-	51	49
Friday-19-Sep-08	33	49	34	48	58	50
Saturday-20-Sep-08	33	40	36	47	49	51
Sunday-21-Sep-08	34	45	36	48	53	51
Monday-22-Sep-08	34	43	34	51	52	50
Tuesday-23-Sep-08	32	44	-	48	49	-
Wednesday-24-Sep-08	-	-	-	-	-	-
Thursday-25-Sep-08	-	-	-	-	-	-
RBL and L_{eq} Overall	33	44	34	48	53	50

Note: '-' refers to invalid data that has been excluded from the data set.

Table 2-3 Summary of Noise Monitoring Results – Logger2 dB(A)

Logger	Background L _{A90} dB(A)			Ambient L _{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Thursday-18-Sep-08	-	36	30	-	39	41
Friday-19-Sep-08	32	37	30	44	40	42
Saturday-20-Sep-08	31	37	35	43	42	-
Sunday-21-Sep-08	32	40	31	52	51	42
Monday-22-Sep-08	33	46	32	44	51	43
Tuesday-23-Sep-08	32	44	34	50	54	46
Wednesday-24-Sep-08	34	35	31	48	43	42
Thursday-25-Sep-08	34	35	29	48	43	42
RBL and L_{eq} Overall	32	37	31	48	48	43

Note: '-' refers to invalid data that has been excluded from the data set.

Table 2.4 Summary of Noise Monitoring Results – Logger 3 dB(A)

Logger	Background L _{A90} dB(A)			Ambient L _{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Thursday-18-Sep-08	-	41	28	-	48	39
Friday-19-Sep-08	31	45	29	42	52	42
Saturday-20-Sep-08	31	43	33	41	51	47
Sunday-21-Sep-08	31	46	29	45	55	42
Monday-22-Sep-08	32	45	29	43	50	45
Tuesday-23-Sep-08	30	45	31	45	53	44
Wednesday-24-Sep-08	31	30	29	42	45	36
Thursday-25-Sep-08	32	35	28	43	46	36
RBL and L_{eq} Overall	31	44	29	43	51	43

Note: '-' refers to invalid data that has been excluded from the data set.

Table 2-5 Summary of Noise Monitoring Results – Logger 4 dB(A)

Logger	Background L _{A90} dB(A)			Ambient L _{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Thursday-18-Sep-08	-	44	28	-	50	42
Friday-19-Sep-08	32	46	28	45	49	44
Saturday-20-Sep-08	31	46	31	45	49	-
Sunday-21-Sep-08	31	47	29	44	51	43
Monday-22-Sep-08	34	50	30	47	53	43
Tuesday-23-Sep-08	33	46	31	49	-	50
Wednesday-24-Sep-08	32	31	28	49	42	41
Thursday-25-Sep-08	35	40	27	48	48	40
RBL and L_{eq} Overall	32	46	29	47	51	46

Note: '-' refers to invalid data that has been excluded from the data set.

Attended noise monitoring was conducted over 15-minute periods at each of the long term monitoring locations. Attended measurements were undertaken using a Bruel and Kjaer 2250 sound level meter (SLM) (serial number 2506887). This SLM is capable of measuring continuous sound pressure levels and is able to record L_{Amin} , L_{A90} , L_{A10} , L_{Amax} and L_{Aeq} noise descriptors. On-site calibration conducted immediately before and after the measurements showed negligible variation. Details of the existing noise environment were also made during these monitoring periods. The results of attended monitoring are shown in Table 2-6.

Table 2-6 15-Minute Attended Noise Monitoring Results

Monitoring Location and Description	$L_{Aeq, 15}$ minute	$L_{A90, 15}$ minute	$L_{A10, 15}$ minute	Comments on Noise Environment
Logger 1 – 1549 Valla Road 26/09/2008 08:15	53	32	45	Typical rural environment with local animals and nearby insects influencing the ambient noise. No traffic or mechanical noise was audible during monitoring.
Logger 2 – 122 Bellingin Road 26/09/2008 09:15	37	30	39	Typical rural environment with local animals and insects influencing the ambient noise. Noise from distant farm animals was audible. Traffic noise on Bellingin Road was barely audible and intermittent in nature.
Logger 3 – 53 Borefield Road 26/09/2008 10:30	46	28	38	Typical rural environment with local animals and insects influencing the ambient noise. Traffic noise on North Arm Road was barely audible and intermittent in nature.
Logger 4 – 42 North Arm Road. 26/09/2008 11:30	41	31	44	Typical rural environment with local animals and insects influencing the ambient noise. Audible but intermittent traffic on North Arm Road was removed from measurements (4 car pass-by's in 15 minutes).



2.3.2 Discussion

Long-term and attended noise monitoring and site observations indicate the following:

- ▶ The ambient noise environment at each of the monitoring locations was influenced by typical rural noises, such as insects, birds and wildlife;
- ▶ Background L_{A90} noise levels were generally low during the day and night periods at all logging locations. As per the Department of Environment and Climate Change's (DECC) NSW Industrial Noise Policy (INP), where the rating background level is less than 30 dB(A), then it is set to 30 dB(A); and
- ▶ Monitoring results showed that evening background noise levels were generally higher than the daytime and nighttime levels. These situations can often arise due to increased insect or bird noise during the evening in the warmer months (or due to temperature inversion conditions during winter). Therefore, in determining the project-specific noise levels, the nighttime rating background level for each monitoring location will be adopted for the evening time period, with consideration to INP Application Notes.

3. Noise Criteria

3.1 Construction Noise

This assessment has been undertaken with consideration to the Department of Environment and Climate Change (DECC) *New South Wales Construction Noise Guidelines: Draft for consultation, August 2008*. The DECC guidelines recommend a qualitative assessment be undertaken for large infrastructure activities.

This guideline recommends standard hours for construction activity as follows:

- ▶ Monday to Friday: 7 am to 6 pm;
- ▶ Saturday: 8 am to 1 pm; and
- ▶ No work on Sundays or Public Holidays.

GHD understand that construction hours will be limited to between 7 am and 6 pm during weekdays, and the recommended hours on weekends.

The DECC construction noise guidelines provides noise management levels for construction noise at residential receivers. These management levels are to be calculated based on the adopted rating background level (RBL) at nearby residential locations. Table 3-1 details the adopted construction noise goals for the proposed project.

The lowest measured daytime RBL of 31 dB(A) was recorded at Logger 3 (53 Borefield Road). GHD has conservatively adopted this daytime RBL for all noise receivers surrounding the project area. The lowest measured nighttime RBL was also adopted from Logger 3 and as previously mentioned, was increased to 30 dB(A) with consideration to the NSW INP.

Table 3-1 NSW DECC Construction Noise Goals

Time period	Management Level L _{Aeq} (15 min) dB(A)	Measured RBL L _{A90} (period) dB(A)	Adopted Noise Goal L _{Aeq} (15 min) dB(A)
Recommended standard hours:	Noise affected RBL + 10 dB(A)	31	41
Monday to Friday: 7 am to 6 pm			
Saturday: 8 am to 1 pm	Highly noise affected 75 dB(A)	N/A	75
No work on Sundays or Public Holidays			
Outside recommended standard hours	Noise affected RBL + 5 dB(A)	30 ⁽¹⁾	35

(1) The DECC's NSW INP, states that where the RBL is less than 30 dB(A), then it is set to 30 dB(A).

Based on the proposed construction times, this assessment will be based on the daytime construction noise goal of 41 dB(A) L_{Aeq} (15 minute).



3.2 Operational Noise

The operational noise goals have been set with consideration to the NSW INP. The INP guidelines include both Intrusive and Amenity criteria that are designed to protect receivers from noise significantly louder than the background level, and to limit the total noise level from all sources near a receiver.

Intrusive noise limits set by the INP control the relative audibility of operational noise compared to the background level. The Amenity criteria limit the total level of extraneous noise. Both sets of criteria are calculated and the more stringent of the two in each time period applies.

The Amenity criteria are determined based on the overall acoustic characteristics of the receiver area and the existing level of noise, excluding other noises that are uncharacteristic of the usual noise environment. Residential receiver areas are characterised into 'urban', 'suburban', 'rural' or other categories based on land uses and the existing level of noise from industry, commerce, and road traffic.

Rating background noise levels have been taken from Logger 3 (53 Borefield Road), as it was believed that the noise levels recorded at this location were a valid representation of the surrounding areas and were not influenced by traffic noise or other extraneous noise.

The project specific noise criteria during operation of the proposed project at residential receivers are provided in Table 3-2.

Table 3-2 Project Specific Noise Levels – Residential Receivers, dB(A)

Criterion	Bowraville Off-River Storage		
	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
A: Rating Background Level	31 $L_{ASQ(day)}$	30 ⁽¹⁾ $L_{ASQ(evening)}$	30 ⁽²⁾ $L_{ASQ(night)}$
B: Intrusiveness Criteria (A + 5dB)	36 $L_{Aeq(15 min)}$	35 $L_{Aeq(15 min)}$	35 $L_{Aeq(15 min)}$
C: Rural Amenity Criteria (INP Table 2-1)	50 $L_{Aeq(day)}$	45 $L_{Aeq(evening)}$	40 $L_{Aeq(night)}$
D: Amenity Criteria: (INP Table 2-2 Adjusted)	NA	NA	NA
Project Specific Noise Level (Pg 21 INP)	36 $L_{Aeq(15 min)}$	35 $L_{Aeq(15 min)}$	35 $L_{Aeq(15 min)}$

(1) Nighttime RBL adopted due to high recorded noise levels during the evening period; and

(2) The DECC's NSW INP, states that where the RBL is less than 30 dB(A), then it is set to 30 dB(A).

The NSW INP requires that the noise level at residences be assessed at the most affected point on or within the residential boundary or, if this is more than 30 m from the residence, at the most-affected point within 30 m of the residence.

3.2.1 Road Traffic Noise Criteria

Due to the potential for the proposed development to create additional traffic levels during the construction phase, road traffic noise criteria may apply. GHD understand that Valla Road will be used as the main access road for the construction of the storage area and dam wall.

Road traffic noise criteria are sourced from the DECC's ECRTN. The ECRTN contains a number of criteria applied to residential receivers near roads, depending on the situation and the road classification. Situation Category 13 in the ECRTN applies to land use developments with potential to create additional traffic on local roads, and as such is applicable to the proposed development.

The ECRTN states that in assessing noise levels at residences, the noise level is to be determined at 1 m from the most exposed façade at a height of 1.5 m. This criterion includes an allowance for noise reflected from the façade of the building (façade correction). When measuring in a free-field location a correction factor of 2.5 dB(A) should be added to the measured value.

Category 13 of the ECRTN's is provided in Table 3-3.

Table 3-3 ECRTN Road Traffic Noise Criteria L_{Aeq}

Situation	Day (7 am – 10 pm) dB(A)	Night (10 pm – 7 am) dB(A)	Where Criteria are Already Exceeded
13. Land use developments with potential to create additional traffic on local roads	$L_{Aeq}(1hr)$ 55	$L_{Aeq}(1hr)$ 50	Where feasible and reasonable, noise levels from existing roads should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicle; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB.

3.2.2 Sleep Disturbance

The DECC publication *Noise Guide for Local Government* (NGLG) provides consideration for sleep arousal levels. It states that noise control should be applied with the general intent to protect people from sleep arousal. The DECC's ECRTN provides further clarification on sleep disturbance.

The purpose of sleep arousal guidelines is to address short high-level noise likely to cause awakening during the night time period 10:00 pm to 7:00 am (8:00 am on Sundays and Public Holidays). To achieve this, the $L_{A1(60 \text{ seconds})}$ or L_{Amax} noise level of any specific noise source should not exceed the background noise level (L_{A90}) by more than 15 dB(A) when measured externally 1 m from a bedroom window. This criterion takes into account the emergence of noise events but does not directly limit the number of such events or their peak level, which are also found to affect sleep disturbance.

Table 3-4 shows the L_{Amax} noise criteria levels at receiver locations.

Table 3-4 ENCM Sleep Disturbance Criteria L_{Amax} dB(A)

Location	Project-Specific Criteria L_{Amax}
All sensitive receivers	45

Due to the proximity of noise receivers to the proposed site, some nighttime operations may have the potential to exceed the sleep disturbance criteria. Therefore, recommendations for noise control have been made in Section 5 of this report.

3.3 Vibration Guidelines

Vibration during construction activity is expected to primarily originate from haul trucks and heavy machinery during earth moving stages of construction. GHD also understand that blasting may occur during the construction phase.

3.3.1 Human Exposure

Vibration goals during the construction phase were sourced from the DECC's *Assessing Vibration: a technical guideline*, which is based on guidelines contained in British Standard (BS) 6472-1992, *Evaluation of human exposure to vibration in buildings (1-80 Hz)*.

Intermittent vibration is assessed using the vibration dose value (VDV), fully described in BS 6472 – 1992. Acceptable values of vibration dose are presented in Table 3-5.

Table 3-5 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime ¹		Nighttime ¹	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas ²	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

¹ Daytime is 7:00 to 22:00 and nighttime is 22:00 to 7:00; and

² Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be need to assess intermittent values against the continuous or impulsive criteria for critical areas.

3.3.2 Building Damage

Currently, there is no Australian Standard that sets the criteria for the assessment of building damage caused by vibration. Guidance of limiting vibration values is attained from reference to the following International Standards and Guidelines:

- ▶ British Standard BS7385.2 - 1993 *Evaluation and Measurement for Vibration in Buildings*, Part 2 - Guide to damage levels from ground borne vibration; and
- ▶ German Standard DIN 4150-3: 1999-02 Structural Vibration – Part 3: *Effects of vibration on structures*.

BS7385.2 – 1993 is utilised in this case in the assessment of potential building damage resulting from ground borne vibration produced by the proposed construction activity.

The recommended Peak Particle Velocity (PPV) guidelines for the possibility of vibration induced building damage are derived from the minimum vibration levels above which any damage has previously been encountered, and are presented in Table 3-6.

Table 3-6 Transient Vibration Guideline Values for Potential Building - Cosmetic Damage

Building Type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures. Residential or light commercial type buildings.	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

1 Values referred to are at the base of the building; and

2 For transient vibration effecting unreinforced or light framed structures at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

3.3.3 Blasting

The DECC's *Assessing Vibration: a technical guideline* requires that vibration and overpressure from blasting be assessed against the levels in the Australian and New Zealand Environment Council (ANZEC) *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration*, 1990.

The recommended maximum level of airblast overpressure during blasting is 115 dB(L) peak. The noise level of 115 dB(L) may be exceeded on up to 5% of the total number of blasts over a period of 12 months though not exceed 120 dB(L).



The recommended maximum level for ground vibration is 5 mm/sec peak particle velocity (ppv). The ppv level of 5 mm/sec may be exceeded on up to 5% of the total number of blasts over a period of 12 months though not exceed 10 mm/sec at any time.

Blasting should generally only be permitted between the hours of 9:00 am and 5:00 pm Monday to Saturday, and should not occur at any time on Sunday or Public Holidays. Blasting should generally only take place once per day.



4. Noise and Vibration Assessment

4.1 Construction Noise

The DECC's Construction Noise Guidelines requires a number of parameters for predicting noise impacts adequately. At the time of this assessment, information to fulfil these requirements was not fully available; hence a detailed quantitative noise assessment has not been undertaken at this stage. Instead a semi-quantitative desktop assessment of construction noise impacts has been undertaken, based on assumptions of the construction schedule, as detailed below.

4.1.1 Anticipated Construction Methodology

Dam Construction

Construction of the dam storage area is expected to include:

- ▶ Clearing of approximately 75 ha of land;
- ▶ Construction of the dam wall and associated facilities; and
- ▶ Surfacing and widening of Valla Road.

Pipeline Construction

Pipeline construction will predominantly be constructed by trenching. This generally involves excavating a trench, laid with a suitable bedding material. Pipe sections are laid in the trench and connected to the adjoining pipe sections to form a seal.

This process requires a construction corridor to allow access for trenching machinery and removal of material, and then space to store and place the pipe. During construction, excess material would be stockpiled on one side of the trench. Once the pipe is installed, the trench is refilled, covering the pipe. The corridor for construction is remediated and revegetated.

The following indicative construction program has been assumed and adopted for the purpose of this assessment:

- ▶ One or more teams will work progressively along the length of the pipeline alignment;
- ▶ Within the active construction corridor, each team will undertake work consecutively at separate locations:
 - Clearing and grading; and
 - Pipe stringing, trenching, pipe-laying and backfilling.

High Lift Pump Station Construction

Construction of the booster pump station is anticipated to employ standard excavation and construction techniques. These are likely to include:

- ▶ Excavation via traditional methods;
- ▶ Construction of concrete foundations;



- ▶ Pump station building construction; and
- ▶ Installation of pumps and plant.

Borefield Pump Construction

Construction of the borefield pumps is anticipated to employ standard excavation and construction techniques. These are likely to include:

- ▶ Drilling of bore via traditional methods;
- ▶ Construction/ Installation of bore encasement;
- ▶ Erection of bore infrastructure; and
- ▶ Installation of pumps and plant.

4.1.2 Major Equipment for Construction

For the purpose of this noise impact assessment, the construction process has been divided into the following components:

- ▶ Dam construction, including the dam wall and dam body;
- ▶ Pipeline trenching; and
- ▶ High lift pump station construction.

Indicative plant inventories for each component of the construction processes have been compiled, based on assumptions at the time of this assessment. These inventories, which include approximate descriptions and numbers for construction plant, formed the basis of this assessment.

As construction noise goals are based on a 15-minute period, worst-case construction conditions have been assumed over this time.

GHD understand that construction activities are only planned during daytime hours (7 am to 6 pm).

Table 4-1, Table 4-2 and Table 4-3 below summarise these inventories.

Table 4-1 Dam Storage Area and Dam Wall Construction Inventory

Activity	Plant
Clearing and earthworks	Excavator
	Dump truck
	D8 Dozer
	Chainsaw

Activity	Plant
Dam wall construction	Excavator
	Dump truck
	Concrete truck
	Crane
	Heavy vehicle
Worker's vehicles	Car ⁽¹⁾

(1) Staff vehicles have been excluded from this assessment as they are anticipated to be active only during brief periods prior to and following each day's work and are expected to be significantly quieter than construction plant, which is expected to present the noise issues of greater concern.

Table 4-2 Pipeline Trenching Construction Inventory

Activity	Plant
Clear and Grade	Excavator
	Dump truck
	D8 Dozer
Trenching and Pipe-laying	Excavator
	Dump truck
	Welder and Generator
Backfill	Loader
	Dump truck
	Excavator
	Back Hoe
	Compactor
Worker's vehicles	Car ⁽¹⁾

(1) Staff vehicles have been excluded from this assessment as they are anticipated to be active only during brief periods prior to and following each day's work and are expected to be significantly quieter than construction plant, which is expected to present the noise issues of greater concern.



Table 4-3 High Lift Pump Station Construction Inventory

Activity	Plant
High Lift Pump Station Construction	Excavator
	Tip Truck
	Loader
	Roller
	Welder and Generator
	Mobile Crane

Table 4-4 Borefield Pumps Construction Inventory

Activity	Plant
Borefield Pumps Construction	Excavator
	Tip Truck
	Welder and Generator
	Mobile Crane

4.2 Construction Noise Results and Discussion

Construction noise impacts associated with the Project were conservatively estimated using the well-known distance attenuation relationship described in Equation (1).

$$SPL = SWL - 20\text{Log}(d) + 10\text{Log}(Q) - 11 \quad \text{Equation (1)}$$

Where d = distance (m) between source and receiver;

Q = Directivity index (2 for a flat surface);

SPL = sound pressure level at the distance d from the source; and

SWL = sound power level of the source.

Typical noise levels produced by the types of construction plants anticipated to be used were sourced from Australian standard AS 2436: 1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* and from GHD's internal database. These represent the loudest construction noise sources expected to be found on site and are summarised in Table 4-5.

Table 4-5 Predicted Plant Item Noise Levels, dB(A)

Plant	Estimated L_W dB(A)	Estimated SPL dB(A) at Distance (m)						
		50	100	200	400	600	1200	2400
Crane	104	62	56	50	44	40	34	28
Dozer	105	63	57	51	45	41	35	29
Excavator	100	58	52	46	40	36	30	24
Back Hoe	97	55	49	43	37	33	27	21
Compactor	108	66	60	54	48	44	38	32
Loader	104	62	56	50	44	40	34	28
Roller	102	60	54	48	42	38	32	26
Dump Truck	102	60	54	48	42	38	32	26
Heavy Vehicle	103	61	55	49	43	39	33	27
Compressor	86	44	38	32	26	22	16	10
Concrete Truck	103	61	55	49	43	39	33	27
Concrete Saw	118	76	70	64	58	54	48	42
Chainsaw	111	69	63	57	51	47	41	35
Rock Breaker	120	78	72	66	60	56	50	44
Welding	101	59	53	47	41	37	31	25

The magnitude of off-site noise impact associated with construction will be dependent upon a number of factors:

- ▶ The intensity of construction activities;
- ▶ The location of construction activities;
- ▶ The type of equipment used;
- ▶ Existing local noise sources;
- ▶ Intervening terrain; and
- ▶ The prevailing weather conditions.



In addition, construction machinery will likely move about the study area, variously altering the directivity of the noise source with respect to individual receivers. During any given period, the machinery items to be used in the study area will operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time. Finally, certain types of construction machinery will be present in the study area for only brief periods during construction.

Assuming construction activities will primarily be undertaken between 7 am and 6 pm Monday to Friday, and 8 am to 1 pm Saturdays, construction noise impacts may exceed the 41 dB(A) construction noise goal at nearby residential receivers based on the conservative estimates made in Table 4-5.

Given the mobile nature of construction activities, it is expected that noise receivers will only be exposed to elevated noise levels for relatively short periods.

4.3 Construction Vibration Impacts

4.3.1 General Construction

Vibration impacts discussed in this section essentially focus on potential structural damage to properties in close vicinity of the study area and/or potentially affected by construction activities.

Construction vibration may be perceived at times at local sensitive receivers; however, the level of annoyance will depend on individuals. Such issues are practically best managed by site monitoring. Circumstances where vibration monitoring should be undertaken are outlined in the construction-related recommendations (refer to Section 5 of this report).

The distance between the potentially impacted receivers and site construction activities will in most cases be well in excess of 100m. However, it is possible that pipeline construction works be carried out at distances closer to residences.

Table 4-6 outlines typical vibration levels for different plant activities sourced from the NSW RTA Publication *Environmental Noise Management Manual*.

Table 4-6 Typical Vibration Levels – Construction Equipment

Item	Peak Particle Velocity at 10m (mm/s)
Loader	6-8
15 Tonne Compactor	7-8
Roller	5-6
Dozer	2.5-4
Backhoe	1

As can be seen in the above figure, the building damage 15 mm/s lower limit (as outlined in Section 3) is normally not exceeded by general construction activities at distances greater than 10 m.

GHD believe that with the general type of construction operations and the typical separation distance to nearby receivers, vibration impacts from general construction activity should be negligible. However, blasting, if it occurs is expected to generate the most significant vibrations levels and may cause vibration impacts at nearby receivers.

4.3.2 Blasting

Estimations for ground vibration and airblast overpressure during blasting have been made with consideration to Australian Standard AS2187.2-2006 *Explosives – Storage and use – Use of explosives*.

Airblast levels have been estimated using the following cube root scaling formula:

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^a \quad \text{Equation (2)}$$

Table 4-7 summarises the constants in Equation (2) and the values that have been assumed to estimate airblast levels in this assessment.

AS2187.2-2000 states that for confined blasthole charges, which would most likely be the case for blasting associated with construction of the proposed off-river storage area, a good estimation may be obtained by using a site exponent (a) of -1.45, with the site constant (K_a) commonly in the range of 10 – 100.

Table 4-7 Airblast Parametres and Assumptions

Parameter	Definition	Assumed Value
P	Pressure (kPa)	N/A
Q	Explosive charge mass (kg)	100 ⁽¹⁾
R	Distance from charge (m)	Range: 200 to 1000 metres
K_a	Site constant	50 ⁽²⁾
a	Site exponent	-1.45

(1) Charge mass has been calculated based on a typical hole diameter of 89 mm, column height of 13 metres and a charge mass of 7.5 kg/meter (specific gravity 1.2); and

(2) A site constant value (K_a) of 50 has been assumed for the sake of this assessment.

Factors that affect the level of ground vibration arriving at a point from a blast typically include:

- ▶ Charge mass fired per hole;
- ▶ Distance; and
- ▶ Ground transmission characteristics.