A further targeted survey was undertaken in July 2008. The objective of this survey was to undertake a habitat assessment to better resolve the likelihood of the presence of suitable habitat for the following threatened frog species:

- green and golden bell frog (*Litoria aurea*)
- stuttering frog (*Mixophyes balbus*)
- giant barred Frog (*Mixophyes iterates*)
- green–thighed frog (*Litoria brevipalmata*).

Potential habitat was found only for the stuttering frog. This was restricted to two small areas; one at Munni Bridge along a small side gully crossed by Heatherbrae Road and the other near the Williams River at Underbank. The habitat in both locations was considered to be too small and limited to support a viable population of the stuttering frog.

Most of the bird species identified are relatively common and widespread, and expected to be found in the habitats present in the Project area. The speckled warbler (*Pyrrholaemus sagittatus*), which is listed as vulnerable under the TSC Act, was identified during surveys (refer Figure 11.3). The following five migratory species listed under the EPBC Act were also recorded:

- white-bellied sea–eagle (*Haliaeetus leucogaster*)
- white–throated needletail (*Hirundapus caudacutus*)
- rainbow bee–eater (*Merops ornatus*)
- black–faced monarch (*Monarcha melanopsis*)
- rufous fantail (*Rhipidura rufifrons*).

Of the 32 mammal species identified during surveys, the following seven are listed as vulnerable under the TSC Act:

- eastern freetail–bat
- southern myotis
- eastern bentwing–bat
- squirrel glider
- brush–tailed phascogale
- koala
- grey–headed flying fox.

The grey–headed flying fox is also listed as vulnerable under the EPBC Act.

In addition to those threatened species positively identified, the greater broad–nosed bat, eastern false pipistrelle and the golden–tipped bat were given a tentative identification based on ultrasonic call analysis. These three species are listed as vulnerable under the TSC Act.

All reptiles recorded were relatively common and widespread species. No snake species were positively recorded although an unidentified snake skin was found adjacent to Quart Pot Creek Road. Several other common reptiles expected to occur within the Project area include the wall skink (*Cryptoblepharus virgatus*), barred–sided skink (*Eulamprus tenuis*) and eastern brown snake (*Pseudonaja textilis*).

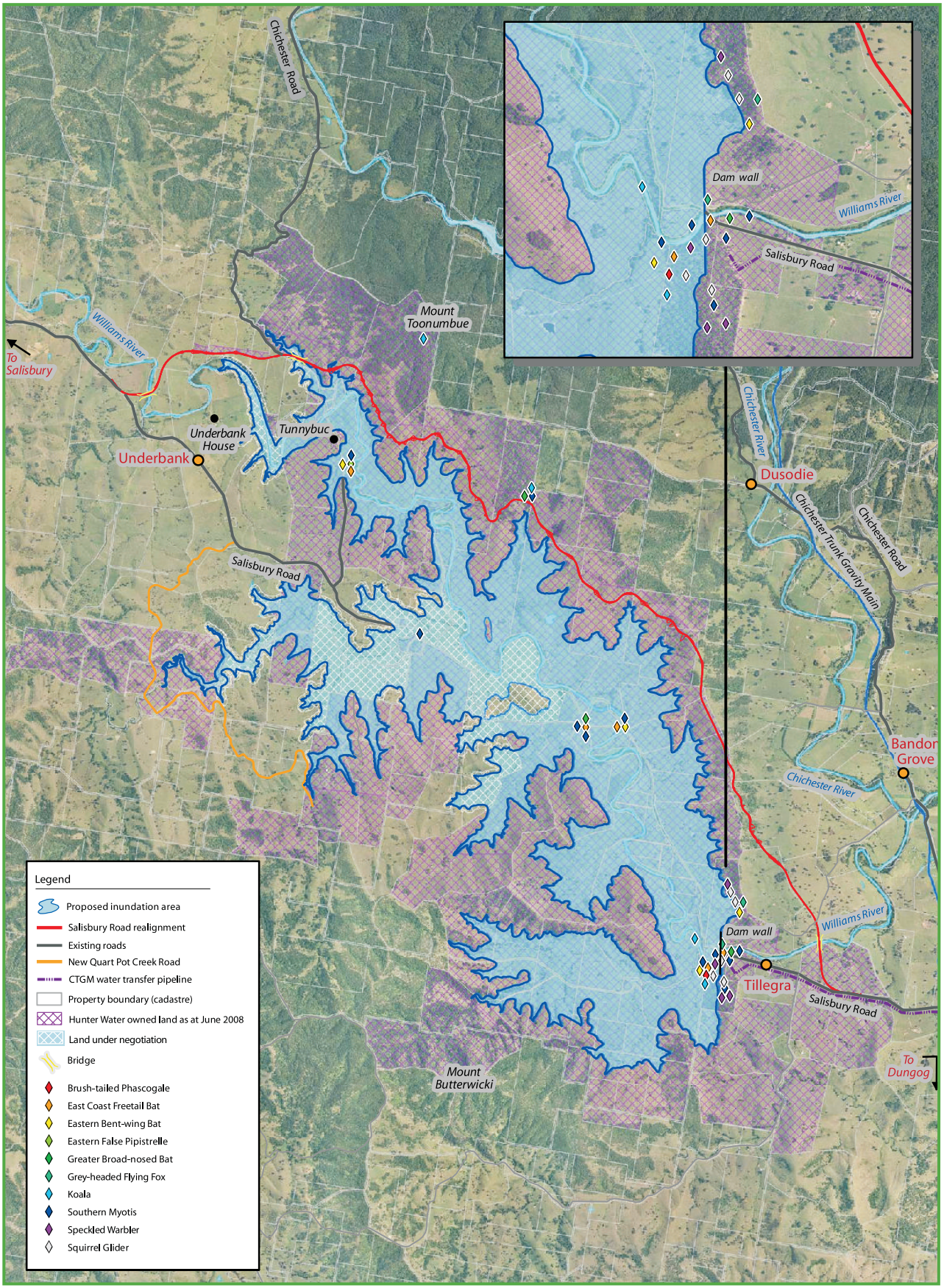

FIGURE 11.3 LOCATIONS OF THREATENED FAUNA SPECIES RECORDED DURING FIELD SURVEYS

Most of the 16 frog species recorded were identified along the Williams River or at the proposed dam site near Tillegra Reserve. No threatened frog species were recorded during the survey.

The Project area contains several habitats which provide a range of foraging and roosting resources for native fauna. These are described in Table 11.1.

TABLE 11.1 HABITAT FEATURES OF THE PROJECT AREA

HABITAT FEATURE	DESCRIPTION
1) Vegetation structure	Spotted gum–ironbark forest Dry slopes forest Floodplain forest Riparian eucalypt and river oak forest Cleared pasture with scattered remnant trees
2) Dominant species	Spotted gum, ironbark Grey box, stringybark Forest red gum, grey box Rough-barked apple, Sydney blue gum, river oak Exotic and native grasses, weeds
3) Density of shrub and ground cover	Moderate to dense shrub and ground cover in some areas, grazed or lantana infested in other areas Sparse shrub layer, sparse to moderate ground layer Generally sparse shrub layer with dense, grassy ground cover Sparse shrub cover, moderate to dense ground cover with many weeds, particularly exotic vines Almost no shrub layer, generally dense ground cover, introduced and native grasses
4) Soil type	Soil landscape types include alluvial, colluvial, erosional and stagnant alluvial
5) Topography	Varies from gently undulating to steep undulating, with limited areas of flat floodplains
6) Presence of:	
Large mature trees (>50 cm DBH)	A number of large mature trees occur throughout the subject site, particularly within Tillegra Reserve, along riparian areas and roadsides. Also occur as paddock trees.
Dead trees	A number of dead standing trees occur within remnant vegetation and paddocks throughout the site
Hollow-bearing trees	A number of hollow-bearing trees occur within the subject site, particularly within Tillegra Reserve, along riparian areas and roadsides. Also occur as paddock trees.
Fallen timber	The bushland areas contain scattered fallen timber with some large hollow logs. The majority of the cleared land has only a limited amount of fallen timber.
Rock outcrops	Some rock outcrops within the study area, though no large cliff areas were observed.
Wet areas or waterbodies	Williams River and associated tributaries, also numerous dams and ponds
7) Extent of weed invasion	Some remnant native vegetation within the study area is relatively free of weeds, though many areas have been heavily grazed and are infested with lantana. Areas of cleared pasture are dominated by introduced species.

HABITAT FEATURE	DESCRIPTION
8) Assessment of previous and present land use and disturbance regimes	Past and present grazing of cattle has resulted in much of the native vegetation within the study area being cleared and replaced by introduced pasture grasses. In many of the remaining patches of native vegetation the understorey has been greatly modified or replaced by lantana. Tillegra Reserve represents the most intact patch of remnant vegetation.
9) Extent of connectivity, movement corridors and refugia	Much of the remnant native vegetation within the subject site exists as isolated patches and movement between these patches is likely only to be possible for more mobile species (eg. bats, birds, large macropods). Reasonably good connectivity exists via riparian vegetation along the Williams River and its tributaries. Patches of vegetation along the ridgeline and hillslopes north of Tillegra bridge may provide some connectivity to larger tracts of bushland towards Chichester Dam and Barrington Tops. Similarly, vegetation south of Tillegra Reserve and along Native Dog Creek may provide some connectivity to larger tracts of bushland to the south-east of the study area.

11.3 Potential impacts on flora

The principal impacts on flora would occur during the construction and filling phases of the Project, with relatively minor potential for impact during the operation phase. Clearing of vegetation would be required in the vicinity of the dam wall and spillway, the main impact being on Tillegra Travelling Stock Reserve, the majority of which would need to be removed. Vegetation would also need to be cleared along the Salisbury Road realignment corridor. The extent of this has already been reduced to a degree through the route selection process which gave consideration to avoiding vegetated areas as far as practicable.

Some clearing of vegetation would also likely be required within the inundation area to reduce the risk of collision to water craft using the storage and for other activities such as swimming. As noted in Chapter 6, HWC intends to operate the storage within the range of 90 per cent of FSL (approximately 148 mAHD) and FSL outside of drought periods. Removal of vegetation from 145 mAHD (approximately 75 per cent of FSL) up to FSL would provide a reasonable margin of safety.

Clearing may be restricted to a designated area within the main body of the dam to provide a safe navigation area for recreational watercraft. Elsewhere, where practicable, vegetation and woody debris would be preserved along the shoreline and tributaries to the storage. This would encourage the creation and/or preservation of fish habitat.

Assessment of potential impacts of the Project on threatened flora has been undertaken in accordance with Appendix 3 to the draft *Guidelines for Threatened Species Assessment* (DEC 2005). This is fully documented in Working Paper E and summarised as follows.

11.3.1 Vegetation communities

As noted, five native vegetation communities occur within the Project area. The predicted extent of impact on each community is indicated in Table 11.2. The majority of the 2,100 hectares to be inundated or additional land affected by the construction activities, including the realigned section of Salisbury Road, consists of pasture land with scattered remnant paddock trees.

TABLE 11.2 EXTENT OF VEGETATION REMOVAL ASSOCIATED WITH THE PROJECT

VEGETATION COMMUNITY	INUNDATION AREA (HA)	DAM AND ROADS (HA)	TOTAL (HA)
Subtropical Rainforest	0	0.2	0.2
Moist Gully Blue Gum Wet Sclerophyll Forest	1.7	0.8	2.5
Spotted Gum-Ironbark Forest	20.6	11.6	32.2
Forest Red Gum Moist Slopes Forest	41	2.7	43.7
Riparian Forest	145.0	0	145
Total area	208.3	15.3	223.6

Within the Project area, the Subtropical Rainforest community is confined to discrete patches in sheltered gullies along the preferred route for the realigned section of Salisbury Road. This community consists of a closed forest with emergent tall rainforest trees and a high diversity of small to medium trees with mesophyllous leaves. Ferns, vines and epiphytes are abundant in the ground layer and on trees and large shrubs. The road alignment has been designed to avoid this community as far as practically possible and as a consequence the Project would affect only a small area of this community.

The Moist Gully Blue Gum Wet Sclerophyll Forest community occurs in small to medium sized patches in moist open gullies or small riparian areas in the upper reaches of creeks within the Project area. This community is dominated by tall eucalypt species with some rainforest elements or moist-adapted species in the understorey. Approximately 2.5 hectares of this community would be impacted by the Project.

The Spotted Gum-Ironbark Forest community occupies large patches of the proposed dam wall, spillway area and adjacent ridge tops, slopes and also some lowland areas. This community is an open forest with a sparse to moderate dry or grassy understorey. The shrub layer is sometimes sparse to absent, but dominated by dense lantana in some patches. The main impact would be in the vicinity of the dam wall where approximately 32.2 hectares would be impacted.

The Forest Red Gum Moist Slopes Forest community occurs mainly on slopes and gullies along the preferred route for the realigned section of Salisbury Road but some remnants also occur in riparian areas and on the floodplain. This community consists of an open forest with a sparse to moderate moist or grassy understorey. The shrub layer is sparse to absent or dominated by moderate to dense lantana patches in some areas. Approximately 43.7 hectares of this community would be impacted by the road realignment and by inundation.

Within the Project area, the Riparian Forest community occupies the flat, low-lying areas in a narrow band, broadening in some places across the floodplain, and along the Williams River and its major tributaries. This community is primarily dominated by river oaks with interspersed and secondary areas of flood-tolerant eucalypts, clumps of paperbarks, usually a mesic understorey and a high proportion of weedy species. The greatest extent of vegetation loss would occur within this community with approximately 145 hectares impacted as a result of inundation.

Overall, the loss of approximately 224 hectares of native vegetation is considered a relatively small impact when considering the extent of the Project and the total area of land that would be affected. Significant areas of the various identified vegetation communities exist elsewhere in the region.

11.3.2 Endangered ecological communities

As previously noted, the vegetation communities within the Project area incorporate two EECs plus small areas of another intergrade EEC. The relocated section of Salisbury Road would affect the edges of a small area of the *Lowland Rainforest* EEC. A substantial area of the Riparian Forest community consisting of the *River-flat Eucalypt Forest on Coastal Floodplains* EEC variant (including a minor intergrading component of the *Subtropical Coastal Floodplain Forest* EEC) would be completely removed due to inundation. This is due to the Project covering a long stretch (approximately 19 kilometres) of the Williams River plus a number of its tributaries, most of which support riparian vegetation along their floodplains.

Table 11.3 identifies the size of the areas which would be affected based on the FSL of 152.3 mAHD.

TABLE 11.3 EXTENT OF EEC REMOVAL

VEGETATION COMMUNITY	CORRESPONDING EEC	IMPACT AREA (HA)
Subtropical Rainforest	Lowland Rainforest	0.2
Riparian Forest	River-flat Eucalypt Forest on Coastal Floodplains (variant)	145.0
	Subtropical Coastal Floodplain Forest (intergrade form)*	

* Small parts of the Riparian Forest where the watercourse runs through a deeper gully contain rainforest elements consistent with the Subtropical Coastal Floodplain Forest EEC however these soon intergrade with the River-flat Eucalypt Forest on Coastal Floodplains EEC variant. Calculated area excludes the river channel to obtain a true estimate of vegetated area.

Data from the vegetation mapping of the Comprehensive Regional Assessment of north eastern NSW (National Parks and Wildlife Service 1999) was reviewed to provide a regional perspective for the extent of each EEC that would be impacted by the Project. The area covered by this regional study broadly corresponds to the North Coast Bioregion. While an exact comparison of the communities identified for this Project with those by NPWS (1999) is not possible, the most closely corresponding communities in the two studies have been used. This may result in minor over or underestimation of areas of EECs affected. The regional extent of EECs affected by the Project is presented in Table 11.4.

TABLE 11.4 EXTENT OF EECS IN THE REGION AND 20 KM RADIUS OF THE PROJECT

EEC	TOTAL EXTENT OF EEC IN REGION (HA)	AREA OF EEC WITHIN 20 KM RADIUS (HA)	AREA OF EEC IMPACTED BY PROJECT (HA)	PERCENTAGE OF EEC IMPACTED	
				WITHIN 20 KM RADIUS	WITHIN ENTIRE REGION
Lowland Rainforest	256,326	4,758	0.2	0.004%	0.00008%
River-flat Eucalypt Forest	21,420	643	145.0	22.5%	0.7%

From Table 11.4 it is evident that only a very small proportion of the Lowland Rainforest EEC would be impacted by the Project at both the local (20 kilometre radius) and regional levels. There would be a moderate impact on the River-flat Eucalypt Forest on Coastal Floodplains EEC at the local level with approximately 20 per cent of the community to be removed. However, only 0.05 per cent of the community would be impacted at the regional level. Indirect effects such as changes to the hydrological regime, edge effects and weed invasion could slightly increase the areas of the EECs affected. Overall it is considered that the Project's impact on these vegetation communities would not be significant.

The impact on the Riparian Forest community consisting of the *River-flat Eucalypt Forest on Coastal Floodplains* EEC variant would occur on top of historic land use and river channel management activities which have already substantially contributed to the extensive decline in species diversity and areal extent of this vegetation community (and others). Brooks *et al* (2004) note that clearance of the floodplain forests along the Williams River valley accompanied the spread of cropping and grazing activities in the mid 19th century. Citing accounts from 1829, 1830 and 1836 of the first survey of the river they further note that

> …the floodplains and banks of the Williams River upstream of the estuary supported 'thick brush' (a local term for subtropical rainforest), while the hillslopes were heavily timbered with either dry or wet sclerophyll eucalypt forest depending on aspect. … While the high country still supports stands of *Nothofagus*-dominated cool-temperate rainforest, few remnants of the pre-settlement rainforest communities remain at lower elevations Brooks *et al* (2004:515).

River training works have also contributed to substantial changes to the riparian vegetation communities. Channel 'improvement' works which commenced in the mid 1950s included the extensive removal of logs and clearance of in-channel vegetation from bars and banks. The purpose of this was to maximise channel capacity and flow velocity, ostensibly to reduce flood risk. The consequence of this was adjustment of the river channel to the altered hydrological regime resulting in bed instability and bank erosion, the latter further impacting on the riparian vegetation community. Various engineering works were subsequently implemented to address this instability and to provide a stable channel alignment. These works included the planting of 48,000 exotic trees (Brooks *et al* 2004).

There is some uncertainty as to whether the Riparian Forest community actually matches the NSW Scientific Committee's description of the *River-flat Eucalypt Forest on Coastal Floodplains* EEC and this is noted in Working Paper E. The final determination of the NSW Scientific Committee identifies a range of criteria to define this EEC and it is considered that there is a degree of ambiguity with respect to the characteristics of the Riparian Forest community satisfying the definitions of several essential criteria.

The final determination states that the EEC occurs

> …on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less.

The study undertaken by Brooks *et al* (2004) examined the nature of channel response to the reintroduction of woody debris into a river channel. Their experimental site was a section of the Williams River located at Munni, ie within the proposed inundation area. Based on a cross section defined by alluvial banks in their test reach, the 'bankfull discharge' was 800 m^3/s and represented a flood event with an average recurrence interval exceeding 100 years. This is generally consistent with the geomorphological investigation undertaken for the Project. One of the sites examined, S7, was located 200 metres downstream of the proposed location of the dam. The site was deeply incised with steep banks and no prominent inset benches were present. The upper valley surface appeared to be a terrace with the hydraulic model predicting no inundation for events up to the highest modelled discharge (>100 year ARI event).

The final determination also states that this EEC

> …has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum

varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple) and *A. subvelutina* (broad-leaved apple). *Eucalyptus baueriana* (blue box), *E. botryoides* (bangalay) and *E. elata* (river peppermint) may be common south from Sydney, *E. ovata* (swamp gum) occurs on the far south coast, *E. saligna* (Sydney blue gum) and *E. grandis* (flooded gum) may occur north of Sydney, while *E. benthamii* is restricted to the Hawkesbury floodplain. Other eucalypts including *Eucalyptus longifolia*(woollybutt), *E. moluccana* (grey box) and *E. viminalis* (ribbon gum) may be present in low abundance or dominant in limited areas of the distribution.

The ecological investigation noted that the tree layer in some sections of riparian vegetation along the rivers and creeks consisted entirely of river oak (*Casuarina cunninghamiana*) with eucalypts absent. It was considered that this could be treated as a variant of this EEC as the final determination states that *C. cunninghamiana* is one of the species that characterises the small tree layer, if present. While this is not an unreasonable interpretation, it is considered that this cannot be treated as a conclusive position to adopt with respect to satisfying the above criterion of a largely eucalyptus–dominated upper floristic layer being present within the community structure.

Effectively, it appears that the Riparian Vegetation community on the upper Williams River has already been impacted upon by such an extent by land clearing and instream flood mitigation works that it no longer meets the description issued by the Scientific Committee for the *River Flat Eucalypt Forest on a Coastal Floodplain* EEC.

In summary therefore, while the Project would clearly have an impact on the Riparian Forest community within the inundation area (and in the vicinity of the dam construction site), whether this would comprise an impact on the *River-flat Eucalypt Forest on Coastal Floodplains* EEC is subject to debate, with both supporting and dissenting views. From an overall Project perspective, it is largely irrelevant how the vegetation is technically described. The most important fact to acknowledge is that the existing vegetation is extremely important from a broad biodiversity conservation perspective. The Project therefore incorporates mitigation measures to contribute substantially toward replacing and enhancing biodiversity values at the project site.

11.3.3 Threatened flora species

Based on the presence of suitable habitat and records within the local area (20 kilometre radius), three flora species were considered to have the potential to occur in the Project area as identified in Table 11.5.

TABLE 11.5 THREATENED FLORA SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

VEGETATION COMMUNITY	STATUS (TSC)	STATUS (EPBC)	RECORDS IN LOCALITY	PREFERRED HABITAT	HABITAT ON SITE
Eucalyptus glaucina *(slaty red gum)*	V	V	12	Grows in grassy woodland and dry eucalypt forest on deep, moderately fertile and well-watered soils	Probably
Marsdenia longiloba *(slender marsdenia)*	E	V	1	Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops	Possibly in moist gullies
Senna acclinis *(rainforest cassia)*	E	-	1	Grows in or on the edges of subtropical and dry rainforest	Possibly in moist gullies

Of the endangered populations known from the Hunter catchment only one, *Cymbidium canaliculatum* (tiger orchid) was considered to have the potential to occur.

No threatened flora species or endangered populations of flora were identified within the Project area. Targeted surveys were undertaken within key areas considered to potentially contain suitable habitat for these species. However, given the large size of the Project area, there is a small possibility that individuals or very small populations of one or more of these species could occur in parts of the Project area not covered by the field surveys. This has been taken into consideration in assessing potential impacts on these species as follows.

***Eucalyptus glaucina* (slaty red gum)**

The habitat for this species is grassy woodland and dry eucalypt forest on deep, moderately fertile and well-watered soils. If any undetected occurrences of the species did occur, they would most likely be on the flats and gentle slopes upslope from the immediate riparian area and could occur as remnant isolated paddock trees. Twelve records of this species occur within 20 kilometres of the centre of the Project area; this includes four records within 10 kilometres. In the unlikely event that individuals of the species were removed by the Project through inundation, the lifecycles of populations of the species remaining in the study locality would be unaffected and it is expected that viable populations within the region would continue to flourish.

***Marsdenia longiloba* (slender marsdenia) and *Senna acclinis* (rainforest cassia)**

Both these species grow in subtropical rainforest or in adjoining moist forest areas. The areas where they are most likely to occur are the rainforest patches and adjoining moist gully forest which mainly occur in the area potentially affected by construction of the new section of Salisbury Road. Refinement of the road alignment has effectively avoided the identified patches of rainforest and moist gully eucalypt forest. In view of this, it is considered neither species would be significantly affected by the Project.

***Cymbidium canaliculatum* (tiger orchid) in the Hunter Catchment**

This orchid grows in the hollows of trees in dry sclerophyll forest or woodland. If present in the Project area, it would be most likely to occur in the spotted gum–ironbark or forest red gum communities on ridge tops and slopes, most of which would be unaffected by the Project.

In summary, the Project is considered unlikely to significantly impact on any threatened flora species or endangered populations.

11.4 Potential impacts on fauna

The potential for impacts on fauna would occur during both the construction and operation phases of the Project. Assessment of potential impacts of the Project on threatened fauna has been undertaken in accordance with Appendix 3 to the *Guidelines for Threatened Species Assessment* (Dept of Environment and Climate Change 2007). This is fully documented in Working Paper E and summarised as follows.

11.4.1 Habitat removal

Within the Project area there are a number of habitat features present which would be lost as a result of construction of the dam wall, spillway and the new section of Salisbury Road and by filling of the storage. Habitat features that would be impacted include:

- large mature trees
- winter flowering trees and preferred food trees for threatened species
- dead trees
- tree hollows
- fallen timber
- shrub layers containing a high proportion of flowering species
- rock outcrops
- watercourses.

Detailed descriptions of habitat features and vegetation habitat types are contained within Working Paper E *Terrestrial Ecology*. These habitat features are distributed across six broad habitat types in the Project area (refer Table 11.6).

Loss of these habitat features and vegetation communities would affect both threatened and non–threatened fauna species within the local area. The approximate areas of habitats that would be impacted as a result of the Project are listed in Table 11.6.

TABLE 11.6 EXTENT OF HABITAT REMOVAL WITHIN INUNDATION AREA

HABITAT TYPE	EXTENT OF IMPACT AREA (HA)
Subtropical Rainforest	0
Moist Gully Blue Gum Wet Sclerophyll Forest	2.5
Spotted Gum-Ironbark Forest	32.2
Forest Red Gum Moist Slopes Forest	43.7
Riparian Forest	145.0
Pasture Land with Remnant Trees	1,821.7
Total area[1]	**2,045.1**

1 Excludes river channel area (approximately 55 ha)

11.4.2 Barriers to fauna movement

The Project would not affect mapped wildlife corridors or areas of key habitat as identified by the NPWS. However, the dam would represent a barrier to fauna movement, particularly along the Williams River and between large areas of bushland to the north and south of the Project area. The existing potential north–south corridor through remnants to the east of the Project area would be retained. The new section of Salisbury Road would pass through or close to some of these remnants.

Mobile flying species would be able to travel over or around the dam and storage. However, for less mobile species the dam would represent a major obstacle to movement between areas currently linked by riparian habitat, vegetation within the road easement and scattered paddock trees. Species most likely to be affected are the brush–tailed phascogale, koala, and squirrel glider. The Project could also potentially separate currently interbreeding populations and affect the dispersal ability of some species although for many species movement would still be possible via the corridor to the immediate east of the Project area.

The Project would result in the loss of habitat connectivity for amphibians along the Williams River between areas upstream and downstream of the dam and storage. This could potentially separate currently interbreeding populations and affect the dispersal ability of some species.

The new section of Salisbury Road and the replacement access to the Quart Pot Creek area are unlikely to greatly affect habitat connectivity within the Project area. While less mobile species (particularly the koala) would be at risk of vehicle strike while crossing the road, the level of risk would not change from what it is at present.

11.4.3 Wildlife injury and mortality

The potential for wildlife injury or death as a result of the Project would vary depending on the mobility and characteristics of individual fauna species, and the Project phase.

The clearing of native vegetation for construction of the dam wall, spillway and road realignment would pose the greatest risk to injury for resident fauna. Species at risk include nocturnal species such as possums and gliders which shelter during the day and ground dwelling species such as snakes, lizards, amphibians and small mammals which may not be able to move fast enough or cover large enough distances to avoid clearing activities. There is also the risk of displaced fauna succumbing to predation or to stress induced by competing with existing resident populations for resources, particularly shelter/refuge habitat.

As the storage progressively fills, it would inundate upstream areas which would be being used to varying degrees by different types of fauna. The rate of filling is not expected to impact directly on fauna as it is anticipated there would be sufficient time for animals to keep ahead of the rising water. There could, however, be consequential impacts from displacement with these likely be similar to impacts associated with removal of habitat for construction.

The potential for wildlife injury or mortality during operation of the storage is considered to be very low. Wildlife such as koalas may be at risk from vehicle strike when crossing the new section of Salisbury Road. This risk would have existed prior to construction of the dam so this is not necessarily a new impact, although the level of risk may increase slightly if vehicle numbers increase.

11.4.4 Key threatening processes

Both the TSC Act and the EPBC Act identify a number of key threatening processes which the Project could contribute to. These are identified and commented on in Table 11.7 and Table 11.8 respectively.

TABLE 11.7 KEY THREATENING PROCESSES – TSC ACT

KEY THREATENING PROCESS	RELEVANCE TO PROJECT
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	The Project involves placement of a major barrier across the Williams River and the associated capture and storage of inflows. The Project would therefore alter the natural flow regime of rivers and streams.
Clearing of native vegetation	The Project is expected to result in the clearing of approximately 280 ha of native vegetation and inundation of approximately 1,820 ha of predominantly cleared land, parts of which include scattered trees. Therefore the Project is expected to contribute to this key threatening process.

KEY THREATENING PROCESS	RELEVANCE TO PROJECT
Competition and grazing by the feral European rabbit	The Project is not expected to encourage increased numbers of the feral European rabbit within the Project area and therefore would not contribute to this key threatening process.
Competition from feral honeybees	The Project is not considered likely to result in increasing numbers of the feral honeybee within the Project area and therefore would not contribute to this key threatening process.
High frequency fire	The Project is not considered likely to increase the frequency of fire within the Project area and therefore would not contribute to this key threatening process.
Human-caused climate change	The Project is expected to generated a certain volume of greenhouse gas emissions related to decay of cleared and inundated vegetation. A relatively small contribution would also be associated with the operation of construction plant (refer also Chapter 19).
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	While it is unlikely that the Project would lead to an increase in the incidence of chytridiomycosis in frog populations within the Project area, this disease is known to affect the stuttering frog and other frog species with potential to occur within the Project area.
Infection of native plants by *Phytophthora cinnamomi*	There is a risk of this fungus being introduced on machinery, clothing and in soil/fill during construction of the Project.
Invasion, establishment and spread of lantana *(Lantana camara L. sens. lat)*	Lantana was found to be common and abundant within most communities in the Project area. Most of it would be removed from the riparian community by inundation. Where it occurs in dryland or moist gully communities not subject to direct inundation its invasion, establishment and spread would need to be managed during both construction and operation of the Project to prevent impacts on adjoining retained habitat.
Invasion and establishment of exotic vines and scramblers	Parts of the Project area were found to contain established populations of exotic vines and scramblers. As with lantana, their invasion and establishment in areas not subject to inundation would need to be managed during both construction and operation of the Project to prevent impacts on adjoining retained habitat.
Invasion of native plant communities by exotic perennial grasses	Numerous species of exotic perennial grasses were recorded in the Project area during field surveys. Some of these are highly invasive in natural vegetation communities. Their spread in areas not subject to inundation would need to be managed during both construction and operation of the Project to prevent impacts on adjoining retained habitat.
Predation by the European red fox *(Vulpes vulpes)*	The Project is unlikely to increase the population of this introduced predator, however, if native fauna is forced to travel over open ground between habitat remnants then an increase in predation levels could occur.
Predation by the feral cat *(Felis catus)*	The Project is unlikely to increase the population of this introduced predator, however, if native fauna is forced to travel over open ground between habitat remnants then an increase in predation levels could occur.
Predation by the plague minnow *(Gambusia holbrooki)*	The plague minnow already occurs in low numbers in the Williams River (The Ecology Lab 2008)and the Project has the potential to increase population numbers through increasing the extent of shallow still waters which would occur around the edge of the storage. Therefore the Project could contribute to this key threatening process.

KEY THREATENING PROCESS	RELEVANCE TO PROJECT
Removal of dead wood and dead trees	Large logs and dead standing trees were generally found to be sparsely scattered throughout the Project area. However, given the large area of land likely to be affected, the Project is expected to result in the removal of large amounts of dead wood and dead trees, principally from within the inundation area, therefore contributing to this key threatening process.
Loss of hollow-bearing trees	While hollow-bearing trees were generally noted to be sparsely distributed throughout the Project area, some areas contained numerous hollow-bearing trees that could provide good fauna habitat for hollow-reliant species. Many of the scattered paddock and roadside trees were large trees observed to contain numerous hollows. Given the large area of land likely to be affected, the Project is expected to result in the loss of a large number of hollow-bearing trees from within the study area and would therefore contribute to this key threatening process.

Seventeen key threatening processes have been determined under the EPBC Act. Eight of these could be potentially relevant to the Project and are commented on in Table 11.8. As can be seen, there is a high degree of commonality between these and key threatening processes listed under the TSC Act.

TABLE 11.8 KEY THREATENING PROCESSES – EPBC ACT

KEY THREATENING PROCESS	RELEVANCE TO PROJECT
Competition and land degradation by feral rabbits	As for TSC Act
Dieback caused by the root-rot fungus *(Phytophthora cinnamomi)*	As for TSC Act
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	As for TSC Act
Land clearance	As for TSC Act
Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	The Project incorporates management strategies and mitigation measures to fully offset greenhouse gas emissions associated with construction and operation (refer Chapter 19). Overall, the Project is not considered likely to contribute to this key threatening process.
Predation by feral cats	As for TSC Act
Predation by the European red fox *(Vulpes vulpes)*	As for TSC Act
Predation, habitat degradation, competition and disease transmission by feral pigs	The Project is not considered likely to increase the incidence of this key threatening process within the Project area

11.4.5 Threatened fauna species

Based on the presence of suitable habitat and records within the local area (20 kilometre radius), 28 threatened fauna species were considered to have the potential to occur in the Project area as identified in Table 11.9. These species were therefore given priority consideration as target species of concern within the broader surveys and general field work undertaken by the consulting ecologist. A full assessment for species identified in Table 11.9 is provided in Working Paper E.

Of the 28 species, only eight were confirmed as occurring within land affected by the Project. The species positively identified on site were as follows:

- brush-tailed phascogale
- koala
- squirrel glider
- eastern freetail-bat
- eastern bent–wing bat
- grey-headed flying–fox
- southern myotis
- speckled warbler.

A summary of the potential impacts related to these eight species recorded during field surveys is provided following Table 11.9. The discussion also provides an overview and assessment of potential impacts related to the stuttering frog and other non–threatened but important species such as the platypus.

11.4.6 Brush–tailed phascogale

The brush–tailed phascogale is a nocturnal, semi-arboreal, carnivorous dasyurid and preys on invertebrates and small vertebrates. Studies have reported a home range of 37.05 hectares for females and 86.53 hectares for males outside the breeding season (Traill and Coates 1993; Soderquist 1995). Female home ranges do not overlap with other unrelated females, however male home ranges can overlap with those of other males and females. The brush–tailed phascogale has a very restricted breeding season which occurs in the winter with annual male die–off occurring after mating. Births tend to occur during July and August with the female having up to eight young. Given the large home range, small population sizes and the reproductive strategy of male die-off, this species is considered to be particularly vulnerable to fragmentation of suitable habitats and local extinctions.

The species was recorded within Tillegra Reserve during field survey work. One lactating female was caught in a tree trap on 28 November 2007 and one individual (probably the same female) was observed during spotlighting that evening. Given the large home ranges required by this species, Tillegra Reserve is likely to be the most suitable habitat available to the brush–tailed phascogale within the Project area. Other patches of remnant vegetation within the Project area tend to be smaller, more fragmented and in generally poorer condition.

The brush–tailed phascogale could potentially utilise some of these areas, particularly as a movement corridor for males during the breeding season or during dispersal of young animals. In particular, the remnants to the east of the proposed impoundment provide some links to large areas of forest to the north of the Project area. Potentially suitable habitat remnants also occur to the south and south-west in the vicinity of Mount Butterwicki.

Construction of the dam and spillway is expected to result in the loss of most of the available habitat for the brush–tailed phascogale within Tillegra Reserve. Given the large home range of this species, the remaining patch of vegetation is unlikely to support a viable population of the brush–tailed phascogale. It is therefore considered that the Project would result in the disturbance of this species and would displace the brush–tailed phascogale from much of the Project area, in particular the Tillegra Reserve area.

TABLE 11.9 THREATENED FAUNA SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

SPECIES	STATUS (TSC)	STATUS (EPBC)	RECORDS IN LOCALITY	PREFERRED HABITAT	POTENTIAL TO UTILISE PROJECT AREA
Barking owl *(Ninox connivens)*	V	-	2	Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting Roosts along creek lines during the day, usually in tall understorey trees with dense foliage such as acacia and casuarina species, or the dense clumps of canopy leaves in large eucalypts Feeds on a variety of prey, with invertebrates predominant for most of the year, and birds and mammals such as smaller gliders, possums, rodents and rabbits becoming important during breeding Live alone or in pairs. Territories range from 30-200 ha and birds are present all year. Three eggs are laid in nests in hollows of large, old eucalypts	Moderate
Brown treecreeper *(Climacteris picumnus)*	V	-	-	Found in eucalypt woodlands (including box-gum woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species Usually not found in woodlands with a dense shrub layer. Fallen timber is an important habitat component for foraging. Hollows in standing dead or live trees and tree stumps are essential for nesting	Limited based on lack of records
Diamond firetail *(Stagonopleura guttata)*	V	-	-	Open forest with a grassy groundcover, woodland, mallee, acacia scrub lands and timber belts along watercourses and roadsides	Moderate
Glossy black–cockatoo *(Calyptorhynchus lathami)*	V	-	13	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1,000 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. In the Riverina area, inhabits open woodlands dominated by belah *(Casuarina cristata)* Feeds almost exclusively on the seeds of several species of she-oak *(Casuarina* and *Allocasuarina species)*, shredding the cones with the massive bill. Dependent on large hollow–bearing eucalypts for nest sites	Moderate

SPECIES	STATUS (TSC)	STATUS (EPBC)	RECORDS IN LOCALITY	PREFERRED HABITAT	POTENTIAL TO UTILISE PROJECT AREA
Grey–crowned babbler (eastern subspecies) *(Pomatostomus temporalis temporalis)*	V	-	7	Open eucalypt woodlands with a grassy groundcover and sparse, tall shrub layer. May also be observed along streams in cleared areas and grassy road verges. Conspicuous large communal nests/roosts are constructed out of twigs. Raucous groups of 2–13 individuals foraging for insects in all substrates	Moderate
Masked owl *(Tyto novaehollandiae)*	V	-	2	Lives in dry eucalypt forests and woodlands from sea level to 1,100 m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500–1,000 ha. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting	Moderate
Powerful owl *(Ninox strenua)*	V	-	10	Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. Requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well Breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. Main prey items are medium-sized arboreal marsupials, particularly the greater glider, common ringtail possum and sugar glider. As most prey species require hollows and a shrub layer, these are important habitat components for the owl 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	Moderate
Sooty owl *(Tyto tenebricosa)*	V	-	9	Large areas of tall open forest and woodland particularly in and around dense creek and gully areas. Nests in large hollows in rainforest trees and eucalypts	Limited to moist forest
Regent honeyeater *(Xanthomyza phrygia)*	E	E	-	Box–ironbark eucalypt associations, though uses other woodland types and wet lowland coastal forest in times of food shortage. The wandering nature of this species makes it difficult to assess. Known to frequent areas with densely blossoming winter–flowering trees (eg spotted gum, red ironbark, forest red gum and swamp mahogany) on an opportunistic basis along the coast and ranges of NSW	Potential seasonal visitor, unlikely to breed

SPECIES	STATUS (TSC)	STATUS (EPBC)	RECORDS IN LOCALITY	PREFERRED HABITAT	POTENTIAL TO UTILISE PROJECT AREA
Speckled warbler *(Pyrrholaemus sagittatus)*	V	-	-	Lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area Diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home range when not breeding The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside	Recorded during survey
Swift parrot *(Lathamus discolour)*	E	E	-	Migratory nature of species makes them difficult to assess. Known to frequent sclerophyll forest and woodlands with winter flowering trees (eg spotted gum, red ironbark, *Eucalyptus crebra* and *E. siderophloia*, forest red gum and swamp mahogany) on an opportunistic basis along the coast and ranges of NSW	Potential winter visitor
Turquoise parrot *(Neophema pulchella)*	V	-	-	Open eucalypt woodland or forest with a grassy or sparsely shrubby understorey. Favours grasslands on the edge of these habitat types, particularly timbered grassland on mountain slopes and ridges. Feeds on seeds of native and introduced grasses and other herbs. Requires suitable hollows in tree limbs, logs or fence posts for breeding. Usually seen in pairs or small, possibly family groups and have also been reported in flocks of up to 30 individuals.	Moderate
Wompoo fruit dove *(Ptilinopus magnificus)*	V	-	4	Lowland rainforest, moist eucalypt forest and brush box forest that provides fleshy fruit resources. Rare south of Coffs Harbour.	Potential rare visitor

SPECIES	STATUS (TSC)	STATUS (EPBC)	RECORDS IN LOCALITY	PREFERRED HABITAT	POTENTIAL TO UTILISE PROJECT AREA
Brush–tailed phascogale *(Phascogale tapoatafa)*	V	-	4	Found in dry sclerophyll open forests and woodlands, with a preference for sparse ground cover. Also inhabits heath, swamps, rainforest and wet sclerophyll forest. Requires large areas of intact habitat to support a large population. Nests and shelters in tree hollows	Recorded during survey
Koala *(Phascolarctos cinereus)*	V	-	17	Forest and woodland habitats that contain suitable regional eucalypt feed trees. In the locality, the forest red gum and grey gum are listed food trees under SEPP 44.	Recorded during survey
Spotted–tail quoll *(Dasyurus maculates)*	V	E	24	Inhabits a variety of habitat types from moist and wet sclerophyll through to dry forests and woodlands on the edge of open grasslands. Requires large hollow logs on the ground for a den and sometimes hollow standing trees.	Moderate
Squirrel glider *(Petaurus norfolcensis)*	V	-	2	Usually inhabits dry open sclerophyll forest and woodlands, but has also been observed in moist regenerating forest and moist gullies Forages on acacia gum, eucalypt sap, nectar, honeydew, manna invertebrates and pollen, utilising areas with an abundance of flowering eucalypts and tall shrubs (eg banksias). Acacia species are the preferred sap feeding trees This species requires an abundance of suitably sized hollow-bearing trees	Recorded during survey
Eastern freetail–bat *(Mormopterus norfolkensis)*	V	-	1	Habitat preference of this species is unclear. Has been predominantly recorded in dry eucalypt forest and woodland, but has been recorded in moist and edge environments. The wing morphology indicates that this species is adapted to the more open habitats. This species primarily roosts in tree hollows, although the roofs of buildings are also used	Recorded during survey
Eastern bent–wing bat *(Miniopterus schreibersii oceanensis)*	V	-	2	Forages within a variety of habitat types including moist and dry eucalypt forest, woodland, rainforest, heath and open environments, including urban areas. Reliant on suitable roosting/breeding habitat in caves and mine tunnels, though would also roost in stormwater channels, road culverts and other comparable structures (including buildings) Estimated nightly foraging ranges of 20 km. Roost sites are limited within the Project area	Recorded during survey

SPECIES	STATUS (TSC)	STATUS (EPBC)	RECORDS IN LOCALITY	PREFERRED HABITAT	POTENTIAL TO UTILISE PROJECT AREA
Eastern false pipistrelle *(Falsistrellus tasmaniensis)*	V	-	3	Tall forest, woodland or heath/ grassland edges. Roosts in hollow trunk of the largest trees and sometimes buildings. Could forage and roost along the edge of habit at remnants	Tentative identification during survey
Golden-tipped bat *(Kerivoula papuensis)*	V	-	1	Rainforest or rainforest gullies in wet sclerophyll forest. Roosts in scrubwren and gerygone nests. Potential habitat could occur in the riparian vegetation and rainforest remnants	Tentative identification during survey
Greater broad-nosed bat *(Scoteanax rueppellii)*	V	-	1	Forages for insects over a range of natural and altered habitats, including tall forest, woodland or heath/grassland edges, often along the tree line boundary. Prefers tree hollows in large, often isolated, mature trees for roosting. Usually associated with tall moist open forest	Tentative identification during survey
Grey–headed flying–fox *(Pteropus poliocephalus)*	V	V	5	Regularly occurs along the eastern coastal plain through NSW. Roosts in camps, usually in dense riparian habitats At dusk disperses in search of the preferred food source, mainly eucalypt blossom and rainforest fruits. Long distances are covered (30+ km) in search of food. No known camps occur within the Project area.	Recorded during survey
Little bent–wing bat *(Miniopterus australis)*	V	-	-	Forages in a range of habitats, including forest, woodland, heath, coastal swamps and rainforest. A nightly foraging range of 20 km from roost sites has been reported. Reliant on suitable roosting habitat in caves and mine tunnels, though has been recorded roosting in hollowed out tree bases and dense foliage.	Moderate
Southern myotis *(Myotis macropus)*	V	-	2	Habitats adjacent to large bodies of water for hunting aquatic insects. Usually forages over or adjacent to water-bodies and associated terrestrial habitats. Roosts in caves, mines, tunnels, bridges, culverts and tree hollows. Likely to roost under the bridges across the Williams River within the Project area	Recorded during survey

SPECIES	STATUS (TSC)	STATUS (EPBC)	RECORDS IN LOCALITY	PREFERRED HABITAT	POTENTIAL TO UTILISE PROJECT AREA
Stephens' banded snake *(Hoplocephalus stephensii)*	V	-	6	Partly arboreal in rainforest, wetter sclerophyll forests and rocky areas up to 950 m. Shelters during the day under loose bark, among vines, under rock slabs or in hollow trunks, limbs and rock crevices. Hunts for frogs, lizards, birds and small mammals at night. Most likely to occur within the larger riparian and moist forest remnants within the Project area, although these may be too small to support a local population.	Limited (forest remnants are small and isolated)
Giant (southern) barred frog *(Mixophyes iterates)*	E	E	-	Forages and lives amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1,000 m. Breeds around shallow, flowing rocky streams from late spring to summer. When not breeding, the frogs disperse hundreds of metres away from streams. Feeds primarily on large insects and spiders Could occur along the banks of the Williams River	Limited
Stuttering frog *(Mixophyes balbus)*	E	V	4	Terrestrial inhabitants of rainforest, Antarctic beech or wet sclerophyll forest along permanent streams. Could occur along the banks of the Williams River.	Limited

Given the extent of clearing involved, there is potential for the Project to disrupt the breeding cycle of the brush–tailed phascogale, especially if a hollow tree or log containing a pregnant female or female with young was removed. A breeding female was recorded in Tillegra Reserve during field survey work.

The breeding cycle of the brush–tailed phascogale may also be impacted by the barrier the proposed dam would present to movement. While the movement and dispersal patterns of this species within the Project area are unknown, the proposed inundation area would represent a large, impassable barrier to this species. This may affect the ability of young animals to disperse and could potentially prevent the exchange of genetic material between currently interbreeding sub-populations.

In summary, impacts associated with the Project include the potential loss of roosting and breeding hollows, the loss of foraging habitat and the further fragmentation of habitat. As a result of these disturbances, it is considered that the Project could potentially affect the life cycle of the brush–tailed phascogale. Ameliorative measures such as supplementary plantings, rehabilitation of currently cleared or degraded habitat and offsets may assist in mitigating long term impacts on the brush–tailed phascogale. Of particular importance to this species is the establishment, rehabilitation and maintenance of fauna movement corridors.

11.4.7 Koala

The koala was recorded at several locations during the field surveys and could occur in any vegetated areas within the Project area, particularly where preferred food trees are found. The Project is expected to result in the loss of a large area of koala habitat, including the loss of koala food and shelter trees. The main areas where this would occur are in Tillegra Reserve, riparian habitat along the Williams River and along the relocated section of Salisbury Road. The koala could, however, utilise stands of vegetation or isolated trees anywhere within the Project area.

The loss of habitat associated with the proposal is expected to displace the koala from the Project area. This is likely to result in an overall reduction in the size of the local population.

As the koala is likely to inhabit areas of bushland to the north and south of the Project area, the dam would present a barrier to movement for this species. In order to move between these two areas after the storage fills, koalas would have to travel a long way to the north-west or south-east ends of the storage in order to cross the Williams River. An existing potential corridor through remnants to the east of the storage would be retained. The relocated section of Salisbury Road passes through or near these remnants and road deaths or injuries could occur.

11.4.8 Squirrel glider

The squirrel glider was recorded at two sites during the field surveys and is likely to occur in other patches of vegetation within the Project area, particularly along the existing and proposed road routes. This species is reliant upon hollow–bearing trees for roosting and breeding purposes, and requires a reasonable level of vegetation connectivity in order to move freely from one area to another. Potential impacts associated with the Project include the loss of roosting and breeding hollows, the loss of foraging habitat and the further fragmentation of habitat.

The Project is expected to displace one or more family groups from their current territories, particularly within Tillegra Reserve. A large number of hollow-bearing trees are expected to be lost as a result of the Project. Some of these were noted to contain potentially suitable roosting and breeding hollows for the squirrel glider. If a roost tree containing one or more squirrel gliders was to be removed, this could result in the direct deaths of those gliders.

The squirrel glider is likely to inhabit areas of bushland to the north and south of the Project area. The dam would present a barrier to movement for this species. However, the existing potential north–south corridor through remnants to the east of the storage would be retained.

11.4.9 Eastern freetail–bat

The eastern freetail–bat was recorded at several sites during the field surveys. It is reliant upon hollow-bearing trees for roosting and breeding purposes. It would also roost behind loose bark and occasionally in buildings. Little is known about the reproductive cycle of the eastern freetail-bat, though it is likely that the breeding period occurs during late spring and summer (Ray Williams pers. comm.).

Potential foraging habitat for this species occurs throughout the Project area. Potential roosting and breeding habitat occurs in forested areas within the Project area and other areas where suitable hollow-bearing trees are located (eg paddock trees). The main potential impacts associated with the Project are expected to be the loss of roosting/breeding hollows and a large area of potential foraging habitat. Given the results of the field surveys and availability of suitable habitat, it is likely that this species roosts within the subject site and would therefore be displaced as a result of the Project. The removal of a roost tree during the day may result in the death of a number of bats, particularly if a tree containing a maternity roost was to be removed during the breeding season. Given the extent of clearing and area of land expected to be inundated, the Project could adversely affect the lifecycle of the local population of one or more of these threatened hollow-roosting bat species.

11.4.10 Eastern bent–wing bat

The eastern bent–wing bat is typically a cave roosting bat and was recorded at several sites during the field surveys. Potential foraging habitat for this species occurs throughout the Project area and individuals of this species could potentially roost seasonally under bridges and culverts within the Project area. While this species is often recorded in open habitats and is likely to be able to forage on the edges of the storage, the clearing and inundation of land associated with the Project would result in the modification of an extensive area of known foraging habitat.

No suitable breeding habitat for the eastern bent–wing bat occurs within the Project area and none is expected to be impacted by the Project. However, as this species may utilise bridges and culverts within the Project area for roosting on a seasonal or occasional basis, there is potential for individuals to be killed if a bridge or culvert containing roosting bats was to be destroyed or removed. This is particularly relevant for Tillegra Bridge which would be removed during construction of the dam wall.

11.4.11 Grey–headed flying–fox

The grey–headed flying–fox has been recorded as foraging on more than 80 plant species of which eucalypt blossom is considered the major food source with figs the most common fruit consumed (Churchill 1998). The species may disperse and commute up to 50 kilometres daily from its day roost to foraging areas (Strahan 2002). The grey–headed flying–-fox roosts in large colonies of up to tens of thousands and often shares camps with the little red flying–fox and black flying–fox (Churchill 1998; National Parks and Wildlife Service 1999). Colonies are usually formed in gullies with a dense vegetation canopy and a water source nearby.

The species was recorded at Sites 3 and 8 during the field surveys and it could forage seasonally in flowering or fruiting vegetation anywhere within the Project area. The nearest known flying–fox camps are at Main Creek and Mt Richardson, 10–12 kilometres from the Project area and well within flying range for the species. There is some potential for small temporary camps to form in riparian habitat along the Williams River, particularly during peak flowering or fruiting periods.

The Project is expected to result in the loss of potential foraging habitat for the grey–headed flying–fox. While this is unlikely to significantly impact the lifecycle of the species, the loss of this vegetation would contribute to the cumulative loss of habitat affecting this species. No known flying–fox camps would be disturbed as a result of the Project and it is unlikely that the breeding cycle of the grey–headed flying–fox would be disrupted. However, the loss of riparian vegetation along the Williams River would prevent the grey–headed flying–fox from establishing temporary camps within this area.

11.4.12 Southern myotis

The southern myotis was recorded at several sites during the field surveys. A variety of foraging habitats are used by this species although it is usually found near large bodies of water including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to the roost site. The southern myotis appears to have specific roost requirements and only a small percentage of available caves, bridges, mines, tunnels and culverts are used. No evidence of roosting bats was observed during an inspection and dusk watch of Tillegra Bridge, however, potential roost sites occur in hollow wooden beams under the bridge. Potential foraging habitat for this species occurs at dams and waterways within the Project area. Potential roosting habitat occurs at bridges, drainage culverts and possibly large hollow-bearing trees overlooking water within the Project area.

For the southern myotis, the main potential impact associated with the Project is the likely loss of roosting habitat. Existing foraging habitat is also likely to be lost though the species would still be able to forage over open water along the edges of the storage. While no maternity roosts were observed during the field surveys, these could form by the time works commence, particularly at Tillegra Bridge. As the southern myotis is known to roost under bridges and culverts, the removal of these structures could result in the deaths of roosting individuals, particularly if non–flying young are present or during winter months when bats enter torpor. If a bridge containing a maternity roost was destroyed, this could potentially result in the loss of an entire colony.

11.4.13 Other bat species

As noted, the terrestrial ecology study tentatively identified the greater broad-nosed bat, eastern false pipistrelle and golden-tipped bat as occurring in the Project area based on ultrasonic call analysis. It was identified that there was moderate potential for these species to utilise the Project area.

The greater broad-nosed bat and eastern false pipistrelle are reliant upon hollow-bearing trees for roosting and breeding. They may also roost behind loose bark and occasionally in buildings. The main potential impacts associated with the Project are expected to be the loss of roosting/breeding hollows and a large area of potential foraging habitat. On the basis of field surveys and availability of suitable habitat, it is likely that one or both of these species roosts within the area and would be affected by the Project. Given the extent of clearing and area of land expected to be inundated, the Project could have a short term adverse effect on the lifecycle of the local population of one or both of these threatened hollow-roosting bat species. However, it is expected that populations of these species would be able to move to roost sites in hollow-bearing trees situated above the FSL.

Suitable potential habitat for the golden-tipped bat occurs in patches of rainforest and moist gullies within the Project area. The Project would result in the loss of potential foraging, roosting and breeding habitat for the golden-tipped bat should it occur. Much of this potential habitat is degraded and not considered ideal for the golden-tipped bat, however the loss of these areas does contribute to the cumulative loss of habitat affecting this species.

11.4.14 Speckled warbler

The speckled warbler occupies eucalypt and cypress woodlands and appears to require contiguous areas of habitat larger than 100 hectares. This species occupies a home range of between 6–12 hectares and prefers areas where the ground cover consists of grass, fallen leaves and bark (Hoskin 1991). The speckled warbler congregates in small family groups of two or three and breeds from September to March (Readers Digest 1979). Dome shaped nests are constructed of dried grasses and bark strips and are camouflaged under a tuft of grass, usually beneath fallen branches or at the base of a small shrub (Hoskin 1991; Readers Digest 1979).

The Project is expected to displace at least one known population of the speckled warbler which occurs in the Tillegra Reserve area, and which covers an area of approximately 31 hectares.

Construction of the dam wall and spillway would result in the loss of most of this vegetation although it is estimated that a patch of eight hectares would remain in the south-east corner. Given that this patch would be isolated from other areas of vegetation, it is unlikely that it would be large enough to support a population of the speckled warbler.

Habitat for the speckled warbler is also expected to be lost along the route of the relocated section of Salisbury Road. As this species is likely to occur in larger patches of vegetation north and south of the subject site, the storage could present a barrier to movement and may affect the dispersal ability of this species or isolate currently interbreeding populations. However, the existing potential north-south corridor through remnants to the east of the storage would be retained.

11.4.15 Stuttering frog

The initial ecological investigations suggested there could be potentially significant impacts on a number of frog species including the stuttering frog. Subsequently, an additional survey was undertaken with the objective of identifying habitat which may be utilised by any of the species in question.

As noted in Section 11.2.2, within the inundation area suitable habitat was found only for the stuttering frog. Two sites were identified. One is a small isolated patch of moist riparian vegetation near Munni Bridge (Heatherbrae Road) while the other is a more extensive 1.5 kilometre stretch of moist riparian vegetation verging on rainforest below the cliff at 'Underbank'. Approximately 500 metres of potential habitat was also identified along Moolee Creek, just outside of the inundation area.

The Munni Bridge site and to a lesser extent the Underbank remnant are considered to be too small and isolated for the stuttering frog to occur. Any population that may occur would be small and already at risk of local extinction as a result of natural changes to habitat such as impacts from drought and flooding.

11.4.16 Platypus

During the field surveys, two platypuses were observed foraging in pools of the Williams River in the vicinity of Tillegra Bridge. Residents along the river also report observing platypuses and it is expected that individuals forage along the whole length of the Project area and beyond. The size of the platypus population within the Project area is not known. The platypus is not listed as threatened under either the TSC Act or the EPBC Act.

Platypuses are seldom found in the deep waters of impoundments and are normally restricted to their headwaters (Grant 1991). At FSL, the storage would remove approximately 19.2 kilometres of the Williams River and parts of its larger tributaries for occupation by platypuses. The dam and

storage may also represent a barrier to normal breeding and foraging movements by adults and to the dispersal of juveniles. Little is known of these aspects of the platypus' breeding biology.

Existing burrows along the Williams River and tributaries within the inundation area would be lost as the storage fills. This could result in the loss of young if burrows are flooded during the season in which dependent young are being fed by lactating females (three to four months during mid–September to mid–March in NSW). It could also result in the possible displacement of adults over a long period of time.

The length of time taken for the storage to reach FSL would be dependent on the magnitude and frequency of inflows. It is estimated that this could take from three to six years. As the storage water level rises, it would require construction of new burrows to stay above the water level. Significant changes in water level could also occur following major rainfall events in the upper catchment, which could occur at any time of the year.

Given the cleared nature of much of the ground cover and the gentle slope, suitable sites for the construction of burrows are expected to be very limited. Recruitment of young platypuses over the filling period may therefore not occur although there may be some dispersal into the storage from upstream of the inundation area. Recruitment to the storage from downstream is unlikely due to the dam wall acting as a barrier. Platypuses can move overland around obstacles but are quite prone to predation, particularly by foxes, while moving on land.

When the dam reaches FSL it is expected that platypuses could forage along the edges of the storage, particularly in the side arms of entering watercourses such as Quart Pot Creek, Native Dog Creek, Black Camp Creek, Sheep Station Creek and Taylor's Creek. However, the ability to construct stable permanent burrows would still depend on the presence of riparian vegetation and a suitable substrate which would be limited by shallow soils over a rocky substrate and the gently-sloping nature of much of the fringe of the storage area. At FSL, the storage shoreline would be approximately 125 kilometres in length.

The change in the hydrological regime downstream of the dam, particularly between the dam and the Chichester River confluence, could affect existing platypus habitat. The following impacts were identified for Tallowa Dam (LesryK Environmental Consultants 2006):

- siltation of the river bed if there are insufficient flows to periodically flush out the river bed would decrease foraging areas and reduce the water depth
- loss of refuge pools if water levels become too low, particularly during drought
- changes to food availability through the loss of riffle areas and if the temperature of water released from the dam is too low (platypuses foraging in cold water would require an increased food intake)
- potential increase in predation could occur if a platypus is required to travel over land from its burrow to reach suitable foraging pools.

11.4.17 Australian water rat

The Australian water rat was not recorded during field surveys but is expected to occur in the larger pools of the Williams River and in the larger farm dams.

The water rat is a large native rodent weighing up to over 1000 grams (average 700 grams). It is a carnivorous species mainly feeding on aquatic items such as large insects, fish, crustaceans and shellfish. Birds eggs, waterbirds, frogs, lizards and small mammals are sometimes taken, particularly in

winter when less time is spent in the water (Olsen 1995). In inhabits both freshwater and marine habitats and nests in burrows or hollow logs, with burrows running parallel to the river bank. Regular tracks are used along the river bank and middens of prey remains are often deposited on flat rocks near the waters edge (Watts and Aslin 1981). The water rat tends to be more terrestrial than the platypus and studies have shown that it is a poorer thermoregulator in water (Fanning and Dawson 1980) and therefore tends to carry out short foraging trips and the resulting catch is consumed on land.

Females start to breed when about eight months old. After a gestation period of about 34 days three to four young are born. The young are weaned after four weeks, however the fur does not become waterproof until they are two to three months old. The main breeding season is between spring and late summer and up to five litters can be born each year, although one or two litters tends to be more normal (Olsen 1995).

With regard to the Project, the impacts on the water rat are likely to be lesser than those identified for the platypus. The water rat is more terrestrial than the platypus, has a higher birth rate and forages on a wider range of prey species including terrestrial vertebrate species. The local population would still suffer a loss of shelter burrows which could affect breeding success and a reduction in aquatic prey once the dam reaches a depth greater than 10 metres. The lack of cover on the edge of dam during and after inundation could lead to increased predation from birds of prey, foxes and cats though the likelihood of this would be expected to decline as vegetation becomes established around the perimeter of the storage. This would be encouraged as a riparian buffer forms part of the strategy to manage water quality in the storage.

11.4.18 Migratory species

Many Australian fauna species are migratory species protected under the EPBC Act. These species are not necessarily vulnerable or endangered species; however they are protected to ensure that populations of such species are maintained and that Australia's obligations under international conventions and agreements are observed.

TABLE 11.10 POTENTIAL IMPACTS ON RECORDED EPBC ACT LISTED MIGRATORY SPECIES

CRITERION	RELEVANCE TO PROJECT
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
a) substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;	No areas of important habitat for migratory species, as defined in the notes below, were identified within the study area. However known habitat for the subject forest/woodland birds would be lost within the inundation and construction areas. No invasive species other than those already occurring in the study area are likely to become established. Foxes, cats and rabbits
b) result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	are known to occur and increases in populations are not expected to occur as a result of the proposal. No areas of important habitat for migratory species were identified within the study area. The proposal would not disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.
c) seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	The proposed revegetation of land above the high water level has the potential to increase and/or improve habitat for most of the subject migratory species.

As noted in Section 11.2.2, five migratory species listed under the EPBC Act were recorded in the Project area. Consideration of potential impacts on these species is provided in the following table.

It is noted that an area of important habitat for a migratory species is that utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or

- habitat that is of critical importance to the species at particular life-cycle stages, and/or
- habitat utilised by a migratory species which is at the limit of the species range, and/or
- habitat within an area where the species is declining.

11.5 Mitigation and management measures

The specialist terrestrial ecology report identified a range of impact mitigation measures and management strategies to avoid and/or minimise impacts on terrestrial flora and fauna. These are described as follows with a distinction made, where appropriate, between the construction and operation stages. The latter includes the initial filling of the storage. It should be noted that some measures, for example the establishment of vegetation offset areas, are intended to mitigate both construction and operation impacts.

Management of impacts associated with construction would be addressed through a formal management plan which would be prepared by the construction contractor. Working Paper O provides general guidance on the preparation of the construction EMP. The final structure of the construction EMP would also be determined to some extent by the contractor's own management systems and by relevant approval conditions.

Establishment of offset areas

Offsetting requirements and principles in NSW vary depending on the legislation governing the development or activity and the legislation's overall objective. Generally within the Part 3A planning process, unless otherwise specifically stipulated, offsetting and management arrangements are tailored to meet the specific merits of the case in consultation with the public and any government agency with a direct regulatory management responsibility. In this regard, DECCW provides broad principles to consider for managing terrestrial threatened species and biodiversity, as does DPI for managing aquatic habitats and fisheries resources.

It is further noted that the avoidance of impacts in the first instance is always preferable to the implementation of offsets, and in some circumstances, no form of offsetting can completely address an identified impact. In such cases the costs can only be weighed against the benefits and an informed decision made on whether to proceed with the proposal.

For the Tillegra Dam project, road alignments and the siting of infrastructure has, as far as practical, been designed to avoid the loss of substantial stands of native vegetation. The loss of vegetation from inundation, however, cannot be avoided and offsetting is an appropriate management response to consider. To protect biodiversity the offsetting of vegetation types should be at least, at a minimum, aimed at re-establishing or enhancing and protecting an area of vegetation of equivalent size, type and condition of that impacted upon by the proposal. Further, as there is normally a lag time for regenerated or established areas to reach similar condition and maturity, it is desirable to increase the offsetting ratio or otherwise take positive steps to compensate for this factor.

The establishment of appropriate offset areas for vegetation and fauna habitat that would be affected by clearing or inundation as outlined in Section 11.3 would be achieved by rehabilitating or

revegetating currently cleared or degraded HWC-owned land above the storage FSL as part of a broader initiative to offset carbon emissions associated with the Project.

The principal area where this would take place is within a buffer area around the entire riparian area of the reservoir, between 50 to 100 metres (from the full supply level of RL152.3 metres, a nominal buffer will be established to RL154 metres + 50 metres) in width, and more substantially, within a corridor to the east of the storage, generally between the storage and the new section of Salisbury Road (refer Figure 11.4). This 'habitat corridor' would provide connectivity between the Williams River below the dam to the Chichester catchment and Barrington Tops National Park. A secondary corridor along the southern margins of the storage would similarly provide connectivity from the Williams River below the dam to the Mount Butterwicki area. Collectively, these corridors would have an area of approximately 1,680 hectares.

Within the total offset areas, an area of 470 hectares currently contains areas of Moist Gully Blue Gum Wet Sclerophyll Forest, Spotted Gum-Ironbark Forest, Forest Red Gum Moist Slopes Forest, and Subtropical Rainforest. General agricultural and grazing practices would be excluded from these areas, to maintain or enhance their biodiversity values. This leaves approximately 1,210 hectares on which additional native vegetation can be established and maintained in perpetuity.

To achieve a carbon neutrality within a 25 year timeframe (refer Chapter 19), there is an immediate need to establish native vegetation on 551 hectares of the available land as soon as practical after construction. This can be achieved though a several techniques including the planting of tubestock, direct seeding and by encouraging natural regeneration from existing seed banks. While direct planting and seeding would be required within this core area, where ever possible it is intended to allow natural regeneration of vegetation to take place as this is more cost effective and ensures a wide diversity of endemic plants have the opportunity to become established.

If the habitat (carbon offset) corridor is supported by the community, a work plan detailing specific rehabilitation and regeneration measures for native vegetation would be developed and incorporated into the draft integrated land use plan (draft ILUP, refer Working Paper N). Where natural regeneration is allowed to occur in specific areas under the plan, this would be monitored. Supplementary direct seeding, cultivation and planting of tubestock in key areas would be undertaken if required. Management activities would include weed and feral pest control, fencing, provision of fire breaks and designated access points. Areas for replanting would be prioritised according to their value in providing connectivity. Priority would also be given to restoring habitat for threatened species.

Monitoring of offset areas would be undertaken to ensure that planting works are appropriately completed, that emerging management issues (weeds, pests, illegal dumping etc), are controlled and that vegetation is properly established. Independent auditing of vegetation establishment would be undertaken to determine and confirm carbon sequestration rates.

Ownership of the buffer area and corridor will be retained at all times by HWC. It is not proposed to enter into a voluntary conservation agreement or otherwise move the land into national park estate, although such action could be considered in the future should the community consider this to be an optimum outcome. While a voluntary conservation agreement, covenant on title or other action is not proposed, it is implicit in the establishment of the offset area in that it would be maintained in perpetuity. For example, to qualify as a voluntary carbon offset, and meet likely conditions of any project approval, the area must be maintained as a forested area for over 100 or more years. Further, allocation of the offset areas for development or high impact uses would not be viewed as acceptable by HWC at anytime in the future, as this would increase the risk of water quality issues occurring within the storage. Finally, Dungog Shire Council currently proposes to rezone the land within the corridor as 7A Environmental Protection (or equivalent under the new zoning template for Local Environment Plans). HWC supports this proposal to ensure that appropriate development controls are placed on the land.

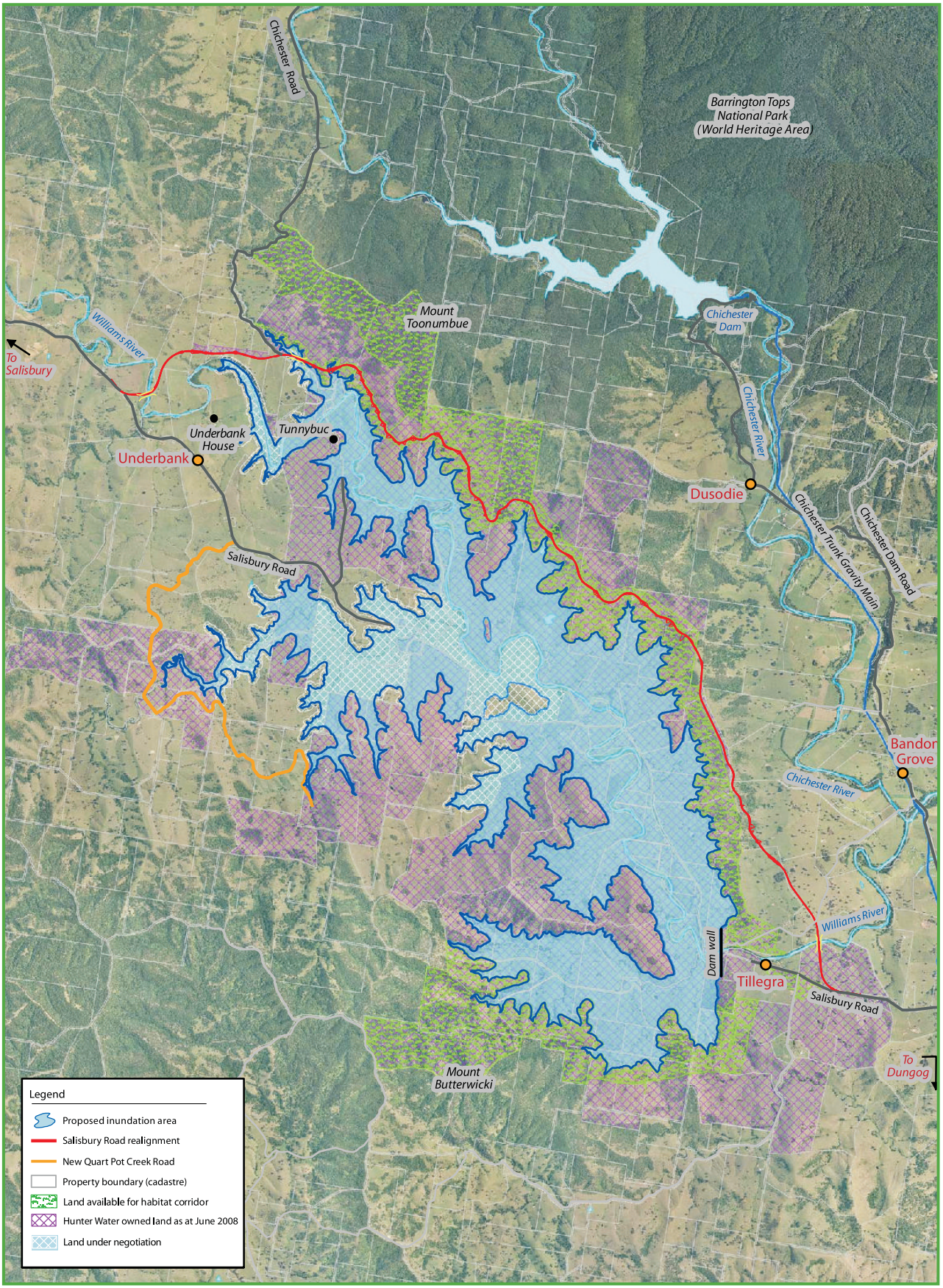

FIGURE 11.4 LAND AVAILABLE FOR HABITAT CORRIDOR

The practical extent to which loss of riparian vegetation could be compensated for is limited by the low availability of upstream and downstream habitat which could be regenerated effectively and which is under HWC control. Additional habitat replacement by HWC for riparian vegetation would however occur, on a one to one basis to ensure a like-for-like replacement and no net loss. A program sponsoring tree planting on private land in riparian areas would be developed in this regard. Details of the different vegetation types impacted, as well as established or protected by the offsetting proposal are provided in Table 11.11. It is also noted that the proposed offset area, is almost 10 times the area of the riparian vegetation that would be affected and when combined with riparian plantings, this would provide an extensive area of important habitat for a range of native species, including threatened species endemic to the area, far in excess to that vegetation lost to the creation of the reservoir.

TABLE 11.11 VEGETATION IMPACTS AND OFFSETTING

VEGETATION COMMUNITY	TOTAL AREA IMPACTED[1]	TOTAL EXISTING AREA PROTECTED[1,2]	AREA REPLANTED OR REGENERATED[1,2]
Subtropical Rainforest	0	20	50
Moist Gully Blue Gum Wet Sclerophyll Forest	1.7	70	100
Spotted Gum-Ironbark Forest	20.6	255	957
Forest Red Gum Moist Slopes Forest	41	125	100
Riparian Forest	145.0	0	145
Subtotals	**208.3**	**470**	**1,352[3]**
Total	**223.6**	**1,822**	

1 Areas are in hectares
2 Note that figures detailed are based on existing vegetation mapping completed in the field by Ecotone Pty Ltd augmented by the interpretation of aerial photography and desktop analysis. Final estimates may be subject to refinement based on the completion of a planting management work plan. Topography, aspect and soils suggest that Spotted Gum-Ironbark Forest would be the dominant forest type likely to be established in the corridor and buffer area, however a mosaic of intergrading forests types can also be expected on lower slopes and gullies.
3 Estimate includes 19 km (145 ha) of riparian vegetation maintained, enhanced or established upstream and downstream of the dam.

It is acknowledged that the sponsorship of a program that encourages tree planting on private land in riparian areas along the Williams River requires the permission of landholders. Accordingly there is no guarantee that such a program will be successful. A number of landholders on the Williams River have however already contacted either Dungog Shire Council or Hunter Water in the last 12 months to explore possible opportunities to access funding for tree planting works on their properties, to promote bank stability and an improved riparian zone. Further, catchment management authorities across NSW currently offer a number of programs of a similar nature that have proven to be a success. It is therefore considered likely that a sponsorship program would attract sufficient interest from landholders to become a success.

In terms of timing, it would be important to commence work as soon as practicable in order to allow sufficient time for vegetation to establish such that it reached suitable height for use by affected species such as the koala, squirrel glider, speckled warbler and brush-tailed phascogale. The priority area would be the area to the south of Tillegra Reserve given that it would be significantly impacted in the early stages of construction of the dam and spillway. This may require supplementary planting concurrent with natural regrowth.

Recommended flora species for planting in offset and corridor areas are identified in Appendix 2 to Working Paper E. It would be important to include a substantial proportion of plant species that provide important food and shelter habitat for threatened fauna species likely to be displaced as a

result of the Project (including koala food trees and winter–flowering trees). These are also identified in Appendix 2 to Working Paper E.

Establishment of the habitat corridor and buffer area is a significant incidental benefit of action to be taken to offset GHG emissions associated with the Project. The approximate cost to establish and manage the buffer area and corridor is in the order of $30 million. This is a significant investment of public funds and has been designed to maximise social, economic and environmental benefits. These benefits include the capacity to tailor land management practices to effectively manage water quality within the storage, while still providing a facility for low impact recreational activities important to the local and regional economy.

Pre–clearing surveys

Prior to any clearing, surveys of hollow–bearing trees would be undertaken in the vicinity of the traveling stock reserve. These trees would be clearly marked and a staged clearing regime implemented. Where practicable, smaller trees and the shrub layer would be removed first to prolong connectivity with adjacent habitat.

Disturbance may encourage fauna to leave the area, however, in the case of nesting birds tree removal may need to be delayed until after the young have fledged. As far as practicable tree removal would be timed to avoid the peak bird and bat breeding season (September to January inclusive). This timing would also cover the period that young brush–tailed phascogales would be left in the nest. However, the squirrel glider can breed over an extended period therefore the complete avoidance of young in a nest would be difficult to achieve.

Erection of nest boxes

Prior to the start of vegetation clearing, nest boxes suitable for use by known hollow-dependant threatened species (brush–tailed phascogale, squirrel glider and insectivorous bats) would be erected in retained remnants above FSL, concentrating on areas where hollow bearing trees are absent or scarce. This would provide short term shelter (up to 10 years) for displaced threatened species and allow new territories to be established.

If the project is approved, future versions of the integrated land use plan will incorporate specific management actions for the ongoing maintenance and management of nest boxes including monitoring of their effectiveness. Nest boxes are exposed to inclement weather that can cause them to deteriorate and hence these will require periodic maintenance or replacement over the longer term (potentially several decades if not significantly longer, until re-forested areas reach a suitable maturity to start naturally generating hollow bearing branches).

HWC and the DECCW currently jointly manage recently declared State conservation areas on the Tillegerry and Tomaree peninsula that cover several thousand hectares. Management plans are currently being developed for these areas. HWC has advised that in a similar co-operative manner, HWC would also be happy to broaden existing consultations with the DECCW to include their feedback on future versions of the integrated land use plan, to ensure best management practices are instituted at the Tillegra Dam site, for the management of flora and fauna, including the provision of next boxes and similar replacement habitat.

Relocation of hollow logs and woody debris

Relocation of felled trees containing hollows which could serve as habitat for various fauna species would also occur to complement the erection of nest boxes. Preference would be given to the relocation of suitable trees at or near the FSL as the cost of transport of trees from lower down in the storage would likely be prohibitive.

Similarly, in various locations where they would not be a hazard to watercraft, trees at or near the FSL could be left in situ to act as habitat for aquatic species such as fish.

Engagement of wildlife handler

An experienced and suitably equipped wildlife handler would be engaged to assist in management of displaced wildlife during initial works undertaken to prepare the dam construction site for major work. Given the likelihood of encountering bats, handlers would be required to be vaccinated against the bat Lyssavirus as a precaution.

Management of bats

Working Paper E includes a bat management plan (Appendix 7) which would be implemented to mitigate and manage impacts on bats occurring in the Project area and which would be affected by the Project. The objectives of the plan include:

- maintenance of the species diversity of microbats within the Project area during and after construction
- retaining the integrity of the southern myotis population known to occur in the Project area and which may possibly use Tillegra Bridge for roosting and breeding
- provision of alternate artificial roost sites, initially under the new bridge over the Williams River downstream of the dam and subsequently under the other new bridges and within fringing vegetation above FSL
- establishment of a program to monitor the effectiveness of mitigation and management measures.

Management of platypus

The specialist terrestrial ecology investigation noted that opportunities to implement mitigation measures above the location of the dam wall would be limited. It did, however, recommend that habitat restoration at the FSL be undertaken. Placement of semi–submerged logs and planting riparian vegetation along sections of the storage shoreline could assist in foreshore stabilisation and allow burrow construction in the future. The side arms of the creeks entering the storage and where steep earth banks occurred would be the best place to target any such habitat restoration for the platypus. The creation of cobbled rocky areas where natural stream flows enter the storage could also be beneficial, however in still water areas such structures would more likely become covered in silt. On this basis, habitat restoration would focus on the establishment of instream habitat and riparian vegetation.

During the initial filling of the storage, it is considered there are no practicable mitigation measures or management strategies available with respect to the potential inundation of burrows during the period mid September to mid–March when young platypus could be in the burrows.

Potential downstream impacts on platypus would be managed and avoided largely through the adopted release strategy (described in the previous chapter). Together with the provision of the multi-level offtake tower, this would provide a high degree of operational flexibility which would allow HWC to release water with physico–chemical properties (eg temperature) that matches as closely as possible the properties of downstream receiving waters. The release strategy would also address timing and duration of releases to avoid impacts on downstream platypus habitat, burrows and populations in general.

Australian water rat

The adopted release strategy would also serve to mitigate impacts on the water rat. The establishment of the riparian buffer around the storage perimeter would, in the longer term, serve to reduce the risk of predation by providing cover.

Erosion and sediment control

Management of erosion and sedimentation risk during construction has been noted elsewhere in this report, for example in relation to managing water quality risks (Chapter 10). As noted, this would be undertaken through the design and implementation of erosion and sediment controls through a formal management plan which would form part of the overall construction EMP.

This would serve equally to manage potential impacts on terrestrial flora and fauna.

Weed and pest management

Management of weeds and pests during construction would be undertaken by the construction contractor. The construction EMP would include a specific management plan in this regard.

Management of weeds and feral pests during filling and eventual operation of the storage would be undertaken through the integrated land use plan (refer Working Paper N).

Phytophthora cinnamomi

As noted in Section 11.4.4, the spread of *Phytophthora cinnamomi* is listed as a key threatening process under both the TSC and EPBC Acts and there is a risk of this fungus being introduced on machinery, clothing and in soil/fill during construction of the Project. The construction EMP would include suitable management protocols to address the risk of spread of *Phytophthora cinnamomi*.

Chytrid fungus

Management protocols consistent with DECC guidelines would be incorporated into the construction EMP to minimise the risk of introduction or spread of chytrid fungus.

Fencing

In view of the known risk to fauna (particularly gliders and flying–foxes) of becoming entangled, the use of barbed wire fencing would be avoided or otherwise minimised where ever possible.

Monitoring

The monitoring of the effectiveness of management strategies and impact mitigation measures would be undertaken initially by the works contractors. Over the longer term (post–construction), they would be undertaken as an action incorporated into the ILUP. Environmental auditing by an independent and appropriately qualified and experienced environmental management specialist would be undertaken to make sure contracted work is performed to a high standard.