3 Existing environment

3.1 Landscape context

The study area is located in the developed central portion of the Hawkesbury Local Government Area (LGA). The Hawkesbury River runs north-easterly through the study area in the South Creek sub-catchment of the Hawkesbury-Nepean catchment. The sub-catchment is heavily degraded as a result of historical vegetation clearance and urbanisation, with riparian zones often infested with woody weeds (HNCMA, 2008). The study area is representative of the degraded environment of the broader sub-catchment.

The construction footprint is wholly located within the Cumberland Plain Sub-region of the Sydney Basin Bioregion situated on the east coast of NSW. The Sub-region extends west from Parramatta to the Hawkesbury-Nepean River and from Windsor in the north to Thirlmere in the south with a total area of about 275,000 hectares (NPWS, 2002). While the Bioregion is one of the most species-diverse in the state, the Cumberland Plain sub-region is considered to be the most highly developed and as a result, the most highly degraded. The region receives an annual mean rainfall of 809.3 millimetres with temperatures averaging between 11–24 degrees Celsius (BOM 2012).

The physical environmental features of the Sydney Basin Bioregion as identified in Mitchell (2003) are summarised in **Table 3-1**. The proportion of cleared estimates for each landscape is derived from the 'overcleared landscapes database (DECCW 2010).

The NSW Landscapes coverage is a statewide map of landscapes, compiled using existing resources and describing land attributes considered to drive ecosystem processes (Mitchell, 2003). Definition of the landscapes emphasises geologic, geomorphic and pedologic factors. In the Eastern and Central Divisions of the state, geology and topography were emphasised. The study area traverses the floodplain of the Hawkesbury River and the low hills typical of the river terrace landscape (Mitchell, 2003).

Table 3-1 Mitchell Landscapes in the study area

Mitchell (2003) ecosystems	Landscape characteristics (geomorphic, pedologic and vegetation)	Percentage cleared*
Hawkesbury-Nepean Terrace Gravels	Three levels of river terrace dating to the Tertiary period. General elevation 20 to 45 m, local relief 10 m. Planar, poorly drained terraces with harsh texture-contrast soils and heavy clays in swamps and cut-off meanders. In places deep sands of crevasse splays support Scribbly Gum *(Eucalyptus sclerophylla*), Narrow-leaved Apple (*Angophora bakeri*) and Old Man Banksia (*Banksia serrata*) on podsols with adjacent sedgelands. Most clay-based soils (harsh texture-contrast profiles) are very gravelly and carry Broad-leaved Ironbark *(Eucalyptus fibrosa* ssp. *fibrosa*) and Narrow-leaved Ironbark *(Eucalyptus crebra*), Grey Box *(Eucalyptus moluccana*), paperbarks (*Melaleuca* sp.) and Drooping Red Gum *(Eucalyptus parramattensis*). Several vegetation communities are now rare, especially on the Pliocene/Pleistocene sand body with podsol soil profiles at Agnes Banks.	67%

Mitchell (2003) ecosystems	Landscape characteristics (geomorphic, pedologic and vegetation)	Percentage cleared*
Hawkesbury-Nepean Channels and Floodplains	Meandering channel and moderately wide floodplain of the Hawkesbury and Nepean rivers on Quaternary sand and gravel. Sand is dominant upstream of the Warragamba River junction, general elevation 0 to 20 m, local relief <10 m. Undifferentiated alluvial sand to poorly structured gradation profiles of sandy loam or clay loam. Forests on the river flats include Blue Box *(Eucalyptus baueriana*), Broad-leaved Apple (*Angophora subvelutina*), Manna Gum *(Eucalyptus viminalis*), River Peppermint *(Eucalyptus elata*) in upstream sectors and dominated by River Oak (*Casuarina cunninghamiana*) possibly originally with rainforest species such as White Cedar (*Melia azedarach*) in the lower sectors. Common Reed (*Phragmites australis*), Cumbungi (*Typha orientalis*) and other aquatic plants are found in the river. Deep organic loams and loamy sands on floodplain with river flat forest of Sydney Blue Gum *(Eucalyptus saligna*), Round-leaved Gum *(Eucalyptus deanei*), Forest Red Gum *(Eucalyptus tereticornis*), Cabbage Gum *(Eucalyptus amplifolia*), Broad-leaved Apple, Rough-barked Apple (*Angophora floribunda*) and River Oak. Water Gum occurs (*Tristaniopsis laurina*) in protected channel sections. Large swamps and lagoons on the floodplain and in tributary streams below Richmond dammed by levees on the main stream support Tall Spike Rush (*Eleocharis* sp*hacelata*), *Juncus* sp., *Melaleuca* sp., and *Lepidosperma* sp. Below Pitt Town the river is tidal and Swamp Oak (*Casuarina glauca*), Common Reed, River Mangrove (*Aegiceras corniculatum*), Grey Mangrove (*Avicennia marina*) and limited salt marsh are found on the muddy sands of the inter-tidal zone.	79%

*Overcleared landscapes database (DECCW 2010)

3.2 Land use

The study area has a mix of residential, public reserve, recreation and agricultural land uses. In the Hawkesbury Local Environment Plan 1989, the study area displays Natural Waterways, Recreation Waterways, Public Recreation, Local Centre, Low Density Residential and Rural Landscape land use zones. It includes Macquarie Park and turf farms to the north, historical landscaped public areas and elements of the Windsor township to the south and the Hawkesbury River and its riparian elements.

Macquarie Park, north of the Hawkesbury River is the only Council managed reserve containing protected or sensitive ecological components within the study area. Another local reserve in the study area is Thomson Square, which is not considered ecologically sensitive but the open area and scattered trees may provide habitat to some fauna. No conservation reserves or State Forest lands and critical habitat occur within the study area. Windsor Downs Nature Reserve (about 360 hectares) and Scheyville National Park (about 900 hectares) both occur within the locality (that is, they occur within a 10 kilometre radius of the study area).

3.3 Previous ecological assessment

LesryK Environmental Consultants (2008) undertook preliminary flora and fauna investigations as part of the options assessment for the upgrade/replacement of Windsor bridge. The study area for that investigation was confined to the immediate riverbank environments of the Hawkesbury River.

A total of 17 indigenous flora species were recorded in the study area, none of which were threatened or endangered populations listed under the TSC or EPBC Acts. A total of 34 species recorded in the study area were introduced species, among them five noxious weeds. One native vegetation community was identified during the survey which may have been derived from the River-flat Eucalypt Forest (RFEF) endangered ecological community (EEC) under the (TSC Act). The community is highly degraded with considerable deviation from the structure, character and condition of the originally described EEC. Three vegetation communities were identified as Exotic Grassland, Disturbed Woodland and Casuarina Woodland based on LEC surveys (RTA, 2011b). These are found on both banks of the river except Disturbed Woodland (which only occurs on the northern side).

Fauna surveys detected 13 native bird species and six introduced bird species found within the study area. No native mammals, reptiles, frog species or invertebrates were observed during the survey.

3.4 Vegetation communities and habitat

3.4.1 Previous vegetation mapping

The NSW National Parks and Wildlife Service conducted a vegetation mapping project for the Cumberland Plain in western Sydney from 1997 – 2002 (NPWS, 2002) which covered the current study area. These vegetation communities have been mapped as either having greater than or less than 10 per cent foliage projected cover. Such ratings typically correspond to the time since their last disturbance (for example clearing) and may indicate the condition of the vegetation (with greater than 10 per cent cover closer to natural condition).

The NPWS (2002) mapping is based on 1997/1998 aerial photographs and as such may have errors and/or limitations which should preclude its sole use in regional biodiversity planning. Ground-truthing of the NPWS mapping was required to provide more accurate advice regarding ecological values and constraints to inform this biodiversity assessment for the project.

The NPWS (2002) work identifies three vegetation associations in the study area which are described in **Table 3-2**. These include Riparian Forest in the north west, Alluvial Woodland in the south and north west, and Shale Plains Woodland in the south. These associations correspond to Threatened Ecological Communities (TECs) listed under the TSC Act and EPBC Act (**Table 3-3**) and reflected in **Figure 3-2**.

These communities have been aligned with those identified in the OEH vegetation types database (Office of Environment and Heritage 2012a and used in BioMetric 2.0). Threatened ecological communities are discussed in further detail in **Section 3.6**.

Table 3-2 Previously mapped vegetation community descriptions and dominant species in the study area (Source: NPWS 2002)

OEH Vegetation Types	Community	Description	Dominant species	Foliage Projected Cover in Study Area
Grey Box-Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	Shale Plains Woodland	Most widely distributed on the Cumberland Plain on soils derived from Wianamatta Shale and also on Holocene alluvium in well drained areas. This community grades into Map Unit 9 with increasing elevation and ruggedness.	Trees: *Eucalyptus moluccana, E. tereticornis, E. crebra, E. eugenioides, Corymbia maculata* Small Trees: *Exocarpos cupressiformis, Acacia parramattensis, A. decurrens* Shrubs: *Bursaria spinosa* Groundcover: *Dichondra repens, Aristida vagans, Microlaena stipoides, Themeda australis, Brunoniella australis, Desmodium varians, Opercularia diphylla, Wahlenbergia gracilis, Dichelachne micrantha*	<10%
Forest Red Gum-Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Alluvial Woodland	Exclusively occurs along, or in close proximity to minor watercourses draining soils derived from Wianamatta Shale. It is the most common community in the region occurring on recent alluvial deposits and on the floodplains of Hawkesbury-Nepean River.	Trees: *Eucalyptus amplifolia, Eucalyptus tereticornis, Angophora floribunda* Small Trees: *Acacia parramattensis, Casuarina glauca, Melaleuca linariifolia* Shrubs: *Bursaria spinosa* Groundcover: *Oplismenus aemulus, Microlaena stipoides, Entolasia marginata, Echinopogon ovatus, Pratia purpurascens, Solanum prinophyllum, Commelina cyanea*	<10%
Forest Red Gum-Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Riparian Forest	This community is relatively restricted in the region occurring only on the banks of the Hawkesbury-Nepean River. In some areas it occurs on the terraces directly adjacent to rivers.	Trees: *Eucalyptus botryoides, Eucalyptus elata, Angophora floribunda, A. subvelutina* Small Trees: *Acacia binervia, A. floribunda, A. mearnsii* Groundcover: *Oplismenus aemulus*, *Pteridium esculentum*, *Microlaena stipoides, Austrostipa ramosissima, Echinopogon ovatus*	<10%

3.4.2 Survey results

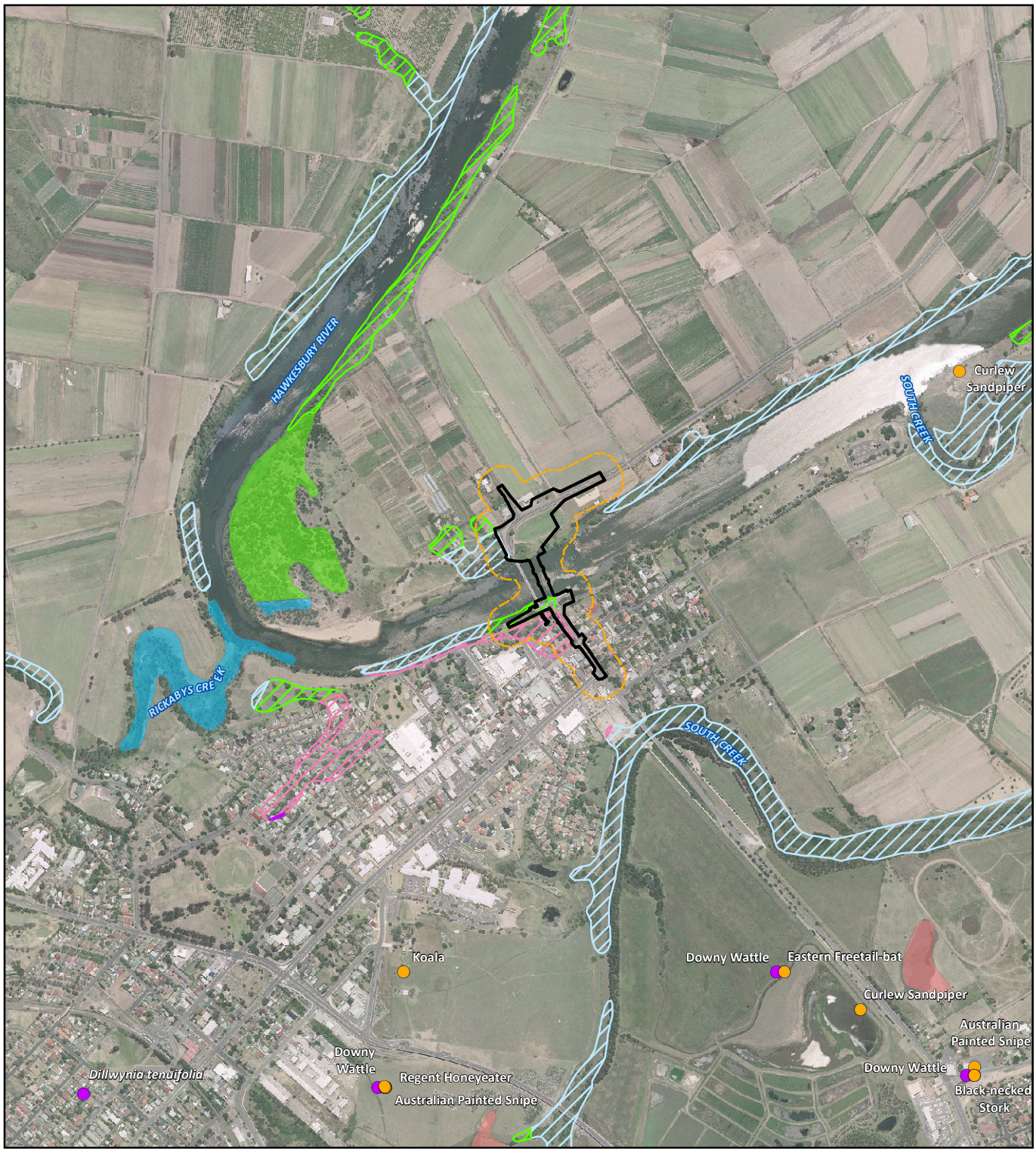
Field verification of vegetation communities was undertaken to determine the type, extent and condition and conservation status of areas of vegetation in the study area. Vegetation communities within the study area are either artificial constructs or modified natural communities. The artificial communities include the parklands of Thompson Square and landscaped streets of The Terrace in the south of the study area, and the parkland of Macquarie Park north of the river. The vegetation east of the bridge along the northern bank is largely devoid of any native species representative of original or derived riparian communities. The riparian corridors along both sides of the riverbank west of the bridge are somewhat representative of a natural vegetation community but appear to have been planted or rehabilitated to re-establish riparian diversity, function and aesthetics to the Hawkesbury River. No remnant vegetation communities exist within the study area. All extant vegetation communities identified within the study area are considered to be in low condition.

Figure 3-2 illustrates the results of the field survey with regard to the vegetation communities present within the study area. As a result of the highly modified nature of the study area, the broadscale vegetation mapping of the Cumberland Plain undertaken by NPWS (2002) is not representative of the vegetation communities at the site. Four vegetation communities were identified, described in **Table 3-3**.

Table 3-3 Vegetation communities and conditions identified in the study area

Vegetation Community	Corresponding OEH Vegetation Type	Condition values
Riparian *Casuarina* open forest	River Oak open forest of major streams, Sydney Basin and South-East Corner	Low
Modified riparian open forest (highly modified)	River Oak open forest of major streams, Sydney Basin and South-East Corner	Low
Cleared grassland	Nil	Low
Parkland/landscaped areas	Nil	Low

Figure 3-1 | Threatened flora and fauna records and vegetation communities



Indicative only – subject to detailed design

LEGEND

- Concept design footprint
- Study area
- Threatened fauna record
- Threatened flora record

Vegetation communities, over 10% crown cover

- Alluvial Woodland
- Riparian Forest
- Freshwater Wetlands

Vegetation communities, under 10% crown cover

- Shale Plains Woodland
- Alluvial Woodland
- Riparian Forest
- Shale/Gravel Transition Forest

GDA 1994 | MGA Zone 56
A4 1:15,000

0 500
Metres

AUSIMAGE SKM

25/10/2012 | I:\NBIF\Projects\NB11459\Technical\GIS\GIS_Directory\ArcMap\Specialist_Reports\Ecology\NB11459_002_EcologyWP_FloraFauna.mxd
Sydney Spatial Team - Prepared by : DD
Checked by : JC

Figure 3-2 | Survey results

Indicative only – subject to detailed design

LEGEND

- Concept design footprint
- Study area
- Aquatic survey locations

Scour protection

- Permanent rock scour protection (if required)
- Temporary rock scour protection (if required)

Fauna habitats

- Cleared grasslands
- Riparian forest

Vegetation communities

- Riparian casuarina open forest
- Modified riparian corridor
- Cleared grasslands
- Parklands / landscaped areas

GDA 1994 | MGA Zone 56
A4 1:6,000

0 200
Metres

Windsor Bridge replacement flora and fauna assessment

AUSIMAGE SKM

Riparian Casuarina Open Forest

This vegetation community occurs on alluvial soils associated with the Hawkesbury River. Historical land clearing era, which involved completely removing original native riparian vegetation communities at Windsor during early European colonisation. The resultant re-growth also appears to have been altered in structure and diversity through planting (**Plate 3-1**). The community occurs in a narrow strip along the southern bank of the Hawkesbury River and bordered by the footpath of The Terrace which is landscaped with White Cedar (*Melia azedarach*), Jacaranda (*Jacaranda mimosifolia*), Liquid Amber (*Liquidambar styraciflua*) and Peppercorn (*Schinus* sp.). The riverbank is dominated by River Sheoak (*Casuarina cunninghamiana*) and Swamp Oak (*Casuarina glauca*) with White Cedar (*Melia azedarach*) along the mid-bank and higher. Occasional eucalypts occur along the mid bank and the community is generally of low condition with a moderately dense but weedy understory including Green Cestrum (*Cestrum parqui*) interspersed with paperbarks (*Melaleuca* sp.) and wattles (*Acacia* sp.). The groundlayer is sparse but pockets of vegetation are dominated by exotic species including Trad (*Tradescantia fluminensis*).

This vegetation most closely aligns with the River Oak open forest of major streams, Sydney Basin and South East Corner vegetation type from the OEH Database for the Hawkesbury-Nepean Catchment Management Area. However, the community is in low condition with commonly found understorey and groundlayer species absent due to the highly modified and partially artificial nature of the community.

Modified Riparian Open Forest

This vegetation community also occurs on alluvial soils associated with the Hawkesbury River. Within the study area it exists along the northern bank of the river adjacent to Macquarie Park (**Plate 3-2**). Historical land clearing completely removed original native riparian vegetation communities at Windsor during early European colonisation. Whether the banks in this part of the study area are representative of highly modified re-growth or have been completely recreated by riparian replanting is unknown. A footpath traverses the mid-bank from east to west and at the time of survey the recent floods had unearthed black plastic matting along the low and mid-banks where mature casuarinas are well established. The community occurs in a narrow strip along the northern bank of the Hawkesbury River both east and west of the bridge. The riverbank is dominated by River Sheoak (*Casuarina cunninghamiana*) and Swamp Oak (*Casuarina glauca*) with occasional plantings of paperbarks (*Melaleuca spp*.) and White Cedar (*Melia azedarach*). One Swamp Mahogany (*Eucalyptus robusta*) was observed near the bridge on the mid-bank. The understorey is generally absent although exotic vines such as Balloon Vine (*Cardiospermum grandiflorum*) and Blackberry Nightshade (*Solanum nigrum*) persist. The groundlayer is sparse but clumps of Lomandra (*Lomandra longifolia*) occur along the toe of the bank.

This vegetation most closely aligns with the River Oak open forest of major streams, Sydney Basin and South East Corner vegetation type from the OEH Database for the Hawkesbury-Nepean Catchment Management Area. However, the understorey and groundlayer species commonly found in that community are not present at the site due to the highly modified and partially artificial nature of the community. This vegetation community is considered to be in low condition within the study area.

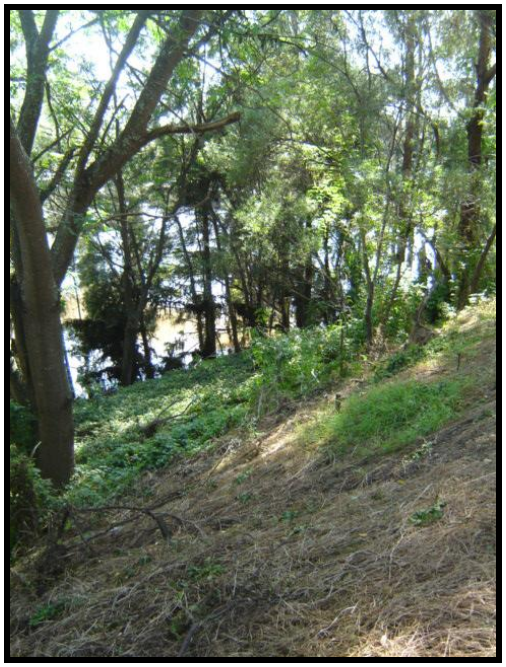


Plate 3-1 Riparian Casuarina open forest in low condition in the study area (south east of the existing bridge)

Plate 3-2 Modified riparian forest in low condition (north west of the existing bridge)

Cleared grassland

Cleared grassland occurs along the riverbank and adjacent floodplain on the northern bank of the Hawkesbury River within the study area east of the bridge. This is an artificially constructed community most likely resulting from intensive land use since the banks were cleared of original vegetation in the first decade of the colonisation of Windsor. The floodplain is managed for turf farming and the creek bank is dominated almost entirely by exotic pasture and roadside weed species, largely herbs and grasses, with the occasional exotic tree such as the willow (*Salix babylonica*) present. One native Kurrajong (*Brachychiton populneus*) and one Swamp Oak (*Casuarina glauca*) were observed to persist in the landscape.

Shrub weeds in this community are clumped across the site and include Castor oil (*Ricinus communis*), Wild Tobacco (*Solanum mauritianum*), Lantana (*Lantana camara*), Fennel (*Foeniculum vulgare*) and Purpletop (*Verbena bonariensis*). Grass and groundcover weeds included Turkey Rhubarb (*Acetosa sagittata*), thistles and Johnson Grass (*Sorghum halapensis*). The exotic Madeira Vine (*Anredera cordifolia*) and Balloon Vine (*Cardiospermum grandiflorum*) were also prolific across the site.

Parkland/Landscaped areas

A number of parkland or landscape environments exist within the study area that are representative of early European colonisation in Australia. These include Thompson Square parkland and associated streetscaping in the southern part of the study area (such as The Terrace), as well as the more recently landscaped Macquarie Park north of the Hawkesbury River. These areas are typically planted with either introduced horticultural species or Australian natives chosen for their aesthetic properties, but which would not occur in local native vegetation communities. These areas consist of mature trees, with no understorey and a completely maintained exotic grass cover. They are thus of low ecological condition and value in the context of this biodiversity assessment.

Mature trees of Thompson Square parkland include a number of Liquid Ambers (*Liquidambar styraciflua*), Silky Oaks (*Grevillea robusta*) and Kurrajongs and one Bunya Pine (*Araucaria bidwillii*). The stature of these trees suggests that some of them may be greater than 80 years in age. Streetscape plantings along The Terrace and other paths within the study area are landscaped with White Cedar (*Melia azedarach*), Jacaranda (*Jacaranda mimosifolia*), Liquid Amber (*Liquidambar styraciflua*) and Peppercorn (*Schinus* sp.).

3.4.3 Structure, function and connectivity

The vegetation in the study area is patchy, linear and extensively fragmented. As a result the site was not observed, nor is expected to support a high diversity or abundance of native species that rely upon high quality habitat or large remnants. No land within the study area or the broader locality falls into the Priority Conservation Lands (PCL) identified in the Cumberland Plain Recovery Plan (DECCW, 2010). Additionally, the study area does not include any land identified as part of the regional biodiversity corridors identified in the Hawkesbury-Nepean Catchment Management Area (HNCMA, 2007). Information on key habitats and movement corridors from the OEH Key Habitats and Corridors project (DEC 2003) and Climate Change Corridors project (DECC 2007) does not extend into the study area.

Plate 3-3 Cleared grassland in the study area (north east of the bridge)

Plate 3-4 Parkland in the study area (Thompson Square)

3.4.4 Noxious weed species

Noxious weed species were recorded within the study area. These have been listed below in **Table 3-4** including the noxious class for each species.

Table 3-4 Noxious weed species identified across the study area

Species	Prevalence on site	Noxious class
Willow *(Salix babylonica)*	Sporadic within the vegetation on the southern bank of the river in the study area and a mature individual immediately east of the bridge on the northern side of the river. Some juveniles emerging.	Class 5: The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.
Croften Weed *(Ageratina adenophora)*	Largely confined to the northern banks of the river to the east of the bridge, adjacent to agricultural land.	Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
African lovegrass *(Eragrostis curvula)*	Largely confined to the northern banks of the river to the east of the bridge, adjacent to agricultural land.	
Lantana *(Lantana camara)*	Scattered clumps along the southern bank of the river west of the bridge and immediately east of the bridge on the northern side of the river.	
Broad-leaf Privet *(Ligustrum lucidum)*	Observed largely within the vegetation immediately east of the bridge on the northern side of the river. Sporadic individuals occur along the southern bank west of the bridge.	
Small-leaf Privet *(Ligustrum sinense)*		
Johnson Grass *(Sorghum halepense)*	Observed on the floodplain and riverbank in areas devoid of trees east of the bridge on the northern side of the river.	
Green Cestrum *(Cestrum parqui)*	Along the southern bank of the river in the study area.	Class 3: The plant must be fully and continuously suppressed and destroyed.
Water Hyacinth *(Eichhornia crassipes)*	None sighted during field surveys, however is present throughout the Hawkesbury River System.	
Alligator Weed (*Alternanthera philoxeroides)*	None sighted during field surveys, however is present throughout the Hawkesbury River System.	
Salvinia *(Salvinia molesta)*	None sighted during field surveys, however is present throughout the Hawkesbury River System.	
Dense Waterweed (*Egeria densa)*	None sighted during field surveys, however is present throughout the Hawkesbury River System.	Class 5: The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.

3.5 Aquatic habitats

The Hawkesbury River provides the only aquatic habitat in the study area. The river is estuarine, 120 metres wide and flows in an easterly direction. The aquatic environment on both sides of the bank at the existing Windsor bridge and the proposed bridge is described in **Table 3-5** below. Aquatic survey locations have been shown on **Figure 3-2**.

The Hawkesbury River currently mapped as 'Key Fish Habitat'. It is also classified as a Class 1 Waterway, as it is a permanently flowing waterway containing major fish habitat, as such requiring a bridge, arch or tunnel structure (Fairfull & Witheridge, 2003). No existing barriers to fish passage were observed within the study area. Aquatic macrophytes and submerged woody debris were largely absent from the study area, potentially due to the high flows and associated flood which had occurred three weeks prior to fieldwork.

No aquatic weeds were sighted during the field survey, however introduced Alligator Weed (*Alternanthera philoxeroides*), Water Hyacinth (*Eichhornia crassipes*), Salvinia (*Salvinia molesta*) and Dense Waterweed (*Egeria densa*) have been recorded within the Hawkesbury-Nepean Catchment.

No threatened aquatic fauna species are expected to occur in the study area and the replacement of Windsor Bridge is expected to be relatively unobtrusive in relation to potential impact upon aquatic fauna. The waterway has been classified as Class 1 and accordingly a bridge structure is proposed to avoid interruptions to fish passage. As such, the temporary nature of the disturbance and the small magnitude of the project did not warrant surveys of aquatic fauna in the Hawkesbury River.

Table 3-5 Aquatic habitat description

Site	Description
Site 1a - Windsor bridge (South Bank)  56H 297971E, 6279656N	Recent flooding at the site has covered the riparian habitat with silt and caused the removal of riparian and aquatic habitat and the deposition of rubbish. The mud/clay steep banks have been stabilised using Gabion Baskets to limit erosion, which has also limited the diversity of aquatic habitat such as overhanging riparian vegetation and a diversity of bank substrate. No aquatic macrophytes were observed at the site.
Site 1b – Windsor bridge (North Bank)  56H 297894E, 6279774N	Recent flooding at the site has covered the riparian habitat with silt, and resulted in the removal of much of the riparian and aquatic habitat and the deposition of rubbish. The northern banks of the river at the project crossing are steep, about two metres in height, with evidence of moderate bank erosion occurring within sections of the bank. Aquatic macrophytes include Slender Knotweed (*Persicaria decipiens),* Hydrilla (*Hydrilla verticillata)* and Hornwort (*Certatophyllum demersum)*.

Site	Description
Site 2a – Hawkesbury River Project Crossing (South Bank)  56H 298666E, 6280041N	Recent flooding at the site has covered the riparian habitat with silt, and resulted in the removal of much of the riparian and aquatic habitat and the deposition of rubbish. Banks are about 1.5 m high with minimal evidence of erosion at the site. The aquatic macrophyte Hydrilla (*Hydrilla verticillata)* was located at the site.
Site 2b – Hawkesbury River Project Crossing (North Bank)  56H 2980567E 6279856N	Recent flooding at the site has covered the riparian habitat with silt, and resulted in the removal of much of the riparian and aquatic habitat and the deposition of rubbish. Several submerged woody snags and Weeping Willow (*Salix babylonica*) occur instream. The northern banks of the river at the project crossing are steep, ranging from one to two metres in height with evidence of some erosion.

Water Quality

Water quality upstream and downstream of the project is moderate, with the average concentration of all parameters except dissolved oxygen within the ANZECC/ARMCANZ (2000) guidelines for slightly disturbed lowland rivers (**Table 3-6**).

Visibility at both sites was low, but within the recommended guidelines (6-50 NTU) both upstream (18.57 NTU) and downstream (26.73 NTU) of the project. The low visibility can be partially attributed to floods and heavy rainfall prior to and during the survey period.

Table 3-6 Water quality in the Hawkesbury River at the study area

Parameter	ANZECC Guideline*	Upstream of Project	Downstream of Project
Turbidity (NTU)	6 - 50	18.57	26.73
Temperature (°C)	n/a	21.31	21.63
pH	6.5-8.5	7.82	7.97
Electrical Conductivity (mS/cm)	0.125-2.2	0.17	0.15
Dissolved Oxygen (% Saturation)	85-110	**114.30^**	**110.81^**
Dissolved Oxygen (mg/L)	n/a	10.40	9.86

** ANZECC/ARMCANZ 2000 default Trigger Values for slightly disturbed lowland rivers*

^Exceeds ANZECC/ARMCANZ Guidelines

3.6 Threatened Ecological Communities

3.6.1 Previous vegetation mapping

NSW NPWS mapping of the Cumberland Plain (2002) suggested the study area may support three vegetation communities which corresponded to two threatened ecological communities (TECs) under NSW and Commonwealth threatened species legislation. These include Cumberland Plain Woodland (TSC Act/EPBC Act) and River-flat Eucalypt Forest (TSC Act). **Table 3-7** presents the vegetation communities predicted to occur in the study area by NPWS (2002) and the corresponding TECs.

Table 3-7 Vegetation associations of the local area (NPWS 2002), corresponding survey vegetation descriptions and relevant Commonwealth and State listed TECs

Community (NPWS 2002)	NSW TSC Act	Commonwealth EPBC Act	Field survey vegetation description
Shale Plains Woodland	Cumberland Plain Woodland (critically endangered)	Cumberland Plain Woodland (critically endangered)	TEC not present in this community. No tree species characteristic of the TEC. No derived grasslands of the TEC present in the study area.
Alluvial Woodland	River-flat Eucalypt Forest in the NSW North Coast, Sydney Basin and South East Corner Bioregions (endangered)	-	TEC not present in this community. Riparian casuarinas open forest in the study area is dominated by Sheoaks with eucalypts sparse or not present. The TEC would be dominated by eucalypts with Sheoaks in low densities.
Riparian Forest	River-flat Eucalypt Forest in the NSW North Coast, Sydney Basin and South East Corner Bioregions (endangered)	-	TEC not present in this community. Modified riparian open forest present within the study area appears largely replanted and dominated by Sheoaks with eucalypts sparse or not present. The TEC would be dominated by eucalypts with Sheoaks in low densities.

Field surveys in the study area did not record vegetation characteristics or key diagnostic species representative of the TECs mentioned in Table 3-7 and previously mapped as occurring in the locale (NPWS, 2002).

Previous flora and fauna investigations (LesryK, 2008) took a precautionary approach to the NPWS mapping of the River-flat Eucalypt Forest TEC within the study area, despite a general absence of key diagnostic community features and characteristic species. Field surveys for the current biodiversity survey did not reveal a dominance of eucalypts in the tree layer with a low density of sheoaks, but rather the reverse. This observation, together with the highly modified nature of the riparian environment suggests that the River-flat Eucalypt Forest TEC is not present within the study area.

3.7 Groundwater dependent ecosystems

Given the nature of floodplain environments, vegetation communities that occur across them are generally considered to be highly dependent upon groundwater to maintain their viability. While the riparian vegetation communities within the study area are groundwater dependent, they are likely to have evolved with short periods of natural groundwater fluctuation without suffering any medium or long-term impacts.

3.8 Threatened species and endangered populations

3.8.1 Flora

Previous occurrences and likelihood

LesryK (2008) recorded a total of 51 flora species, but recorded no plant species of national or state significance. The site is regarded as heavily fragmented with little or no remnant vegetation and contains numerous exotic and introduced plant species.

A review of the OEH NSW Bionet data and EPBC Act Protected Matters Search Tool for this assessment identified 15 threatened plant species previously recorded in the locality. These species have been listed in **Table 3-8** along with an assessment of the potential for each species to occur in the study area. The locations of the recorded threatened flora species specific to the study area have been illustrated in **Figure 3-1**. The distribution and habitat requirements identified in **Table 3-8** have been adapted from threatened species profiles provided online by OEH and Department of Sustainability, Environment, Water and Population and Communities (DSEWPaC).

Survey results

Field surveys targeted the presence of threatened flora species, endangered populations and their habitats. No threatened flora species that were expected to occur based on the likelihood of occurrence assessments were observed during the survey.

Table 3-8 Known or potentially occurring threatened flora species

Species	Status		Distribution and habitat requirements*	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act			
Bynoe's Wattles *Acacia bynoeana*	V	E	Found in central eastern NSW, from the Hunter District south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include Red Bloodwood (*Corymbia gummifera),* Scribbly Gum *(Eucalyptus haemastoma),* Drooping Red Gum *(E. parramattensis),* Old Man Banksia *(Banksia serrata)* and Small-leaved Apple (*Angophora bakeri).*	Limited - dry sclerophyll forest	Unlikely
Gordon's Wattle *Acacia gordonii*	E	E	Restricted to north-west Sydney occurring in the lower Blue Mountains to Maroota/Genorie area. 2000 individuals are thought to occur. Grows in dry sclerophyll forest and heathlands around sandstone rock outcrops.	Limited - dry sclerophyll forest	Unlikely
Downy Wattle *Acacia pubescens*	V	V	Concentrated around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/ Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland. Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravely soils, often with ironstone.	Woodlands	Low
Leafless-tongue Orchid *Cryptostylis hunteriana*	V	V	Recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra although it is uncommon at all sites. Also recorded at Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park, and Ben Boyd National Park. Does not appear to have well-defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black She-oak (*Allocasuarina littoralis*). Seems to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*Cryptostylis subulata*) and the Tartan Tongue Orchid (*Cryptostylis erecta*).	Various forest and woodland types	Unlikely

Species	Status		Distribution and habitat requirements*	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act			
Dillwynia tenuifolia	V	V	Core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Other populations in Western Sydney are recorded at Voyger Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. Disjunct localities include the Bulga Mountains at Yengo in the north, and Kurrajong Heights and Woodford in the Lower Blue Mountains. In western Sydney, it may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone.	Limited - dry sclerophyll forest	Low
Juniper-leaf Grevillea *Grevillea juniperina subsp. juniperina*	-	V	Endemic to Western Sydney centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor with outlier populations at Kemps Creek and Pitt Town. Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium often with a shale influence, typically containing lateritic gravels. Recorded from Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition Forest. Associated canopy species within Cumberland Plain Woodland and Shale/Gravel Transition Forest include Forest Red Gum (*Eucalyptus tereticornis),* Grey Box *(E. moluccana),* Narrow-leaved Ironbark *(E. crebra),* Broad-leaved Ironbark (*E. fibrosa*) *and* Thin-leaved Stringybark (*E. eugenioides*). Understorey species include Sweet Bursaria (*Bursaria spinosa),* Prickly parrot pea (*Dillwynia sieberi*), White Dogwood (*Ozothamnus diosmifolius),* Gorse Bitter Pea (*Daviesia ulicifolia),* Sickle Wattle (*Acacia falcata*), Parramatta Wattle (*Acacia parramattensis*), Kangaroo Grass (*Themeda australis),* Purple Wiregrass (*Aristida ramose),* Barbwire Grass (*Cymbopogon refractus),* Brown's Lovegrass *(Eragrostis brownie),* Rock Fern (*Cheilanthes sieberi),* Blue Flax Lily (*Dianella revolute)* and Ivy Goodenia *(Goodenia hederacea).* In Castlereagh Woodland on more sandy soils the dominant canopy species are Broad-leaved Ironbark (*Eucalyptus fibrosa),* Scibbly Gum (*E. sclerophylla),* Small-leaved Apple (*Angophora bakeri)* and Honey Myrtle (*Melaleuca decora*). Understorey species include Prickly-leaved Paperbark *(Melaleuca nodosa),* Needlebush (*Hakea sericea), Cryptandra spinescens,* Slender Wattle (*Acacia elongate),* Forest Raspwort (*Gonocarpus teucrioides*), Spiny-headed Mat Rush (*Lomandra longifolia)* and the threatened species *Dillwynia tenuifolia,* Prickly-bush Pea (*Pultenaea parviflora), Micromyrtus minutiflora* and *Allocasuarina glareicola*.	Woodlands	Unlikely
Deane's Paperbark *Melaleuca deanei*	V	V	Deane's Paperbark occurs in two distinct areas, in the Ku-ring-gai, Berowra, Holsworthy and Wedderburn areas, and there are also more isolated occurrences at Springwood, Wollemi National Park, Yalwal and the Central Coast areas. The species grows in heath on sandstone	Limited - dry sclerophyll forest	Unlikely

Species	Status		Distribution and habitat requirements*	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act			
Micromyrtus minutiflora	V	E	Restricted between Richmond and Penrith of western Sydney. Grows in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest and open forest on tertiary alluvium.	Shale Plain Woodland	Low
Hairy Geebung *Persoonia hirsuta*	E	E	The Hairy Geebung has been recorded in the Sydney coastal area, the Blue Mountains area and the Southern Highlands. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	Limited - dry sclerophyll forest	Unlikely
Nodding Geebung *Persoonia nutans*	E	E	Restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south. Core distribution occurs within the Penrith, and to a lesser extent, Hawkesbury LGAs, with isolated and relatively small populations also occurring in the Liverpool, Campbelltown, Bankstown and Blacktown LGAs. Confined to aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities, with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland.	Various map units	Low
Slender Curved Rice Flowers *Pimelea curviflora var. curviflora*	V	V	Confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west. Former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.	Limited - dry sclerophyll forest	Unlikely
Spiked-rice Flower *Pimelea spicata*	E	E	Broad distribution in western Sydney, occurring on the Cumberland Plain (Narellan, Marayong, Prospect Reservoir areas). Another smaller population is recorded in districts (Landsdowne to Shellharbour to northern Kiama) Illawarra. It grows on well structured clay soils. On the inland Cumberland Plain sites it is associated with Grey Box and Ironbark. In the coastal Illawarra it occurs commonly in Coastal Banksia open woodland with a more well developed shrub and grass understorey.	Grassy Woodlands	Low
Sydney Plains Greenhood *Pterostylis saxicola*	E	E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south. There are very few known populations and they are all very small and isolated. Only one population occurs within a conservation reserve at Georges River National Park. Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where it occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	Limited - dry sclerophyll forest	Low

Species	Status		Distribution and habitat requirements*	Potential habitat in the study area	Likelihood of occurrence in the study area
	EPBC Act	TSC Act			
Sydney-bush Pea *Pultenaea parviflora*	E	E	Endemic to the Cumberland Plain the core distribution is from Windsor to Penrith and east to Dean Park. Outlier populations are recorded from Kemps Creek and Wilberforce. May be locally abundant, particularly within scrubby/dry heath areas of Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. *Eucalyptus fibrosa* is usually the dominant canopy species. *Eucalyptus globoidea, E. longifolia, E. parramattensis, E. sclerophylla* and *E. sideroxylon* may also be present or co-dominant, with *Melaleuca decora* frequently forming a secondary canopy layer. Associated species may include *Allocasuarina littoralis, Angophora bakeri, Aristida* spp. *Banksia spinulosa*, *Cryptandra* spp*., Daviesia ulicifolia*, *Entolasia stricta, Hakea sericea, Lissanthe strigosa, Melaleuca nodosa, Ozothamnus diosmifolius* and *Themeda australis*.	Limited - dry sclerophyll forest	Unlikely
Glandular-pink Bell *Tetratheca glandulosa*	V	V	Endemic to NSW, with about 150 populations from Yengo National Park to Lane Cove National Park. Associates in areas with shale cappings over sandstone. Occurs in heath, scrublands to woodlands and open forest. Common woodland tree species include: *Corymbia gummifera, C. eximia, Eucalyptus haemastoma, E. punctata, E. racemosa*, and/or *E. sparsifolia,* with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae.	Shale Plain Woodland	Unlikely

1. Sources: * Distribution and habitat requirement information adapted from:
   - Office of Environment and Heritage (updated March 2012) http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx)
   - Australian Government Department of Sustainability, Environment, Water, Populations and Community http://www.environment.gov.au/biodiversity/index.html

3.8.2 Fauna

Previous occurrences and likelihood

LEC (RTA, 2011b) fauna surveys identified 17 bird species and no fauna species of national or state significance. Most of the fauna habitats were recorded as having a disturbed nature with fragments of scatted modified woodland.

A review of state and federal government databases (OEH, 2012 and DSEWPaC, 2012) revealed records for 48 threatened fauna species within the locality. These species have been listed in **Table 3-9**, along with their known geographical distribution and preferred habitats, and an assessment of their potential to occur in the study area.

The locations of recorded threatened fauna species specific to the study area and surrounding local area have been illustrated in **Figure 3-1**. This figure only provides the locations of confirmed sightings.

Table 3-9 Threatened fauna species potentially occurring in the study area

Species	Status		Distribution and habitat requirements*	Likelihood of occurring in the study area
	EPBC Act	TSC/FM Act		
MAMMALS				
Brush-tailed Rock Wallaby (*Petrogale penicillilata*)	E	E	Open forest habitats on steep terrain with exposed rocks, rock overhangs and platforms.	Unlikely
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	-	V	Occurs on east and north west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.	Moderate
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	-	V	Occurs in a variety of open forest and woodland habitats with hollow-bearing trees. Requires hollows for roosting. May forage in re-growth and modified environments.	Moderate
Eastern Freetail Bat (*Mormopterus norfolkensis*)	-	V	Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in human-made structures.	Moderate
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Forages on nectar and pollen in sclerophyll forests and on rainforest fruits and vines, orchards, gardens.	Low
Koala (*Phascolarctos cinereus*)	V	V	Open forests and woodlands with favoured food tree species.	Low
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	Forages over a broad range of open forest and woodland habitats, this species is a cave roosting bat which favours sandstone escarpment habitats for roosting, in the form of shallow overhangs, crevices and caves.	Low
Long-nosed Potoroo (*Potorous tridactylus*)	V	V	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature.	Unlikely

Species	Status		Distribution and habitat requirements*	Likelihood of occurring in the study area
	EPBC Act	TSC/FM Act		
New Holland Mouse (*Psuedomys novaehollandiae*)	V	-	Distribution is fragmented across all eastern states of Australia, where it inhabits open heath lands, open woodlands with heath understorey and vegetated sand dunes.	Unlikely
Southern Myotis (*Myotis macropus*)	-	V	Generally roost in groups close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forages over streams and pools catching insects and small fish.	Moderate
Spotted-tailed Quoll (*Dasyurus maculatus*)	E	V	Wet and dry sclerophyll forests and rainforests, and adjacent open agricultural areas. Generally associated with large expansive areas of habitat to sustain territory size. Requires hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	Unlikely
Squirrel Glider (*Petaurus norfolcensis*)	-	V	Forest and woodland habitats, particularly areas with a diversity of eucalypt species in the canopy and other suitable food resources (shrubs and small trees). Requires tree hollows for denning.	Unlikely
Yellow-bellied Glider (*Petaurus australis*)	-	V	Tall open forest habitats, favours mature wet sclerophyll forest and dense gullies.	Unlikely
BIRDS				
Australasian Bittern (*Botaurus poiciloptilus*)	E	E	They are widespread but uncommon over south-eastern Australia. It extends mainly along the coasts of eastern Australia and is found all over NSW except for the far north west. It inhabits freshwater wetlands with tall dense vegetation where it feeds in shallow waters.	Low
Australian Painted Snipe (*Rostratula benghalensis australis*)	V	E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	Unlikely
Barking Owl (*Ninox connivens*)	-	V	Forest and woodland habitats, particularly drier western slopes and riverine areas, hunts for birds and small mammals.	Unlikely
Black Bittern (*Ixobrychus flavicollis*)	-	V	Occurs from south NSW to Cape York, and extends to the Kimberley region. Inhabits terrestrial and estuarine wetlands, preferring permanent water and dense vegetation.	Unlikely
Black-chinned Honeyeater (*Melithreptus gularis*)	-	V	Woodland bird species, favour dry sclerophyll forests and woodlands, generally with a sparse understorey, grassy areas and logs.	Unlikely
Black-necked Stork (*Ephippiorhynchus asiaticus*)	-	E	Open wetlands & adjoining agricultural areas.	Unlikely
Black-tailed Godwit (*Limosa limosa*)	-	V	A migratory wading bird that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently found at Kooragang Island (Hunter River estuary). Occurs in sheltered bays, estuaries and lagoons with large intertidal mudflats and sand flats. Also found at inland mudflats, swamps.	Unlikely

Species	Status		Distribution and habitat requirements*	Likelihood of occurring in the study area
	EPBC Act	TSC/FM Act		
Comb-crested Jacana (*Irediparra gallinacean*)	-	V	Occurs in freshwater wetlands of north and eastern Australia. A dispersive species in response to condition of wetlands.	Unlikely
Curlew Sandpiper (*Calidris ferruginea*)	-	E	It is distributed along most of the Australian coastline. It occurs in littoral and estuarine habitats and intertidal mudflats and also non tidal lakes, swamps and lagoons. Sometimes found at inland freshwater wetlands.	Unlikely
Flame Robin (*Petroica phoenicea*)	-	V	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with an open understorey.	Unlikely
Freckled Duck (*Stictonetta naevosa*)	-	V	Open wetlands, large open lakes and their shores, creeks, farm dams, sewage ponds and floodwaters and adjoining agricultural areas.	Moderate
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	-	V	Occurs within a variety of forest and woodland types. Usually frequents forested areas with old growth attributes required for nesting and roosting purposes.	Low
Little Eagle (*Hieraaetus morphnoides*)	-	V	Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used.	Low
Little Lorikeet (*Glossopsitta pusilla*)	-	V	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in apples (*angophora* sp.), paperbarks (*melaleuca* sp.) and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country (e.g. paddocks, roadside remnants) and urban trees also help sustain viable populations of the species.	Low
Major Mitchell's Cockatoo (*Cacatua leadbeateri)*	-	V	Mainly occurs in arid and semi-arid NSW, with sporadic records further east. Inland woodlands and treeless areas within close proximity to water.	Low
Masked Owl (*Tyto novaehollandiae*)	-	V	Dry eucalypt forests and woodland, typically prefers open forest with low shrub density. Requires old trees for roosting and nesting	Low
Painted Honeyeater (*Grantiella picta*)	-	V	Occurs around inland slopes of the Great Dividing Range in NSW. It is found in Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and wattles (*acacia* sp.).	Unlikely
Powerful Owl (*Ninox strenua*)	-	V	Open forests with dense wet gullies and creek areas, requires large mature trees with hollows for breeding and dense areas of vegetation for prey and roosting	Low
Regent Honeyeater (*Xanthomyza phrygia*)	E	E	A nomadic species typically associated with forest and woodland habitats with the presence of suitable foraging species such as Yellow Box (*Eucalyptus melliodora*) and Red Ironbark (*Eucalyptus sideroxylon*).	Low

Species	Status		Distribution and habitat requirements*	Likelihood of occurring in the study area
	EPBC Act	TSC/FM Act		
Scarlet Robin (*Petroica boodang*)	-	V	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and re-growth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps.	Unlikely
Speckled Warbler (*Pyrrholaemus sagittatus*)	-	V	The Speckled Warbler 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 re-growth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	Unlikely
Spotted Harrier (*Circus assimilis*)	-	V	Occurs throughout the Australian mainland and disperses into NSW as one single population. It occurs on grassy open woodland, inland riparian woodlands, grasslands and shrub steppe.	Unlikely
Square-tailed Kite (*Lophoictinia isura*)	-	V	It is widely distributed to the coastal and sub-coastal area of Australia. Migrates to NSW in September for breeding. Occurs in dry woodlands and open forests, and timbered watercourses.	Low
Star Finch	E	-	Extinct in NSW with last records shown in Sydney area. Extremely limited population in central Queensland. Occurs in specific habitat types of grassy woodlands.	Unlikely
Superb Parrot (*Polytelis swainsonii*)	V	V	Occurs in eastern inland NSW. Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest	Unlikely
Swift Parrot (*Lathamus discolour*)	E	E	On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculate)*, Red Bloodwood (*C. Gummifera),* Red Ironbark (*E. sideroxylon*), and White Box (*E. albens*).	Low
Varied Sittella (*Daphoenositta chrysoptera)*	-	V	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and acacia woodland.	Low
REPTILES				
Broad-headed Snake (*Hoplocephalus bungaroides*)	V	V	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer.	Unlikely
AMPHIBIANS				
Giant Burrowing Frog (*Heleioporus australiacus*)	V	V	Found in heath, woodland and open forest with sandy soils.	Unlikely

Species	Status		Distribution and habitat requirements*	Likelihood of occurring in the study area
	EPBC Act	TSC/FM Act		
Green and Golden Bell Frog (*Litoria aurea*)	E	E	Ephemeral and permanent freshwater wetlands, ponds, dams with an open aspect and fringed by Typha and other aquatics, free from predatory fish.	Low
Red-crowned Toadlet (*Pseudophryne australis*)	-	V	It has restricted distribution from Pokolbin to Nowra and west to Mt Victoria. Occurs in open forests and wet drainage lines below sandstone ridges that often have shale lenses or cappings in the Hawkesbury and Narrabeen Sandstones.	Unlikely
INVERTEBRATES				
Adam's Emerald Dragonfly (*Archaeophya adamsi)*		E (FM Act)	Adams Emerald Dragonfly larvae have been found in narrow, shaded riffle zones with moss and abundant riparian vegetation in small creeks with gravel or sandy bottoms.	Low
Cumberland Land Snail (*Meridolum corneovirens*)	-	E	Primarily inhabits Cumberland Plain Woodland (an endangered ecological community). This community is grassy, open woodland with occasional dense patches of shrubs. Lives under litter of bark, leaves and logs, or shelters in loose soil around grass clumps. Occasionally shelters under rubbish.	Low
Sydney Hawk Dragonfly (*Austrocordulia leonardii*)		E (FM Act)	The Sydney Hawk dragonfly has specific habitat requirements, and has only ever been collected from deep and shady river pools with cooler water.	Low
FISH				
Black Cod (*Epinephelus daemelii)*	V	V (FM Act)	Its main range occurs along the NSW coastline with records in the lower reaches of the Hawkesbury River where it prefers rocky gutters, rock caves and rock reefs. It has not been recorded in the vicinity of the study area.	Low
Australian Grayling (*Prototroctes maraena*)	V		The Australian Grayling has been recorded within the upper reaches of the Hawkesbury-Nepean River Catchment. It inhabits clear, flowing waters and has not been recorded in the vicinity of the study area.	Low
Macquarie Perch (*Macquaria australasica*)	E	E (FM Act)	Macquarie Perch has been recorded within the upper reaches of the Hawkesbury –Nepean System. It has not been recorded within the vicinity of the study area.	Low

Sources: * Distribution and habitat requirement information adapted from:

- Australian Government Department of Sustainability, Environment, Water, Populations and Community http://www.environment.gov.au/biodiversity/index.html
- Department of Primary Industries – Threatened Fish and Marine Vegetation
- http://pas.dpi.nsw.gov.au/Species/All_Species.aspx
- Office of Environment and Heritage (updated February 2012) http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx

3.8.3 Survey results

Fauna habitat and condition

Limited potential fauna habitats occur in the study area. These were identified from the broad-scale mapping of vegetation communities in the region (NPWS 2002) and site surveys. The fauna habitats in the study area are illustrated on **Figure 3-2** and comprise:

- Riparian forest.
- Cleared grassland (with scattered parkland trees).
- Freshwater aquatic habitats (within the Hawkesbury River).
- Potential roosting locations under the existing Windsor bridge.

Fauna habitat in the study area has been extensively cleared and fragmented for agricultural and rural settlements, mostly north of the Hawkesbury River, but also historically for urban and residential development south of the river. The historical clearing of land particularly on private rural properties within the study area has significantly reduced the value of the habitat by removing connectivity, foraging, shelter and breeding resources for fauna.

Within the study area there is a notable absence of mature forest elements and the area is dominated by cleared and modified habitats with limited connectivity potential. All vegetation within the study area was considered to be of poor quality fauna habitat, with poor structure of canopy, midstorey and lower groundcover flora, including shrubs, graminoids and herbs. These areas generally were also devoid of low densities of fallen timber, and other debris known to support populations of the threatened Cumberland Land Snail (*Meridolum corneovirens*).

All riparian areas were in poor condition and provided minimal resources for fauna in terms of breeding and foraging opportunities. The canopy in this area may provide shelter and refuge for some bird and arboreal mammal species, particularly Common Ringtail Possum (*Pseudocheirus peregrines*). The absence of mature trees with hollows suggests the study area is unlikely to provide roost habitat for threatened microchiropteran bats, although the modified canopy may still provide potential foraging habitat and also the existing bridge may provide potential habitat for these species. No Cumberland Land Snails were found in this habitat, and while it is not considered entirely suitable for the species, an individual was recorded from the locality a decade ago, however it remains unknown as to whether the specimen observed was living or only a shell (LesryK, 2002).

These habitats are likely to provide shelter, breeding and foraging resources for several common frog and reptile species and a low diversity of urban-tolerant woodland and forest bird species, as well as mammals such as the Common Ringtail and Common Brushtail Possum. However, no habitat trees (hollow-bearing trees including large dead trees) were identified in the study area.

Fauna species

The species of fauna recorded from the survey in relation to the habitat types identified is provided as **Appendix B**. A total of nine fauna species were recorded, comprising seven bird species and two reptile species. Two bird species are introduced fauna, with the remainder native species. The range of fauna species recorded habitats is described below.

The range of fragmented riparian and modified habitats present support a low diversity of bird species represented predominantly in abundance by common birds tolerant of modified habitats, as well as wide-ranging species adapted to fragmented habitats such as parrots, miners and swallows.

The most abundant species observed included the Magpie (*Gymnorhina tibicen*), Welcome Swallow (*Hirundo neoxena*) and Noisy Miner (*Manorina melanocephala*). Swallows and introduced doves were observed roosting on the pylons and piers under the bridge. A mating pair of Red-rumped Parrots was observed feeding in Thompson Square (cleared grassland). Reptile species recorded at the study area included the Eastern Water Dragon (*Physignathus lesueurii*) and Eastern Water Skink (*Eulamprus quoyii*).

The bridge over the Hawkesbury River may provide suitable roosting habitat for some threatened cave-roosting microchiropteran bats likely to occur within the locality. This includes the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) and Southern Myotis (*Myotis macropus*), both of which have been recorded roosting in artificial structures including bridges and culverts. However, no bats were observed roosting under the bridge at the time of survey. As these two species have recently been recorded utilising similar concrete bridge structures along the north coast of NSW (Stokes, J, Biodiversity Officer, RMS, *pers comm*., 2012), assessments of significance following the heads of consideration (**Appendix C**) have been undertaken for these species as a precautionary measure.

Plate 3-5 Potential microchiropteran bat habitat beneath Windsor bridge

Plate 3-6 Red-rumped Parrot in parkland (Thompson Square)

3.9 Migratory and marine species

3.9.1 Previous occurrences and likelihood

A total of 13 migratory fauna species were identified in the EPBC Act Protected Matters Report (February 2012) as potentially occurring in the locality (10 kilometre radius of the study area). These migratory species have been listed in **Table 3-10** along with their preferred habitat requirements and a preliminary assessment of their likely presence in the study area.

Table 3-10 Potential occurrence of migratory species listed under the EPBC Act

Species	Preferred habitat	Likelihood of occurrence
Migratory terrestrial species		
Black-faced Monarch (*Monarcha melanopsis*)	Rainforests, eucalypt forests and coastal scrubs	Low
White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Predominantly ocean shores and estuaries, occasionally inland rivers and streams.	Moderate: Potentially fly over, forage and occasionally refuge in the study area.
White-throated Needletail (*Hirundapus caudacutus*)	An aerial foraging species which occupies a range of habitats from open modified landscapes to woodland and forest.	Moderate: Potentially fly over, forage and occasionally refuge in the study area.
Rufous Fantail (*Rhipidura rufifrons*)	Predominantly rainforest and forests	Low
Rainbow Bee-eater (*Merops ornatus*)	Predominantly woodland and timbered plains	Low
Regent Honeyeater (*Xanthomyza phrygia*)	A nomadic species typically associated with forest and woodland habitats with the presence of suitable foraging species such as Yellow Box and Red Ironbark.	Low
Satin Flycatcher (*Myagra cyanoleuca)*	Predominantly forests, in particular thick vegetation in gullies	Unlikely
Swift Parrot (*Lathamus discolour*)	On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations.	Low
Migratory wetland/marine species		
Latham's snipe (*Gallinago hardwickii*)	Wetlands, wet meadows, flooded grassy paddocks, open grassland and drainage areas	Unlikely
Painted snipe (*Rostratula benghalensis australis)*	Wetlands, reedlands, marshes and swamps	Unlikely
Cattle Egret (*Ardea ibis*)	Grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Often seen with cattle.	Moderate: Potentially forage in agricultural lands.
Great Egret (*Ardea alba)*	Prefers shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands.	Low
Fork-tailed Swift (*Apus pacificus*)	The species breeds in Asia and migrate to Australia in the summer from which they spend their entire life-cycle on the wing, hunting, resting and sleeping.	Low

3.9.2 Survey results

No migratory species were observed during the field survey, and there is no evidence to suggest that an area of important habitat exists in the study area for any listed migratory species. Areas of 'important habitat' for a migratory species are described in DEWHA (2009) as:

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

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4 Potential impacts

4.1 Loss of vegetation/habitat

The project would need to remove and/or disturb about 1.7 hectares (17, 000 metres squared) of terrestrial modified vegetation communities (**Table 4-1**). About 0.5 hectares (5000 metres squared) of riparian vegetation would be cleared as a result of the project. This riparian community does not constitute a TEC and is not declared to be critical habitat for any threatened fauna species in the locality.

Table 4-1 Loss of terrestrial habitat in the construction footprint

Habitat type	Project stage	Total area to be removed and/or disturbed in the construction footprint	Condition values
Riparian *Casuarina* open forest	All developments	1000 m²	Low
Modified riparian open forest (highly modified)	All developments	4000 m²	Low
Cleared grassland	All developments	9000 m²	Low
Parkland/landscaped areas	All developments	3000 m²	Low

4.1.1 Cumberland Plain Land Snail

The Cumberland Plain Land Snail (*Meridolum corneovirens*) was not observed during the field survey. One individual of the species was recorded from the locality over a decade ago (LesryK, 2002), however, it is unknown whether the observation was of a living specimen or shell.

Targeted surveys for the current biodiversity assessment involved dedicated hand searches for the Cumberland Land Snail (*Meridolum corneovirens*) throughout potential habitat across the study area. No individuals were observed from this survey. Natural habitats comprising suitable microhabitat (small-scale habitats) conditions are not present in the study area, with all historical OEH records occurring away from urbanised areas or rural residential locations and generally associated with the larger remnants. The predominately cleared lands of the study area do not provide optimum habitat for this species, and therefore the project is not considered likely to have an impact upon the Cumberland Plain Land Snail.

4.1.2 Microchiropteran bats

While the vegetation communities in these areas are of low condition, the modified riparian environments may provide potential roosting and foraging habitat for microchiropteran bats. These bats forage for insects above or below the canopy of vegetated areas and the removal vegetation in the study area may result in the removal of potential foraging habitat. However, the foraging range of these species has been known to extend beyond 10 kilometres and there is a number of high quality foraging environments conserved in national park estate within the study region.

Removal of the bridge may also result in the loss of potential roosting habitat for bats. There are no confirmed records of bats roosting in the bridge, and new potential habitat would be constructed with the replacement bridge. The potential roosting habitat of this community for hollow-roosting microchiropteran bats is marginal due to the absence of hollow-bearing trees in the study area and the lack of suitable hollow cavities in the solid concrete bridge structure.

Assessments of significance following the heads of consideration were completed for threatened cave and hollow roosting microchiropteran bats (**Appendix C**) and indicated that the project is unlikely to have a significant impact upon these species.

4.1.3 Migratory species

No migratory species were observed during the field survey, and there is no evidence to suggest that an area of important habitat exists in the study area for any listed migratory species. However the species listed below have been considered in an assessment of significance (**Appendix D**) for having a moderate likelihood of occurrence based on database searches and potential foraging habitat revealed in the habitat assessment.

- White-throated Needletail.
- White-bellied Sea Eagle.
- Cattle Egret.

The project would not reduce populations of either species nor substantially reduce the extent of potential habitat in the region.

4.1.4 Freckled Duck

The freshwater aquatic habitat of the Hawkesbury River provides potential habitat for this species and there are 12 historic records from Windsor between 1981 and 2002, indicating occasional visitation on the Bionet database. The Freckled Duck may occasionally spend its lifecycle in productive areas of Hawkesbury River, however the aquatic environment in the study area is absent of macrophytes and submerged woody debris due to high levels of water flow and does not constitute high quality habitat. Given the low condition of potential habitat and lack of recent records it is unlikely that a population of Freckled Duck is present or that the river system within the study area is important. An assessment of significance following the heads of consideration was undertaken for the Freckled Duck (**Appendix C**) and indicated that the project is unlikely to have a significant impact upon this species.

4.2 Wildlife connectivity and habitat fragmentation

No land within the study area or the broader study region falls into the Priority Conservation Lands (PCL) identified in the Cumberland Plain Recovery Plan (2011). Additionally, the study area does not include any land identified as part of the regional biodiversity corridors identified in the Hawkesbury-Nepean Catchment Management Area (HNCMA, 2007). Information on key habitats and movement corridors from the OEH Key Habitats and Corridors project (DEC 2003) and Climate Change Corridors project (DECC 2007) does not extend into the study area. Therefore, the project would not impact on habitat connectivity and fragmentation.

4.3 Injury and mortality

Given the lack of fauna observed across the study area, together with the mobility adaptations of the species that may exist in the area, it is unlikely that threatened species would suffer injury and mortality as a result of the project. In addition, implementing pre-clearing surveys prior to project construction would further reduce the risk of injury or mortality to fauna at the site.

4.4 Weeds

Noxious species recorded in the study area are listed in **Table 3-4**. Most of these species are relatively common in riparian and aquatic habitats. Mitigation measures would be implemented to limit the spread and germination of noxious weeds (refer to **Table 5-1**).

4.5 Pests and pathogens

No evidence of feral animals was observed during the field survey, however European Red Fox (*Vulpes vulpes*), Feral Cat (*Felis cattus*) and Feral Dog (*Canis familiaris*) are expected to occur in habitats at the site. The water borne pathogen *Phytophthora cinnamomi* (root rot) has been identified as occurring in nearby Scheyville National Park. It is possible that soil disturbance as a result of the project could result in the transfer of Phytophthora contaminated soils, and affect adjacent vegetation communities. Mitigation measures would be implemented to avoid the spread of pests and pathogens during construction.

4.6 Changed hydrology

Significant changes to flow velocities, depths of the waterway, realignment of the watercourse or the alteration of natural flow regimes of the river are not expected to result from the demolition and replacement of the bridge.

4.7 Groundwater dependent ecosystems

Given the nature of floodplain environments, vegetation communities that occur across them are generally considered to be highly dependent upon groundwater to maintain their viability. While the riparian vegetation communities within the study area are groundwater dependent, they are likely to have evolved with short periods of natural groundwater fluctuation without suffering any medium or long-term impacts. The project is unlikely to significantly raise or lower the groundwater table to such an extent that groundwater dependent ecosystems at the site are impacted.

4.8 Aquatic impacts

The Hawkesbury River provides habitat for fish and other aquatic organisms. Potential impacts to aquatic species include loss of aquatic habitat as a result of over-shadowing, obstruction of fish passage and pollution of waterways. The greatest potential for impact to aquatic habitat is during construction, and the adoption of best-practice water quality controls and protection measures would be implemented to minimise impact on aquatic habitats (**Section 0**).

4.8.1 Loss of Aquatic Habitats

Construction efforts may require the removal of woody debris/snags and clearing of riparian vegetation. The removal of large woody debris or snags and the degradation of riparian vegetation along waterways are listed under Schedule 6 of the FM Act as Key Threatening Processes. However there is little or no woody debris or snags in the construction footprint due to the relatively high velocity of river flows.

Establishing woody debris or snags near or around the bridge would require the sourcing of appropriate trees from outside the construction area (as the trees proposed for clearing are not suitable) and would require substantial anchoring structures to ensure the woody debris is not washed away in regular flooding. Given these two issues the establishment of woody debris or snags is not considered feasible.

Construction of instream scour protection would require dredging of the river banks and river bed around the piers so that rock below water level can be placed to the existing river bed profile. This would result in localised disturbance of instream benthic habitats (primarily aquatic sediment). The impact to the aquatic habitat and direct adjoining areas would be about 0.5 hectares (5000 metres squared) shown in **Table 4-2.**

Construction of the project would also result in localised disturbance and potential loss (refer to **Table 4-2**) of riparian habitat. Riparian habitats include the zone of land immediately adjacent to creeks and rivers and form an important part of healthy ecosystem functioning. However, mitigation measures have been designed to minimise the potential for further habitat loss.

Table 4-2 Loss of aquatic habitat in the construction footprint

Habitat type	Project stage	Approximate area to be removed and/or disturbed in the construction footprint
Aquatic habitat and adjoining riparian zone	Scour Protection	2700 m²
Aquatic habitat	Dredging	2300 m²

4.8.2 Obstruction and displacement of fish passage

Installation and operation of in-stream structures and other mechanisms that alter the natural flow regimes of rivers is listed as a Key Threatening Process under Schedule 6 of the FM Act. The bridge construction would need to be in accordance with the *Fish passage requirements for waterway crossing* detailed in Fairfull and Witheridge (2003). Where feasible, bridge works would be undertaken from the banks and would not block fish passage. It is unlikely the project would result in extensive changes to the hydrology of the Hawkesbury River that would alter flow velocities, water way depth or the natural flow regimes of the waterway.

4.8.3 Impacts to water quality

There is the potential for increased sedimentation and erosion during construction, bridge demolition and river dredging. Increased suspended solids can impact fish and macroinvertebrate abundance through clogging gill structures and benthic smothering. Increased particulates in the water column can also reduce light infiltration which may limit plant growth and influence predator foraging behaviour. Increased turbidity can result in a reduction of light penetration and in turn reduce the number of aquatic macrophytes or algae, altering the existing aquatic habitat.

The main operational activity that would impact the Hawkesbury River is increased traffic flow, which may lead to increased pollutant load in the road run-off. Road run-off can contain a variety of pollutants, which may impact negatively on the aquatic environment and in turn reduce commercial and recreational fishing viability, including aquaculture present in the study area. Pollutants can include cigarette butts, nutrients, heavy metals, pesticides, herbicides and petroleum hydrocarbons.

Management and mitigation measures would be designed to minimise potential impacts to water quality within the Hawkesbury River to minimise potential impacts to aquatic habitats.

4.9 Noise, vibration and light

Given the low habitat potential of the study area it is unlikely that noise, vibration or light associated with the project would increase and have an adverse impact on the surrounding flora and fauna. The construction stage of the project would increase noise, vibration and light, but it is not considered to have impact to biodiversity if the level and magnitude of these effects are kept to a minimum.

4.10 Impact on relevant key threatening processes

The TSC Act and the FM Act list Key Threatening Processes (KTPs) as activities or processes that:

a) Adversely affect threatened species, populations or ecological communities, or
b) Could cause species, populations or ecological communities that are not threatened to become threatened.

KTPs associated with aquatic habitats have been described in **Section 4.8**.

Bridge demolition and bridge construction would be associated with the following key threatening processes as listed under the TSC Act:

1) Clearing of native vegetation.
2) Invasion of native plant communities by exotic perennial grasses.

The project would result in the clearing of up to 5000 square metres of highly modified and fragmented native vegetation, which is unlikely to have a significant impact. The potential for exotic perennial grasses to invade remaining native plant communities within the study area is possible as the recovery potential of disturbed ground in the area is expected to be low. If areas of soil disturbance resulting from the project are left unmanaged there would be a high potential for these works corridors to become sites for invasion of perennial grasses, such as the noxious African Lovegrass (*Eragrostis curvula*) which is currently widespread and abundant in the study area. The invasion of grasses has potential to negatively impact on germination and recovery of native trees and shrubs. The issue of weed development and management would need to be managed to conserve the integrity of the remaining areas of woodland outside of the construction footprint. Mitigation measures associated with minimising the impact of relevant key threatening processes are described in **Section 5**.

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5 Environmental management measures

The *Biodiversity Guidelines- Protecting and managing biodiversity on RTA projects* (RTA, 2011a) outline the key mitigation measures for RMS projects. These should be followed throughout the project in order to ensure potential ecological impacts are minimised. The following mitigation measures are highlights from those guidelines as they are particularly relevant for the project (see **Table 5-1**).

Table 5-1 Recommended environmental management measures during construction and operation

Item	Timing	Environmental management measures
Site personnel induction	Pre-construction	• The project induction will include relevant information, mitigation measures and procedures on protecting the biodiversity of the area during construction.
Site planning	Pre-construction	• Locate temporary infrastructure (plant sites and offices etc) in cleared areas away from vegetation. • Apply clear boundaries for construction and exclusion zones for equipment, machinery and traffic to prevent unnecessary damage to native vegetation and fauna habitats.
Identification of clearing limits	Pre-construction	• Accurately and clearly mark out the limits of clearing and trees/vegetation to be retained including riparian zones.
Pre-clearing fauna survey	Pre-construction	• Once construction areas have been surveyed and marked, a suitably qualified and experienced fauna ecologist will undertake a pre-clearing survey to identify any concerns to specific species. • A survey of the existing bridge structure will be undertaken by boat by an ecologist to confirm the bridge is not providing habitat for microchiropteran bats or other roosting bats. • Should the results of the bat survey and roost assessment indicate that the existing bridge occupied by microbats, a bat management plan will be prepared to mitigate the potential impacts on bats. The plan would include details of an appropriate work schedule, any further close inspections that may be required and exclusion and relocation of fauna away from the construction site. • WIRES will be made aware of the project and consulted if any injured fauna are encountered or if any fauna are injured as a result of the works. • An ecologist or WIRES representative will be present during the clearing of suspected vegetation that may support a habitat for fauna to manage and/or relocate any fauna present.
Erosion and sediment control and impacts on water quality	Pre-construction and construction	• Management plans and measures will be developed and implemented to minimise water quality impacts from construction. A discussion on water quality mitigation measures has been provided in Soil, sediments, water and waste working paper.

Item	Timing	Environmental management measures
Riparian areas	Pre-construction and construction	• Minimise the area of disturbance in riparian zones by clearly marking out work zones in riparian areas and protect areas with para-web fencing or similar material. • All works near riparian zones will have adequate sediment and erosion control.
Noxious weed management	Pre-construction and construction	• Establish a noxious weed management protocol. • All noxious weeds which are cleared as part of the project will be disposed of appropriately. • Inspection/maintenance procedures will be implemented to reduce the carriage of weed material on machinery.
Monitoring	Pre-construction and construction	• A monitoring program (including a weekly checklist) will be developed to check that all proposed impact mitigation measures have been effectively implemented. • In the event that impact mitigation measures do not perform effectively, the management program will be adjusted with further appropriate measures.
Potential impact on fauna habitat	Construction	• While no substantial trees with hollows were identified during the survey, if trees with hollows are found, their removal will be avoided where practicable. Where this is not possible, the tree will be maintained intact as far as possible and placed on the ground in adjoining vegetation. • Habitat trees will be inspected for fauna by ecologist or WIRES carer and habitat trees will be felled carefully to minimise impact.
Riparian and aquatic habitat	Construction	• In-stream and riparian disturbance will be minimised during construction through clearly delineated working areas. • Removal of instream woody snags (>3 m in length and >300 mm diameter) will be avoided where practicable. Any woody snags that require removal during construction will be relocated insitu.
Riparian and aquatic habitat	Construction	• In-stream disturbance from dredging will be managed and mitigated as appropriate to minimise impacts. Appropriate measures will include insitu measures to limit the risk of sediment plumes and increased turbidity, such as silt curtains (or similar).
Rehabilitation	Construction and post-construction	• Areas disturbed as a result of the project will be stabilised and rehabilitated through a progressive landscaping program that takes advantage of optimal growing conditions and is appropriate to the final land use. • Where possible riparian zone rehabilitation will include appropriate native species.

6 Significance Assessments

Significance assessments have been conducted for threatened biodiversity that have been positively identified or that have a moderate or high likelihood of occurring in the study area.

For threatened biodiversity listed under the TSC Act, this section details the heads of consideration for threatened species assessment as suggested in the Department of Environment and Conservation/ Department of Primary Industries draft *Guidelines for Threatened Species Assessment* (DEC and DPI 2005). The guidelines present methods to consider the impacts on biodiversity of projects assessed under Part 3A as updated by Part 5.1 of the EP&A Act, including presenting heads of consideration for determining the significance of impacts.

Species with similar taxonomy or ecological requirements have been assessed together, for example tree-roosting microchiropteran bats.Full details of assessment of significance under the EP&A Act are presented in **Appendix C**. The conclusions of the EP&A Act are provided in **Table 6-1.** Assessments of significance for migratory species listed under the EPBC Act indicated that the project is not likely to have a significant impact on listed species with a moderate or higher likelihood of occurring in the study area, and the full assessment for these species can be found in **Appendix D**.

Table 6-1 Summary of EP&A Act assessments of significance

Species	Status		Part 5.1 EP&A Act question of significance*						Likely Significant Impact	Potential to occur in the Study area
	EPBC Act	TSC Act	a	b	c	d	e	f		
MAMMALS										
AVES										
Wetland dependent birds										
Freckled Duck (*Stictonetta naevosa*)	-	V	N	X	X	N	X	X	No	Moderate
MAMMALS										
Cave-dwelling Microbats										
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	-	V	N	X	X	N	X	X	No	Moderate
Southern Myotis (*Myotis macropus*)	-	V							No	Moderate
Tree-dwelling Microbats										
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	-	V	N	X	X	N	X	X	No	Moderate
Eastern Freetail-bat (*Mormopterus norfolkensis*)	-	V							No	Moderate

* Y= Yes (negative impact), N = No (no or positive impact), X = not applicable,

1. Significance Assessment Questions (heads of consideration) as set out in the *draft Guidelines for Threatened Species Assessment (DEC and DPI, 2005):*
   - a: Is the project likely to affect the lifecycle of a threatened species and/or population?
   - b: Is the project likely to affect the habitat of a threatened species, population or ecological community?
   - c: Does the project affect any threatened species or populations that are at the limit of its known distribution?
   - d: Is the project likely to affect current disturbance regimes?
   - e: Is the project likely to affect habitat connectivity?
   - f: Is the project likely to affect critical habitat?

7 Conclusion

7.1 Key findings of the assessment

The assessment methodology for this assessment included database searches, literature reviews and field surveys comprising flora survey, fauna survey, terrestrial habitat assessment and aquatic habitat assessment. Database searches were conducted of existing information and government maintained databases relevant to the study area. A flora survey was conducted to provide baseline floristic data and determine the presence of threatened plant species, populations and/or endangered ecological communities. A targeted fauna survey was undertaken to assess the habitat value of areas which would be impacted by the project. A qualitative habitat assessment of the Hawkesbury River was undertaken to assess the condition of aquatic habitats.

The study area supports riparian re-growth vegetation, cleared grasslands and parklands/landscaped areas in poor ecological condition. Riparian vegetation is typically narrow and patchy with a high degree of disturbance associated with clearing, weed invasion and flooding. These areas are heavily modified, with the remainder of vegetation across the site comprising modified grasslands infested with weeds, and artificial parklands and landscaped areas comprising scattered mature trees. Disturbance is widespread and associated with current and previous land-uses. Weeds are common throughout, particularly in rural and partially cleared land and in riparian areas.

Previously mapped threatened ecological communities within the study area were not observed during the field survey, and are not considered likely to occur. The total area of land likely to be cleared is about 1.7 hectares (17,000 metres squared), of which 0.5 hectares (5000 metres squared) would comprise Casuarina (riparian) open forest. Potential fauna use and connectivity across the study area appears low, reducing the potential for impact to fauna and permanent impacts to connectivity during and after project delivery. No threatened ecological communities or threatened species were observed during field surveys, however Windsor bridge does provide suitable potential roosting habitat for threatened microchiropteran bats with a moderate likelihood of occurring in the study area, and three species of migratory birds have been recorded within 10 kilometres of the study area. An assessment of significance for both hollow-roosting and cave roosting threatened bat species and migratory species known or likely to occur from the study region (within 10 kilometres of the study area) confirms that the project is not likely to have a significant impact upon these species. Assessments of significance for the Freckled Duck and the migratory species also indicate the project is unlikely to have a significant impact upon any of these species.

The Hawkesbury River provides the only aquatic habitat in the study area with aquatic macrophytes and submerged woody debris largely absent, potentially due to the high flows and associated flood which had occurred three weeks prior to fieldwork. Potentially the greatest risk to aquatic biodiversity would be the construction of scour protection and dredging operations which are likely to impact about 0.5 hectares (5000 metres squared) of aquatic habitat. The bridge construction and demolition poses water-related risks in the river and sedimentation and erosion risks from shore based works may result in pollution of the waterway. Water-based construction and sedimentation and erosion control mitigation measures would be required to minimise any risks on water quality and aquatic ecosystems during construction.

The project is not likely to significantly impact upon the biodiversity of the study area and, wherever possible the design would aim to minimise the removal of natural vegetation cover, removing only those trees directly in the construction footprint. Additionally, stockpiles, storage and compound sites would be sited appropriately to avoid vegetation. Mitigation measures to minimise potential risks arising from water-based construction and sedimentation and erosion impacts have been developed in the *soil, sediments and water working paper* (RMS, 2012) and would need to be implemented during the construction phase to protect water quality and aquatic ecosystems.

7.2 Concluding statement

Based on the assessments of significance for threatened species (**Appendix C** and **Appendix D**) with a moderate or higher likelihood of occurrence in the study area, the project to replace the bridge at Windsor over the Hawkesbury River is unlikely to significantly impact on biodiversity in the study area. However, it would be necessary to avoid, minimise and mitigate the impacts of the project on potential habitats and remaining vegetation. Wherever possible, the detailed design would aim to avoid clearing of natural vegetation cover, removing only those trees directly in the construction footprint. Additionally stockpiles, storage and compound sites would be sited appropriately to avoid vegetation and these considerations would continue to be included throughout the remainder of the detailed design process.

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Appendix A List of flora species

Scientific name	Common name
Acacia decurrens	Fine-leaf Green Wattle
Acacia longifolia	Sydney Golden Wattle
*Acetosa sagittata**	Turkey Rhubarb
*Ageratina adenophora**	Crofton Weed
*Anagallis arvensis**	Pimpernell
Anredera cordifolia	Madeira Vine
Araucaria bidwillii	Bunya Pine
*Araujia sericifera**	Moth Vine
*Bidens pilosa**	Cobblers Peg
Brachychiton populneus	Kurrajong
Callistemon salignus	Willow Bottlebrush
*Cardiospermum grandiflorum**	Balloon Vine
Capsella bursa-pastoris	Shepherds Purse
Casuarina cunninghamiana	River She Oak
Casuarina glauca	Swamp Oak
*Cestrum parqui**	Green Cestrum
*Cirsium vulgare**	Scotch Thistle
*Conyza bonariensis**	Fleabane
Cynodon dactylon	Common Couch
Delairea odorata	Cape Ivy
*Eragrostis curvula**	African Lovegrass
*Ehrharta erecta**	Panic Veldt Grass
Eucalyptus amplifolia	Cabbage Gum
*Foeniculum vulgare**	Fennel Weed
Grevillea robusta	Silky Oak
*Jacaranda mimosifolia**	Jacaranda
Juncus usitatus	Rush
*Lactuca serriola**	Prickly Lettuce
*Lantana camara**	Lantana
*Ligustrum lucidum**	Large-leaf Privet
*Ligustrum sinense**	Small-leaf Privet
*Liquidambar styraciflua**	American Sweetgum
Lomandra longifolia	Mat-rush
*Lonicera japonica**	Japanese Honeysuckle
Melaleuca nodosa	Prickly leaved Paperbark
Melia azedarach	White Cedar
*Olea europaea subsp. europaea**	Common Olive
*Oxalis sp.**	Oxalis
*Pennisetum clandestinum**	Kikuyu
Phragmites australis	Common Reed
*Ricinus communis**	Castor Oil Plant
*Rumex crispus**	Curled Dock
*Salix babylonica**	Willow Tree
*Schinus areira**	Pepper Tree
*Setaria sp.**	Pigeon Grass

Scientific name	Common name
*Sida rhombifolia**	Paddys Lucerene
*Solanum nigrum**	Black Nightshade
*Solanum mauritianum**	Wild Tobacco
*Sonchus oleraceus**	Common Sow-thistle
*Sorghum halepense**	Johnson Grass
*Tagetes minuta**	Stinking Roger
*Tradescantia fluminensis**	Trad
*Verbena bonariensis**	Purple Top

* denotes introduced species

Appendix B List of fauna species

Scientific Name	Common Name	Records		
		Current Study	LEC(2008)	LEC(2002)
MAMMALS				
MACROPODIDAE				
Wallabia bicolor	Swamp Wallaby			X
CANIDAE				
Vulpes vulpes *	Fox			X
LEPORIDAE				
Oryctolagus cuniculus *	Rabbit			X
REPTILES				
Agamidae				
SCINCIDAE				
Eulamprus quoyii	Eastern Water Skink	X		
ELAPIDAE				
Pseudechis porphyriacus	Red-bellied Black Snake			X
AMPHIBIANS				
MYOBATRACHIDAE				
Crinia signifera	Common Eastern Froglet			X
BIRDS				
ANATIDAE				
Chenonetta jubata	Australian Wood Duck		X	
THRESKIORNITHIDAE				
Threskiornis molluca	Australian White Ibis			X
Accipitridae				
Elanus axillaris	Black Shouldered Kite			X
FALCONIDAE				
Falco cenchroides	Nankeen Kestrel			X
Rallidae				
Gallinula tenebrosa	Dusky Moorhen		X	
Columbidae				
*Columba livia**	Rock Dove	X	X	
*Streptopelia chinensis**	Spotted Turtle-Dove	X	X	X
Ocyphaps lophotes	Crested Pigeon			X
Laridae				
Larus novaehollandiae	Silver Gull		X	

Scientific Name	Common Name	Records		
		Current Study	LEC(2008)	LEC(2002)
CACATUIDAE				
Eolophus roseicpilla	Galah		X	
PSITTACIDAE				
Psephotus haematonotus	Red-rumped Parrot	X		
Cuculidae				
Eudynamys scolopacea	Common Koel		X	
HALCYONIDAE				
Dacelo novaeguineae	Laughing Kookaburra		X	X
Todiramphus sanctus	Sacred Kingfisher		X	
MALURIDAE				
Malurus cyaneus	Superb Fairy-wren		X	X
PARDALOTIDAE				
Pardalotus punctatus	Spotted Pardalote			X
Acanthiza nana	Yellow Thornbill			X
Acanthiza chrysorrhoa	Yellow-rumped Thornbill			X
MELIPHAGIDAE				
Anthochaera carunculata	Red Wattlebird		X	X
Manorina melanocephala	Noisy Miner	X		X
Lichenostomus pencillatus	White-plumed Honeyeater		X	
Rhipiduridae				
Rhipidura leucophrys	Willie Wagtail	X	X	X
Grallina cyanoleuca	Magpie-lark		X	X
CAMPEPHAGIDAE				
Coracina novaehollandiae	Black-faced Cuckoo-shrike		X	X
ARTAMIDAE				
Cracticus torquatus	Grey Butcherbird			X
Gymnorhina tibicen	Australian Magpie	X	X	
CORVIDAE				
Corvus coronoides	Australian Raven		X	X
PASSERIDAE				
Neochmia temporalis	Red-browed Firetail			X
*Passer domesticus**	House Sparrow		X	
Hirundinidae				
Hirundo neoxena	Welcome Swallow	X	X	
Pycnonotidae				

Scientific Name	Common Name	Records		
		Current Study	LEC(2008)	LEC(2002)
Pycnonotus jocosus	Red-whiskered Bulbul		X	
Sturnidae				
Sturnus vulgaris	Common Starling		X	X
Acridotheres tristis	Common Myna		X	X
INVERTEBRATES				
Camaenidae				
Meridolum corneovirens	Cumberland Plain Land Snail			X

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Appendix C Assessment of Significance EP&A Act

Threatened Cave-roosting microchiropteran bats

Two cave-roosting threatened bat species are known to occur in the study region (a ten kilometre radius from the study area) and the concrete structure of the Windsor bridge may provide potential roosting habitat for these species. This includes the Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) and Southern Myotis (*Myotis macropus*), both of which are listed as vulnerable under the TSC Act.

Therefore, a test of significance has been undertaken based on the assessment of significance for projects being assessed under Part 3A of the EP&A Act, recently repealed by Part 5.1.

How is the project likely to affect the lifecycle of a threatened species and/or population?

Bridges (of varying materials, including concrete and timber structures) are recognised as providing potential roosting habitat for these subject species, although bats generally have more than one roosting site in any given home range which could include maternity roosts and temporary seasonal roosts. At the time of survey, bats were not observed to be using the bridge as a roost site and the bridge is only considered marginal as a potential roost site. There are no records of this bridge being used by bachelor males or as a maternity roost for breeding females.

Should a colony take roost between the time of survey and the time of demolition, disturbance of bats using the structure would have the potential to result in increased predation of bats if forced to take flight during the day, or the loss of non-flying young if the site constitutes a maternity roost. This would be avoided by an additional survey of the underside of the bridge prior to demolition to ensure no roosts are present and delay of disturbance to the existing bridge until the bats had dispersed the site. This would involve the preparation of a bat management plan to implement this process.

These bat species are likely to forage over extensive home ranges (often between 10 and 20 kilometres) and the environs surrounding the Windsor bridge do not provide optimum foraging habitat although may be used a different times depending on the abundance of insect prey. At the time of survey it is considered unlikely that the demolition of the Windsor bridge would negatively affect breeding or roosting lifecycle events.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

No foraging habitat would be removed or impacted as a result of the project. Southern Myotis prefers to forage for aquatic insects over waterbodies and the Hawkesbury River, which the Windsor bridge spans, would not be affected by the project in such a manner to impact upon the foraging habitat of the species. The Eastern Bentwing Bat forages for insects above the canopy of intact valley vegetation, a habitat type not present in the study area, although has potential to forage in open areas adjoining riparian vegetation, particularly where insect prey is abundant. Additionally, at the time of survey, bats were not utilising the Windsor bridge although the structure remains a potential roost site. At present, the project would not result in the loss of known roosting or breeding habitat from the area.

The absence of any roosts for threatened microchiropteran bats under the Windsor bridge at the time of survey, together with the fact that the preferred vegetation communities for

foraging are not present within the study area, suggests that habitat for the threatened bats would not be fragmented or isolated as a result of the demolition of the Windsor bridge.

If bats are present under existing bridge at the time of demolition a bat management plan would be developed to avoid bat losses due to predation if individuals are forced to take flight during the day. Losses of non-flying young may also occur if the overbridge supports a maternity roost should demolition occur during the breeding season. Given that bat populations are likely to have a number of alternative roost sites in their home range, the removal of Windsor bridge is unlikely to be important to the long-term survival of the species in the locality. Additionally, the highly modified vegetation communities in the study area are not characteristic of potential foraging habitat of any of the species of bat considered to have a moderate likelihood of occurring in the area.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

Neither species is at their limit of distribution in the study area and occur along eastern Australia from Victoria to Queensland, and across northern Australia

How is the project likely to affect current disturbance regimes?

The habitat in the study area is highly modified and has a long history of disturbance and degradation. Current disturbance regimes may be associated with traffic noise, lighting and run-off of polluted stormwater as well as general rubbish entering the aquatic and terrestrial habitat. The proposed demolition and reconstruction of a new bridge would see the continuation of these current disturbance regimes although would not introduce new ones or increase their presence.

How is the project likely to affect habitat connectivity?

Both species are highly mobile and capability of moving over large areas for foraging and movements between roosts, in the order of 10-20 kilometres in a single night. The proposed removal and reconstruction of a new bridge would not negatively impact on a continuous area of habitat or affect the movements of these species.

How is the project likely to affect critical habitat?

There is no evidence to suggest the study area is critical habitat for these species of bats. Potential foraging habitat may occur and bats may occasionally visit study area. Further survey of the bridge structure microchiropteran bats is required prior to removal.

Conclusion

The project is likely to have no impact on the above mentioned species' providing biodiversity management measures are implemented to confirm the presence of bats and mitigate potential impacts.

Threatened hollow-roosting microchiropteran bats

Two threatened hollow-roosting bat species are known to occur in the study region (a 10 kilometre radius from the study area) and the vegetation in the study area may provide potential foraging habitat for these species, this includes the Eastern Freetail Bat (*Mormopterus norfolkensis*) and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) both of which are listed as vulnerable under the TSC Act.

How is the project likely to affect the lifecycle of a threatened species and/or population?

Disturbed riparian vegetation in the study area provides potential marginal foraging and roosting habitat for the assessed species. These bat species frequent a variety of habitat types ranging from sclerophyll forests, to woodland and open modified landscapes.

Important life-cycle activities include roosting and breeding and both are typically associated with tree hollows as well as foraging for insect prey which occurs in a variety of habitat types. The size of local populations is not known, although expected to be moderately small given the limited resources, particularly roosting habitat. About 0.5 hectares (5000 metres squared) of low condition riparian Casuarina open forest with sparse emerging eucalypts (less than 15m) would be removed as a result of the replacement of Windsor bridge. Comparable habitats are well represented throughout the locality and regional area and it is unlikely that the project would have a significant impact on the foraging or roosting life-cycle events for local populations of these bat species and continued presence in the locality could be expected.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

About 0.5 hectares (5000 metres squared) of low condition riparian Casuarina open forest with sparse emerging eucalypts (less than 15m) would be removed as a result of the replacement of Windsor bridge. The vegetation in the study area is heavily fragmented, although narrow corridors of modified riparian vegetation are present along either side of the Hawkesbury River. At the time of survey the study area did not support any hollow trees and no diurnal roosts were observed in the area. These bats are likely to forage over extensive home ranges (often between 10 and 20 kilometres) and the environs surrounding the Windsor bridge do not provide optimum foraging habitat for bats.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

None of these tree roosting threatened bat species are at the limit of their distribution in the study area. Dry and moist sclerophyll forest habitats are very common and widespread throughout the region particularly further west of the study area.

How is the project likely to affect current disturbance regimes?

The habitat in the study area is highly modified and has a long history of disturbance and degradation. Current disturbance regimes may be associated with traffic noise, lighting and run-off of polluted stormwater as well as general rubbish entering the aquatic and terrestrial habitat. The proposed demolition and reconstruction of a new bridge would see the continuation of these current disturbance regimes although would not introduce new ones or increase their presence.

How is the project likely to affect habitat connectivity?

Both species are highly mobile and capability of moving over large areas for foraging and movements between roosts, in the order of 10-20 kilometres in a single night. The proposed removal and reconstruction of a new bridge is unlikely to negatively impact on a continuous area of habitat or affect the movements of these species.

How is the project likely to affect critical habitat?

Some potential foraging habitat would be removed or impacted as a result of the project, however roosting habitat in the form of hollow trunks was not observed across the study area. Therefore no critical habitat is present in the study area.

Conclusion

The project is likely to have no impact on the above mentioned species' providing biodiversity management measures are implemented to mitigate potential habitat impacts.

Freckled Duck (*Stictonetta naevosa*)

The Freckled Duck (*Stictonetta naevosa*) is listed as vulnerable in NSW under the TSC Act.

How is the project likely to affect the lifecycle of a threatened species and/or population?

The freshwater aquatic habitat of the Hawkesbury River provides potential habitat for this species and there are 12 historic records from Windsor between 1981 and 2002, indicating occasionally visitation. Lifecycle activities of the Freckled Duck include foraging, breeding, resting and nesting and generally occur on or close to high quality waterbodies, which are rich with plankton and protected with native macrophytes and swamp vegetation and fallen trees. The Freckled Duck may occasionally spend its lifecycle in productive areas of Hawkesbury River, however the aquatic environment in the study area is absent of macrophytes and submerged woody debris due to high levels of water flow and does not constitute high quality habitat. Given the low condition of potential habitat and lack of recent records it is unlikely that a population of Freckled Duck is present or that the river system within the study area is important. On this basis the project is unlikely to effect the lifecycle of the species.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

Known records of the Freckled Duck from the NSW Atlas of Wildlife database occur in lagoon habitats of Pitt Town Lagoon, Bushells Lagoon and Bakers Lagoon within the locality but outside the study area. The replacement of Windsor bridge and removal of associated vegetation would not directly or indirectly affect the lagoon habitats situated between three to four kilometres away from study area. The low condition of habitat in the Hawkesbury River and riparian zones are not considered to be important areas of habitat for this species on the basis of the highly modified condition and lack of microhabitat elements such as shallow macrophyte beds and submerged woody debris. Historical clearing of land within the study area has significantly reduced the value of the riparian habitat by removing connectivity, foraging, shelter and breeding resources for this species. The project would not substantially affect or decrease the Freckled Duck's habitat preference to the study area.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

The Freckled Duck distribution occurs in wetland systems of coastal and western NSW as far as the Murray Darling Basin where the majority of the population occurs. The study area occurs within the known distribution of the Freckled Duck, but not at its limit. Within the wider locality lagoon habitats such as Pitt Town Lagoon, Bushells Lagoon and Bakers Lagoon provide more optimum habitat for this species than the riverine habitat in Windsor.

How is the project likely to affect current disturbance regimes?

The habitat in the study area is highly modified and has a long history of disturbance and degradation. Current disturbance regimes may be associated with traffic noise, lighting and run-off of polluted stormwater and light vehicle oil spills as well as general rubbish entering the aquatic and terrestrial habitat and invasion of weeds. The proposed demolition and reconstruction of a new bridge would see the continuation of these current disturbance regimes although would not introduce new ones or increase their presence. However the bridge demolition and river dredging may potentially cause sediment to flow downstream, affecting lagoon habitats. This would be mitigated by implementing management to erosion and sediment controls.

How is the project likely to affect habitat connectivity?

The Freckled Duck is typically able to move large distances between preferred habitats to access suitable water bodies. The proposed removal and reconstruction of a new bridge is unlikely to negatively impact on a continuous area of habitat or affect the movements of this species.

How is the project likely to affect critical habitat?

There are no records or evidence to suggest the occurrence of critical habitat in the study area for the Freckled Duck. The species is only an occasional visitor to the locality where records suggest a preference for lagoon habitats. The habitat in the study area is only of low condition and marginal for the species.

Conclusion

The project is likely to have no impact on the above mentioned species providing biodiversity management measures are implemented to mitigate potential impacts on habitat.

Appendix D Assessment of Significance EPBC Act (Migratory Species)

This assessment refers to the significance of impacts from the proposed action on nationally listed migratory species known to occur or considered to have a moderate to high likelihood of occurring in the study area.

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 listed migratory species (EPBC Act) were identified from the field survey however a number of species may occasionally or periodically occur based on the habitat assessment, database searches and literature review and include:

- White-throated Needletail
- White-bellied Sea Eagle
- Cattle Egret

There is no evidence to suggest that an area of important habitat exists in the study area for these species, based on the Atlas of NSW Wildlife, review of literature and habitat assessment. The project would not reduce populations of either species nor substantially reduce the extent of potential habitat in the region.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species

There is no evidence to suggest that an area of important habitat exists in the study area for either of the listed migratory species.

The study area has highly modified habitats with common exotic and noxious weeds as result of a long history of disturbance and degradation. The project would not introduce new invasive species or increase the dispersal of weeds that would harm these assessed migratory species.

Suitable measures would be incorporated into the project to control the spread of weeds during the construction and operation phases of the project and these would be detailed in an environmental management plan.

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

There is no evidence to suggest that an area of important habitat exists or that the study area is occupied by an ecologically significant proportion of a population of any migratory species. The pre clearing surveys would aid to mitigate impacts and confirm the unexpected presence of migratory species prior to clearing and demolition operations.

Conclusion

The project is likely to have no impact on the above mentioned species. The biodiversity management measures would be implemented to mitigate potential impacts on habitat.