AMENDMENTS TO THE APPROVED EA FOR THE PROVISION OF DRINKING WATER AND WASTEWATER RELATED SERVICES FOR THE FIRST RELEASE PRECINCTS OF THE NORTH WEST GROWTH CENTRE

Ecological Impact Assessment

For:

SYDNEY WATER

March 2012

Final Report

V2 6th January 2011

Cumberland Ecology
PO Box 2474, Carlingford Court 2118

Report No. 9094RP10v1

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology

Approved by:	David Robertson
Position:	Project Director
Signed:	
Date:	*20 March, 2012*

Table Of Contents

Table Of Contents

Table Of Contents

Table Of Contents

List of Figures

List of Tables

List of Tables

Table Of Appendices

Executive Summary

INTRODUCTION

In 2004, the NSW Government announced the strategic release of new urban development areas (Growth Centres) in western Sydney to accommodate around 181,000 new dwellings over the next 30 years in order to cater for Sydney's expanding population. This report relates to amendments and additions for water-related services for the first release precincts, which were originally approved in 2008. The changes proposed are located in and adjacent to the Riverstone Precinct, and include:

- realignment to four sections of the Chain of Ponds wastewater pipeline (1300m)
- one drinking water pipeline (Edmund Street Carrier) (290m)
- two wastewater pipelines to service the scheduled lands (1760m)
- a sewage pumping station (SP1154) at Chapman Road, Vineyard (0.4 ha)

Sydney Water is seeking a modification to the existing Part 3A approval for these works.

The purpose of this report is to assess the impacts on terrestrial flora and fauna that could result from the amendments and additions to the approved Environmental Assessment.

STATUTORY CONSIDERATIONS

Ecological assessment within the North West Growth Centre (NWGC) is governed by a number of State acts, policies and guidelines, including the Growth Centres SEPP and the Biodiversity Certification Order, which have been put in place to guide the development of the Growth Centres, whilst planning conservation offsets on a regional scale.

Under the Relevant Biodiversity Measures (RBMs) of the Biodiversity Certification Order, conservation offsets are only required for vegetation impacted in non-certified areas that falls into the definition of existing native vegetation under Schedule 1 of the Order. The definition of existing native vegetation (ENV) is provided in the Biodiversity Certification Order[9] as being:

"areas of indigenous trees (including any sapling) that:

(a) had 10% or greater over-storey canopy cover present,

(b) were equal to or greater than 0.5 ha in area, and

(c) were identified as "vegetation" on maps 4 and 5 of the draft Growth Centres Conservation Plan,

at the time the biodiversity certification order took effect, subject to condition 13"

(Condition 13 states that "if new information becomes available after the biodiversity certification order took effect that demonstrates that the vegetation within an area does not otherwise meet the definition of existing native vegetation, then…only the area of confirmed existing native vegetation shall be considered")[9].

Communities and Species listed under the EPBC Act

Biodiversity certification does not currently extend to species and communities listed under the Commonwealth EPBC Act and these require independent assessment under the EPBC Act.

METHODS

A review of all available relevant literature and databases was conducted to provide detailed information on the ecological values of the study area. Field surveys were conducted on the 1st and 2nd June 2011 (with minor amendments assessed on Friday 28th October 2011). Surveys assessed the extent of vegetation communities present and flora and fauna habitat across the Field Assessment Area (a 20m wide survey corridor for all pipelines and the site boundary for sps sites). Field survey methods included:

- Random meander surveys
- 20 x 20m quadrat sampling in potential derived native grasslands
- Threatened flora searches
- Fauna habitat assessment.

Data collected during field survey was considered appropriate to allow an accurate assessment of the flora and fauna values of the Field Assessment Area to be made.

The flora survey was conducted over two days in June and it is unlikely that all species present have been recorded. Despite this, it is probable that the majority of species have been recorded, and that issues including conservation significance of the flora, condition of the vegetation and likely impact on native vegetation have been satisfactorily assessed.

RESULTS

Vegetation Communities

Three native vegetation communities were found to occur within the Field Assessment Area. The extent of each community (as described under the Threatened Species Conservation Act (TSC Act) is listed below and illustrated in Figure 4.1:

TABLE S.1 TSC ACT LISTED VEGETATION COMMUNITIES IN THE FIELD ASSESSMENT AREA (HA)

Vegetation Community	Non-Certified	Certified	TOTAL
Cumberland Plain Woodland	0.57	0.43	1.00
River Flat Eucalypt Forest	0.65	0.00	0.65
Shale Gravel Transition Forest	0.01	0.68	0.69
Grand Total	**1.23**	**1.11**	**2.35**

**Notes: NSW Scientific Committee Determinations have been used in this table. EPBC Act definitions are assessed separately.*

All numbers rounded to 2 decimal places.

The definition of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest under the Environment Protection and Biodiversity Conservation Act (EPBC Act) includes condition thresholds for assessing whether vegetation patches conform to the community description or not. **Table S.2** below shows the vegetation that falls within the EPBC Act definition (which is a sub-set of that occurring under the TSC Act definition).

TABLE S.2 EPBC ACT LISTED VEGETATION COMMUNITIES IN THE FIELD ASSESSMENT AREA (HA)

Vegetation Community	Non-Certified	Certified	Total
Cumberland Plain Woodland	0.34	0.19	0.53
Shale Gravel Transition Forest	0.00	0.57	0.57
Grand Total	**0.34**	**0.76**	**1.10**

Notes: For ease of comparison between the definitions of EPBC Act and TSC Act listed vegetation communities, Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest[14] is shown as two separate entries.

All numbers rounded to 2 decimal places.

Threatened Flora

No threatened plants were recorded within the Field Assessment Area for the preferred alignment. However, potential habitat for a number of threatened flora species occurs, including:

- *Acacia pubescens*
- *Dilwynia tenuifolia*
- *Grevillea juniperina*
- *Marsdenia viridiflora* subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas
- *Micromyrtus minutiflora*
- *Persoonia nutans* (Nodding Geebung)
- *Pimelea spicata* (Spiked Rice-flower)
- *Pultenaea parviflora*
- *Pultenaea pedunculata* (Matted Bush-pea)
- *Thesium australe* (Austral Toadflax)

Fauna Habitats

Fauna habitats in the Field Assessment Area are generally limited to patches of trees along roadsides or amongst rural residential properties, riparian corridors and a few small waterbodies.

No critical habitats are listed at either state or commonwealth level within the Field Assessment Area.

Threatened Fauna

In broad terms, the habitat for woodland-dependent threatened fauna in the Field Assessment Area is relatively limited. Much of the land is cleared and there are few larger areas of remnant vegetation present that represent good quality habitat for fauna. Suitable foraging habitat occurs for a number of wide ranging threatened /migratory birds and bats (over 30 species) protected under the TSC Act and / or the EPBC Act, however, this is considered to be marginal. Additionally, a number of nature reserves and protected areas containing good quality habitat for these species occur nearby.

Potential habitat for the Cumberland Plain Land Snail occurs across the majority of the Field Assessment Area, although generally the habitat is highly disturbed and therefore not likely to provide optimal conditions for this species. The area zoned environmental conservation around Loftus and Sydney Streets (in proximity to water pipelines for scheduled land) provides better quality potential habitat for this species.

Very little suitable habitat for the Green and Golden Bell Frog occurs within the Field Assessment Area, with pipeline corridors generally avoiding water bodies. At Wastewater Pipeline L7 (near Junction Road) however, where the pipeline is being re-aligned, the new route runs adjacent to a small area of artificial waterway and nearby foraging/ shelter habitat that may provide some habitat for this species. The lack of emergent vegetation does reduce the potential of the site being used for breeding however.

IMPACT ASSESSMENT

Direct Impacts

A number of alignment options were assessed for this proposal. The impacts of the preferred options are discussed in the main body of this report and are summarised below.

Vegetation Removal

This impact assessment considers the worst-case scenario for direct impact on vegetation by assuming:

- For infrastructure sites, that all vegetation on site will be removed
- For all pipeline alignments, that a 10 metre-wide corridor of vegetation will be removed.

Table S.3 indicates maximum direct impacts on vegetation as a result of the Proposal.

TABLE S.3 POTENTIAL DIRECT IMPACT OF THE PROPOSAL ON ENDANGERED ECOLOGICAL COMMUNITIES IN THE FIELD ASSESSMENT AREA (HA)

Vegetation Community	Non-Certified	Certified	Total
Cumberland Plain Woodland (EPBC listed)	0.22	0.10	0.32
Cumberland Plain Woodland (TSC listed – additional to above)*	0.13	0.11	0.25
Shale Gravel Transition Forest (EPBC listed)	0.00	0.18	0.18
Shale Gravel Transition Forest (TSC listed – additional to above)*	0.00	0.01	0.01
River Flat Eucalypt Forest	0.32	0.00	0.32
Total	**0.67**	**0.41**	**1.08**

**Notes: All EPBC Act listed Cumberland Plain Woodland (CPW) and Shale Gravel Transition Forest (SGTF) also qualify as the TSC Act listed communities. TSC Act listed communities include low condition vegetation that do not meet the condition criteria to conform to this community under the EPBC Act.*

All numbers rounded to two decimal places

The Field Assessment Area incorporates 2.35 ha of EEC vegetation. Within this area, 1.08 ha occurs within the maximum direct impact zone.

Direct Impacts on Existing Native Vegetation

Some of the vegetation within the Field Assessment Area occurs as small isolated patches and does not conform to the definition of ENV in the Biodiversity Certification Order. **Table S.4** below illustrates the amount of ENV that could be lost as a result of the Proposal. According to the Biodiversity Certification Order, only impacts to ENV in non-certified areas must be offset.

TABLE S.4 EXISTING NATIVE VEGETATION WITHIN THE DIRECT IMPACT ZONE			
Vegetation Community	**Non-Certified ENV**	**Certified ENV**	**TOTAL**
Cumberland Plain Woodland (EPBC Listed)	0.22	0.10	0.32
Cumberland Plain Woodland (TSC Listed - additional to above)*	0.13	0.10	0.23
Shale Gravel Transition Forest (EPBC Listed)	0.00	0.18	0.18
Shale Gravel Transition Forest (TSC Listed - additional to above)*	0.00	0.01	0.01
River Flat Eucalypt Forest	0.32	0.00	0.32
TOTAL	**0.67**	**0.39**	**1.06**

Note: all numbers rounded to two decimal places

Threatened Flora

No threatened plants were detected within the Field Assessment Area for the preferred alignment options.

The Proposal will involve removing up to 1.08 ha of potential woodland habitat for threatened plants, which generally follows roadsides or occurs as narrow linear remnant vegetation along disturbed creeklines. The condition of these areas is typically low and heavily impacted by weeds, soil modification and dumping. The Field Assessment Area is not known to provide key habitat for any of these species and is not considered to be important to their long-term survival. A number of conservation reserves occur nearby that provide good quality potential habitat for these species, and in some cases, support important populations (including sites at Marsden Park North, Colebee, the Air Services Australia site at Shane's Park, Castlereagh Nature Reserve, Windsor Downs Nature Reserve and Scheyville National Park (refer to **Table 5.4** below). No significant impact is therefore predicted on any threatened plant species as a result of the Proposal.

Threatened Fauna

The Proposal has the potential to result in the removal of up to 1.06 ha of native woodland vegetation. This will result in a minor loss of potential foraging, roosting and breeding habitat for all fauna species associated with these communities, including a number of threatened fauna species (EPBC Act and TSC Act) known to occur in the locality of the Field Assessment Area.

Areas that do not comprise native vegetation generally occur as exotic grassland or shrubs which would provide minor foraging and sheltering opportunities for common fauna

as they tend to occur in the most disturbed areas. These habitats occur throughout Riverstone and the wider area.

Habitat for the Cumberland Plain Land Snail is considered to be marginal across most of the Field Assessment Area due to the highly disturbed nature of much of the site. However, the vegetation within the conservation area adjacent to Sydney Street is likely to provide suitable habitat for this species and therefore mitigation measures will need to be employed when clearing small patches of vegetation here, to ensure that impacts to this species are minimised...

Impacts on the Green and Golden Bell Frog as a result of the re-alignment of Wastewater Pipeline L7 are likely to be negligible. The implementation of mitigation measures listed in Chapter 6 to minimise impacts to the Green and Golden Bell Frog at this site is considered sufficient to deal with any potential impacts to this species and no further offsets are considered necessary.

TSC Act Assessments

Whilst 7-part Tests (Assessments of Significance) are not required for Part 3A projects, these were undertaken for all TSC Act listed threatened flora and fauna as part of the original EA assessment in order to ensure that all impacts had been assessed in detail. No significant changes to impacts have been detected during the current assessment as a result of the amendments to the approved EA. Therefore the 7-part Tests completed for the original EA are still considered applicable to all relevant TSC Act list threatened flora and fauna species.

Impacts on Matters of National Environmental Significance

Matters of National Environmental Significance (MNES) are not currently covered by the Biodiversity Certification Order. Direct impacts on EPBC Act listed species and communities (refer to Table S.3) are summarised below and include the loss of:

- Up to 0.5 ha of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest
- Up to 1.08 ha of potential woodland habitat (mostly marginal) for EPBC Act listed woodland dependent birds and bats
- Up to 1.08 ha of potential woodland habitat (mostly marginal) for EPBC Act listed threatened plants
- Minimal loss of potential foraging, sheltering and sub-optimal breeding habitat near Junction Road at Wastewater Pipeline L7 for the Green and Golden Bell Frog and potential foraging habitat for the Cattle Egret and Latham's Snipe

INDIRECT IMPACTS

Broadly, the indirect impacts of the Proposal include increased fragmentation of existing remnant vegetation, which may increase the degradation of habitat for woodland birds and threatened plants through edge effects (including the infection of native plants by fungi /pathogens) and increase the degree of isolation of individual remnant patches.

Habitat fragmentation and associated edge effects reduce the availability and quality of refugia for native fauna and increase feral access to resources, thus increasing the risk of predation and competition for resources for native fauna by rabbits, foxes and feral cats. All of the Field Assessment Area has been subject to previous disturbance however, most of it suffering fairly high levels of disturbance.

Many of the wider ranging threatened fauna would not be impacted by the disappearance of small patches of woodland, as they tend to prefer less disturbed habitats for nesting and roosting, and other foraging habitat occurs in the general vicinity. Individuals of the Cumberland Plain Land Snail could be locally affected by the removal of patches of woodland increasing habitat fragmentation and creating a localised barrier to movement. However, the vegetation to be removed is not considered to be important habitat for the species in general as the vegetation is highly disturbed and already suffering from habitat fragmentation. The Green and Golden Bell Frog is unlikely to be indirectly affected by the Proposal as similar habitat occurs in the surrounding area.

The loss of hollow-bearing trees has the potential to further isolate fauna species that are dependent on hollows for roosting or nesting. This can lead to increased isolation of local populations, which in turn, can result in genetic inbreeding and/or extinction of local populations. In the case of this Proposal however, the loss of hollow-bearing trees will be avoided where possible (as outlined in the Statement of Commitments). Any unavoidable losses are unlikely to have a significant indirect impact on threatened fauna as the majority of the Field Assessment Area occurs as narrow linear strips throughout the landscape and few significant hollow-bearing trees occur in general.

SIGNIFICANCE OF IMPACTS

Whilst threatened vegetation communities are to be removed as part of the Proposal, the vegetation in the Field Assessment Area suffers from weed infestation and is generally highly disturbed. Therefore, whilst the loss of threatened vegetation communities may be considered to be significant, particularly in relation to critically endangered vegetation communities, the fact that they occur as small patches of vegetation in a rural residential (soon to become urban) landscape, limits their conservation significance and the role that they might play in the preservation of threatened species associated with them. Offsetting of this vegetation in protected areas will help to conserve large remnant patches of these vegetation communities in-perpetuity.

An area of better quality woodland occurs around Sydney and Loftus Streets, which is zoned environmental conservation and will be retained and protected in the long-term. Mitigation measures to minimise impacts in this area are discussed in Chapter 6 and are considered sufficient to address the impacts to this vegetation that will occur as a result of the Proposal.

The species that is most likely to be impacted by the Proposal is the Cumberland Land Snail and individuals may be lost through vegetation clearance in some areas. Again, as the vegetation to be cleared does not involve the removal of large remnant patches, the impact on the Cumberland Land Snail is not likely to be significant and any lost individuals would be unlikely to play an important role in maintaining the long-term viability of this species.

The minor loss of some potential foraging and shelter habitat for the Green and Golden Bell Frog is not considered to be significant as suitable habitat occurs adjacent to the Field Assessment Area and across the Riverstone area in general.

No habitat features that are likely to be affected by the Proposal are considered likely to play an important role in maintaining the long-term viability of the vegetation communities affected by the proposal or the potential habitat for threatened species.

A number of areas nearby are being retained for conservation and include important habitat for threatened vegetation communities and/or threatened species. This includes a conservation area within the scheduled lands; two sites at Cranebrook and Colebee which have been purchased by OEH and between them hold several populations of threatened plant species including important populations of *P. Parviflora*, *D. tenuifolia* and *M. minutiflora* and potential habitat for several other species; and the Air Services Australia site at Shanes Park, Castlereagh Nature Reserve, Windsor Downs Nature Reserve and Scheyville National Park. As intact areas of bushland, these areas also provide suitable habitat for threatened woodland birds and bats and in some areas, the Cumberland Plain Land Snail. Therefore the significance of impacts of the removal of vegetation within the Field Assessment Area is expected to be low.

MITIGATION MEASURES

A suite of mitigation strategies were recommended in the Flora and Fauna Assessment[39] submitted as part of the Environmental Assessment which has now been approved. Additional recommended mitigation measures include:

- any pipes left on site are capped/covered overnight to prevent fauna (particularly Green and Golden Bell Frogs) from sheltering in them. A suitably qualified ecologist should carry out a pre-clearance survey in the Wastewater Pipeline L7 (Junction Road) area immediately before any clearance works take place. A methodology for this should be included in the Flora and Fauna Management Plan required under the Conditions of Approval for the project.

- The area zoned for environmental conservation around Sydney and Loftus Streets should be subject to a Plan of Management to be approved by OEH. The Plan should consider available practical options for minimising impacts in this area (i.e. boring or taking the line of least environmental impact, as Sydney Water has elected to do) and outline specific measures to mitigate impacts following construction, including weed control and re-planting.

RECOMMENDED OFFSETS

The Proposal will result in some impacts that cannot be addressed using the mitigation measures outlined above and offset measures will be required to compensate for these impacts.

Offsets for the approved Environmental Assessment have already been agreed with OEH and secured. The amendments outlined in this report require additional offsets to compensate for the loss of threatened vegetation communities and potential threatened species habitat.

Offsets must be calculated and secured in line with the RBMs of the Biodiversity Certification Order. This entails the offsetting of 0.67 ha of existing native vegetation in non-certified areas, which will need to be retained and protected elsewhere within the Growth Centres.

This Proposal impacts on Matters of National Environmental Significance listed under the EPBC Act, which are not currently covered by the Biodiversity Certification Order. As such the Proposal is likely to be required to be referred to the commonwealth government. However, a referral may not be required if approval is granted for the Strategic Assessment currently underway.

CONCLUSION

Whilst there will be some unavoidable impacts to threatened vegetation communities as a result of the Proposal, measures taken to avoid, mitigate and compensate for impacts will result in an improve or maintain outcome for biodiversity values in the long-term by contributing towards securing large areas of protected native vegetation. As such, the Proposal is not likely to reduce the long-term viability of, or accelerate the extinction of, a local population of any threatened species, population or ecological community. No significant impacts are therefore predicted on threatened species or vegetation communities as a result of the Proposal. No critical habitat will be affected by the Proposal.

The original Environmental Assessment regarding the provision of water-related services to the First Release Precincts of the NWGC has already been approved. The amendments to the approved EA are not considered to change the significance of any

impacts to vegetation or threatened species. With the existing and additional mitigation measures, and suitable offsets provided, the amended proposal is considered likely to achieve an 'improve or maintain' outcome for EECs and threatened species.

Chapter 1

INTRODUCTION

Introduction

1.1 Background

In 2004, the NSW Government announced the strategic release of new urban development areas (Growth Centres) in western Sydney to accommodate around 181,000 new dwellings over the next 30 years in order to cater for Sydney's expanding population. First release precincts in the North West Growth Centre included Riverstone, Riverstone West, Alex Avenue, Colebee and North Kellyville. **Figure 1.1** at the end of this chapter shows the location of the North West Growth Centre in a regional context.

Sydney Water will install essential trunk infrastructure for the supply of drinking water, recycled water and wastewater services for the Riverstone, Riverstone West, Alex Avenue and North Kellyville Precincts of the North West Growth Centre. The infrastructure required includes trunk pipelines, reservoirs, pumping stations and an upgrade and amplification of Riverstone and Quakers Hill Wastewater Treatment Plants. Ecological assessments have already been conducted to assess these proposed water related services as part of the Environmental Assessment under Part 3A of the *Environmental Planning and Assessment Act 1979*. The Minister for Planning approved the project with Conditions of Approval in November 2008. Since approval, further planning and design has identified several project changes (see **Figure 1.2**). The changes proposed are located in and adjacent to the Riverstone Precinct, and include:

- realignment to four sections of the Chain of Ponds wastewater pipeline (1300m)
- one drinking water pipeline (Edmund Street Carrier) (290m)
- two wastewater pipelines to service the scheduled lands (1760m)
- a sewage pumping station (SP1154) at Chapman Road, Vineyard (0.4 ha)

Sydney Water is seeking a modification to the existing Part 3A approval for these works.

1.1.1 Previous Work

A number of previous flora and fauna assessments have been conducted in the vicinity of the Proposal area and the general area has been well researched for its flora and fauna values. Of particular note is the study that was conducted in 2007 [39] for the original assessment for water-related services, which has now been approved. The report concluded that no significant impacts to threatened species or communities would occur

as a result of the proposal and that a number of mitigation measures and offset requirements would be required to deal with the residual impacts. The Conditions of Approval for the Proposal included ecological mitigation and offset requirements and suitable offsets have subsequently been agreed between Sydney Water, the Department of Planning and Infrastructure (DP&I - previously the Dept. of Planning) and the Office of Environment and Heritage (OEH).

1.2 Purpose

The purpose of this report is to outline the ecological values identified within the Field Assessment Area and to assess the impacts on terrestrial flora and fauna that could result from the amendments to the approved Environmental Assessment. It also discusses any additional mitigation measures and offsets that may be required as a result of these amendments. This report does not cover aquatic ecology issues.

The aims of this report are to:

- Verify and outline the ecological values within the Field Assessment Area
- Identify potential impacts on terrestrial flora and fauna as a result of the modification and additions to the Proposal
- Assess the significance of impacts on threatened species and communities;
- Assess the whether the mitigation measures outlined in the previous Environmental Assessment are adequate to cover the impacts of the amended Proposal and if not, recommend additional measures;
- Calculate additional offsets to compensate for unavoidable ecological impacts, if required.

1.3 Terms, Definitions and Abbreviations

The following terms and abbreviations have been used throughout this report:

- Field Assessment Area: area where field surveys have been undertaken, as shown in **Figure 1.2**
- CPW: Cumberland Plain Woodland
- The Proposal: covers all infrastructure components for Project Approval
- LGA: Local Government Area
- NWGC: North West Growth Centre

- RBMs: Relevant Biodiversity Measures as outlined in the Biodiversity Certification Order[9]
- OEH: Office of Environment and Heritage
- SEWPaC: Department of Sustainability, Environment, Water, Population and Communities
- DP&I: Department of Planning and Infrastructure
- EP&A Act*: Environmental Planning and Assessment Act 1979*
- EPBC Act: Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
- TSC Act: NSW *Threatened Species Conservation Act 1995*

1.4 Statutory Requirements

This report has been prepared to meet the requirements of Part 3A of the EP&A Act. . Whilst there is a proposal to repeal Part 3A projects, the draft Bill categorises large linear infrastructure as State Significant Infrastructure (SSI). Sydney Water Part 3A projects are deemed SSI and therefore would be assessed under Part S.1, which follows very similar arrangements as the former Part 3A process. Flora and fauna assessments have been undertaken in accordance with the *Draft Guidelines for Threatened Species Assessment 2005* [4].

The report also takes into account the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities 2004* [5], the *Matters of National Environmental Significance: Significant Impact Guidelines 2009* [18], and the *Draft EPBC Act Strategic Assessment Report for the Sydney Growth Centres Program (2010)* [26].

1.5 Description of Assessment Area

1.5.1 Geology, Soils and Vegetation

The North West Growth Centre (NWGC) occurs on the Cumberland Plain in western Sydney. The Cumberland Plain landscape consists generally of undulating plains and low hills with altitude ranging from approximately 20m to 100m. Rainfall is low and the plain receives less than 800 millimetres of rainfall each year[37].

The NWGC largely occurs on clay soils derived from Wianamatta Group geology, with limited occurrences of Tertiary Alluvium, Holocene Alluvium, the Mittagong Formation, Aeolian Deposits and Hawkesbury Sandstone [24].

The Cumberland Plain is characterised by a number of ecological communities with restricted distributions that have been listed as threatened under NSW State legislation; the *Threatened Species Conservation Act 1995* (TSC Act) and in some cases are also listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A range of associated threatened flora and fauna species and populations are also listed under these Acts.

In generic terms, the Cumberland Plain is characterised by three main vegetation communities that incorporate a number of transitional ecological communities[8]. These are:

- Cumberland Plain Woodland: typically occurring on heavy clay soils
- Shale Sandstone Transition Forest: occurring at the edges of the Cumberland Plain where the shale-influenced soils gradually change to sandstone
- Sydney Coastal River-flat Forest: occurring on the moister and the more fertile deposits along creeks and rivers.

Large areas of native vegetation on the Cumberland Plain have been previously cleared, firstly by European settlers for agricultural purposes due to the fertile soils of the plain, and more recently for residential and industrial development. The current landscape is a fragmented mosaic of bushland and rural or urban development.

Coordinate System: MGA Zone 56 (GDA 94)

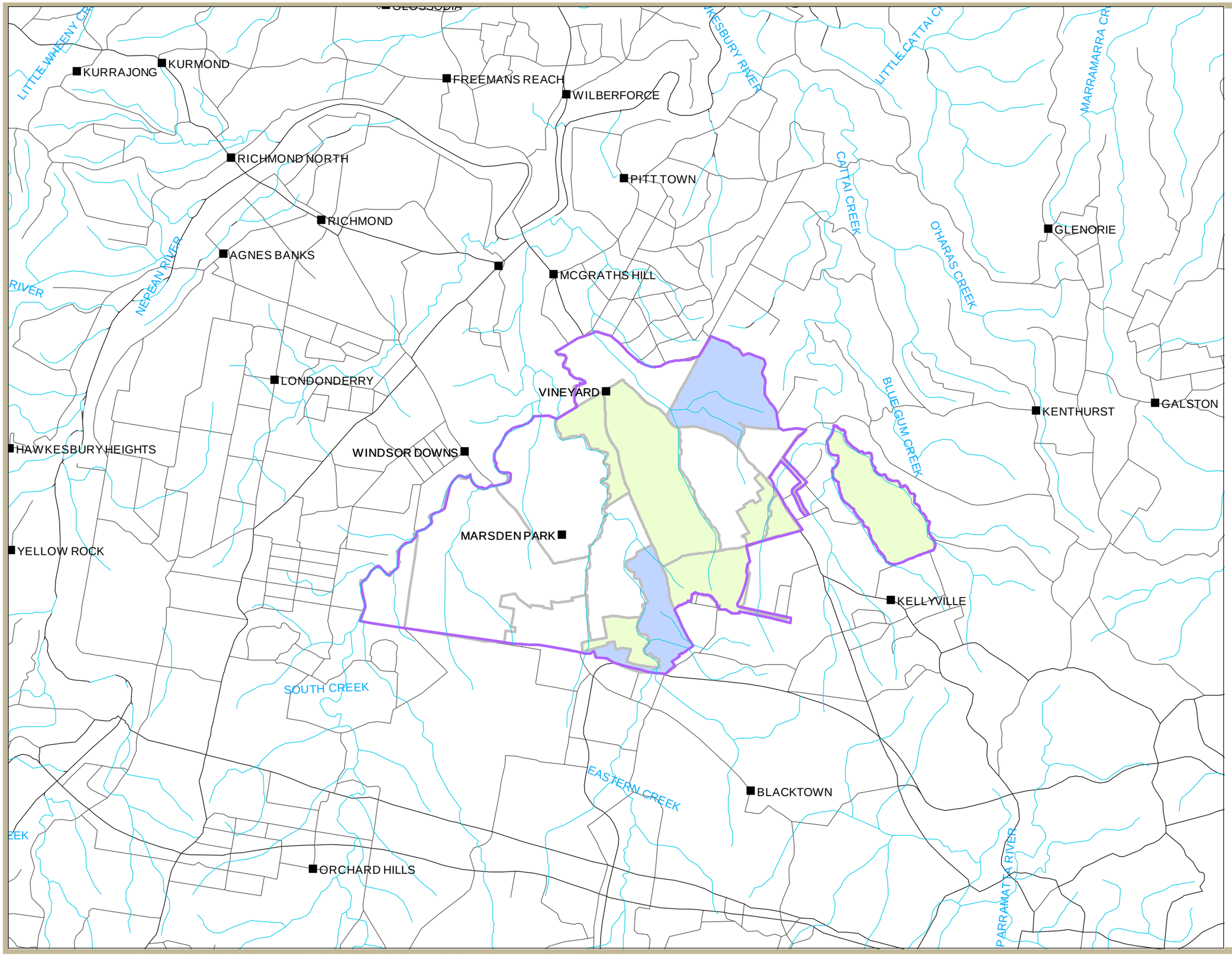

Figure 1.1. NORTH WEST GROWTH CENTRE IN A REGIONAL CONTEXT

Coordinate System: MGA Zone 56 (GDA 94)

KILLARNEY CHAIN OF PONDS

Chain of Ponds Creek Carrier

Vineyard

OLD PITT TOWN RD

Realignment a

SP1154 Option D

Realignment b

Box Hill

Realignment c

Rising Pipeline 3

KILLARNEY CHAIN OF PONDS

KILLARNEY CHAIN OF PONDS

WW L4-6

Riverstone West

Hamilton Street

Realignment d

WW L7

Box Hill Industrial

Underground boring pit

Riverstone

WINDSOR RD

Marsden Park North

Edmund Street

Riverstone East

GARFIELD RD EAST

FIRST PONDS OF CREEK

First Ponds Creek Carrier

Area

Legend

- Growth Centre Boundary
- Precincts
- Field Assessment Area
- Waterways

Pipelines assessed in the current survey

- New Drinking water pipeline
- New Wastewater pipeline realigned
- New Wastewater pipeline
- New rising main option
- Underground bore pits

Original pipelines (already approved)

- Drinking water pipeline
- Wastewater pipeline

SP1154 site option

- SP1154 Option D
- Original location (approved)

Grid North

I:\...\19094\Figures\Additional Assessment_MAY 2011_20110530\Report Figures 20110701\Figure 1.2 Infrastructure

CUMBERLAND ECOLOGY

Figure 1.2. PROPOSED AMENDMENTS AND ADDITIONS TO THE APPROVED EA INFRASTRUCTURE ALIGNMENTS

500 0 500 1000 1500 2000 m

Chapter 2

STATUTORY CONSIDERATIONS

Statutory Considerations

2.1 State Legislation

Whilst there is a proposal to repeal Part 3A projects under the EP&A Act, the draft Bill categorises large linear infrastructure as State Significant Infrastructure (SSI). Sydney Water Part 3A projects are deemed SSI and therefore amendments to the approved Environmental Assessment will be assessed under Part S.1, which follows very similar arrangements as the former Part 3A process.

Ecological assessment within the NWGC is governed by a number of State acts, policies and guidelines. An outline of those relevant to this Proposal is provided in **Table 2.1** below.

2.2 Commonwealth Legislation

2.2.1 Referring a Project

Under the EPBC Act, any project that is considered likely to have a significant impact on Matters of National Environmental Significance (MNES - including nationally threatened ecological communities and species, and listed migratory species) must be referred to the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities. To determine whether impacts are likely to be significant or not, the project must be assessed against Significant Impact Criteria outlined in the Significant Impact Guidelines for Matters of National Environmental Significance[18].

2.2.2 Strategic Assessment of the Sydney Growth Centres Program

A Strategic Assessment of the Growth Centres Program has been undertaken by the NSW Government under the Commonwealth EPBC Act. The Strategic Assessment assesses the potential impacts of urban development of the North West and South West Growth Centres on MNES protected under the EPBC Act. One of the aims of the Strategic Assessment is to ensure that MNES have been fully identified, considered and addressed during the State planning process. If the Commonwealth Minister determines that the

measures outlined in the Strategic Assessment report are suitable for protecting MNES, no further referrals to the Commonwealth will be required for works inside the Growth Centres.

Table 2.1 ACTS POLICIES AND GUIDELINES RELEVANT TO BIODIVERSITY ISSUES IN THE FIELD ASSESSMENT AREA

Legislation	Relevant Objectives	How it applies to this Project
State		
Environmental Planning and Assessment Act 1979	To encourage the proper management, development and conservation of natural and artificial resources for the purpose of promoting the social and economic welfare of the community and a better environment.	This Act is the principal planning instrument in NSW and as such dictates the assessment approach for the Proposal, including flora and fauna impact assessment and consideration of other Acts and planning policies.
Threatened Species Conservation Act 1995	Provides for the conservation of threatened species, populations and ecological communities and sets out a number of specific objectives relating to the conservation of biological diversity and the promotion of ecologically sustainable development. The Act sets up a Scientific Committee whose functions include: • Identifying and classifying (as endangered, critically endangered or vulnerable) the species, populations and ecological communities with which it is concerned • Identifying key threatening processes that may threaten the survival of those species, populations and ecological communities.	Threatened species assessments for projects assessed under Part 3A of the EP&A Act must be completed in accordance with the *Draft Part 3A Guidelines for Threatened Species Assessment*[4]. The *Threatened Species Conservation Amendment (Special Provisions) Act 2008* amends the *Threatened Species Conservation Act 1995* by inserting a new part to Schedule 7, which confirms that biodiversity certification has been conferred on the Growth Centres SEPP (see Section 2.3 below).
National Parks and Wildlife Act 1974	Under the National Parks and Wildlife Act, the Director-General of the NPWS is responsible for the care, control and management of all national parks, historic sites, nature reserves, reserves, Aboriginal areas and state game reserves. State conservation	The Field Assessment Area runs through an area set aside for environmental conservation. Works within these areas must be in accordance with a plan of management as outlined by RBM 12 of the Biodiversity Certification Order (see below). This area is located around

Table 2.1 ACTS POLICIES AND GUIDELINES RELEVANT TO BIODIVERSITY ISSUES IN THE FIELD ASSESSMENT AREA

Legislation	Relevant Objectives	How it applies to this Project
	areas, karst conservation reserves and regional parks are also administered under the Act.	Sydney and Loftus Streets and is discussed in further detail in Section 5.5 of this report.
Policies		
State Environmental Planning Policy (Sydney Region Growth Centres) 2006	To co-ordinate the release of land for residential, employment and other urban development in the Growth Centres and provide for appropriate planning, economic, sustainability and conservation controls within the Growth Centres.	The Growth Centres SEPP is designed to streamline development and conservation goals within the Growth Centres by allowing large areas of land to be developed without further threatened species assessments and setting higher conservation value areas aside for long-term protection. The Growth Centres SEPP has biodiversity certification under the TSC Act. This is discussed further in Section 2.3.
State Environmental Planning Policy No 19 — Bushland in urban areas (SEPP19)	Protect and preserve bushland within certain urban areas because of its value to the community as part of the natural heritage, its aesthetic value, and its value as a recreational, educational and scientific resource. The policy is designed to ensure that bush preservation is a high priority when local environmental plans for urban development are prepared.	This policy applies to parts of a number of LGAs within the NWGC including Blacktown LGA in which Riverstone is located. The policy only applies to areas zoned Community Land under the Local Government Act 1993 and does not apply to the Field Assessment Area. However, this Proposal is consistent with the aims of SEPP 19.
State Environmental Planning Policy No 44 — Koala Habitat Protection (SEPP44)	Encourages the proper conservation and management of natural koala habitat to ensure that there is a permanent free-living population of koalas throughout their present range and to reverse the current trend of population decline. SEPP 44 imposes restrictions on certain developments in areas of 'core koala habitat'.	Blacktown LGA is not listed under Schedule 1 of SEPP 44 and therefore this SEPP does not apply to the Blacktown area. One record of a koala scat has previously been recorded in the Blacktown LGA however[12] and the intent of this SEPP has been taken into account in this report.
Commonwealth		
Environment Protection and Biodiversity Conservation Act	To provide for the protection of the environment, particularly, Matters of National Environmental Significance, which include nationally listed	Nationally listed endangered ecological communities and threatened species, and listed migratory species, are not automatically covered by biodiversity

Table 2.1 ACTS POLICIES AND GUIDELINES RELEVANT TO BIODIVERSITY ISSUES IN THE FIELD ASSESSMENT AREA		
Legislation	**Relevant Objectives**	**How it applies to this Project**
1999	threatened species and ecological communities, and migratory species	certification. Assessments of impacts to these species in certified and non-certified areas need to be carried out under the EPBC Act (further discussion is provided in Section 2.3 below).

2.3 Biodiversity Certification

The Growth Centres SEPP establishes the broad framework for development of the Growth Centres over the next 20-30 years. In conjunction with the SEPP, a Conservation Plan was prepared which identified existing biodiversity values within the Growth Centres and proposed a range of mechanisms to achieve conservation goals through landscape planning. Biodiversity Certification was conferred on the Growth Centres SEPP on 14 December 2007, under the TSC Act.

2.3.1 Amendments to the Growth Centres Biodiversity Certification

An amendment to the TSC Act was made in July 2008 to directly confer biodiversity certification on the Growth Centres SEPP. The amendment is now incorporated into Part 7, Schedule 7 of the Act. The amendment essentially validates the certification and gives the Minister for the Environment the power to suspend or revoke the certification if any of its conditions, now termed relevant biodiversity measures (RBMs) are not complied with.

Biodiversity certification applies to developments and activities carried out under the Growth Centres SEPP and removes the need to undertake TSC Act listed threatened species surveys in certified areas under certain circumstances. For Part 3A projects however, biodiversity certification does not apply and threatened species assessments are required to be undertaken in both certified and non-certified areas.

The aim of biodiversity certification is to streamline the development assessment process within the Growth Centres whilst planning conservation offsets on a regional scale. A minimum of 2000 ha of native vegetation is required to be retained and protected within the Growth Centres, as well as other conservation goals which are outlined in the RBMs.

2.3.2 Existing Native Vegetation

Under the Relevant Biodiversity Measures (RBMs) of the Biodiversity Certification Order, conservation offsets are only required for vegetation impacted in non-certified areas that falls into the definition of existing native vegetation under Schedule 1 of the Order. The

definition of existing native vegetation (ENV) is provided in the Biodiversity Certification Order[9] as being:

"areas of indigenous trees (including any sapling) that:

(a) had 10% or greater over-storey canopy cover present,

(b) were equal to or greater than 0.5 ha in area, and

(c) were identified as "vegetation" on maps 4 and 5 of the draft Growth Centres Conservation Plan,

at the time the biodiversity certification order took effect, subject to condition 13"

(Condition 13 states that "if new information becomes available after the biodiversity certification order took effect that demonstrates that the vegetation within an area does not otherwise meet the definition of existing native vegetation, then…only the area of confirmed existing native vegetation shall be considered")[9].

2.3.3 Communities and Species listed under the EPBC Act

Biodiversity certification does not currently extend to species and communities listed under the Commonwealth EPBC Act and as noted in Section 2.2.2, these currently require independent assessment under the EPBC Act.

Additionally in some cases, EPBC Act listed vegetation community definitions differ from those under the TSC Act and therefore require separate assessment under the EPBC Act definition.

2.4 Consideration of Legislative Definitions of Cumberland Plain Woodland

On 10th December 2009, the status of Cumberland Plain Woodland was upgraded to 'critically endangered' under the Commonwealth EPBC Act. The description of the critically endangered community is now *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* to better reflect the key location, substrate and vegetation structure of the community[14].

The commonwealth listing of *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* states that in order to be recognised as the nationally listed community, the vegetation must always have an upper tree layer species present with a minimum projected foliage cover of 10%, and either a shrub or ground layer. The EPBC Act also stipulates condition thresholds (refer to Chapter 3, **Table 3.2**) that apply to patches of vegetation that meet the description of *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest*. The purpose of the condition thresholds is to guide the

conservation of the ecological community towards those areas that retain the highest conservation values so as to be considered a Matter of National Environmental Significance. Areas that meet these condition criteria are considered to be the ecological community, whilst areas that do not meet these criteria are excluded from the EPBC Act listing[14].

The NSW Scientific Committee also made a final determination on the 18th December 2009 to list Cumberland Plain Woodland as 'critically endangered' under the TSC Act. The state listing includes derived native grasslands where they contain characteristic native non-woody species[33]. It does not state minimum condition thresholds, patch size or projected foliage cover requirements for Cumberland Plain Woodland or derived native grasslands.

Survey Methodology

3.1 Desk-based Assessment

3.1.1 Literature Review

A review of all available relevant literature was conducted to provide detailed information on the ecological values of the study area. This included reviewing previous surveys and reports that had been conducted within the Growth Centres and collating information from resources such as OEH Scientific Committee Determinations and SEWPaC threatened species and threats listings[3].

3.1.2 Database Analysis

Records of threatened species that had been recorded from the locality were obtained from OEH's Wildlife Atlas[12]. The EPBC Protected Matters Search Tool[15] was also interrogated to assess which EPBC Act listed threatened vegetation communities, species and migratory species have habitat occurring within the locality.

3.2 Field Survey

3.2.1 Background

The flora and fauna of the NWGC and immediate surrounds have been subject to a series of surveys by Cumberland Ecology and other ecological consultants over recent years and the ecology of the NWGC and indeed the flora and fauna of the locality is relatively well known. Therefore excellent ecological baseline data exists including vegetation mapping, and information about individual flora and fauna species.

Field surveys were conducted across the Field Assessment Area (refer to **Figure 3.1**) on the 1st and 2nd June 2011 (with minor amendments assessed on Friday 28th October 2011) by a Botanist and an Ecologist. Surveys assessed the extent of vegetation communities

present and flora and fauna habitat across the Field Assessment Area. Field survey methods included:

- Random meander surveys
- 20 x 20m quadrat sampling in relevant habitat
- Threatened flora searches
- Fauna habitat assessment.

Total survey effort equated to 38 hours. As far as practically possible, surveys were conducted in accordance with the:

- Draft Guidelines for Threatened Species Assessment[4]
- Draft Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities (DEC 2004)
- Significant Impact Guidelines 1.1 - Matters of National Environmental Significance (DEWHA 2006)

A description of the survey methods is provided below:

3.2.2 Vegetation Community Mapping

Vegetation communities were assessed according to the descriptions in Tozer[37] and NSW Scientific Committee Final Determinations. Nationally listed communities (Cumberland Plain Woodland and Shale-Gravel Transition Forest) were also assessed under the Commonwealth description of the communities[14]. Section 2.4 outlines the statutory framework for the definitions of these two communities under the TSC and EPBC Acts. Random meander surveys were used to identify and map the presence and extent of native vegetation on site.

i. Random meander surveys

A random meander technique was utilised to ground-truth existing vegetation mapping and to identify the flora species present within the Field Assessment Area. Using the NPWS vegetation mapping[11] of Western Sydney as a base, vegetation communities were verified/re-mapped at a fine-scale. The time spent in each vegetation community was proportional to the size of the community and its species richness.

ii. Quadrat surveys

Quadrat surveys were undertaken in areas that required the verification of the presence/absence of derived native grasslands (refer below). In each quadrat, the following information was recorded on structure and floristics:

- All vascular flora species present within the quadrat or directly adjacent to the quadrat
- The relative frequency of occurrence of each plant species
- Vegetation structural data (i.e. height and percentage foliage cover of each stratum)
- The percentage foliage cover of weeds in each stratum
- Photographs of the quadrat

The relative abundance and cover of each species within the quadrat was approximated using a scoring system based on the Braun-Blanquet scoring system. The scores used are provided in **Table 3.1** below:

Table 3.1 MODIFIED BRAUN-BLANQUET SCORES USED IN QUADRAT SURVEYS

Class	Cover-abundance (%)	Notes
+	Rare (less than 1% cover)	Herbs, sedges and grasses: within 4 m^2 Shrubs and small trees: less than 5 individuals.
1	Few Individuals (less than 5% cover)	Herbs, sedges and grasses: within 20 m^2 Shrubs and small trees: 5 or more individuals Medium - large overhanging tree.
2	5% - less than 25 % cover	-
3	25% - less than 50 % cover	-
4	50% - less than 75 % cover	-
5	75% – 100 % cover	-

All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden[22]. Taxonomy and nomenclature follows the Royal Botanic Gardens Trust *PlantNET*[1].

Raw quadrat data can be found in **Appendix A**.

3.2.3 Mapping Cumberland Plain Woodland

i. Mapping Cumberland Plain Woodland under the State definition

The NSW Scientific Committee's determination of Cumberland Plain Woodland under the TSC Act[33] includes 'derived native grasslands' that result from the removal of woody strata from woodlands and forests. Currently (as at June 2011) there are no specific guidelines as to the native forb diversity or the percentage of native understorey cover that should be present in a grassland community in order for it to be categorised as Cumberland Plain Woodland derived native grasslands under the TSC Act. Therefore Tozer's[37] description of positive diagnostic species for Cumberland Plain Woodland was adapted to apply to derived native grasslands, which were considered to be those that exhibited 10 or more positive diagnostic groundcover species within a 20m x 20m quadrat.

ii. Mapping Cumberland Plain Woodland and Shale-Gravel Transition Forest under the Commonwealth definition

Under the EPBC Act, Cumberland Plain Woodland is referred to as *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest*[14] and as the name suggests, includes the closely related Shale-Gravel Transition Forest community. The EPBC Act Listing Advice[14] applies condition thresholds to the definition that native vegetation must meet in order to be classified as the nationally threatened community. Derived native grasslands are not included in the EPBC Act definition which notes that a minimum canopy cover of 10% must be present in order for the community to be classed as *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest*[14].

The condition thresholds from the EPBC Act Listing Advice are outlined in **Table 3.2**. These were used during field survey to identify which patches of Cumberland Plain Woodland and Shale-Gravel Transition Forest conformed to the EPBC Act listing. Where it was not immediately apparent in the field, patch size and contiguity thresholds were measured using Geographical Information Systems (GIS: MapInfo Professional 10.0.1).

Table 3.2 EPBC ACT CONDITION THRESHOLDS FOR CUMBERLAND PLAIN SHALE WOODLANDS AND SHALE-GRAVEL TRANSITION FOREST

Category and Rationale	Thresholds
A. Core thresholds that apply under most circumstances: patches with an understorey dominated by natives and a minimum size that is functional and consistent with the minimum mapping unit size applied in NSW.	Minimum patch[a] size is ≥ 0.5 ha **AND** Native perennial understorey[b] vegetation cover is ≥ 50%
OR	
B. Larger patches that are inherently valuable due to their rarity.	Minimum patch size is ≥ 5 ha **AND** Native perennial understorey vegetation cover is ≥ 30%
OR	
C. Patches with connectivity to other large native vegetation remnants in the landscape.	Minimum patch size is ≥ 0.5 ha **AND** Native perennial understorey vegetation cover is ≥ 30% **AND** The patch is contiguous[c] with a native vegetation remnant (i.e. any native vegetation where cover in each layer present is dominated by native species) that is ≥ 5 ha in area
OR	
D. Patches that have large mature trees or trees with hollows (habitat) that are very scarce on the Cumberland Plain.	Minimum patch size is ≥ 0.5 ha **AND** Native perennial understorey vegetation cover is ≥ 30% **AND** The patch has at least one tree with hollows per hectare or at least one large tree (≥ 80cm dbh) per hectare from the upper tree layer species (as listed in the Description and Appendix A of the Advice to the Minister)

Notes:

a. A *patch* is defined as a discrete and continuous area that comprises the ecological community, outlined in the Listing Advice. Permanent man-made structures, such as roads and buildings, are typically excluded from a patch but a patch may include small-scale disturbances, such as tracks or breaks or other small-scale variations in native vegetation that do not significantly alter the overall functionality of the ecological community.

b *Perennial understorey vegetation cover* includes vascular plant species of the ground and shrub layers (as outlined in Appendix A of the Listing Advice) with a life-cycle of more than two growing seasons.

c. *Contiguous* means the woodland patch is continuous with, or in close proximity (within 100 m), of another patch of vegetation that is dominated by native species in each vegetation layer present.

3.2.4 Threatened Flora Surveys

Targeted surveys for threatened flora were conducted for threatened flora species considered to have potential habitat occurring within the Field Assessment Area (refer to Appendix B). Threatened flora surveys were conducted in suitable habitat using the random meander method, which allows for greater coverage than plot-based techniques, particularly along linear routes.

Where a threatened plant was found, a population count was undertaken. Locations of individuals or patches of threatened species were then recorded on a map.

3.2.5 Fauna Habitat Assessments

Due to the linear nature of the proposed pipeline corridors, it was determined that in general, habitat assessments were more appropriate for determining the potential use of the site by threatened fauna than targeted surveys, particularly as no large tracts of woodland occur within the Field Assessment Area.

i. Wide ranging threatened fauna

Fauna habitat assessment was conducted across the Field Assessment Area and included an evaluation of the nature and extent of habitats on site for native fauna and identification of areas where threatened fauna species could reside or forage. Consideration was made of important indicators of habitat condition and complexity, including the occurrence of microhabitats such as tree hollows, fallen logs, loose bark, bush rock and wetland areas. Known records of threatened species were also considered. Observations of all fauna sighted during the survey period were recorded.

ii. Cumberland Plain Land Snail

The Cumberland Plain Land Snail occurs in Cumberland Plain and Castlereagh Woodlands. Preferred habitat is usually under leaf litter or loose soil, around the base of mature eucalypts or under logs where the soil remains shaded and moist.

Due to its inconspicuous nature, this species is difficult to detect during targeted surveys therefore to take an extremely conservative approach, the presence of this species throughout the Field Assessment Area (including certified and non-certified areas) was assumed to occur where Cumberland Plain Woodland, Shale Gravel Transition Forest, Castlereagh Ironbark Forest and River-flat Eucalypt Forest were present.

3.2.6 Habitat Assessment for the Green and Golden Bell Frog

Green and Golden Bell Frogs utilise vegetated dams, creeks and ephemeral drainage lines in order to breed and forage and can disperse several kilometres to reach suitable habitat. Extant and historical populations of the species are known to occur in the Riverstone area.

Wildlife Atlas database records were checked for the location of previous sightings (since 1980) of Green and Golden Bell Frogs in the North West Growth Centre. Previous flora and fauna surveys[23,39] have been undertaken within the locality and these were also reviewed prior to the commencement of habitat surveys. Targeted surveys for the Green and Golden Bell Frog were carried out in parts of the Field Assessment Area and surrounds by both UBM Consultants in 2007 and Cumberland Ecology in 2010 with no individuals being recorded. Therefore further targeted surveys were not considered necessary and the potential presence of this species within the Field Assessment Area was based on habitat assessment.

During field survey investigations, areas considered to provide potential habitat for the Green and Golden Bell Frog were those that exhibited a number of relevant habitat characteristics, such as a water body or ephemeral pond/drainage line containing emergent vegetation and rocks or logs or adjacent grassy foraging habitat.

3.2.7 Limitations

Data collected during field survey was considered appropriate to allow an accurate assessment of the flora and fauna values of the Field Assessment Area to be made. Inevitably, some limitations occurred. These were not considered to change the outcome of the assessment.

The flora survey was conducted over two days in June. Growing conditions in the vicinity of the survey area were suitable for adequate production of features to enable identification to be made of most plants to species level at the time of the survey and accurate assessment of the conservation significance of the Field Assessment Area.

It is unlikely that all species present have been recorded. Despite this, it is probable that the majority of species have been recorded, and that issues including conservation significance of the flora, condition of the vegetation and likely impact on native vegetation have been satisfactorily assessed.

Some threatened flora species with the potential to occur within the Field Assessment Area are cryptic and may occur on the site but were not detected during the survey. This does not preclude their presence on site and a precautionary approach was undertaken with habitat suitability being considered the best method of assessing the potential impacts to these species.

Coordinate System: MGA Zone 56 (GDA 94)

Grid North

Legend

- Field Assessment Area
- Waterways
- Flora Quadrat

KILLARNEY CHAIN OF PONDS
OLD HAWKESBURY RD
WALLACE RD
CHAPMAN RD
ST JAMES RD
BANDON RD
CAMBERWELL RD
O'CONNELL ST
OTAGO ST
HAMILTON ST
VICTORIA ST
PRINCES ST
GRANTHAM ST
WILLIAM ST
BRISBANE RD
PICCADILLY ST
EDWARD ST
LOFTUS ST
WELLINGTON ST
HOBART ST
CROWN ST
WINDSOR RD
BOUNDARY RD
SYDNEY ST
EDMUND ST
JUNCTION RD
GARFIELD RD EAST
RIVERSTONE PDE

SP1154 Option D
Realignment A
Realignment B
Realignment C
Realignment D
Rising Pipeline 3
WW L4-6
WW L7

CUMBERLAND ECOLOGY

I:\...\9094\Figures\First Release Precinct-Riverstone\Report Figures_20111206\

Figure 3.1. LOCATION OF FIELD ASSESSMENT AREA SUBJECT TO RANDOM MEANDER SURVEYS AND QUADRAT TO DETERMINE IF DERIVED NATIVE GRASSLAND

250 0 250 500 750 1000 m

Survey Results

4.1 Vegetation Communities

4.1.1 Verification of Previous Vegetation Mapping

The Cumberland Plain was the subject of an extensive vegetation mapping project in 2002[28], which was reviewed and updated in 2007 to reflect changes to vegetation distribution based on recent aerial photography[11].

Three native vegetation communities have been mapped as occurring within the Field Assessment Area by NPWS[11] and were verified by ground-truthing to occur there. The communities are summarised in **Table 4.1** below.

Table 4.1 VEGETATION COMMUNITIES WITHIN THE FIELD ASSESSMENT AREA AND THEIR CONSERVATION STATUS

Vegetation Community	TSC Act Status	EPBC Act Status
*Cumberland Plain Woodland	Critically Endangered	Critically Endangered
**River Flat Eucalypt Forest	Endangered	-
Shale/Gravel Transition Forest	Endangered	Critically Endangered

*Notes: *Incorporates Shale Hills Woodland and Shale Plains Woodland[33,28,28]*

*** Includes Alluvial Woodland [32]*

4.1.2 Vegetation Communities Recorded during Field Survey

Due to the difference in definition of Cumberland Plain Woodland under the TSC and EPBC Acts, vegetation communities under State legislation and Commonwealth legislation are discussed separately below. As the State definition has a wider definition encompassing low condition vegetation and derived native grasslands, all vegetation that qualifies under the EPBC Act also falls into the TSC Act listing.

i. State listed vegetation communities recorded during field survey

The vegetation communities recorded in the Field Assessment Area are summarised in **Table 4.2** below and shown in **Figure 4.1** at the end of this Chapter. Detailed vegetation maps are provided in **Appendix D**.

Table 4.2 TSC ACT LISTED VEGETATION COMMUNITIES IN THE FIELD ASSESSMENT AREA (HA)

Vegetation Community	Non-Certified	Certified	TOTAL
Cumberland Plain Woodland	0.57	0.43	1.00
River Flat Eucalypt Forest	0.65	0.00	0.65
Shale Gravel Transition Forest	0.01	0.68	0.69
Grand Total	**1.23**	**1.11**	**2.35**

**Notes: NSW Scientific Committee Determinations have been used in this table. EPBC Act definitions are assessed separately.*

All numbers rounded to 2 decimal places.

4.1.3 Commonwealth Listed Vegetation Communities Recorded During Field Survey

The definition of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest under the EPBC Act[14] includes condition thresholds for assessing whether vegetation patches conform to the community description or not (refer to Chapter 3, Table 3.2). The purpose of the condition thresholds is to provide guidance for identifying when a patch of the community retains sufficient conservation values to be considered as a Matter of National Environmental Significance. As a consequence of this, some areas that are considered to be Cumberland Plain Woodland under the NSW State definition are not considered to conform to the Commonwealth listing for Cumberland Plain Woodland. **Table 4.3** below shows the vegetation that falls within the EPBC Act definition (which is a sub-set of that occurring under the TSC Act definition).

Table 4.3 EPBC ACT LISTED VEGETATION COMMUNITIES IN THE FIELD ASSESSMENT AREA (HA)			
Vegetation Community	**Non-Certified**	**Certified**	**Total**
Cumberland Plain Woodland	0.34	0.19	0.53
Shale Gravel Transition Forest	0.00	0.57	0.57
Grand Total	**0.34**	**0.76**	**1.10**

Notes: For ease of comparison between the definitions of EPBC Act and TSC Act listed vegetation communities, Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest[14] is shown as two separate entries.

All numbers rounded to 2 decimal places.

Figure 4.1 at the end of the chapter shows the location of State and Commonwealth listed vegetation communities within the Field Assessment Area.

4.2 Vegetation Community Descriptions

4.2.1 Cumberland Plain Woodland

The most extensive community occurring within the Field Assessment Area is Cumberland Plain Woodland. Cumberland Plain Woodland is a community that typically occurs on flat to undulating terrain and is associated with shale soils derived from the Wianamatta Group, making it highly suitable for development and agriculture. Two thirds of its occurrence within the Growth Centres occurs on developable land[33]. This community is a type of grassy woodland that is dominated by *Eucalyptus moluccana* and *Eucalyptus teretecornis* (Forest Red Gum), with the occasional occurrence of *Eucalyptus crebra*. Variants of the community can also include *Corymbia maculata* (Spotted Gum) as a co-dominant tree.

The shrub stratum can be locally dense, and is represented generally by *Bursaria spinosa* (Blackthorn), *Dillwynia sieberi, Pultenaea microphylla* and *Daviesia uliciolia* (Gorse Bitter Pea). Particularly dense thickets of shrubs are often the result of disturbance like slashing activities, grazing or fire.

The ground cover of woodland in reasonably good condition is dominated by a range of grasses and supported by a diversity of forb species. However, much of the occurrence of this community within the Field Assessment Area was highly weed infested. The typical assemblage of species and condition of the community within the Field Assessment Area is shown in **Table 4.4.**

Table 4.4	TYPICAL ASSEMBLAGE OF SPECIES AND CONDITION OF CUMBERLAND PLAIN WOODLAND WITHIN THE FIELD ASSESSMENT AREA	
Stratum	**Typical species**	**Typical height (metres) & projective foliage cover (%)**
Canopy	Eucalyptus moluccana - dominant Eucalyptus tereticornis - occasionally	10-20 m; 5-30%
Small Tree	Generally absent, but sometimes contained regenerating canopy trees and/or scattered Ligustrum lucidum, Olea europaea ssp cuspidata	5-10 m; <5%
Shrub	Bursaria spinosa, *Ligustrum sinense, very variable density	0.5-2 m; 0-60%
Ground cover	*Eragrostis curvula, Microlaena stipoides, *Sida rhombifolia, Dichondra repens	0-0.5 m; 5-80%
Canopy	Canopy present but variable from sparse to dense with exotics absent	
Small tree	Small tree stratum where present contained 0-90% exotics	
Shrubs	2-80% exotic cover	
Ground cover	5-90% exotic cover	

Much of the woodland surveyed is fragmented and reduced to small stands of trees with an absent shrub stratum and a much disturbed understorey. The understorey is often weed infested, containing exotics like *Sida rhombifolia* (Paddy's Lucerne), *Eragrostis curvula* (African Lovegrass) and *Paspalum* spp. Where the understorey contains native species, the assemblage typically supports a few grass species with very few forb representatives. The Cumberland Plain Woodland listing under the TSC Act now includes grasslands derived from the clearing of the canopy stratum and to a large extent, the shrub stratum. To qualify as the listed 'derived native grassland', the area needs to have a species composition that approaches that observed in nearby remnant examples of the community and must include characteristic non-woody species[33].

One patch of improved pasture occurring within the Riverstone Sewage Treatment Plant was assessed by quadrat survey for its potential to conform to Cumberland Plain Woodland derived native grasslands. Although better quality grassland (largely *Themada australis*) occurred as small scattered patches in drier areas upslope of the Field Assessment Area, the vegetation within the Field Assessment Area itself was dominated by approximately 90% weeds, with the quadrat containing a total of only eight diagnostic

groundcover species (refer to Section 3.2.3). Therefore it did not conform to Cumberland Plain Woodland derived native grassland as described in this report. Quadrat data can be found in **Appendix A.**

The EPBC Act description of Cumberland Plain Woodland includes Shale Gravel Transition Forest within the listing and sets condition thresholds for vegetation patches that are recognised under the listing. Thus, the occurrence of EPBC Act-listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest[14] generally equates to better connected patches of the community, such as around Loftus Street, where the vegetation is in better condition and connected amongst rural residential properties.

4.2.2 Shale-Gravel Transition Forest

Shale Gravel Transition Forest is associated with Cumberland Plain Woodland and occurs where there are shallow alluvium deposits over shale soils, often containing thin deposits of lateritic gravel. As the influence of gravel declines, Shale Gravel Transition Forest grades to Cumberland Plain Woodland. The floristics of Shale Gravel Transition Forest can contain species from both communities, depending on the amount of gravel present and/or its proximity to Cumberland Plain Woodland[30,33].

Shale Gravel Transition Forest is an open forest typically dominated by *Eucalyptus fibrosa* (Broad-leaved Ironbark), although *Eucalyptus moluccana* and *Eucalyptus teretecornis* may also be present. Shale-Gravel Transition Forest often enjoys wetter conditions than Cumberland Plain Woodland and is typically supported by a small tree stratum of *Melaleuca decora*. The understorey assemblage is not dissimilar to that of Cumberland Plain Woodland, although the shrub stratum of the latter is generally sparser. The typical assemblage of species and condition of this community within the Field Assessment Area is shown in **Table 4.5.**

Table 4.5 TYPICAL ASSEMBLAGE OF SPECIES AND CONDITION OF SHALE GRAVEL TRANSITION FOREST WITHIN THE FIELD ASSESSMENT AREA		
Stratum	**Typical species**	**Typical height (metres) & projective foliage cover (%)**
Canopy	*Eucalyptus moluccana* – dominant *Eucalyptus fibrosa* - variable *Eucalyptus tereticornis* - occasionally	10-15 m; 5-30%
Small Tree	Frequently absent, but sometimes contained regenerating canopy trees and *Allocasuarina littoralis*	4-8 m; <5%
Shrub	*Bursaria spinosa*, juvenile *Acacia parramattensis*, *Daviesia ulicifolia, Lissanthe strigosa*	0.5-2 m; 0-50%
Ground cover	**Eragrostis curvula, Themeda australis, Dianella revoluta, Aristida vagans*	0-0.5 m; 5-70%
Canopy	Canopy present but variable from sparse to dense with exotics absent	
Small tree	Small tree stratum where present contained 0-90% exotics	
Shrubs	2-80% exotic cover	
Ground cover	5-95% exotic cover	

Good condition vegetation generally occurred outside of the 20m wide survey corridor although some better quality Shale Gravel Transition Forest occurred along the northern side of Otago Street.

The EPBC Act includes Shale Gravel Transition Forest within the listing for Cumberland Plain Woodland, which is discussed in the section above.

4.2.3 River-flat Eucalypt Forest

River-flat Eucalypt Forest is a coastal floodplain community that occurs on the flats bounding creeks and rivers. Many of the non-certified areas within the Growth Centres occur along riparian corridors, which would have once contained this community but have been extensively cleared for grazing.

This community is best characterised by the dominance of *Eucalyptus tereticornis*, with occasional occurrences of *Eucalyptus amplifolia* (Cabbage Gum), *Eucalyptus baueriana* (Blue Box) and *Eucalyptus elata* (River Peppermint). The small tree stratum contains a diversity of *Melaleuca* spp. and the shrub stratum is represented by *Bursaria spinosa* and

Breynia oblongifolia (Coffee Bush). The typical assemblage of species and condition of this community within the Field Assessment Area is shown in **Table 4.6.**

Table 4.6 TYPICAL ASSEMBLAGE OF SPECIES AND CONDITION OF RIVER-FLAT EUCALYPT FOREST WITHIN THE FIELD ASSESSMENT AREA

Stratum	Typical species	Typical height (metres) & projective foliage cover (%)
Canopy	Eucalyptus moluccana - dominant Eucalyptus tereticornis, Eucalyptus amplifolia, Casuarina glauca occasionally	10-20 m; 5-30%
Small Tree	Generally absent, but sometimes contained regenerating canopy trees and/or scattered Ligustrum lucidum, Acacia parramattensis, Melaleuca decora	5-10 m; <5%
Shrub	Bursaria spinosa, *Ligustrum sinense, Cestrum parqui - very variable density	0.5-2 m; 0-30%
Ground cover	*Pennisetum cladestinum, Cynodon dactylon, Microlaena stipoides, *Axonopus affinis	0-0.5 m; 5-80%
Canopy	Canopy present but variable from sparse to dense with exotics absent	
Small tree	Small tree stratum where present contained 0-90% exotics	
Shrubs	2-80% exotic cover	
Ground cover	5-90% exotic cover	

The River-flat Eucalypt Forest surveyed suffers from trampling by livestock where it occurs on farms, and suffers from weed degradation along creek lines due to urban and agricultural runoff. Whilst the characteristic assemblage of species in the understorey include *Microlaena stipoides*, *Dichondra repens* (Kidney Weed) and *Oxalis perennans*, these species are generally outcompeted by exotic shrubs, grasses, vines and forbs, particularly *Ligustrum* species (Privet), *Tradescantia fluminensis* (Wandering Jew) and *Bidens pilosa* (Cobblers Pegs). All occurrences of River-flat Eucalypt Forest within the Field Assessment Area were highly weed infested, with small patches of better quality vegetation occurring rarely.

4.2.4 Unclassified Vegetation

The remaining woody vegetation within the Field Assessment Area largely represents scattered or individual remnant native trees along roadsides where there is little to no native understorey. Away from roadsides, much of the vegetation is planted, either as

garden ornamentals or for agriculture, particularly in the rural residential areas. Most of the cleared areas in larger private lots constitute pasture-improved grasslands.

4.3 Threatened Flora

4.3.1 Threatened Flora Recorded in the Field Assessment Area

No threatened plants were recorded within the Field Assessment Area for the preferred alignment.

However, one species, *Pultenaea parviflora*, was recorded within the alternative options assessed for Rising Pipeline 3 on the southern side of Camberwell Road**.** Approximately four individuals are located within the area that was assessed but the population as a whole extends beyond this, consisting of at least 20 plants. The preferred alignment for Rising Pipeline 3 runs along O'Connell and Otago Streets, Therefore, the nearby population of *Pultenea parviflora* on Camberwell Road will not be impacted by the Proposal.

Two populations of *Grevillea juniperina* were also identified along Camberwell Road, just outside of the Field Assessment Area. Approximately four plants occurred on the northern side of the road and more than 20 plants extended into the bushland along the southern side. As above for this species, although Camberwell Road was assessed as a potential alignment option in initial surveys, the preferred alignment for Rising Pipeline 3 now runs along O'Connell and Otago Streets. This species will not be impacted by the Proposal.

i. Pultenaea parviflora

Pultenaea parviflora is a threatened pea-shrub that is endemic to the Cumberland Plain. It is listed as an Endangered species under the TSC Act and as a Vulnerable species under the EPBC Act. This species is known to occur within Cooks River Castlereagh Ironbark Forest or Shale Gravel Transition Forest on laterised clays or tertiary alluvium and in open habitats.

The individuals found during this survey are likely to form part of a large population of over 500 individuals occurring within bushland off Camberwell Road[26]. Other important populations within the NWGC occur at the Marsden Park North Precinct, the Air Services Australia site at Shanes Park and an area adjacent to the Colebee Precinct[26].

ii. Grevillea juniperina subsp. juniperina

G. juniperina ssp*. juniperina* is a dense, spreading shrub that can reach up to 1.5 metres tall. It is listed as a Vulnerable species under the TSC Act. It generally persists on roadsides as it has been cleared of much of its original distribution and is known from the

area bounded by St Marys, Londonderry and Prospect, in and adjacent to the NWGC. The species occurs on laterised clays derived from Wianamatta Shale and Tertiary Alluvium and is thus associated with Cumberland Plain Woodland, Castlereagh Woodlands and alluvial woodlands.

Additional records for *Grevillea juniperina* ssp*. juniperina* were collected in the NWGC in an earlier study of the Riverstone area[38]. Two populations were recorded off Schofields Road, Schofields. One of these populations contains approximately 200 individuals and is located in a horse paddock in a grazed stand of Cumberland Plain Woodland. Approximately 17 individuals were recorded along the road reserve along Bandon Road approaching the Riverstone Wastewater Treatment Plant (WWTP) in Riverstone. These records are all located within certified areas.

Wildlife Atlas records for the species show that there is also a significant population at Shanes Park. A population is also known from Castlereagh Nature Reserve, which is north-west of, but close to the Shanes Park population.

4.3.2 Potential Threatened Flora in the Field Assessment Area

The following sections discuss the possible occurrence of additional threatened flora species that have the potential to occur in the Field Assessment Area based on available habitat, known distribution and previous records.

A summary of the likely occurrence of threatened flora species is provided in **Appendix B**. This summary considers a full list of species that have previously been recorded in the locality and those that are considered to have suitable habitat occurring there.

Other threatened flora species considered to have the potential to occur within the Field Assessment Area include the following species:

- *Acacia pubescens*
- *Dilwynia tenuifolia*
- *Marsdenia viridiflora* subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas
- *Micromyrtus minutiflora*
- *Persoonia nutans* (nodding Geebung)
- *Pimelea spicata* (Spiked Rice-flower)
- *Pultenaea pedunculata* (Matted Bush-pea)
- *Thesium australe* (Austral Toadflux)

i. Acacia pubescens

This threatened wattle is protected under the TSC and EPBC Acts as a Vulnerable species. This species grows to 5 metres in height and is identified by the long fine hairs on the foliage. It is known from the Hills Shire LGA and suitable habitat occurs within the Field Assessment Area. It is a conspicuous and easily identifiable species (although it is known to hybridise with *Acacia baileyana*, *Acacia cardiophylla* and other species) and was not recorded during field surveys. Therefore it is considered to have a low chance of occurring within the Field Assessment Area but has been included here for completeness.

ii. Dilwynia tenuifolia

D. tenuifolia is a low spreading pea-flower shrub to a metre high. It is listed as a Vulnerable species under both the TSC Act and the EPBC Act. The species typically occurs in habitat containing scrubby/dry heath and is associated with the vegetation communities of Castlereagh Ironbark Forest and Shale Gravel Transition Forest. Core habitat for the species is found on the Cumberland Plain.

There are approximately 35 known populations, including four large populations within the NWGC. This includes 300+ plants in the Riverstone precinct and 10,000+ individuals in Marsden Park North[26]. This species has the potential to occur in the Field Assessment Area and can be found in association with *P. parviflora.*

iii. Marsdenia viridiflora ssp. viridiflora

Marsdenia viridiflora ssp. *viridiflora* is a climber that grows in vine thickets and open shale woodlands. The species itself is not considered endangered and has a wide distribution in sub-coastal and southern Queensland[31]. However, the species occurs rarely in NSW and the population within the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas is listed as an Endangered population under the TSC Act because it occurs as a disjunct population at the southern limit of its range[31].

In a study conducted by Cumberland Ecology in 2010[2] individuals from this population were identified in two locations in the NWGC in the Riverstone Precinct, with populations of 21 and 13 individuals respectively. The populations were found in disturbed Cumberland Plain Woodland and Shale Gravel Transition Forest. The proximity of the recent findings would suggest that individuals from this population also have the potential to occur within the Field Assessment Area.

iv. Micromyrtus minutiflora

Micromyrtus minutiflora is a slender spreading shrub to 2 m high. The species is listed as Vulnerable under the EPBC Act and Endangered under the TSC Act. The NWGC supports two important populations of the species: a population within the Marsden Park North

Precinct and one within the Air Services Australia site at Shanes Park[26]. Suitable habitat includes Ironbark Forest and Shale Gravel Transition Forest, and potential habitat for the species occurs within the Field Assessment Area.

v. Persoonia nutans

Persoonia nutans is an erect to spreading shrub to 2.5 m high. It is listed as Endangered under both the TSC and EPBC Acts. The species has a disjunct distribution with the majority of populations occurring to the west of the NWGC between Penrith and Windsor. Several smaller populations occur to the south, in the LGAs of Blacktown, Liverpool, Campbelltown and Bankstown. Although the species has not been previously recorded within the NWGC, it occurs in similar habitat to several species that have (including *Grevillea juniperina* and *Pultenaea parviflora*[26]. Therefore the species is considered to have the potential to occur in the Field Assessment Area.

vi. Pimelea spicata

Pimelea spicata is an erect/prostrate shrub to 50 cm tall. It is listed as Endangered under both the TSC and EPBC Acts. It was not detected in the Field Assessment Area and there are no records (post 1980) for this species within the NWGC. However, *Pimelea spicata* can be inconspicuous when not in flower and suitable habitat for this species exists within Cumberland Plain Woodland as well as Shale Gravel Transition Forest within the Field Assessment Area.

vii. Pultenaea pedunculata

Pultenaea pedunculata is a shrub that forms carpets 1m or more wide. It is listed as Endangered under the TSC Act. It has a very limited occurrence within the Sydney Basin Bioregion, being represented by three known populations on the Cumberland Plain to the south of the Field Assessment Area. However, the species is associated with Shale Gravel Transition Forest and therefore potential habitat for this species occurs in the Field Assessment Area. It is considered to have a low chance of occurrence here.

viii. Thesium australe

Thesium australe is a parasitic herb associated with *Themeda australis* (Kangaroo Grass). It is listed as Vulnerable under both the TSC and the EPBC Acts. It is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. No known records occur in the NWGC. However, because of its association with *T. australis* it has the potential to occur in vegetation containing *T. australis* within the Field Assessment Area.

4.3.3 Other Threatened Species within the NWGC and surrounds

A number of other threatened flora species that have been recorded in the NWGC or surrounds are considered unlikely to occur within the Field Assessment Area. These are discussed below:

i. Melaleuca deanei

Melaleuca deanei is a shrub to 3m high with fibrous-flaky bark and is listed as a Vulnerable species under both the TSC and EPBC Acts. A NSW Wildlife Atlas record for *Melaleuca deanei* exists in the Riverstone Precinct from 2007. However, this species typically grows in wet heath on sandstone and is mostly known from the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas. The occurrence of this species in the Field Assessment Area is unlikely.

ii. Other species

Other species that have Wildlife Atlas records in the NWGC, including *Darwinia biflora, Leucopogon fletcheri* ssp. *fletcheri, Persoonia hirsuta, Pimelea curviflora* var *curviflora, Pomaderris brunnea* and *Tetratheca glandulosa* occur infrequently and are largely sandstone / ridgetop species. Sandstone habitats do not occur within the Field Assessment Area.

4.4 Threatened Fauna

4.4.1 Fauna Habitats within the Field Assessment Area

Fauna habitats in the Field Assessment Area are limited to patches of trees along roadsides or amongst rural residential properties, riparian corridors and a few small farm dams.

Whilst most of the treed areas contain fairly weedy or mown understoreys, they still hold some value for fauna as they can continue to provide foraging resources for mobile species like birds and bats, particularly the larger mature trees retained on roadsides and along creek lines. Additionally, roadside/riparian remnants connect larger habitat areas by acting as “stepping stones” for wildlife movement.

Riparian corridors generally occur as eroded creeks within farmland and therefore provide limited habitat for fauna. These creeks provide suitable habitat for a range of amphibians, aquatic reptiles and to a limited extent, wetland birds. However, they are highly disturbed, with most occurring within grazing paddocks on private property.

One larger patch of woodland occurs around Loftus and Sydney Streets which comprises Cumberland Plain Woodland transitioning into Shale Gravel Transition Forest at the

western end of Sydney Street. Although this patch occurs amongst rural residential properties and suffers some disturbance, it remains fairly structurally intact and provides suitable habitat for a number of threatened woodland birds and bats as well as the Cumberland Plain Land Snail. This area is zoned environmental conservation in the Indicative Layout Plan for Riverstone. The preferred alignment for this area involves underboring to minimise impacts to threatened vegetation communities. Therefore minimal vegetation clearance will be required here (three small pits approximately 3m x6m – refer to **Figure D.2** in Appendix D) and fauna habitat will be largely unchanged).

Little suitable habitat occurs for amphibians within the Field Assessment Area with dams and waterbodies generally being avoided during the design process. However some small drainage lines would provide habitat for amphibians, as well as the creekline at Wastewater Pipeline L7 (near Junction Road) where the Field Assessment Area traverses it. Parts of the surrounding area may provide habitat for the Green and Golden Bell Frog. This is discussed below in section 4.4.3ii.

4.4.2 Critical Habitat

No critical habitats are listed at either state or commonwealth level within the Field Assessment Area.

4.4.3 Potential for Threatened Fauna to Occur in the Field Assessment Area

Threatened fauna surveys were based on habitat assessments. The following sections discuss the species that have the potential to occur in the Field Assessment Area based on available habitat and known distribution. A detailed list of the likely occurrence of threatened fauna species in the Field Assessment Area is provided in **Appendix B**.

i. Invertebrates

a. Cumberland Plain Land Snail

The Cumberland Plain Land Snail (*Meridolum corneovirens*) is listed as Endangered under the TSC Act. This species primarily inhabits Cumberland Plain and Castlereagh Woodlands. It also occurs in River Flat Eucalypt Forest, particularly where this lies adjacent to the other two preferred woodland communities. The Cumberland Plain Land Snail occurs throughout western Sydney, but is restricted to small and isolated populations within areas of suitable habitat. This species usually occurs under litter of bark, leaves and logs, or in loose soil around grass clumps. It occasionally shelters under rubbish.

The Cumberland Plain Land Snail can occur in disturbed habitat. As the species is difficult to detect through targeted surveys, its presence was assumed in all areas of potential habitat (Cumberland Plain Woodland, Shale Gravel Transition Forest and River Flat Eucalypt Forest). However, available evidence indicates that the species tends to be

absent from small, fragmented patches of vegetation and therefore the Field Assessment Area is unlikely to form primary habitat for this species[9].

ii. Amphibians

a. Green and Golden Bell Frog

During field surveys, the Common Eastern Froglet (*Crinia signifera*) was the only species recorded within the Field Assessment Area. Recent NSW Wildlife Atlas records do occur for the Green and Golden Bell Frog from the Riverstone area however and are likely to refer to a known extant population located within private property there.

Very little suitable habitat for the Green and Golden Bell Frog occurs within the Field Assessment Area, with pipeline corridors generally avoiding water bodies. At Wastewater Pipeline L7 (near Junction Road) however, where the pipeline is being re-aligned (re-alignment D – see **Figure 4.2**) the new route impacts on a small area of artificial waterway that may provide some habitat for this species. The water body is generally open with planted Casuarinas along the banks and therefore is not optimal habitat for the Green and Golden Bell Frog. However, dumped piles of rubble and long grass do occur nearby within the Field Assessment Area which would provide suitable foraging, shelter and potentially sub-optimal breeding habitat for this species in the wetter months (the site was waterlogged at the time of survey following heavy rain). Whilst the lack of emergent vegetation does reduce the potential of the site being used for breeding, suitable mitigation measures should be undertaken prior to and during construction to minimise any potential impacts on Green and Golden Bell Frogs in this area. Mitigation measures are discussed in Chapter 6.

iii. Nectivorous Birds

The Swift Parrot and the Regent Honeyeater are both listed as endangered under the EPBC Act. The Swift Parrot is also listed as endangered under the TSC Act and the Regent Honeyeater as Critically Endangered. OEH Wildlife Atlas records[12] indicate that both the Swift Parrot and Regent Honeyeater are known to occur in the locality of the Field Assessment Area.

The Swift Parrot is a winter migrant, with records in the area usually restricted to between May and October. The Regent Honeyeater has been known to occur in both winter and summer months. Both bird species are primarily blossom feeders, although they are also known to feed on lerps.

The Field Assessment Area provides foraging habitat for both species. However, this is expected to be minimal considering the wide areas that the species cover, the linear and patchy nature of the woodland vegetation within the Field Assessment Area and the availability of suitable habitat for these species across large areas of NSW.

The Swift Parrot breeds in Tasmania. Two known breeding locations are known in NSW for the Regent Honeyeater, at Capertee Valley and Bundarra-Barraba regions. The Field Assessment Area is unlikely to provide breeding habitat for this species.

Habitat assessment indicates that the Field Assessment Area provides suitable habitat for two additional nectivorous species. These are:

- Little Lorikeet (*Glossopsitta pusilla*) – listed as Vulnerable under the TSC Act
- Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*) – listed as Vulnerable under the TSC Act

Foraging habitat requirements for these two species are the same as for the Regent Honeyeater and Swift Parrot. In addition, the Little Lorikeet also relies on small tree hollows as suitable nesting habitat.

iv. Woodland Birds

Eight TSC Act listed threatened forest or woodland dependant birds are known to occur in the NWGC. These are:

- Gang-gang Cockatoo (*Callocephalon fimbriatum*) listed as Vulnerable under the TSC Act
- Glossy Black-cockatoo (*Calyptorhynchus lathami*) - listed as Vulnerable under the TSC Act
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) - listed as Vulnerable under the TSC Act
- Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*) - listed as Vulnerable under the TSC Act
- Scarlet Robin (*Petroica boodang*)- listed as Vulnerable under the TSC Act
- Speckled Warbler (*Pyrrholaemus sagittatus*) - listed as Vulnerable under the TSC Act
- Diamond Firetail (*Stagonopleura guttata*) - listed as Vulnerable under the TSC Act
- Varied Sittella *(Daphoenositta chrysoptera)* listed as Vulnerable under the TSC Act

Suitable foraging and roosting (and in some cases nesting) habitat occurs within the Field Assessment Area for all these species, although it is fairly marginal. The Gang-gang Cockatoo nests at higher altitudes in sub-alpine or tall wet montane forests. Limited foraging (*Allocasuarina /Casuarina* seeds) and nesting (mature tree hollows) resources occur for the Glossy Black-cockatoo.

v. Wetland Birds

Two threatened wetland birds have been recorded in the NWGC since 1980:

- Blue-billed Duck (*Oxyura australis*) - listed as Vulnerable under the TSC Act
- Australasian Bittern (*Botaurus poiciloptilus)* - listed as Endangered under the TSC Act.

Very few records of these species occur within the NWGC. Both species prefer vegetated freshwater wetlands, the Blue-billed Duck favouring large, deep, permanent waterbodies whilst the Australasian Bittern requires tall dense emergent vegetation to shelter in. Neither of these habitats occurs within the Field Assessment Area and these species are considered unlikely to occur here.

vi. Raptors and Owls

Six threatened diurnal raptors and owls are considered to have the potential to occur in suitable habitat within the Field Assessment Area. These are:

- Spotted Harrier (*Circus assimilis*) - listed as Vulnerable under the TSC Act
- Little Eagle (*Hieraaetus morphnoides*): listed as Vulnerable under the TSC Act
- Square-tailed Kite (*Lophoictinia isura*) - listed as Vulnerable under the TSC Act
- Powerful Owl (*Ninox strenua*) - listed as Vulnerable under the TSC Act
- Barking Owl (*Ninox connivens*) - listed as Vulnerable under the TSC Act
- Masked Owl (*Tyto novaehollandiae*) - listed as Vulnerable under the TSC Act

Raptors and owls have large home ranges to meet their foraging needs. In addition they require large trees to provide suitable nesting habitat, and in the case of owls, large tree hollows and dense vegetation in forests/woodlands to provide suitable breeding and diurnal roosting habitat. The Field Assessment Area is unlikely to provide breeding or roosting habitat for these species because suitable forest and woodland vegetation generally occurs in small isolated patches along creeklines and roadsides. However, larger patches of forest and woodland occur in the locality, and the Field Assessment Area could form part of a wider foraging area for these species.

vii. Microchiropteran Bats

The following species have been recorded within or in proximity to the Field Assessment Area during previous ecological surveys or from NSW Wildlife Atlas records:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) - listed as Vulnerable under the TSC Act
- Eastern Freetail-bat (*Mormopterus norfolkensis*) - listed as Vulnerable under the TSC Act
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) - listed as Vulnerable under the TSC Act
- Southern Myotis (*Myotis macropus*) - listed as Vulnerable under the TSC Act
- Large-eared Pied Bat (*Chalinolobus dwyeri*) - listed as Vulnerable under the TSC Act and the EPBC Act
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) - listed as Vulnerable under the TSC Act
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) - listed as Vulnerable under the TSC Act
- Little Bentwing-bat (*Miniopterus australis*) - listed as Vulnerable under the TSC Act

These species are wide-ranging and all of them are likely to forage wherever forest and woodland vegetation occur. Suitable roosting habitat also occurs in remnant mature stands of vegetation for the hollow-dependant Eastern Freetail-bat, Eastern False Pipistrelle and the Yellow-bellied Sheathtail Bat.

The Southern Myotis roosts close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, bridges and in dense foliage. It forages over open water, preying on insects and small fish taken from the water surface. Suitable roosting and foraging habitat for this species occurs across the NWGC - in forest and woodland communities and man-made structures, and wetlands and waterbodies. This includes parts of the Field Assessment Area.

The Large-eared Pied Bat is known to occur in the wider locality of the NWGC. This species is mainly found in areas with extensive cliffs and caves, and in well-timbered areas containing gullies. These habitats do not occur within the Field Assessment Area. Considering the availability of more relevant habitat elsewhere, it is unlikely that the Field Assessment Area would provide roosting, breeding, or anything more than very occasional foraging habitat for this species.

The Greater Broad-nosed Bat is known to forage in a range of forest and woodland habitats though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. The large size and direct flight pattern of this species indicates a preference for foraging in open forest-woodland communities and along creeklines. The Field Assessment Area would provide foraging habitat for this species and potentially, limited roosting opportunities.

There is no suitable roosting or breeding habitat present for the cave-dependant Eastern Bentwing-bat or the Little Bentwing-bat. This species also roosts in man-made structures and based on the location of previous records may forage across the site on occasion.

viii. Megachiropteran bats

a. Grey-headed Flying-fox

The Grey-headed Flying-fox is listed as Vulnerable under both the TSC Act and the EPBC Act. It is known to occur throughout the wider locality of the NWGC. Foraging occurs in a variety of habitats including closed forests, open forest and woodland, and trees within urban and agricultural surroundings. Roosting and breeding sites for the Grey-headed Flying-fox occur in large, easily detectable colonies.

Suitable foraging habitat for this species occurs throughout the wider locality of the NWGC wherever blossoming and fruiting trees occur. The forest and woodland communities within the Field Assessment Area provide suitable foraging habitat for this species. No roosting or breeding colonies occur.

ix. Other mammals

a. Koala

The Koala (*Phascolarctos cinereus*) is listed as Vulnerable under the TSC Act and it is cited as a "rare resident" in South West Sydney by OEH[10].

Koala habitat is addressed in State Environmental Planning Policy (SEPP) No. 44 – Koala Habitat Protection. SEPP 44 aims to encourage the proper conservation and management of natural vegetation that provides habitat for koalas to ensure a permanent free-living population over their present range.

One record of a koala scat was recorded in the NSW Wildlife Atlas database[12] in 2006 within the Blacktown LGA. The record does not occur within the vicinity of the Field Assessment Area. Blacktown LGA is not listed under Schedule 1 of SEPP 44 and therefore this SEPP does not apply to the Blacktown area.

In general, the habitat values of the Field Assessment Area consist of cleared land on farms or private property with small, linear patches of woodland scattered along creek-lines and roadsides. Suitable foraging habitat occurs within the Field Assessment Area of the Blacktown LGA in the form of Forest Red Gum (*Eucalyptus tereticornis*) although it is fairly patchily distributed due to previous clearing activities. No signs of koala activity (scats, scratches, individual animals) were recorded during fauna habitat surveys and no previous records occur within the Field Assessment Area. Therefore it is considered unlikely that the Koala would occur here. Featherdale Wildlife Park is located in the Blacktown LGA and the 2006 record is potentially a result of one of the koalas dispersing

from the park. As the species is considered unlikely to occur within the Field Assessment Area, it is not considered further in this report.

x. Migratory Fauna

In the NWGC a further eight EPBC listed migratory fauna species have been recorded or have the potential to occur. These include:

- Latham's Snipe (*Gallinago hardwickii*)
- Fork-tailed Swift (*Apus pacificus*)
- Cattle Egret (*Ardea ibis*)
- White-throated Needletail (*Hirundapus caudacutus*)
- Rainbow Bee-eater (*Merops ornatus*)
- Rufous Fantail (*Rhipidura rufifrons*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Satin Flycatcher (*Myiagra cyanoleuca)*

Due to the migratory nature of these species, they are unlikely to be dependent on the habitats occurring within Field Assessment Area but may occasionally forage within or above them. Suitable foraging habitat for these species also occurs throughout the wider locality.

Coordinate System: MGA Zone 56 (GDA 94)

Grid North

OLD HAWKESBURY RD
KILLARNEY CHAIN OF PONDS
WALLACE RD
CHAPMAN RD
ST JAMES RD
SP1154 Option D
Realignment A
Realignment B
BANDON RD
WINDSOR RD
O'CONNELL ST
CAMBERWELL RD
OTAGO ST
Realignment C
Rising Pipeline 3
HAMILTON ST
VICTORIA ST
PRINCES ST
GRANTHAM ST
WILLIAM ST
WW L4-6
WELLINGTON ST
Water Pipeline
WW L7
SYDNEY ST
Realignment D
BRISBANE RD
PICCADILLY ST
EDWARD ST
RIVERSTONE PDE
LOFTUS ST
Boring Pit
HOBART ST
WW L4-6
CROWN ST
EDMUND ST
JUNCTION RD
GARFIELD RD EAST

Legend

- Field Assessment Area
- Certified Land
- Waterways

Vegetation Community

- Cumberland Plain Woodland (TSC Act)
- Cumberland Plain Woodland (EPBC Act)
- Shale Gravel Transition Forest (TSC Act)
- Shale Gravel Transition Forest (EPBC Act)
- River Flat Eucalypt Forest (TSC Act)

Threatened Species

Current Survey

- *Grevillea juniperina*
- *Pultenaea parviflora*

CUMBERLAND ECOLOGY

I:\...\9094\Figures\First Release Precinct-Riverstone\Report Figures_20111206

Figure 4.1. VEGETATION COMMUNITIES AND THREATENED SPECIES IN THE FIELD ASSESSMENT AREA AND SURROUNDS

250 0 250 500 750 1000 m

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Field Assessment Area
- Rivers

Pipelines to be assessed

- Wastewater pipeline realignment
- New wastewater pipeline
- Potential Green and Golden Bell Frog Habitat

Grid North

CUMBERLAND ECOLOGY

I:\...\9094\Figures\First Release Precinct-Riverstone\Report Figures 20110701\Figure 4.2.pdf

Figure 4.2. POTENTIAL GREEN AND GOLDEN BELL FROG HABITAT OCCURRING WITHIN THE FIELD ASSESSMENT AREA

25 0 25 50 75 100 m

Impact Assessment

5.1 Chapter Layout and Considerations

The impacts of the Proposal can be divided into direct and indirect impacts that will occur during varying stages of the Proposal. The direct impacts entail vegetation clearance during construction and are discussed in Section 5.3 below. These sections also discuss the impacts of the Proposal upon endangered ecological communities. The indirect impacts include potential impacts both during and after construction such as run-off, severance of wildlife corridors and weed invasion. Indirect impacts are discussed in Section 5.4. The Proposal will have impacts upon a range of threatened species, and these are covered in Sections 5.3.3 and 5.3.4.

Potential impacts on ecology will be minimised and avoided where possible during detailed design of alignments and infrastructure sites for the Proposal. During this process, a number of important measures to reduce or avoid triggering Key Threatening Processes (KTPs) and other potential impacts will be incorporated into the Proposal design. Recommended mitigation measures are discussed in Chapter 6.

5.2 Impact Assessment Approach

5.2.1 Pipeline Corridors

Detailed field survey has been undertaken in the Field Assessment Area. The survey assessed 20 metre-wide buffers along each proposed pipeline corridor (10m either side).

To calculate direct impacts to vegetation, a corridor width of 10m of vegetation removal (5m either side of the centre-line of each proposed pipeline) has been assumed along each corridor. This is the maximum width of vegetation removal that will be required along any pipeline route, and is considered to more than adequately reflect the maximum amount of vegetation removal likely to result from the Proposal, even if minor adjustments to the route are made within the Field Assessment Area. A number of options were assessed for this proposal. The impacts of the preferred options are discussed below. A breakdown of potential impacts to all areas assessed is provided in Appendix E, **Tables E.6** and **E.7**.

5.2.2 Infrastructure sites

A number of sites were assessed along Chapman Road in determining the location for SP1154 (refer to **Figure D.3 in Appendix E**). Option D has been chosen as the preferred alignment and for the pusposes of this report, it has been assumed that all vegetation within the site (0.4ha) will require removal.

5.2.3 Maximum Direct Impact Zone

The above assumptions are considered to represent the worse case scenario in terms of potential vegetation removal within the Field Assessment Area, with the actual impacts likely to be far less than this. The area identified using these methods is therefore referred to as the 'maximum direct impact zone' in the remainder of this report.

5.3 Direct Impacts

A number of Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act and/or the EPBC Act have the potential to directly impact on the Proposal Area. These are:

- Clearing of native vegetation
- Removal of dead wood and dead trees
- Loss of hollow-bearing trees
- Bushrock removal

5.3.1 Removal of Native Vegetation

Construction of infrastructure will require the removal of native vegetation. Within the Field Assessment Area, all native vegetation communities are listed as threatened ecological communities under either the TSC and/or EPBC Acts.

The results for each pipeline carrier and infrastructure site are shown individually in **Appendix E**. A summary of the maximum direct impacts on vegetation communities for the preferred alignments is provided in **Table 5.1** below.

Table 5.1 POTENTIAL DIRECT IMPACT OF THE PROPOSAL ON ENDANGERED ECOLOGICAL COMMUNITIES IN THE FIELD ASSESSMENT AREA (HA)

Vegetation Community	Non-Certified	Certified	Total
Cumberland Plain Woodland (EPBC listed)	0.22	0.10	0.32
Cumberland Plain Woodland (TSC listed – additional to above)*	0.13	0.11	0.25
Shale Gravel Transition Forest (EPBC listed)	0.00	0.18	0.18
Shale Gravel Transition Forest (TSC listed – additional to above)*	0.00	0.01	0.01
River Flat Eucalypt Forest	0.32	0.00	0.32
Total	**0.67**	**0.41**	**1.08**

**Notes: All EPBC Act listed Cumberland Plain Woodland (CPW) and Shale Gravel Transition Forest (SGTF) also qualify as the TSC Act listed communities. TSC Act listed communities include low condition vegetation that do not meet the condition criteria to conform to this community under the EPBC Act.*

All numbers rounded to two decimal places

The Field Assessment Area incorporates 2.35 ha of EEC vegetation. Within this area, 1.08 ha occurs within the maximum direct impact zone.

i. Direct Loss of TSC Act listed Vegetation Communities

Maximum direct loss of native vegetation under the TSC Act includes up to 0.57 ha of TSC Act listed Cumberland Plain Woodland, 0.19 ha of Shale Gravel Transition Forest and 0.32 ha of River Flat Eucalypt Forest (including 0.04 ha removed as a result of pipeline realignment – see Section 5.3.6 below).

0.41 ha of this vegetation occurs within certified land and 0.67 ha occurs within non-certified areas of the Growth Centres. However, not all of this vegetation meets the minimum condition criteria (including canopy cover, connectivity and patch size) of 'existing native vegetation' as defined under the Growth Centres Biodiversity Certification Order[9]. The implications of this are discussed in Section 5.3.2 below and Chapter 7, which covers offsetting requirements for the Proposal.

ii. Direct loss of EPBC Act listed vegetation Communities

Maximum direct loss of EPBC Act listed native vegetation communities includes 0.5 ha of Cumberland Plain Shales Woodland and Shale Gravel Transition Forest that meets the condition criteria for this community under the EPBC Act.

5.3.2 Direct Impacts on Existing Native Vegetation

Some of the vegetation within the Field Assessment Area occurs as small isolated patches and does not conform to the definition of ENV in the Biodiversity Certification Order. **Table 5.2** below illustrates the amount of ENV (as measured by field survey) that could be lost as a result of the Proposal. According to the Biodiversity Certification Order, only impacts to ENV in non-certified areas must be offset.

Table 5.2 EXISTING NATIVE VEGETATION WITHIN THE DIRECT IMPACT ZONE

Vegetation Community	Non-Certified ENV	Certified ENV	TOTAL
Cumberland Plain Woodland (EPBC Listed)	0.22	0.10	0.32
Cumberland Plain Woodland (TSC Listed - additional to above)*	0.13	0.10	0.23
Shale Gravel Transition Forest (EPBC Listed)	0.00	0.18	0.18
Shale Gravel Transition Forest (TSC Listed - additional to above)*	0.00	0.01	0.01
River Flat Eucalypt Forest	0.32	0.00	0.32
TOTAL	**0.67**	**0.39**	**1.06**

Note: all numbers rounded to two decimal places

5.3.3 Loss of Fauna Habitat Elements

The clearing of vegetation for construction will also impact directly on fauna habitat elements. Relevant KTPs include:

- Clearing of native vegetation
- Removal of dead wood and dead trees
- Loss of hollow-bearing trees
- Bush rock removal.

Fauna species have the potential to be directly affected by the Proposal through habitat loss and modification. Fauna habitat types occurring within the Field Assessment Area include remnant canopy trees and small linear patches of woodland along roadsides, and largely cleared riparian vegetation corridors. As such, fauna resources are likely to include occasional hollow-bearing trees, as well as fallen timber and leaf litter, flowering eucalypts, small patches of dense understorey vegetation, open grassland, and creeks and drainage lines. As these areas generally occur on flats adjacent to roads or creeks, little bushrock occurs within the Field Assessment Area.

Fauna habitats within roadside areas to be cleared are extremely limited and much of the land has been previously cleared. Very few hollow-bearing trees occur and generally the understorey is mown or weedy. However, remnant roadside trees can provide nesting and sheltering opportunities for a range of fauna species including threatened fauna.

Fauna habitats along creek-lines vary from negligible (cleared and eroded banks) to small patches of closed canopy forest with some native understorey remaining. The understorey is generally dominated by weeds but can still provide nesting and shelter habitat for small birds, mammals and reptiles. Leaf litter also provides microhabitat for reptiles and insects.

As the Proposal requires a narrow corridor of direct impact (10m), impacts on fauna from direct loss or modification of habitat in general are likely to be minimal as adjacent vegetation would provide similar sheltering and nesting opportunities. The exception is the loss of hollow-bearing trees, where hollow-dwelling fauna may be reliant on a particular hollow for breeding, nesting or sheltering purposes. This is particularly relevant in areas such as the Cumberland Plain where extensive clearing of remnant woodland has resulted in the significant loss of mature and hollow-bearing trees across the landscape.

Few significant hollow-bearing trees were detected in the Field Assessment Area. However, scattered hollow-bearing trees do provide habitat for hollow-dwelling fauna. Mitigation measures for addressing these impacts are discussed in Chapter 6.

5.3.4 Impacts on Threatened Fauna

The Proposal has the potential to result in the removal of up to 1.06 ha of native woodland vegetation. This will result in a minor loss of potential foraging, roosting and breeding habitat for all fauna species associated with these communities, including a number of threatened fauna species (EPBC Act and TSC Act) known to occur in the locality of the Field Assessment Area.

Areas that do not comprise native vegetation generally occur as exotic grassland or shrubs which would provide minor foraging and sheltering opportunities for common fauna as they tend to occur in the most disturbed areas. These habitats occur throughout Riverstone and the wider area.

Habitat for the Cumberland Plain Land Snail is considered to be marginal across most of the Field Assessment Area due to the highly disturbed nature of much of the site. However, the vegetation within the conservation area adjacent to Sydney Street is likely to provide suitable habitat for this species and therefore mitigation measures will need to be employed when clearing small patches of vegetation here, to ensure that impacts to this species are minimised.

Impacts on the Green and Golden Bell Frog as a result of the re-alignment of Wastewater Pipeline L7 are likely to be negligible. The implementation of mitigation measures listed in Chapter 6 to minimise impacts to the Green and Golden Bell Frog at this site is considered

sufficient to deal with any potential impacts to this species and no further offsets are considered necessary.

The potential impacts on threatened fauna species are outlined in **Table 5.3**.

TABLE 5.3 POTENTIAL DIRECT IMPACTS ON THREATENED FAUNA IN THE FIELD ASSESSMENT AREA

Threatened Fauna Group	Species Within This Group	Potential Impacts Under The Proposed Development
Invertebrates		
TSC Act	Cumberland Plain Land Snail	Loss of up to 1.08 ha of forest/woodland/scattered roadside trees providing suitable (often marginal) habitat for this species.
Amphibians		
EPBC Act & TSC Act	Green and Golden Bell Frog	Minimal loss of potential foraging, sheltering and sub-optimal breeding habitat near Junction Road at Wastewater Pipeline L7.
Nectivorous birds		
EPBC Act & TSC Act	Swift Parrot, Regent Honeyeater	Loss of up to 1.08 ha of forest/woodland/scattered roadside trees providing suitable foraging habitat. Loss of very marginal potential breeding habitat for some species.
TSC Act	Black-chinned Honeyeater, Little Lorikeet	
Aerial birds		
EPBC Act - migratory	White-throated Needletail, Fork-tailed Swift	Loss of up to 1.08 ha of forest/woodland/scattered roadside trees and patches of exotic grassland providing suitable foraging habitat.
Woodland birds		
EPBC Act - migratory	Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail, Satin Flycatcher.	Loss of up to 1.08 ha of forest/woodland/scattered roadside trees providing potential foraging (and in some cases nesting) habitat.
TSC Act	Glossy Black Cockatoo, Gang-gang Cockatoo, Brown Treecreeper, Speckled Warbler, Diamond Firetail, Hooded Robin, Scarlet Robin, Varied Sittella.	
Wetland birds		

TABLE 5.3 POTENTIAL DIRECT IMPACTS ON THREATENED FAUNA IN THE FIELD ASSESSMENT AREA		
Threatened Fauna Group	**Species Within This Group**	**Potential Impacts Under The Proposed Development**
EPBC Act- migratory	Cattle Egret, Latham's Snipe	Minimal loss of artificial wetland foraging habitat near Junction Road. The Cattle Egret also forages in open paddocks, some of which will be cleared for the Proposal.
TSC Act	Australasian Bittern, Blue-billed Duck,	
Raptors and owls		
TSC Act	Little Eagle, Square-tailed Kite, Spotted Harrier, Powerful Owl, Masked Owl, Barking Owl	Loss of up to 1.08 ha of forest/woodland/scattered roadside trees and patches of exotic grassland providing potential foraging and nesting habitat.
Microchiropteran bats		
EPBC Act & TSC Act	Large-eared Pied Bat	Loss of up to 1.08 ha of forest/woodland/scattered roadside trees providing potential foraging habitat. Potential loss of wooded roosting habitat for hollow-dependant species (including loss of trees that have yet to produce hollows but which could develop hollows in the long term).
TSC Act	Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bentwing-bat, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat, Little Bent-wing Bat, Southern Myotis	
Megachiropteran bats		
EPBC Act and TSC Act	Grey-headed Flying-fox	Loss of up to 1.08 ha of forest/woodland/scattered roadside trees providing potential foraging habitat. No suitable roosting or breeding habitat present.

As noted above, most of this vegetation occurs as scattered roadside patches or largely cleared creek-line vegetation and the loss of small linear patches of vegetation is not expected to have a significant impact on any of the threatened fauna species listed above, particularly as most of these species are wide-ranging and better quality habitat occurs elsewhere in the locality, including in areas protected for conservation.

5.3.5 Impacts on Threatened Flora

i. Threatened flora occurring within the Field Asseessment Area

No threatened plants were detected within the Field Assessment Area for the preferred alignment options.

ii. Potential habitat for threatened flora within the Field Assessment Area

The Proposal will involve removing up to 1.08 ha of potential woodland habitat for threatened plants, which generally follows roadsides or occurs as narrow linear remnant vegetation along disturbed creeklines. The condition of these areas is typically low and heavily impacted by weeds, soil modification and dumping. The Field Assessment Area is not known to provide key habitat for any of these species and is not considered to be important to their long-term survival. A number of conservation reserves occur nearby that provide good quality potential habitat for these species, and in some cases, support important populations (including sites at Marsden Park North, Colebee, the Air Services Australia site at Shane's Park, Castlereagh Nature Reserve, Windsor Downs Nature Reserve and Scheyville National Park (refer to **Table 5.4** below). No significant impact is therefore predicted on any threatened plant species as a result of the Proposal.

Table 5.4 summarises the potential impacts on threatened flora.

Table 5.4 POTENTIAL DIRECT IMPACTS ON THREATENED FLORA

Scientific Name	Common Name	Status		Habitat	Potential Impacts under the Proposed Development
		TSC Act	EPBC Act		
Acacia pubescens	Downy wattle	V	V	Gravelly clay or sandy soils on alluviums, shales and at the interface between shales and sandstone	Key potential habitat occurs in Cumberland Plain Woodland and Shale Gravel Transition Forest[26]. Loss of up to 0.76 ha of suitable habitat generally occuring as small disturbed patches. No known individuals are to be cleared and core population occurs outside of the NWGC. Therefore this species is not expected to be impacted by the Proposal.
Dillwynia tenuifolia		V	V	Scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest. May also occur in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland	Shale Gravel Transition Forest provides key habitat for this species. Loss of up to 0.19 ha of suitable habitat generally occuring as small disturbed patches. Also known to occur in association with *Grevillea juniperina* ssp. *juniperina,* therefore other marginal habitat may be lost in woodland areas. Not detected during field survey and key habitat for this species is being retained nearby in conservation reserves (including at Marsden Park North and the Air Services Australia site at Shane's Park). Therefore the Proposal is considered unlikely to cause a significant impact to the species.
Grevillea juniperina ssp. *juniperina*	Juniper-leaved Grevillea	V		Cumberland Plain Woodland, Castlereagh Woodlands and alluvial woodlands on laterised clays derived from Wianamatta Shale and tertiary alluvium	Potential to occur in all woodland areas in the Field Assessment Area. Loss of up to 1.08 ha of suitable habitat generally occuring as small disturbed patches. No plants detected within the Field Assessment Area during survey. Individuals identified as lying just outside are unlikely to be affected by the proposal. Key habitat for this species is being retained nearby in conservation reserves (including a significant

Table 5.4 POTENTIAL DIRECT IMPACTS ON THREATENED FLORA

Scientific Name	Common Name	Status		Habitat	Potential Impacts under the Proposed Development
		TSC Act	EPBC Act		
					population at Shane's Park). Therefore the Proposal is considered unlikely to cause a significant impact to the species
Marsdenia viridiflora ssp. *viridiflora* Blacktown and Penrith LGAs		EP		Vine thickets and open shale woodlands.	Loss of up to 0.76 ha of Cumberland Plain Woodland and Shale Gravel Transition Forest generally occuring as small disturbed patches. Not detected during field survey and suitable habitat for this species is being retained nearby in conservation reserves containing Cumberland Plain Woodland and Shale Gravel Transition Forest. Therefore the Proposal is considered unlikely to cause a significant impact to the species.
Micromyrtus minutiflora		E	V	Restricted to the general area between Richmond and Penrith, western Sydney. The distribution of this species overlaps with the distribution of *Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest*.	Loss of up to 0.76 ha of Cumberland Plain Woodland and Shale Gravel Transition Forest providing suitable habitat for this species. No individuals detected during survey. The species is well represented in large populations in the NWGC (including a large population at Shanes Park in the Marsden Park Precinct). Therefore the Proposal is considered unlikely to cause a significant impact to the species.
Persoonia nutans	Nodding Geebung	E	E	Associated with dry woodland, Castlereagh Scribbly Gum Woodland, Agnes Banks Woodland, Shale Gravel Transition	Loss of up to 0.19 ha of Shale Gravel Transition Forest providing key habitat for this species. No individuals detected during survey. Key habitat for this species is being retained nearby in conservation reserves, particularly at the Air Services Australia site at Marsden Park. Therefore the Proposal is

Table 5.4 POTENTIAL DIRECT IMPACTS ON THREATENED FLORA

Scientific Name	Common Name	Status		Habitat	Potential Impacts under the Proposed Development
		TSC Act	EPBC Act		
				Forest and Castlereagh Ironbark Forest.	considered unlikely to cause a significant impact to the species.
Pimelea spicata	Spiked Rice-flower	E	E	Woodlands and grasslands of *Eucalyptus moluccana* (Grey Box), *E. crebra* (narrow-leaved ironbark), *E. tereticornis* (Forest Redgum), *Bursaria spinosa* (Blackthorn) and *Themeda australis* (Kangaroo Grass	Loss of up to 0.76 ha of Cumberland Plain Woodland and Shale Gravel Transition Forest. No individuals were detected within the Field Assessment Area and due to the linear nature of the project, it is unlikely to provide optimum suitable habitat. Although it is noted that the species is cryptic when not in flower, the majority of the species distribution lies outside of the NWGC boundary. Offsetting Cumberland Plain Woodland and Shale Gravel Transition Forest will result in offsetting potential habitat for this species. Therefore the Proposal is considered unlikely to cause a significant impact to the species.
Pultenaea parviflora		E	V	Cooks River Castlereagh Ironbark Forest or Shale Gravel Transition Forest on laterised clays or tertiary alluvium and in open habitats	Loss of up to 0.19 ha of Shale Gravel Transition Forest providing suitable habitat for this species. Key populations occur nearby in areas that are being set aside for conservation. The species is well represented within the wider NWGC, particularly at Shanes Park off Stony Creek Road. Therefore the Proposal is considered unlikely to cause a significant impact to the species.
Pultenaea pedunculata		E		Shale Gravel Transition Forest in the Wianamatta Shale - Tertiary alluvium intergrade areas	Loss of up to 0.19 ha of Shale Gravel Transition Forest providing potential habitat for this species. However, no known individuals are to be cleared and the core population occurs south of the NWGC. Therefore the Proposal is considered unlikely to cause a significant impact to the species
Thesium-	Austral	V	V	Occurs in	Widespread but rare across NSW. Not

Table 5.4 POTENTIAL DIRECT IMPACTS ON THREATENED FLORA					
Scientific Name	**Common Name**	**Status**		**Habitat**	**Potential Impacts under the Proposed Development**
		TSC Act	**EPBC Act**		
australe	Toadflax			grassland or grassy woodland. A parasitic herb associated with *Themeda australis.*	previously recorded in the NWGC. Potential to occur in the Field Assessment Area where the native grass *T. Australis* is present. Unlikely to be significantly impacted by Proposal.

5.3.6 Comparison of Direct Impacts to those outlined in the previously approved Environmental Assessment

i. Partial re-alignment of Existing Corridors

The Environmental Assessment for water-related services for First Release Precincts was approved in November 2008. With minor pipeline alignment changes (re-alignments a-d Chain of Ponds Creek Carrier), the new alignments will result in an additional 0.27 ha of River Flat Eucalypt Forest and 0.01 ha of Cumberland Plain Woodland to be directly impacted by the Proposal (refer to **Table E.2** in **Appendix E**). This is not considered to be significant, particularly as these areas occur as small scattered patches in highly disturbed areas subject to weed infestation and dumping.

The partial re-alignment of pipeline corridors is therefore not considered to alter the findings of the previous flora and fauna impact assessment that determined that no significant impact would occur as a result of the Proposal. However, the loss of this vegetation will need to be offset along with the offsets required for additional pipeline and infrastructure sites. This is discussed in Chapter 7.

ii. Additional Corridors/Infrastructure

The additional infrastructure for this Proposal will result in the further loss of up to 0.8 ha of EEC vegetation (additional to above) occurring as scattered patches across the Field Assessment Area. **Tables E.1** and **E.2** in **Appendix E** show the breakdown of vegetation loss by carrier /infrastructure site and illustrate the scattered nature of the vegetation to be removed. 1.06 ha of this vegetation (including the 0.28 ha noted above) qualifies as ENV under the Biodiversity Certification Order (refer to **Tables E.3** and **E.4** in **Appendix E**)

0.39 ha of which occurs in Certified areas and is being offset as part of the Biodiversity Certification Order.

The loss of up to 0.67 ha of ENV occurring in non-certified areas is not considered to cause a significant impact to those vegetation communities, particularly as this vegetation will be offset elsewhere within the Growth Centres in areas protected for long-term conservation. Section 5.7 at the end of this chapter discusses the significance of the direct and indirect impacts of the Proposal on threatened vegetation communities and threatened flora and fauna.

iii. TSC Act Assessments

Whilst 7-part Tests (Assessments of Significance) are not required for Part 3A projects, these were undertaken for all TSC Act listed threatened flora and fauna as part of the original EA assessment in order to ensure that all impacts had been assessed in detail. No significant changes to impacts have been detected during the current assessment as a result of the amendments to the approved EA. Therefore the 7-part Tests completed for the original EA are still considered applicable to all relevant TSC Act list threatened flora and fauna species.

5.3.7 Impacts on Matters of National Environmental Significance

Matters of National Environmental Significance (MNES) are not currently covered by the Biodiversity Certification Order. Impacts on EPBC Act listed species and communities are summarised below and include the loss of:

- Up to 0.5 ha of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest
- Up to 1.08 ha of potential woodland habitat (mostly marginal) for EPBC Act listed woodland dependent birds and bats
- Up to 1.08 ha of potential woodland habitat (mostly marginal) for EPBC Act listed threatened plants
- Minimal loss of potential foraging, sheltering and sub-optimal breeding habitat near Junction Road at Wastewater Pipeline L7 for the Green and Golden Bell Frog and potential foraging habitat for the Cattle Egret and Latham's Snipe

Assessments of Significance have been conducted for these species and community in **Appendix C** of this report. The assessments conclude that no significant impact will occur on MNES as a result of the Proposal. However, due to the presence of a critically endangered ecological community on site and habitat (albeit marginal) for the Green and Golden Bell Frog, it is recommended that a conservative approach is undertaken and the

Proposal is referred to the Commonwealth for an independent assessment of impacts to MNES.

5.4 Indirect Impacts

Broadly, the indirect impacts of the Proposal include increased fragmentation of existing remnant vegetation, which may increase the degradation of habitat for woodland birds and threatened plants through edge effects, and increase the degree of isolation of individual remnant patches. Relevant KTPs that could contribute to indirect impacts on the Proposal Area include:

- Invasion and establishment of weeds (various species including exotic perennial grasses)
- Invasion and establishment of fauna pest species (rabbits and foxes)
- Alteration of the natural flow regimes of rivers, streams, floodplains and wetlands
- Clearing of native vegetation (leading to habitat fragmentation and barrier effects)
- Loss of hollow-bearing trees (leading to increased isolation of hollow-dependent fauna).
- Infection of native plants by *Phytophthora cinnamomi*

Impacts not listed as KTPs but with the potential to indirectly affect flora and fauna include:

- Infection of Myrtaceae plants by *Uredo rangelii* (Myrtle Rust)
- Cumulative impacts.

These are considered in more detail below.

5.4.1 Weed infestation and the establishment of pest species and pathogens

Edge effects resulting from habitat disturbance and fragmentation can include increased susceptibility to infection (such as infection of native plants by the fungus *Phytophthora cinnamoni*), weed invasion and feral animal invasion.

Habitat fragmentation and associated edge effects reduce the availability and quality of refugia for native fauna and increase feral animal access to resources, thus increasing the risk of predation and competition for resources for native fauna by rabbits, foxes and feral cats.

A number of noxious weeds and listed exotic species occur within the Growth Centres and these have the potential to spread, through disturbance activities and the introduction of weed seed to less disturbed areas. All of the Field Assessment Area has been subject to previous disturbance, most of it suffering fairly high levels of disturbance and therefore it is not expected that construction activities will significantly increase weed levels. However, appropriate mitigation measures should be implemented to minimise the spread of exotic species and pathogenic fungi during construction and post construction works.

5.4.2 Alteration to the natural flow regimes of rivers, streams floodplains and wetlands

The Proposal has the potential to impact on the natural flow regimes of rivers and streams where pipeline corridors need to cross creek-lines. The aquatic impacts of the Proposal are being assessed separately to this report. In terms of construction works in riparian areas affecting the natural flow regimes of rivers, streams, floodplains and wetlands, there is likely to be little impact as the majority of sites for infrastructure are relatively dry and well drained and mitigation measures will be put in place to minimise run-off and siltation.

5.4.3 Habitat fragmentation, barrier effects and increased isolation

The Field Assessment Area occurs in a largely cleared landscape with patches of native vegetation occurring in amongst farmland and rural residential properties. The Proposal will result in the clearing or partial clearing of some of these patches, which although generally have minimal wildlife value in themselves, may provide stepping stone habitat between larger areas of better quality vegetation. Further fragmentation of these areas will increase separation between remaining vegetation patches which could have implications for fauna dispersing between treed areas.

Many of the wider ranging threatened fauna would not be impacted by the disappearance of small patches of woodland, as they tend to prefer less disturbed habitats for nesting and roosting, and other better quality foraging habitat occurs in the general vicinity. The Cumberland Land Snail could be locally affected by the removal of patches of woodland increasing habitat fragmentation and creating a barrier to movement. Habitat fragmentation also has the potential to impact upon the viability of some native plants within forest and woodland patches as fragmentation can reduce the success of pollination and gene flow, and can also reduce the size of some populations or subpopulations. However, no threatened plant species were found within the Field Assessment Area and fragmentation is very unlikely to affect gene flow of any significant species.

As well as direct impacts to native fauna, the potential loss of hollow-bearing trees could further isolate fauna species that are dependent on hollows for roosting or nesting. This can lead to increased isolation of local populations, which in turn, can result in genetic inbreeding and/or extinction of local populations. In the case of this Proposal however, the loss of hollow-bearing trees is unlikely to have a significant indirect impact on threatened fauna as the majority of the Field Assessment Area occurs as narrow linear strips

throughout the landscape and few significant hollow-bearing trees occur. Methods to further mitigate the impact from the loss of hollow-bearing trees are discussed in Chapter 6.

5.5 Impacts to Vegetation covered under RBM 12 of the Biodiversity Certification Order

The Biodiversity Certification Order includes maps showing areas of land (marked with red hatching) where Existing Native Vegetation (ENV) should not be cleared unless it is in accordance with a plan of management or unless such clearance has been agreed to by the OEH. RBM 12 of the Biodiversity Certification Order covers this condition and includes part of the Field Assessment Area adjacent to Sydney Street (refer to **Figure 5.2**) which is zoned Environmental Conservation under the Riverstone Indicative Layout Plan.

Field survey identified Cumberland Plain Woodland transitioning into Shale Gravel Transition Forest in this area. The woodland was fairly structurally intact and despite large amounts of dumping in some parts, was considered to be in fairly good condition.

Sydney Water proposes to underbore the zoned conservation area in order to minimise potential direct impacts here. Therefore impacts will be limited to the clearing of three 6m x 3m drill pad areas in order to facilitate this process.

A small area of River Flat Eucalypt Forest and Shale Gravel Transition Forest (approximately 0.05 ha) also occurs within the zoned conservation area along Edmund Street. This vegetation is severely weed infested.

Additional mitigation measures have been recommended for the area zoned for conservation (refer to Chapter 6) in order to minimise impacts both during and after construction. This includes preparation of a management plan that incorporates the requirements of RBM 12, to be submitted to OEH, which describes how impacts will be minimised prior to and during construction and how the Field Assessment Area will be rehabilitated post-construction, as per the original EA, including restoration of relevant pipeline corridors.

5.6 Cumulative Impacts

The Proposal forms part of the strategic development of the Growth Centres over the next 30 years to provide over 180,000 new homes in the area to house Sydney's growing population. As such, the purpose of the Proposal is to create infrastructure that provides drinking water and wastewater facilities to the first release precincts of the NWGC.

The landscape of the Growth Centres will be subject to significant change over the next 30-50 years, with much of the certified areas being developed for other infrastructure,

housing, industrial and community service needs. This is likely to have a considerable cumulative impact on biodiversity in the wider area of Western Sydney.

Cumulative impacts to flora and fauna caused by the development of the Growth Centres as a whole have already been considered by the NSW Government as part of the regional assessment of the Growth Centres land[21,27]. Appropriate offsets for cumulative impacts on vegetation in certified areas have been calculated on a regional basis as part of this process and are outlined in the Biodiversity Certification Order[9].

Residual impacts of the Proposal in non-certified areas will need to be further offset. Suitable sites within the Growth Centres will need to be chosen in consultation with OEH and DP&I. Chapter 7 provides further details of offset approaches.

5.7 Significance of Impacts

This section discusses the significance of the impacts of the Proposal in relation to the conservation importance of the habitat, individuals and populations that are likely to be affected. The Part 3A Guidelines for Impact Assessment[4] note that impacts will be more significant if:

- areas of high conservation value are affected
- individual animals and/or plants and/or subpopulations that are likely to be affected by the proposal play an important role in maintaining the long-term viability of the species, population or ecological community
- habitat features that are likely to be affected by the proposal play an important role in maintaining the long-term viability of the species, population or ecological community
- the duration of impacts are long-term
- the impacts are permanent and irreversible

Whilst threatened vegetation communities are to be removed as part of the Proposal, the vegetation in the Field Assessment Area suffers from weed infestation and is highly disturbed. Therefore, whilst the loss of threatened vegetation communities may be considered to be significant, particularly in relation to critically endangered vegetation communities, the fact that they occur as small patches of vegetation in a rural residential (soon to become urban) landscape, limits their conservation significance and the role that they might play in the preservation of threatened species associated with them. Offsetting of this vegetation in protected areas will help to conserve large remnant patches of these vegetation communities in-perpetuity.

An area of better quality woodland occurs adjacent to Sydney Street, which is zoned environmental conservation and will be retained and protected in the long-term. Small

areas of this woodland will require clearing to facilitate underboring through this area (refer to Section 5.5 above). Mitigation measures to further minimise impacts in this area are discussed in Chapter 6 (including post-construction weeding and re-planting as per the original EA and Statement of Commitments) and are considered sufficient to address the impacts to this vegetation that will occur as a result of the Proposal.

No significant impact is predicted on threatened flora or fauna as a result of the Proposal. The species that is most likely to be impacted by the Proposal is the Cumberland Plain Land Snail and individuals may be lost through vegetation clearance in some areas. Again, as the vegetation to be cleared does not involve the removal of large remnant patches, the impact on the Cumberland Land Snail is not likely to be significant and any lost individuals would be unlikely to play an important role in maintaining the long-term viability of this species.

No habitat features that are likely to be affected by the Proposal are considered likely to play an important role in maintaining the long-term viability of the vegetation communities affected by the proposal or the potential habitat for threatened species.

Direct impacts to vegetation will be long-term and irreversible in most areas, due to the nature of ongoing management requirements for pipelines. However, the significance of this in terms of the long-term conservation goals of the region is low, as these areas will be offset in protected areas in line with regional conservation goals.

A number of areas nearby are being retained for conservation and include important habitat for threatened vegetation communities and/or threatened species. This includes two sites at Cranebrook and Colebee which have been purchased by OEH and between them hold several populations of threatened plant species including important populations of *P. Parviflora*, *D. tenuifolia* and *M. minutiflora* and potential habitat for several other species, as well as the Air Services Australia site at Shanes Park, Castlereagh Nature Reserve, Windsor Downs Nature Reserve and Scheyville National Park. As intact areas of bushland, these areas also provide suitable habitat for threatened woodland birds and bats and in some areas, the Cumberland Plain Land Snail. Therefore the significance of impacts of the removal of vegetation within the Field Assessment Area is expected to be low. The following chapter outlines methods that should be undertaken to minimise impacts and Chapter 7 discusses offsets considered suitable to ensure a net positive gain for conservation.

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Field Assessment Area
- Certified Land
- Waterways

Vegetation Community

- Cumberland Plain Woodland (TSC Act)
- Cumberland Plain Woodland (EPBC Act)
- Shale Gravel Transition Forest (TSC Act)
- River Flat Eucalypt Forest (TSC Act)

N
Grid North

CUMBERLAND ECOLOGY

I:\...\9094\Figures\First Release Precinct-Riverstone\Report Figures_20111216\

Figure 5.1. NON-CERTIFIED EXISTING NATIVE VEGETATION IN THE FIELD ASSESSMENT AREA

250 0 250 500 750 1000 m

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Field Assessment Area
- Certified Land
- Waterways

Vegetation Community

- Cumberland Plain Woodland (TSC Act)
- Cumberland Plain Woodland (EPBC Act)
- Shale Gravel Transition Forest (TSC Act)
- Shale Gravel Transition Forest (EPBC Act)
- River Flat Eucalypt Forest (TSC Act)
- Area Zoned for Conservation to which RMB 12 applies

N
Grid North

CUMBERLAND ECOLOGY

I:\...\19094\Figures\First Release Precinct-Riverstone\Report Figures_20111216\

Figure 5.2. LAND TO WHICH RBM 12 APPLIES

250 0 250 500 750 1000 m

Mitigation Measures

6.1 Mitigation Strategies

A suite of mitigation strategies were recommended in the Flora and Fauna Assesssment[39] submitted as part of the Environmental Assessment which has now been approved. The relevant recommended mitigation strategies are outlined below:

The extent of vegetation clearing should be restricted to the minimum necessary for the safe undertaking of the project.

The pipeline alignment selected should be one that minimises the damage to native vegetation, particularly where an Endangered Ecological Community has been identified. Not only should mature trees be protected, areas of intact native groundcovers and shrubs should also be protected where possible.

Prior to the works being undertaken within the Study Area, it is recommended that any suitable logs and ground debris material (including to top 10 cm of the topsoil) be collected and stored on site. This material should be incorporated into the remediation of the site post development. Relocation of this material will provide suitable sheltering sites for the Cumberland Plain Land Snail populations that are potentially present within this area.

Where creek lines are encountered, the pipeline should be bored under these. Launch and exit pads should be sighted in adjacent cleared land.

Where boring is not an option, an alignment should be selected that results in the pipeline being placed within areas that have been previously cleared or are lightly timbered.

**In instances where the trench is to be left open over night it is recommended that a qualified ecologist be engaged to check for any captured animals. Species such as frogs, reptiles and ground traversing mammals are known to get caught in open trenches. The ecologist should be present to check the trench prior to its filling thereby preventing the entombment of any species.*

**Similarly, in instances where trenches are to be left open overnight, measures should be implemented to provide any captured animals with shelter and protection from predator species (i.e. the placement of sand bags, sheltering sites).*

Habitat trees (i.e. hollow-bearing) or potential habitat trees (i.e. large, mature eucalypts) that occur in close proximity to the proposed works area should be clearly marked on site to ensure they are not directly affected by the works.

Works undertaken in the vicinity of any of the marked habitat trees should consider the potential for the trenching to affect these plants primary and secondary roots. At these locations, an arboriculturalist should be engaged to appropriately manage those trees that occur adjacent to the project.

Where possible, an alignment for the pipeline should be established that negates the clearing of any hollow-bearing trees.

Prior to their removal, any hollow-bearing tree proposed for clearing should be checked for any sheltering animals. Methods that should be used when checking these trees will depend on the technique adopted by the contractor to fell these plants. Once the felling method is determined, consultation with a qualified ecologist should be entered into to determine the most appropriate technique to check for any sheltering native species, thereby preventing/reducing the extent of impact on these animals.

Thorough weed control should be undertaken through the area of direct impact prior to the commencement of works.

If possible, noxious and keystone environmental weeds on directly adjoining land should also be controlled. Land ownership will vary: requiring liaison and a co-operative approach between stakeholders. Note that noxious weed control is the legal responsibility of the landowner.

Protect Grevillea juniperina ssp juniperina clumps and individuals from adverse impacts wherever possible, including indirect impacts such as sediment laden run-off, alterations to run-off patterns. No works should be undertaken within five (5) metres of this population.

Exclusion fencing should be erected around stands of Grevillea juniperina ssp juniperina at least three (3) metres away from the threatened plants and maintained in place until such time as construction works are completed.

Manual digging should be undertaken in the vicinity of the threatened Grevillea rather than machinery excavations if digging is required within three (3) metres of these plants.

Ensure soil levels following trenching in the vicinity of Grevillea juniperina ssp juniperina are as similar as possible to current levels to avoid any alterations to runoff patterns.

All workers required to work in the vicinity of the Grevillea juniperina individuals are to be inducted to the site, and made aware of its location and significance. Wherever possible, works adjacent to these individuals should be carefully supervised.

Exclusion fencing should be erected to identify the boundaries of all native vegetation communities (bushland) to be retained and protected. These fences are to be maintained in good order for the duration of the construction works.

Storage areas, construction sheds and access routes should be sited only in areas that contain no or minimum native vegetation. All such structures are to be kept away from trees to be protected.

Trees to be retained within the construction corridor (or directly adjacent) are to be protected by the erection of wooden tree shields and by exclusion fencing erected at the outside canopy line.

Appropriate soil and water management plans are to be set in place and adhered to. These safeguards are to be monitored and maintained as required.

Appropriate machine hygiene should also be adhered to. Any machinery used in a weed infested sections of bushland should be thoroughly cleaned prior to its use in relatively weed-free areas.

Topsoil excavated from weed-free areas and designated for re-use should be stored in a manner that allows the separation of weed-free topsoil from native timbers and brush cleared from the site.

Replace topsoil following the completion of works. Topsoil replacement should be undertaken in a manner that considers the soil type (and consequently vegetation community that it supports) when choosing the location of distribution.

Cut timbers and brush are to be stockpiled in windrows which do not exceed one (1) metre in height. Stockpiles should not be kept for more than 60 days (if possible) as seed will drop from the brush if left too long (especially in hot weather).

Reserved timbers and cut (native) brush is to be replaced over the restored topsoil to provide a seed source for natural regeneration (note time factor for storage), provide habitat for native fauna, protect exposed topsoil from scour and wash.

Weedy topsoil (or polluted soils) should be scraped (or scalped) to a depth of at least 10 centimetres and removed off-site to a designated landfill site. Weedy topsoil should not be reserved.

Regular weed control should be undertaken on all impacted land subsequent to pipeline works, and this should continue for a period of at least 12 months, particularly in areas identified as endangered ecological communities. However, it is considered impractical to control Privet in currently heavily infested areas due to the expected rapid reinfestation rate from directly adjacent areas. Such areas should be subject to a site-specific restoration strategy, which is separately funded.

It is expected that much of the land within the Study Area has sufficient resilience to adequately regenerate naturally and that planting is not likely to be required following works. However, where natural regeneration is sparse or slow to occur an indigenous planting program may be required.

If a planting program is required, only locally indigenous plants should be used to improve soil stability and provide potential foraging and nesting resources for native fauna species.

If there is any degree of flexibility within the construction program, clearing of native vegetation along the proposed pipeline route should not be undertaken in the spring bird-nesting season.

Where the removal of mature hollow-bearing trees is necessary, these should be cleared outside of the Powerful Owl's breeding season (i.e. June – September)[39].

In general, the mitigation measures proposed in the approved environmental assessment are considered appropriate and sufficient to mitigate impacts arising from works associated with the amended proposal. Several additional mitigation measures are also recommended below to deal with impacts relating to specific areas within the amended Proposal area.

6.1.1 Additional Mitigation Measures

i. Green and Golden Bell Frog

A number of the above items deal with mitigation measures to minimise impacts to amphibians and other fauna that may become entrapped in open trenches overnight. Additionally, it is recommended that any pipes left on site are capped/covered overnight to prevent fauna from sheltering in them. A suitably qualified ecologist should carry out a pre-clearance survey in the Wastewater Pipeline L7 area immediately before any clearance works take place. A methodology for this, including standard measures to prevent the spread of Chytrid Fungus, should be included in the Flora and Fauna Management Plan required under the Conditions of Approval for the project (Condition 6.2)[25].

ii. Area zoned for Environmental Conservation

The area zoned for environmental conservation adjacent to Sydney Street is required to be subject to a Plan of Management to be approved by OEH prior to any clearance works taking place, in line with RBM 12 of the Biodiversity Certification Order. The plan of management should consider available practical options for minimising impacts in this area (i.e. boring or taking the line of least environmental impact as Sydney Water has elected to do) and outline specific measures to further mitigate impacts following construction, including weed control and re-planting. This information will be included in the environmental management plan for the Proposal as outlined in the Statement of Commitments.

6.2 Recommended Measures to Compensate for Impacts

The Proposal will result in some impacts that cannot be addressed using the mitigation measures outlined above and offset measures will be required to compensate for these impacts.

Offsets for the approved Environmental Assessment have already been agreed with OEH and secured. The amendments outlined in this report require additional offsets to compensate for the loss of threatened vegetation communities and potential threatened species habitat.

Offsets must be calculated and secured in line with the RBMs of the Biodiversity Certification Order. As discussed in Section 2.3.2 of this report, this entails the offsetting of existing native vegetation in non-certified areas. **Table 5.2** in Chapter 5 shows that 0.67 ha of non-certified ENV occurs within the maximum direct impact zone of the Field Assessment Area and therefore this amount of vegetation will need to be retained and protected elsewhere within the Growth Centres.

This Proposal impacts on Matters of National Environmental Significance listed under the EPBC Act, which are not currently covered by the Biodiversity Certification Order. As such the Proposal is likely to be required to be referred to the commonwealth government.. However, a referral may not be required if approval is granted for the Strategic Assessment currently underway.

Recommended Offset Requirements

7.1 Recommended Offset Requirements

7.1.1 Offsetting Existing Native Vegetation

The Proposal will result in some impacts that cannot be addressed using the mitigation measures outlined above and offset measures will be required to compensate for these impacts.

Offsets for the approved Environmental Assessment have already been agreed with OEH and secured. The amendments outlined in this report require additional offsets to compensate for the loss of threatened vegetation communities and potential threatened species habitat. Offsets must be calculated and secured in line with the RBMs of the Biodiversity Certification Order.

RBM 8 of the Biodiversity Certification Order states that the protection of an equal or greater area of ENV within the Growth Centres is required to offset that which is being cleared, or revegetation/restoration of vegetation is required at a ratio of 3:1 to that which is being cleared. 0.67 ha of native vegetation to be directly impacted by the Proposal occurs as ENV within non-certified areas of the NWGC. This means that to adequately offset the impacts of the Proposal on biodiversity in non certified areas, at least 0.67 ha of vegetation that meets the required condition criteria outlined in the RBMs would need to be protected, or 2.01 ha of land would be required to be restored or revegetated. Suitable sites for offsetting will need to be agreed with DP&I and OEH.

7.1.2 Threatened Species Offsets

The impacts of the Proposal are unlikely to cause significant impacts to any listed threatened species under either the TSC Act or the EPBC Act as discussed previously in this report. The mitigation measures outlined here are considered sufficient to ensure an 'improve or maintain' outcome for threatened species and the retention and protection of 0.67 ha of good quality woodland habitat will also contribute towards conserving habitat for these species.

7.1.3 Commonwealth Government Offsetting Principles

Potentially significant impacts on Matters of National Environmental Significance (MNES) that are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) currently require referral to SEWPaC for an independent assessment of impacts on MNES and additional suitable offsets may be required to compensate for these.

The NSW State Government is currently undertaking a Strategic Assessment of the Growth Centres with the support of the Commonwealth Government. This Strategic Assessment assesses the impacts of the development of the Growth Centres on MNES[26]. If the Strategic Assessment is endorsed by the Commonwealth Government, it will remove the requirement for a separate assessment and approval under the EPBC Act for areas within the Growth Centres that are covered by Biodiversity Certification. It is unclear at this stage how the Strategic Assessment will affect requirements for Commonwealth offsets.

Conclusions and Recommendations

8.1 Loss of Vegetation Communities

The Field Assessment Area is located largely within the Riverstone Precinct and incorporates 2.35 ha of native vegetation, all of which comprise EECs.

The maximum direct loss of TSC Act listed native vegetation that would occur as a result of the Proposal includes up to 0.57 ha of Cumberland Plain Woodland, 0.19 ha of Shale Gravel Transition Forest and 0.32 ha of River Flat Eucalypt Forest, totalling 1.08 ha. This incorporates 0.5 ha of the EPBC Act listed community Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest.

The native vegetation that occurs within the Field Assessment Area consists of patches of re-growth and remnant vegetation amongst cleared land. Most of the re-growth vegetation is highly disturbed and the areas of remnant vegetation to be removed generally occur as small scattered patches. Mitigation measures that will be undertaken as part of the Proposal, such as placing pipelines outside areas of native vegetation where possible, and re-planting/rehabilitation in relevant areas, will help to reduce impacts on threatened vegetation communities.

Due to their size and condition, some of the patches of vegetation occurring within the Field Assessment Area do not meet the definition of ENV provided in the Growth Centres Biodiversity Certification Order and therefore do not require offsetting.

Appropriate offsets will need to be provided for ENV in non-certified areas which includes offsets for up to 0.67 ha of ENV. As such, a significant impact is not predicted on any of the vegetation communities as a result of the Proposal. The mitigation measures and offsetting requirements are expected to achieve an 'improve or maintain' outcome for the conservation of these communities and species in the long-term.

8.1.1 Threatened Flora

No threatened plants were detected within the Field Assessment Area and due to the linear nature of the Proposal, impacts to potential habitat for threatened plants are considered to be minimal. Suitable habitat for the following threatened plant species/populations does occur:

- *Acacia pubescens*
- *Dilwynia tenuifolia*
- *Grevillea juniperina* ssp*. juniperina*
- *Marsdenia viridiflora* subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas
- *Micromyrtus minutiflora*
- *Persoonia nutans* (nodding Geebung)
- *Pimelea spicata* (Spiked Rice-flower)
- *Pultenaea parviflora*
- *Pultenaea pedunculata* (Matted Bush-pea)
- *Thesium australe* (Austral Toadflux)

However, much of the Field Assessment Area is highly disturbed and suitable habitat for these species is considered to be marginal. Good quality habitat for these species is being provided elsewhere as part of the Growth Centres Biodiversity Certification Order. This includes nearby sites at Cranebrook, Shanes Park and the Air Services Australia site in Colebee. No significant impacts to threatened flora with the potential to occur within the Field Assessment Area are therefore expected. Even so, it is recommended that Sydney Water avoids areas of native vegetation where possible during the detailed design phase, notwithstanding other design requirements such as hydrology and engineering constraints.

No significant impact is considered likely to occur on threatened plant species or populations in the Field Assessment Area as a result of the Proposal.

8.1.2 Threatened Fauna

Suitable habitat for a number of threatened fauna species occurs within the Field Assessment Area. This includes wide ranging species such as birds and bats. The Field Assessment Area is likely to provide no more than occasional foraging habitat for species such as these because of its disturbed and fragmented nature and the fact that larger, more suitable tracts of vegetation occur nearby such as at Castlereagh Nature Reserve, Windsor Down Nature Reserve and Scheyville National Park.

Very few hollow-bearing or old-growth trees occur within the Field Assessment Area but their scarcity across the western Sydney landscape makes them a significant fauna habitat resource. Hollow-bearing trees should be avoided where at all possible. Where this is not possible, suitable fauna clearance protocols must be followed to minimise the risks to native fauna.

Individuals of the Cumberland Plain Land Snail may be lost as a result of the Proposal. However, although it is restricted to the Cumberland Plain, a significant impact on this species is not expected as the Field Assessment Area does not generally provide optimal habitat for the Land Snail.

Whilst known from the NWGC, the Green and Golden Bell Frog is generally considered to have a low chance of occurring within the Field Assessment Area due to the lack of suitable breeding, shelter and foraging habitat and the occurrence of more suitable habitat elsewhere in Riverstone. Where suitable habitat does exist in the Field Assessment Area, the mitigation measures outlined in this report are considered adequate to deal with any potential minor impacts to individuals of the species during the construction phase.

8.2 Cumulative impacts

The impacts of vegetation and habitat loss in the Field Assessment Area as a result of this Proposal cannot be considered in isolation and the cumulative effects of the development of the Growth Centres (which will result in large losses of native vegetation (including critically endangered communities) needs to be taken into account. Biodiversity Certification of the Growth Centres addresses the loss of threatened vegetation communities across the Growth Centres on a regional scale and incorporates offsetting these losses in large protected areas that can be conserved in the long-term. If passed, the Strategic Assessment of the Growth Centres by the Commonwealth may result in further measures to offset EPBC Act listed species in conjunction with the State initiative.

8.3 Offsetting Impacts

Maximum direct loss of native vegetation for the Project includes up to 1.08 ha of TSC Act listed native vegetation. 0.41 ha of this vegetation occurs in certified areas and is being offset at State level through the Growth Centres Biodiversity Certification Order.

Of the remaining vegetation, 0.67 ha qualifies as ENV in non-certified areas and will need to be offset in accordance with the RBMs outlined in the Biodiversity Conservation Order. Offsets should be of equivalent or better conservation value to that which are to be cleared and should include consideration of habitat for threatened species such as the Cumberland Plain Land Snail.

Approximately 0.5 ha of EPBC Act listed vegetation occurs within the maximum direct impact zone that will be cleared as a result of the Proposal. The Strategic Assessment of the Growth Centres may result in Biodiversity Certification extending to EPBC Act listed species and communities. However, currently (as at December 2011) impacts to the community Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest will require a Referral to the Commonwealth Government to assess these impacts separately under the EPBC Act.

8.4 Significance of Impacts

Whilst there will be some unavoidable impacts to threatened vegetation communities as a result of the Proposal, measures taken to avoid, mitigate and compensate for impacts will result in an improve or maintain outcome for biodiversity values in the long-term by contributing towards securing large areas of protected native vegetation. As such, the Proposal is not likely to reduce the long-term viability of, or accelerate the extinction of, a local population of any threatened species, population or ecological community. No critical habitat will be affected by the Proposal.

The original Environmental Assessment regarding the provision of water-related services to the First Release Precincts of the NWGC has already been approved. The amendments to the approved EA are not considered to change the significance of any impacts to vegetation or threatened species. Therefore the 7-part Tests completed for the original EA are still considered applicable to all relevant TSC Act list threatened flora and fauna species. These concluded that no significant impact was predicted on any threatened vegetation communities, flora or fauna as a result of the proposal.

With the existing and additional mitigation measures, and suitable offsets provided, the amended proposal is considered likely to achieve an 'improve or maintain' outcome for EECs and threatened species.

References

1. Botanic Gardens Trust (2010) **PlantNET** http://www.rbgsyd.nsw.gov.au/search_plant_net *last accessed* 2010

2. Cumberland Ecology (2010) **Biodiversity Assessment for Water Related Services for the North West and South West Growth Centres** Prepared for Sydney Water

3. Cumberland Ecology (2010) **Revised Ecological Desktop Assessment and Sensitivity Mapping: Water Related Services for the North West and South West Growth Centres** Cumberalnd Ecology, Sydney.

4. DEC and DPI (2005) **Draft Guidelines for Threatened Species Assessment** Department of Environment and Conservation and Department of Primary Industries, Sydney.

5. DEC (NSW) (2004) **Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)** New South Wales Department of Environment and Conservation, Hurstville, NSW.

6. DEC (NSW) (2005) **Draft NSW and National Recovery Plan for *Persoonia nutans*** Department of Environment and Conservation, Hustville.

7. DEC (NSW) (2005) ***Micromyrtus minutiflora* - profile** Department of Environment and Conservation (NSW), Hurstville, NSW.

8. DEC (NSW) (2005) **Recovering bushland on the Cumberland Plain: Best Practice Guidelines for the Management and Restoration of Bushland** Department of Environment and Conservation (NSW), Sydney South.

9. DECC (2006) **Order to confer biodiversity certification on the State Environmental Planning Policy (Sydney Region Growth Centres)**

10. DECC (NSW) (2007) **Threatened and Pest Animals of Greater Southern Sydney** DECC, Sydney, NSW.

11. DECCW (2007) **Change in the distribution of Cumberland Plain Woodland** DECCW, Hurstville.

12. DECCW (2011) **Atlas of NSW Wildlife** http://wildlifeatlas.nationalparks.nsw.gov.au/wildlifeatlas/watlas.jsp *last accessed 2011*

13. Department of Environment and Conservation (NSW) **Persoonia nutans (Nodding**

Geebung) Recovery Plan Department of Environment and Conservation, Hurstville.

14. Department of Environment, Water Heritage and the Arts (2010) **Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest - SPRATS profile** Department of the Environment, Water, Heritage and the Arts, Canberra

15. DEWHA (2009) **EPBC Protected Matters Search Tool** http://www.environment.gov.au/erin/ert/epbc/index.html

16. DEWHA (2009) **Fork-tailed Swift** , Species Profile and Threats Database.

17. DEWHA (2009) ***Hirundapus caudacutus* White-throated Needletail in Species Profile and Threats Database** Department of the Environment, Water, Heritage and the Arts, Canberra, ACT.

18. DEWHA (2009) **Matters of National Environmental Significance - Significant Impact Guidelines 1.1** Environment Australia, Canberra, ACT.

19. DSEWPC (2011) ***Lathamus discolor in* Species Profile and Threats Database** Department of Sustainability, Environment, Water, Population and Communities, Canberra.

20. DSEWPC (2011) ***Merops ornatus* Rainbow Bee-eater in Species Profile and Threats Database** Department Sustainability, Environment, Water, Populations and Communities, Canberra.

21. Eco Logical Australia (2007) **Growth Centres Conservation Plan - Exhibition Draft** Growth Centres Commission, Parramatta, NSW.

22. Harden, G. J. (1990-1993) **Flora of NSW Volumes 1-4** New South Wales University Press, Kensington.

23. Hayes Environmental (2001) **Lot 4 DP 618451, Pioneer Place, Castle Hill - Proposed Residential Subdivision: Flora and Fauna Assessment** Hayes Environmental, Church Point.

24. Hazelton, P. A., Bannerman, S. M., and Tille, P. J. (1989) **Map accompanying Bannerman S.M. and Hazelton P.A. (1990) Soil Landscapes of Penrith 1: 100 000 sheet.** Soil Conservation of NSW, Sydney.

25. Minister for Planning (2008) **Conditions of Approval for the North West Growth Centre Water-related Services for First Relase Precincts** NSW Government Department of Planning

26. NSW Department of Planning (2010) **Sydney Growth Centres Strategic Assessment - Draft Assessment Report** NSW Department of Planning, Sydney.

27. NSW Government**State Environmental Planning Policy (Sydney Region Growth Centres).**

28. NSW NPWS (2002) **Native Vegetation Maps of the Cumberland Plain Western Sydney** NSW National Parks and Wildlife Service, Sydney.

29. NSW Scientific Committee (2002) **Cooks River/Castlereagh ironbark forest in the Sydney Basin Bioregion - endangered ecological community listing** NSW National Parks and Wildlife Service, Hurstville.

30. NSW Scientific Committee (2002) **Shale gravel transition forest in the Sydney Basin Bioregion - endangered ecological community listing** NSW National Parks and Wildlife Service, Hurstville.

31. NSW Scientific Committee (2003) ***Marsdenia viridiflora* R. Br subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas - endangered population listing** NSW National Parks and Wildlife Service, Hurstville.

32. NSW Scientific Committee (2004) **River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing** Department of Environment and Conservation (NSW), Hurstville, NSW.

33. NSW Scientific Committee (2009) **Cumberland Plain Woodland in the Sydney Basin Bioregion - critically endangered ecological community listing** Department of Environment, Climate Change and Water (NSW), Hurstville.

34. NSW Scientific Committee & C. C. Simpson (2008) **Change in the distribution of Cumberland Plain Woodland** DECCW, Hurstville, NSW.

35. SEWPaC**Green and Golden Bell Frog SPRATS Profile** Dept. of Sustainability, Environment, Water, Population and Communities.

36. Threatened Species Scientific Committee (2008) **Commonwealth Conservation Advice on *Micromyrtus minutiflora*** Canberra, Department of the Environment, Water, Heritage and the Arts

37. Tozer, M. (2003) **The Native Vegetation of the Cumberland Plain, western Sydney: Systematic classification and field identification of communities** *Cunninghamia* 8(1):1-75

38. UBM Ecological Constulants (2009) **Flora and Faua Assessment and vegetation Management Plan for Riverstone Sewage Treatment Plant**, Richmond, NSW.

39. Urban Bushland Management Consultants (2007) **Flora and Fauna Assessment: Riverstone Integrated Water Services Proposal** Prepared for Sydney Water Corporation Urban Bushland Management Consultants Pty Ltd, Castle Hill, NSW.

Appendix A

Field Data

A.1 FLORA RECORDED IN THE FIELD ASSESSMENT AREA

TABLE A.1 LIST OF PLANTS DETECTED IN THE FIELD ASSESSMENT AREA DURING RANDOM MEANDER SURVEYS

Family	Scientific Name	Common Name
Trees		
Casuarinaceae	*Allocasuarina littoralis*	Black She-oak
	Casuarina glauca	Swamp Oak
Fabaceae	**Acacia binervia*	Coast Myall
	A. paramattensis	Parramatta Wattle
Myrtaceae	*Angophora floribunda*	Rough-barked Apple
	Callistemon salignus	Willow Bottlebrush
	Eucalyptus amplifolia	Cabbage Gum
	E. crebra	Narrow-leaved Ironbark
	E. eugenioides	Thin-leaved Stringybark
	E. fibrosa	Broad-leaved Ironbark
	E. globoidea	White Stringybark
	E. moluccana	Grey Box
	E. tereticornis	Forest Red Gum
	Melaleuca decora	Feather Honey-myrtle
Oleaceae	**Ligustrum lucidum*	Large-leaved Privet
	**Olea europaea ssp cuspidata*	African Olive
Shrubs		
Asteraceae	*Cassinia arcuata*	Sifton Bush
	Ozothamnus diosmifolius	White Dogwood
Chenopodiaceae	*Maireana microphylla*	
Epacridaceae	*Lissanthe strigosa*	Peach Heath
Fabaceae	*Acacia falcata*	Sickle Wattle
	A. floribunda	Sally Wattle
	**A. sophorae*	Coast Wattle
	Daviesia ulicifolia	Gorse Bitter Pea
	Dillwynia sieberiana	Prickly Parrot Pea
	Jacksonia scoparia	
	Pultenaea parviflora	

TABLE A.1 LIST OF PLANTS DETECTED IN THE FIELD ASSESSMENT AREA DURING RANDOM MEANDER SURVEYS

Family	Scientific Name	Common Name
	P. villosa	
	**Senna pendula var glabrata*	Cassia
Myrtaceae	*Kunzea ambigua*	Tick Bush
	Melaleuca nodosa	Ball Honey-myrtle
Oleaceae	**Ligustrum sinense*	Small-leaved Privet
Pittosporaceae	*Bursaria spinosa*	Blackthorn
Proteaceae	*Grevillea juniperina ssp. juniperina*	Prickly Spider Flower
	**G. robusta sapling*	Silky Oak
Sapindaceae	*Dodonaea viscosa ssp cuneata*	
Solanaceae	**Cestrum parqui*	Yellow Cestrum
Verbenaceae	**Lantana camara*	Lantana
Herbs - Ferns	*Cheilanthes sieberi*	Rock Fern
Herbs - Dicots		
Apiaceae	*Centella asiatica*	Pennywort
Asteraceae	**Aster subulatus*	Wild Aster
	**Bidens pilosa*	Farmers Friends
	**B. subalternans*	
	Calotis cunaeata	Blue Burr-daisy
	C. lappulacea	Yellow Burr-daisy
	Chrysocephalum apiculatum	Yellow Buttons
	**Gnaphalium sp*	a Cudweed
	**Hypochaeris radicata*	Flatweed
	**Senecio madagascariensis*	Fireweed
	**Sonchus oleraceus*	Sow Thistle
Chenopodiaceae	*Einadia hastata*	
	E. nutans	
Clusiaceae	**Hypericum perforatum*	St Johns Wort
Convolvulaceae	*Dichondra repens*	Kidney Plant
Crassulaceae	**Bryophyllum delagoense*	Mother-of-millions
Euphorbiaceae	*Poranthera microphylla*	
Fabaceae	**Trifolium repens*	White Clover

TABLE A.1 LIST OF PLANTS DETECTED IN THE FIELD ASSESSMENT AREA DURING RANDOM MEANDER SURVEYS

Family	Scientific Name	Common Name
Gentianaceae	**Centaurium tenuifolium*	Centaury
Goodeniaceae	*Goodenia hederacea*	
Lamiaceae	*Mentha satureioides*	Native Mint
Lobeliaceae	*Pratia purpurascens*	Whiteroot
Malvaceae	**Modiola caroliniana*	
	**Sida rhombifolia*	Paddys Lucerne
Meliaceae	*Melia azedarach seedling*	White Cedar
Myoporaceae	*Eremophila debile*	Winter Apple
Oxalidaceae	*Oxalis perennans*	
Plantaginaceae	**Plantago lanceolata*	Lambs Tongue
Polygonaceae	*Persicaria decipiens*	
	**Rumex crispus*	Curled Dock
Primulaceae	**Anagallis arvensis*	
Verbenaceae	**Verbena spp.*	Purpletop
Herbs - Monocots		
Anthericaceae	*Arthropodium millieflorum*	Vanilla Lily
	Laxmannia gracilis	
Bambusaceae	**Bambusa sp.*	Bamboo
Commelinaceae	*Commelina cyanea*	Blue Wandering Jew
	**Tradescantia fluminensis*	Wandering Jew
Cyperaceae	**Cyperus sp.*	
Lomandraceae	*Lomandra filiformis ssp filiformis*	
	L. multiflora	Many-flowered Mat-rush
Phormiaceae	*Dianella revoluta*	Paroo Lily
Poaceae	**Andropogon virginicus*	Whisky Grass
	Aristida vagans	Three-awned Grass
	Austrostipa ramosissima	Bamboo Grass
	**Axonopus affinis*	Carpet Grass
	Bothriochloa decipiens	Pitted Blue Grass
	B. macra	Red Leg Grass
	**Briza subaristata*	
	**Bromus catharticus*	Prairie Grass

TABLE A.1 LIST OF PLANTS DETECTED IN THE FIELD ASSESSMENT AREA DURING RANDOM MEANDER SURVEYS

Family	Scientific Name	Common Name
	**Chloris gayana*	Rhodes Grass
	C. ventricosa	Windmill Grass
	Cymbopogon refracta	Barb-wire Grass
	**Cynodon dactylon*	Couch Grass
	Echinopogon caespitosus	Hedgehog Grass
	**Ehrharta erecta*	Veldt Grass
	Eragrostis brownii	Browns Love-grass
	**E. curvula*	African Love-grass
	E. leptostachya	Paddock Love-grass
	**Lolium perenne*	Perennial Rye
	Microlaena stipoides	Weeping Meadow-grass
	Paspalidium distans	
	**Paspalum dilatatum*	Paspalum
	**Pennisetum cladestinum*	Kikuyu
	**Setaria gracilis*	Slender Pigeon Grass
	Sporobolus creber	Rats Tail Grass
	Themeda australis	Kangaroo Grass
Vines		
Asclepiadaceae	**Araujia sericifera*	Moth Vine
Basellaceae	**Anredera cordifolia*	Madeira Vine
Fabaceae	*Glycine clandestina*	
	G. microphylla	
	Hardenbergia violacea	Purple Coral Pea
	**Vicia sativa*	Common Vetch
Rosaceae	***Rubus fruticosus*	Blackberry
Asparagaceae	**Asparagus asparagoides*	Bridal Veil Creeper
Mistletoe		
Loranthaceae	*Amyema gaudichaudii*	Paperbark Mistletoe

**indicates an introduced species*

***Indicates a noxious weed*

** = introduced species*

adj = species recorded within c.20 m of quadrat

Key

+ Rare (less than 1% cover)

1 Few Individuals (less than 5% cover)

2 5% - less than 25 % cover

3 25% - less than 50 % cover

4 50% - less than 75 % cover

5 75% – 100 % cover

Table A.2 QUADRAT DATA FOR QUADRAT UNDERTAKEN IN GRASSLAND AT RIVERSTONE STP			
Family	**Scientific Name**	**Common Name**	**Abundance score**
Shrubs			
Asteraceae	Ozothamnus diosmifolius	White Dogwood	adj
Chenopodiaceae	Maireana microphylla		adj
Fabaceae	Pultenaea villosa		adj
Myrtaceae	Eucalyptus tereticornis	Forest Red Gum saplings	1
Herbs - Ferns	Cheilanthes sieberi	Rock Fern	3
Herbs - Dicots			
Apiaceae	Centella asiatica	Pennywort	1
Asteraceae	Calotis cunaeata	Blue Burr-daisy	adj
	C. lappulacea	Yellow Burr-daisy	adj
	*Gnaphalium sp	a Cudweed	2
	*Hypochaeris radicata	Flatweed	3
	*Senecio madagascariensis	Fireweed	3
Chenopodiaceae	Einadia nutans		adj
Clusiaceae	*Hypericum perforatum	St Johns Wort	2
Gentianaceae	*Centaurium tenuifolium	Centaury	1
Goodeniaceae	Goodenia hederacea		3
Myoporaceae	Eremophila debile	Winter Apple	adj
Plantaginaceae	*Plantago lanceolata	Lambs Tongue	2
Herbs - Monocots			
Anthericaceae	Laxmannia gracilis		1
Lomandraceae	Lomandra filiformis ssp filiformis		adj
Poaceae	*Andropogon virginicus	Whisky Grass	2
	Aristida vagans	Three-awned Grass	4
	*Axonopus affinis	Carpet Grass	6
	Bothriochloa decipiens	Pitted Blue Grass	2
	*Briza subaristata		5

Table A.2 QUADRAT DATA FOR QUADRAT UNDERTAKEN IN GRASSLAND AT RIVERSTONE STP

Family	Scientific Name	Common Name	Abundance score
	Cymbopogon refracta	Barb-wire Grass	adj
	*Cynodon dactylon	Couch Grass	2
	Eragrostis brownii	Browns Love-grass	4
	*Paspalum dilatatum	Paspalum	2
	*Setaria gracilis	Slender Pigeon Grass	2
	Themeda australis	Kangaroo Grass	3

A.2 List of Fauna Species Observed During Survey

Table A.3 FAUNA RECORDED INCIDENTALLY WITHIN THE FIELD ASSESSMENT AREA

Family	Scientific Name	Common Name
AMPHIBIA		
ANURA		
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet
AVES		
ANSERIFORMES		
Anatidae	*Anas castanea*	Chestnut Teal
Anatidae	*Anas superciliosa*	Pacific Black Duck
PASSERIFORMES		
Maluridae	*Malurus cyaneus*	Superb Fairy-Wren
Meliphagidae	*Manorina melanocephala*	Noisy Miner
Artamidae	*Cracticus torquatus*	Grey Butcherbird
Artamidae	*Cracticus tibicen*	Australian Magpie
Artamidae	*Strepera graculina*	Pied Currawong
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail
Corvidae	*Corvus coronoides*	Australian Raven
Monarchidae	*Grallina cyanoleuca*	Magpie-lark
Timaliidae	*Zosterops lateralis*	Silvereye
Hirundinidae	*Hirundo neoxena*	Welcome Swallow
Pycnonotidae	*Sturnus tristis**	Common Myna*
Estrildidae	*Neochmia temporalis*	Red-browed Finch
MAMMALIA		
PERISSODACTYLA		
Equidae	*Equus caballus**	Horse*
LAGOMORPHA		
Leporidae	*Oryctolagus cuniculus**	Rabbit*

**Indicates an exotic species*

Appendix B

Likelihood of Occurrence Tables for Threatened Flora and Fauna

B.1 THREATENED FAUNA LIKELIHOOD OF OCCURRENCE

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
Amphibians		**TSC Act**	**EPBC Act**		
Heleioporus australiacus	Giant Burrowing Frog	V	V	The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from the collected water. The species was recorded in the wider locality in Riverstone in 1997. However, it is generally confined to sandstone geology in heathland or open woodland communities and therefore the Riverstone record is likely to be an anomaly or an extremely unusual occurrence.	U
Litoria aurea	Green and Golden Bell Frog	E	V	Large permanent freshwater wetlands, with dense stands of reeds	P
Litoria booroolongensis	Booroolong Frog	E	E	Typically inhabits rocky western-flowing creeks and their headwaters, although a small number of animals have also been recorded in eastern-flowing streams	U
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	Habitats include dams, creeks and lagoons. Favours higher woodland areas	U
Mixophyes balbus	Stuttering Frog, Southern Barred Frog	E	V	Found in mountain areas in rainforest	N
Mixophyes iteratus	Giant Barred Frog	E	E	Found on forested slopes of the escarpment and adjacent ranges in riparian vegetation, subtropical and dry rainforest, wet sclerophyll forests and swamp sclerophyll. This species is associated with flowing streams with high water quality, though habitats may contain weed species. This species is not known from	U

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
				riparian vegetation disturbed by humans. During breeding, eggs are kicked up onto an overhanging bank or the streams edge	
Pseudophryne australis	Red-crowned Toadlet	V		Hawkesbury sandstone and may be found beside temporary creeks, gutters and soaks, and under rocks and logs. Breeds in damp leaf litter that become inundated with heavy rain.	U
Invertebrates					
Meridolum corneovirens	Cumberland Plain Land Snail	E		Primarily inhabits Cumberland Plain Woodland. This community is a grassy, open woodland with occasional dense patches of shrubs.	P
Petalura gigantea	Giant Dragonfly	E		Swamps, streamlines and seepages in mainly natural condition with short to moderate vegetation and a relatively deep soil base. Larvae permanently burrow into soil and so do not survive in permanent ponds or other open water.	U
Reptiles					
Eulamprus leuraensis	Blue Mountains Water Skink	E	E	A high elevation species associated with naturally fragmented habitat of sedge and shrub swamps that have boggy soils and appear to be permanently wet	U
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Occur under large exfoliating slabs of sandstone and rock crevices in areas of undisturbed bushland, usually on tops of cliffs. Commonly found in rock on rock situations in this context also includes crevices in cliff faces	U
Varanus rosenbergi	Rosenberg's Goanna	V		Found in coastal heaths, humid woodlands and wet and dry sclerophyll forests. Shelters in burrows, rock hollows or crevices. Known to lay eggs in burrow in termite mound.	U
Aves					
Apus pacificus	Fork-tailed Swift		M	Aerial, over open country, from semi-deserts to coasts, sometimes forests and cities.	P

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
Ardea alba	Great Egret, White Egret		M	Shallows of rivers, estuaries, tidal mudflats, freshwater wetlands, larger dams	L
Ardea ibis	Cattle Egret		M	Stock paddocks, pastures, croplands, garbage tips, wetlands, tidal mudflats	P
Botaurus poiciloptilus	Australasian Bittern	V		Boggy marsh, wetland margins	L
Burhinus grallarius	Bush Stone-curlew	E		Well wooded floodplain forests, amongst fallen timber	U
Callocephalon fimbriatum	Gang-gang Cockatoo	V		Wetter forests, and woodlands, from sea level to 2000m on divide. From timbered foothills and valleys to suburban gardens.	L
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		Eucalypt forests and woodlands and forage in Allocasuarina. Nest in tree hollows	P
Circus assimilis	Spotted Harrier	V		The Spotted Harrier occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods). It is found mostly commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	P
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V		Drier forests, woodlands, scrub with fallen branches	P

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
Daphoenositta chrysoptera	Varied Sitella	V		The Varied Sittella is sedentary and inhabits most of mainland Australia. Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	P
Ephippiorhynchus asiaticus	Black-necked Stork	E		Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands, floodplains. Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains.	U
Gallinago hardwickii	Latham's Snipe, Japanese Snipe		M	Soft wet ground or shallow water with tussocks and other green and dead growth. Wet drainage areas	L
Glossopsitta pusilla	Little Lorikeet	V		Mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes.	P
Grantiella picta	Painted Honeyeater	V		A nomadic species that typically inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests with abundant mistletoe. It is a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias, preferring Amyema sp (mistletoe).	U
Haliaeetus leucogaster	White-bellied Sea-Eagle		M	Rivers, large dams. Roost and nest on large platforms built in large Eucalypts	U
Hieraaetus morphnoides	Little Eagle	V		The Little Eagle occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a	P

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
				remnant patch, where pairs build a large stick nest in winter and lay in early spring. Young fledge in early summer. It eats birds, reptiles and mammals, occasionally adding large insects and carrion	
Hirundapus caudacutus	White-throated Needletail		M	Open space above canopy. Forages over large areas	P
Irediparra gallinacea	Comb-crested Jacana	V		Freshwater wetlands, such as lagoons, billabongs, swamps, lakes and reservoirs, generally with abundant floating aquatic vegetation	N
Ixobrychus flavicollis	Black Bittern	V		Boggy marsh, wetland margins	L
Lathamus discolor	Swift Parrot	E	E	Forests, woodlands, plantations, banksias, street trees and gardens on the mainland	P
Limosa limosa	Black-tailed Godwit	V		Primarily found along the coast on sandspits, lagoons and mudflats. The species has also been found to occur inland on mudflats or shallow receding waters of portions of large muddy swamps or lakes	U
Lophoictinia isura	Square-tailed Kite	V		Diverse habitats from woodlands to timbered watercourses	P
Melanodryas cucullata	Hooded Robin	V		Occurs in open woodland often near clearings or open areas from Brisbane to Adelaide throughout much of inland NSW. Requires structurally diverse habitats of eucalypt canopy, some shrub layer and areas of tall grass.	P
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V		Drier eucalypt forests, woodlands, timber on water courses, often no understorey, scrubs. Favours ironbark woodlands on western slopes.	P
Merops ornatus	Rainbow Bee-		M	Open woodlands with sandy, loamy soils, dunes, cliffs, mangroves golf courses	P

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
	eater				
Monarcha melanopsis	Black-faced Monarch		M	Rainforests, eucalypt woodlands, coastal shrubs, damp gullies in rainforest, eucalypt forest and more open woodland when migrating	P
Myiagra cyanoleuca	Satin Flycatcher		M	Heavily vegetated gullies in forests, and taller woodlands of coastal south-east Australia. Also occurs in various sites during migration including farms and parks	P
Neophema pulchella	Turquoise Parrot	V		Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species. Spends much of the time on the ground foraging on seed and grasses. It is associated with coastal scrubland, open forest and timbered grassland, especially low shrub ecotones between dry hardwood forests and grasslands with high proportion of native grasses and forbs.	L
Ninox connivens	Barking Owl	V		Open forests, woodlands, dense scrubs, other large trees near watercourses, also open grasslands	P
Ninox strenua	Powerful Owl	V		Pairs occupy large, probably permanent home ranges in forests to woodlands. Nest in large hollow	P
Oxyura australis	Blue-billed Duck	V		Well vegetated freshwater swamps, large dams, lakes. In winter more open waters.	L
Pandion haliaetus	Osprey	V		Coasts, estuaries, bays inlets.	U
Petroica boodang	Scarlet Robin	V		The Scarlet Robin breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. It	P

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
				forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris.	
Petroica rodinogaster	Pink Robin	V		Inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies	U
Polytelis swainsonii	Superb Parrot	V		The Superb Parrot is found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round. Inhabit box-gum woodland and Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest foraging at or near the ground. Nest in hollows	U
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V		Open woodlands dominated by mature eucalypts with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs. This species avoids very wet areas	U
Pyrrholaemus sagittatus	Speckled Warbler	V		Lives in a wide range of eucalypt dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.	P
Rhipidura rufifrons	Rufous Fantail		M	Undergrowth of rainforests/wetter eucalypt forests/gullies. Also occurs in various random sites during migration including farms and parks	L
Rostratula australis	Australian Painted Snipe	E	E, M	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall	U

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
				vegetation, such as grasses, tussocks or reeds (ibid.). Breeding is often in response to local conditions; generally occurs from September to December. Roosts during the day in dense vegetation. Forages nocturnally on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter	
Stagonopleura guttata	Diamond Firetail	V		Open eucalypt forests, woodlands	P
Stictonetta naevosa	Freckled Duck	V		Associated with a variety of plankton-rich wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters	U
Tyto capensis	Grass Owl	V		Reported habitats include tall grass, swampy, sometimes tidal areas, mangrove fringes, grassy plains, coastal heaths, grassy woodland, cane grass, sedges, cane fields and grain stubble. The Grass Owl nests on the ground within dense tall grass, sedges, reeds and even sugarcane plantations. The Grass Owl primarily feeds on rodents, hunting on the wing over heathland, grassland and sedgeland, as well as along the edge of sugar cane, crops and pastureland	U
Tyto novaehollandiae	Masked Owl	V		Occurs in forests, open woodlands, farmlands with large trees. Roosts in large hollow	P
Tyto tenebricosa	Sooty Owl	V		Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall Eucalyptus species. Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. Typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows	U
Xanthomyza phrygia	Regent Honeyeater	CE	E, M	Dry open forests, woodlands, especially red ironbark, yellow box, yellow gum	P

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
Mammals					
Cercartetus nanus	Eastern Pygmy-possum	V		Inhabits eastern forests and woodlands and feeds mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit	U
Chalinolobus dwyeri	Large-eared Pied Bat,	V	V	Roosts in caves, mines. Uncommon but observed in wet and dry eucalypt forests	P
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Occurs in wide variety of habitats in large remnants. Dens in tree hollows, hollow logs or rock crevices	U
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		Usually roosts in tree hollows in the higher rainfall forests within its range.	P
Isoodon obesulus obeseulus	Southern Brown Bandicoot	E	E	Variety of habitats from heathland, shrubland, dry eucalypt forest with heathy understorey, sedgeland and woodland	N
Miniopterus australis	Little Bentwing-bat	V		Moist eucalypt forest, rainforest or dense coastal banksia scrub. Little Bentwing-bats roost in caves, tunnels and sometimes tree hollows during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters	P
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		Forages above the canopy and eats mostly moths. Roosts in caves, old mines, road culverts	P
Mormopterus norfolkensis	Eastern Freetail-bat	V		Inhabits dry and wet sclerophyll forests, coastal woodland. Roosts in tree hollows and buildings. Have been found roosting under the bark of trees.	P

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
Myotis macropus	Southern Myotis	V		Known from a range of habitats close to water from lakes, small creeks to large lakes and mangrove lined estuaries	P
Petaurus australis	Yellow-bellied Glider	V		Patchily distributed in wet sclerophyll forest	U
Petaurus norfolcensis	Squirrel Glider	V		Associated with dry hardwood forest and woodlands. Habitats typically include gum barked and high nectar producing species, including winter flower species. The presence of hollow bearing eucalypts is a critical habitat value	U
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Rocky areas of sclerophyll forest of inland and subcoastal southeastern Australia. Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices	N
Phascolarctos cinereus	Koala	V		Widespread in sclerophyll forest and woodlands. Requires relatively large home ranges. No known population within assessment area.	U
Potorous tridactylus tridactylus	Long-nosed Potoroo		V	Known from coastal heathy woodland but also occurs in rainforest, wet sclerophyll and coastal wallum. Dense cover for shelter adjacent to open areas for foraging	U
Pseudomys oralis	Hastings River Mouse	E	E	An open canopy and shrub layer appear to be the major predictive habitat features of this species. Open forest or woodland with a grassy sedge rush or heath understorey that is about 10-75cm above the ground. Ground cover may vary from almost no cover to a dense, rank cover of grasses, herbs and sedges. Sedges, particularly Carex, Juncus and Cyperus spp. are common to most sites. This habitat occurs beside creeks (permanent and ephemeral) and soakages, but is also found on ridges and grassy plains.	N
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Roosts in large camps and disperses nightly up to 20km to feed in flowering eucalypts	P

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		Occur in all habitats, from wet and dry sclerophyll forest, open woodland. Insectivorous and forage above the tree canopy. The species roosts in tree hollows and tend to be solitary for most of the year.	P
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Usually in tall wet forest, extending into drier forest along gullies. Forages along forest edges. Roosts in tree hollows	P

^Status: V=Vulnerable
E=Endangered
CE=Critically endangered
M=Migratory species

**Likelihood of Occurrence: K=Known*
P=Possible
L=Low
U=Unlikely
N=No

B.2 THREATENED FLORA LIKELIHOOD OF OCCURRENCE

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
		TSC Act	EPBC Act		
Acacia bynoeana	Bynoe's Wattle	E	V	Found in heath and woodland on sandy soils. Scattered from coast to mountains, uncommon. Associated overstorey species include Corymbia gummifera (Red Bloodwood), Scribbly Gum (Eucalyptus haemastoma), Parramatta Red Gum (Eucalyptus parramattensis), Banksia serrata and Angophora bakeri. Records occur north and east of the NWGC.	U
Acacia pubescens	Downy Wattle	V	V	Associated with on Cumberland Plain Woodlands, Shale/Gravel Forest and Shale/ Sandstone Transition Forest. Clay soils, often with ironstone gravel.	L
Allocasuarina glareicola		E	E	Castlereagh Woodlands on lateritic soils. Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool. There are no records for this species within the Growth Centres since 1980.	U
Asterolasia elegans		E	E	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby local government areas. Also likely to occur in the western part of Gosford LGA. Occurs on Hawkesbury sandstone in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest. The canopy at known sites includes Turpentine (Syncarpia glomulifera subsp. glomulifera), Smooth-barked Apple (Angophora costata), Sydney Peppermint (Eucalyptus piperita), Forest Oak (Allocasuarina torulosa) and Christmas Bush (Ceratopetalum gummiferum).	U
Cynanchum elegans	White-flowered Wax Plant	E	E	Climber or twiner with a variable form. It occurs in dry rainforest gullies, scrub and scree slopes. It prefers the ecotone between dry subtropical rainforest and sclerophyll woodland/forest. However has been found in littoral rainforest;	U

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
		TSC Act	EPBC Act		
				Eucalyptus tereticornis aligned open forest/ woodland; E. maculata aligned open forest/woodland; and Melaleuca armillaris scrub to open scrub. Flowers between August and May, peaking in November. Seeds are unlikely to persist in the seedbank. No previous records in the NWGC	
Darwinia biflora		V	V	Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Appears to occur frequently on sheet rock which often contains moss beds.	U
Dillwynia tenuifolia		V	V	It has a core distribution within the Cumberland Plain, where it may be locally abundant 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 the ecotone between these areas and Castlereagh Scribbly Gum Woodland. Flowers sporadically from August to March.	P
Epacris purpurascens var. purpurascens		V		Found in a range of habitat types, most of which have a strong shale soil influence. Grows in sclerophyll forest, scrubs and swamps on sandstone from Gosford and Sydney districts.	U
Eucalyptus benthamii	Camden White Gum	V	V	Occurs in wet open forest on well drained sandy alluvial soils along stream channels, small terraces and alluvial flats on valley floors	U
Grammitis stenophylla	Narrow-leaf Finger Fern	E		In NSW it has been found on the south, central and north coasts and as far west as Mount Kaputar National Park near Narrabrai. Moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest	U
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	V		Restricted to red sandy to clay soils – often lateritic on Wianamatta Shale and Tertiary alluvium in Cumberland Plain Woodland and Castlereagh Woodland	P
Grevillea parviflora subsp. parviflora	Small Flower Grevillea	V	V	Occurs on sandy clay loam soils, often with lateritic ironstone gravels. Soils are mostly derived from Tertiary sands or alluvium and from the Mittagong	U

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
		TSC Act	EPBC Act		
				Formation with alternating bands of shale and fine-grained sandstones. Soil landscapes include Lucas Heights and Berkshire Park. Often occurs in open, slightly disturbed sites such as along tracks. Flowering has been recorded between July to December as well as April-May. Although suitable habitat occurs for this species in the NWGC, it is outside of the species known range and therefore is considered unlikely to occur there.	
Gyrostemon thesioides		E		Associated with riverbanks along the Georges and Nepean Rivers in NSW. Within NSW, has only ever been recorded at three sites, to the west of Sydney, near the Colo, Georges and Nepean Rivers. The most recent sighting was of a single male plant near the Colo River within Wollemi National Park. The species has not been recorded from the Nepean and Georges Rivers for 90 and 30 years respectively, despite searches.	U
Hibbertia superans		E		Occurs chiefly from the north west Sydney region between Baulkham Hills and Wisemans Ferry, where there are currently 16 known sites, and at one locality at Mount Boss, inland from Kempsey on the mid north coast of NSW. Occurs in both open woodland and heathland, and appears to prefer open disturbed areas, such as tracksides. In the Sydney region it occurs in Dry Sclerophyll Forest on sandstone ridgetops. The northerly occurrence is on granite.	U
Hypsela sessiliflora		E	Ex	Currently known from only two adjacent sites on a single private property at Erskine Park in the Penrith LGA. Previous sightings are all from western Sydney, at Homebush and at Agnes Banks. Known to grow in damp places, on the Cumberland Plain but has an extremely restricted distribution.	U
Leptospermum deanei		V	V	Woodland on lower hill slopes or near creeks. Sandy alluvial soil or sand over sandstone	U

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
		TSC Act	EPBC Act		
Leucopogon fletcheri subsp. fletcheri		E		Restricted to north-western Sydney between St Albans in the north and Annangrove in the south, within the local government areas of Hawkesbury, Baulkham Hills and Blue Mountains. Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs.	U
Marsdenia viridiflora subsp. viridiflora	Marsdenia viridiflora subsp. Viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs	E		Recent records are from Riverstone, Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Previously known north from Razorback Range. Grows in vine thickets and open shale woodland	P
Melaleuca deanei	Deane's Melaleuca	V	V	Marshy heath on coastal sandstone plateaus.	U
Micromyrtus minutiflora		E	V	Restricted to the general area between Richmond and Penrith, western Sydney. Grows in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, open forest on tertiary alluvium and consolidated river sediments.	P
Olearia cordata		V	V	The species habitat is woodland on exposed Hawkesbury Sandstone ridges. Soils are shallow or skeletal and are usually neutral to slightly acidic. Shale-influence may be a habitat attribute. Associated soil landscapes are Gymea and Hawkesbury. The species tends to prefer the more sheltered easterly aspects. Associated flora includes Angophora costata, A. bakeri, Eucalyptus	U

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
		TSC Act	EPBC Act		
				punctata and Corymbia eximia with understorey species including Allocasuarina torulosa, Acacia linifolia, Persoonia linearis and Leucopogon muticus along with various grasses. There have also been listings of E. eugenioides as an associate; and E. oblonga, E. notabilis and Leptospermum trinervium as dominant species near Wollomi. Recent observation have noted C. gummifera and in northern areas, Angophora euryphylla as common canopy species.	
Persoonia hirsuta	Hairy Geebung	E	E	Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	U
Persoonia nutans	Nodding Geebung	E	E	Associated with dry woodland, Castlereagh Scribbly Gum Woodland, Agnes Banks Woodland and sandy soils associated with tertiary alluvium, occasionally poorly drained. Also occurs in Shale Gravel Transition Forest and Castlereagh Ironbark Forest. Endemic to the Western Sydney.	P
Pilularia novae-hollandiae	Austral Pillwort	E		In NSW has been recorded from suburban Sydney, Khancoban, the Riverina between Albury and Urana (including Henty, Walbundrie, Balldale and Howlong) and at Lake Cowal near West Wyalong. Grows in shallow swamps and waterways, often among grasses and sedges. Widespread but not common in seasonally dry depressions and margins of marshes; may grow submerged.	U
Pimelea curviflora var. curviflora		V	V	Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands	U
Pimelea spicata	Spiked Rice-flower	E	E	In western Sydney, it occurs on an undulating topography of well structured clay soils, derived from Wianamatta shale. It is associated with Cumberland Plain Woodland (CPW), in open woodland and grassland often in moist	P

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
		TSC Act	EPBC Act		
				depressions or near creek lines. Has been located in disturbed areas that would have previously supported CPW	
Pomaderris brunnea	Brown Pomaderris	V	V	Associated with open forests in association with Eucalyptus amplifolia, Angophora floribunda, Acacia parramattensis, Bursaria spinosa and Kunzea ambigua. It is found on the Colo River, the Nepean R. floodplain at Menangle, in creeklines at Wirrumbirra Sanctuary (Bargo) and on the Hawkesbury River. The distribution may extend into the southern section of Yengo NP along major creeklines and floodplains	U
Pultenaea parviflora		E	V	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 ecotone between these communities and Castlereagh Scribbly Gum Woodland. Eucalyptus fibrosa is usually the dominant canopy species. E. 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, M. nodosa, Ozothamnus diosmifolius and Themeda australis . Often found in association with other threatened species such as Dillwynia tenuifolia, Dodonaea falcata, Grevillea juniperina, Micromyrtus minutiflora, Persoonia nutans and Styphelia laeta. Flowering may occur between August and November. Four plants identified in the Field assessment Area.	K
Pultenaea pedunculata	Matted Bush-pea	E		Shale Gravel Transition Forest in the Wianamatta Shale - Tertiary alluvium intergrade areas	L

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
		TSC Act	EPBC Act		
Tetratheca glandulosa		V	V	Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gymea, Lambert and Faulconbridge. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Records occur in the Baulkham Hills LGA, around the Lane Cove and Pennant Hills area to the east of the NWGC.	U
Tetratheca juncea	Black-eyed Susan	V	V	Occurs on predominantly low nutrient soils with a dense grassy understorey of grasses although it has been recorded in heathland and moist forest. It is associated with dry open forest or woodland habitats dominated by Corymbia gummifera, E. capitellata, E. haemastoma and Angophora costata. Themeda australis is generally the dominant ground coverFlowers July to December. Confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock	U
Thesium australe	Austral Toadflax, Toadflax	V	V	Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (Themeda australis). A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.	L
Zieria involucrata		E	V	Associated with Sydney Sandstone Gully Forest on sheltered slopes and among gullies. Found primarily in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest, although some populations extend upslope into drier vegetation. Also known from at least two atypical ridgetop locations. The canopy typically includes Syncarpia glomulifera subsp. glomulifera (Turpentine), Angophora costata	U

Scientific Name	Common Name	Status^		Habitat	Likelihood of occurrence*
		TSC Act	EPBC Act		
				(Smooth-barked Apple), Eucalyptus agglomerata (Blue-leaved Stringybark) and Allocasuarina torulosa (Forest Oak).	

^Status: V=Vulnerable
E=Endangered
E2=Endangered population
CE=Critically endangered

**Likelihood of Occurrence: K=Known*
P=Possible
L=Low
U=Unlikely

Appendix C

EPBC Act Significance Assessments

C.1 Introduction to the EPBC Act Significance Assessment

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the key piece of national legislation for protection of the environment, particularly Matters of National Environmental Significance (MNES). It provides a framework for environmental assessment and approval that is designed to protect Australian biodiversity and provide management of important natural and cultural places.

MNES defined under the EPBC Act are:

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- World Heritage properties
- National Heritage places
- nuclear actions

This report considers the potential impact of the project on those MNES relating to threatened species and ecological communities.

C.2 Threatened Ecological Communities

One threatened ecological community listed under the EPBC Act occurs within the NW Field Assessment Area.

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

The assessment of this community against the EPBC Act Significant Impact Criteria[18] is presented below.

C.2.1 Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest

Status

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest is listed as a Critically Endangered Ecological Community (CEEC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The community is treated as two separate vegetation communities under the *Threatened Species Conservation Act 1995* (TSC Act); Cumberland Plain Woodland, and Shale-Gravel Transition Forest. Cumberland Plain Woodland is also listed as a CEEC under the TSC Act and Shale-Gravel Transition Forest is listed as an Endangered Ecological Community (EEC).

Distribution

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest is endemic to the shale hills and plains of the Sydney Basin Bioregion, with most occurrences on the Cumberland Plain in western Sydney. The community typically occurs on flat to undulating or hilly terrain up to about 350 m elevation but may also occur on locally steep sites and at slightly higher elevations. This community is found on clay soils derived from the Wianamatta Group geology.

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest has experienced significant decline in its pre-European distribution. There is strong evidence of a continuing decline in the distribution of Cumberland Plain Woodland since its listing as an Endangered Ecological Community in 1997[34]. This is largely a consequence of dispersed, small scale clearing associated with urban development. The Cumberland Plain Recovery Plan states that 27,935 ha of Cumberland Plain Woodland and Shale Gravel Transition Forest occur across the Cumberland Plain landscape (this includes all occurrences of these communities, rather than just those that would qualify under the EPBC Act).

The community continues to be at risk of further decline and fragmentation, with much of the continuing growth of Sydney projected to occur in western Sydney. A large majority of the community is on private land or public easements, with approximately 720 ha currently within nature reserves, national parks, state conservation areas and regional parks and likely to be secure from future clearing[34].

Description

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest is a grassy shale woodland typically dominated by tall eucalypts *Eucalyptus moluccana* (Grey Box) and *Eucalyptus teretecornis* (Forest Red Gum). A sparse lower tree layer may be present, typically with young eucalypts of upper tree canopy species and species of *Acacia*, *Exocarpos* and *Melaleuca*, but a shrub stratum is usually present, to variable extent, and is often dominated by *Bursaria spinosa* (Blackthorn) while other species include *Daviesia*

ulicifolia (Gorse Bitter Pea), *Dillwynia sieberi*, *Dodonaea viscosa* subsp. *cuneata* (Wedge-leaf Hop-bush).

The ground layer typically comprises a variety of perennial native graminoids and forbs; and include grasses *Aristida ramosa* (Purple Wiregrass), *A. vagans* (Threeawn Speargrass), *Cymbopogon refractus* (Barbed Wire Grass), *Dichelachne micrantha* (Plumegrass), *Echinopogon caespitosus* var. *caespitosus* (Tufted Hedgehog Grass), *Eragrostis leptostachya* (Paddock Lovegrass), *Microlaena stipoides* subsp. *stipoides* (Weeping Grass); and forbs such as *Asperula conferta* (Common Woodruff), *Brunoniella australis* (Blue Trumpet), *Cheilanthes sieberi* (Poison Rock-Fern), *Desmodium varians* (Slender Tick-trefoil), *Dianella longifolia* (Blue Flax-Lily), *Dichondra repens* (Kidney Weed).

The majority of the extant community represents regrowth stands, with remnant stands containing old growth trees being very rare. The EPBC Act recognises the community to be woodland with a minimum projected foliage cover of 10% or more, and with either a shrub or groundcover stratum present. For this reason, derived grassland and shrubland are not included within the EPBC Act definition of *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest*.

The Proposal

The Field Assessment Area contains 1.10 ha of EPBC listed *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest*, occurring across two remnant woodland patches, mostly along roadside corridors (Otago Street and Loftus Street). 0.5 ha of this community occurs within the direct impact zone.

Significant Impact Criteria

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- *reduce the extent of an ecological community*

The action will reduce the extent of *Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest.* The Proposal will necessitate the removal of up to 0.5 ha of this community where pipelines and infrastructure will be installed.

- *fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines*

In the Field Assessment Area, this community generally occurs along, or adjacent to, existing roadside corridors where the vegetation is already fragmented. The proposal will require up to a 10m strip of vegetation to be removed along these corridors (in many cases works can be contained within the road verge itself but 10m allows for a worse case scenario estimate). Where it occurs in the area zoned for conservation, mitigation measures (including under-boring and re-planting) will be undertaken. Therefore the community will not be further fragmented here. In general, pipeline location will aim to minimise clearance of threatened native vegetation where possible. No further

fragmentation of *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* is expected as a result of the Proposal.

- *adversely affect habitat critical to the survival of an ecological community*

The action will not adversely affect habitat critical to the survival of Cumberland Plain Woodland. *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* is widely distributed across western Sydney although it is generally restricted to the Cumberland Plain. The Field Assessment Area does not represent critical habitat for this CEEC and offset measures will help to conserve large remnants of this community elsewhere in western Sydney.

- *modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns*

The action is unlikely to substantially modify any abiotic factors necessary for the survival of the CEEC.

- *cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting*

The action will cause a localised change in the species composition of occurrences of *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* where vegetation is removed within the Field Assessment Area. However, the vegetation is generally highly disturbed and already subject to high levels of weed invasion because of its occurrence along existing roadsides. The removal of highly disturbed vegetation is unlikely to cause a significant decline or loss of functionally important species, as these habitats and species occur elsewhere adjacent to the Field Assessment Area and in the wider locality.

Where this community occurs in the Sydney Street area zoned for environmental conservation, mitigation measures will be implemented to ensure that it does not cause a substantial change in the species composition as the vegetation will either be avoided by under-boring or re-planted.

- *cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:*

  - *assisting invasive species, that are harmful to the listed ecological community, to become established, or*

  - *causing regular mobilization of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or*

In general, the removal of up to 0.5 ha of the community, mostly along roadside corridors is not likely to cause a reduction in the quality and integrity of occurrences of the CEEC

within and in proximity to the Field Assessment Area, as much of it is highly fragmented and disturbed already. Invasive species already occur throughout the community. In the area zoned for conservation, mitigation measures have been outlined to ensure that further invasion by weeds as a result of the proposal does not occur.

- *interfere with the recovery of an ecological community:*

The action is unlikely to interfere in the recovery of the ecological community. The clearance of isolated patches of vegetation along roadside corridors and the offsetting of these by purchasing higher condition vegetation for long-term conservation is likely to assist in the long term conservation of this community and is consistent with the Cumberland Plain Recovery Plan. In better quality vegetation, such as that between Sydney and Loftus Streets, additional measures will be undertaken to minimise impacts as discussed above.

Conclusion

The Proposal will reduce the extent of *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* with up to 0.5 ha being cleared. In general this consists of disturbed isolated patches of vegetation along roadside corridors, and their clearance and subsequent offsetting of large areas of habitat for conservation is consistent with the Cumberland Plain Recovery Plan.

Additional measures to be undertaken in the area zoned for conservation will ensure that impacts are minimised here, by avoidance of vegetation removal bu underboring and carrying out post-construction rehabilitation. Therefore no significant impacts are expected to occur here.

However, as the Strategic Assessment of the Growth Centres has yet to be approved by the Commonwealth Government and therefore Biodiversity Certification does not currently extend to EPBC Act listed communities, a separate referral to the Commonwealth is recommended for this community to independently assess the impacts under the EPBC Act.

C.3 Endangered Flora

There are two EPBC Act Endangered flora species that have the potential to occur within the Field Assessment Area:

- *Persoonia nutans* (Nodding Geebung); and
- *Pimelea spicata* (Spiked Rice Flower).

C.3.1 Persoonia nutans

Persoonia nutans is typically found in dry woodland, Castlereagh Scribbly Gum Woodland and Agnes Banks Woodland. It usually occurs in sandy soils associated with tertiary alluvium. These soils are occasionally poorly drained. This species also occurs in Shale Gravel Transition Forest and Castlereagh Ironbark Forest. It is endemic to Western Sydney.

Persoonia nutans was not recorded from within the Field Assessment Area during surveys and has not been previously recorded within the NWGC. However, it occurs in similar habitat to several species that have (including *Grevillea juniperina* and *Pultenaea parviflora)*[26]. Therefore the species is considered to have the potential to occur in the Field Assessment Area.

C.3.2 Pimelea spicata

Pimelea spicata typically occurs in woodlands and grasslands of *Eucalyptus moluccana* (Grey Box), *E. crebra* (Narrow-leaved Ironbark), *E. tereticornis* (Forest Redgum), *Bursaria spinosa* (Blackthorn) and *Themeda australis* (Kangaroo Grass).

Pimelea spicata was not recorded in the Field Assessment Area and there are no records (post 1980) for this species within the NWGC. However, the species is inconspicuous when not in flower and suitable habitat for this species exists within Cumberland Plain Woodland, as well as Shale Gravel Transition Forest and Castlereagh Ironbark Forest within the Field Assessment Area.

C.3.3 Significant Impact Criteria for Endangered Flora

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of a population*

It is unlikely that the Proposal will lead to a long-term decrease in the size of populations of either *Persoonia nutans* or *Pimelea spicata* because of the following:

- The Field Assessment Area is not considered to provide important or critical habitat to these species
- The absence of any records of *Persoonia nutans* or recent records of *Pimelea spicata* within the Field Assessment Area;
- The occurrence of more extensive suitable habitat for both species in the wider locality; and
- The clearance of narrow, linear areas of vegetation from the Field Assessment Area, with adjacent vegetation remaining intact in these areas.

➢ *reduce the area of occupancy of the species*

Persoonia nutans and *Pimelea spicata* are not currently known from the Field Assessment Area. The Proposal will result in the removal of small, linear areas of vegetation, therefore reducing the area of potential habitat for these species. However, better quality potential habitat occurs nearby and within the locality. This includes the Air Services Australia site at Shanes Park (identified as a key area of potential habitat for *P. nutans* in the National Recovery Plan for the species[13]) and the retention and protection of 710 ha of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (potential habitat for *P. spicata*) within the NWGC as part of the Growth Centres Biodiversity Certification. Therefore the proposal is unlikely to result in a reduced area of occupancy for either of these species.

➢ *fragment an existing population into two or more populations*

Some habitat will be removed for these species, although generally this occurs in linear strips along roadsides. No known individuals occur within the Field Assessment Area.

The strategic assessment of the Growth Centres[26] notes that no records for *P. nutans* occur in the NWGC. However the recovery plan for this species, prepared in 2006[6] notes a population of 31 extant individuals located within the Air Services Australia site at Shanes Park. It is not clear whether these records still exist. However, *P. nutans* has similar habitat requirements to a number of other threatened plants that are known from the NWGC, in particular the Air Services Australia site, and it is noted in the recovery plan as potential habitat for the species[6]. This site lies outside of the Field Assessment Area and as such removal of vegetation within the Field Assessment Area is not considered likely to fragment existing populations of this species.

The Proposal is unlikely to result in further fragmentation or isolation of populations of *Pimelea spicata*. Only one other population has been recorded in the North West Growth Centre which occurs in the Alex Avenue Precinct. However, the Growth Centres Strategic Assessment[26] notes that recent surveys failed to detect this species here. The majority of the species distribution lies outside of the NWGC boundary.

- *adversely affect habitat critical to the survival of a species*

It is considered unlikely that the Proposal will adversely affect habitat critical to the survival of *Persoonia nutans* or *Pimelea spicata* because of the following:

- Neither of these species was found to occur within the Field Assessment Area
- While the habitat to undergo clearing is considered suitable, it is far from optimal and therefore not considered critical to the survival to these species
- Habitat within the Field Assessment Area is not considered necessary for the long-term maintenance of these species as neither species is limited to the habitat within the Field Assessment Area;
- Habitat within the Field Assessment Area is not considered necessary to maintain genetic diversity and long term evolutionary development of these species as neither species was found to occur in the Field Assessment Area and potential habitat for these species is not limited to that within the Field Assessment Area
- The Field Assessment Area is not considered necessary for the reintroduction of populations or recovery of these species for the reasons stated above.

- *disrupt the breeding cycle of a population*

Neither of these species was found to occur within the Field Assessment Area. It is therefore unlikely that the Project will result in disruption to the breeding cycle of populations of these species.

- *modify, destroy, move, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

The Proposal will remove an area of habitat that is considered to constitute suitable habitat for these species. However this habitat is not considered to be important to these species and its removal is not likely to cause these species to decline because:

- The Field Assessment Area is not considered to constitute critical habitat for these species.
- The occurrence of more extensive suitable habitat for both species in the wider locality; and the comparatively small, linear areas of vegetation that will be removed compared with the larger areas of vegetation that will remain intact, indicates suitable habitat will remain in the vicinity of the Field Assessment Area for these species.

The Proposal will not modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that either of these species is likely to decline.

- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*

The Proposal is not expected to result in the introduction or increase in abundance of invasive species that will have a significant impact on *Persoonia nutans* and *Pimelea spicata*. The area is highly modified and any invasive species with potential to impact upon these species are already well established in the region.

- *introduce disease that may cause the species to decline, or*

The Field Assessment Area is already highly disturbed and subject to machinery and human traffic and the Proposal is unlikely to result in the introduction of disease that may cause the decline of *Persoonia nutans* or *Pimelea spicata*.

- *interfere with the recovery of the species*

As outlined above, it is considered unlikely that the Proposal will interfere with the recovery of *Persoonia nutans* and *Pimelea spicata*.

Conclusion

The removal of potential habitat for *Persoonia nutans* and *Pimelea spicata* is not considered likely to result in a significant adverse impact to these species. Neither species was detected on site (although it is noted that *P. spicata* can be inconspicuous when not in flower).

Nearby habitat at Shanes Park has been identified as key potential habitat for *P. nutans* and this is being set aside for conservation.

The one 'known' population of *Pimelea spicata* within the NWGC was recently surveyed for and not found. Therefore it is considered unlikely that this population still exists (although it is noted that seeds could persist in the soil). The main distribution of this species occurs outside of the NWGC. Therefore no significant impact on this species is considered likely as a result of the Proposal. As the species occurs sporadically throughout the Cumberland Plain in low numbers it is likely that the offsetting of good quality Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest in areas of suitable habitat for *Pimelea spicata* (or known habitat areas outside of the NWGC) will result in suitable offsets for this species.

C.4 Vulnerable Flora

There are two Vulnerable (EPBC Act) flora species which have suitable habitat occurring within the Field Assessment Area, one of which was detected nearby during field survey. These are:

- *Micromyrtus minutiflora*
- *Pultenaea parviflora* (a population of 20+ individuals detected during survey along Camberwell Road extending into bushland behind. This area does not form part of the preferred alignment option and will not be impacted by the proposal.

*EPBC Act listed Vulne*rable species considered to have a low chance of occurring within the Field Assessment Area (*A. pubescens, T. australe*) have been discussed in the main body of this report and are not considered further here.

For the purposes of this assessment, an 'important population' of Vulnerable flora as listed in the EPBC Act Significant Impa*ct Guidelines is:*

"a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- *Key source populations either for breeding or dispersal;*
- *Populations that are necessary for maintaining genetic diversity; and/or*
- *Populations that are near the limit of the species range"*[18].

There are no known populations of *Micromyrtus minutoflora or Pultenaea parviflora* occurring within the Field Assessment Area for the preferred alignment options presented in this report.

C.4.1 Micromyrtus minutiflora

Micromyrtus minutiflora is a slender spreading shrub to 2 m high. Leaves are 1–4 mm long and 0.5–1 mm wide with ciliate margins. *Micromyrtus minutiflora* is endemic to the western parts of the Cumberland Plain in the Richmond-Castlereagh area of the Sydney Region[7]. It occurs on sandy clay or gravelly soils of Tertiary alluvium. The distribution of this species overlaps with the distribution of *Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest*. There are 11 sites with a total of 1800 individuals across the Blacktown, Hawkesbury and Penrith Local Government Areas[36].

No specimens occur within the Field Assessment Area.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of an important population of a species*

No important populations occur within the Field Assessment Area. No known plants will be cleared in the Field Assessment Area as a result of the Proposal.

The NWGC supports two important populations of the species in the locality: a population within the Marsden Park North Precinct and one within the Air Services Australia site at Shanes Park[26].

- reduce the area of occupancy of an important population

As above, no important populations occur within the Field Assessment Area and no individuals have been detected.

- *fragment an existing important population into two or more populations*

The Proposal will involve removing a small area (0.76 ha) of potentially suitable habitat for this species. However, no important populations occur within the Field Assessment Area and the Proposal will not fragment an existing important population into two or more populations.

- *adversely affect habitat critical to the survival of a species*

No known habitat critical to the survival of the species occurs within the Field Assessment Area. Therefore the Proposal is unlikely to adversely affect habitat critical to the survival of the species.

- *disrupt the breeding cycle of an important population*

The Proposal is unlikely to disrupt the breeding cycle of an important population as no populations are known from the Field Assessment Area

- *modify, destroy, move, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

Some suitable habitat will be removed (0.76 ha of Cumberland Plain Woodland and Shale Gravel Transition Forest). Field survey of this area did not detect any individuals. Additionally, the species is well represented in large populations in the NWGC (including a large population at Shanes Park in the Marsden Park Precinct). The habitat within the Field Assessment Area is not considered to be important to the long-term survival of the species and its removal is unlikely to cause the species to decline.

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

Generally, the vegetation follows road sides and creek lines with narrow linear remnant vegetation. The condition of these areas is typically low and heavily impacted by weeds, soil modification and dumping. The clearing of vegetation will result in the removal of some potential habitat which is degraded and largely considered non-viable. It is unlikely that the species will rely on such habitat for recovery. Offsetting large areas of native vegetation for conservation is likely to reduce impacts on this species in the long-term.

- *introduce disease that may cause the species to decline*

The Proposal is unlikely to introduce disease that may cause the species to decline as the Proposal generally involves the removal of vegetation along heavily disturbed roadsides and creek-lines that have been subject to edge effects for long periods of time. Additionally, key populations occur outside of the Field Assessment Area.

- *interfere substantially with the recovery of the species*

The Proposal is unlikely to interfere with the recovery of the species as the main populations occur outside of the Field Assessment Area.

Conclusion

The Proposal will involve the clearing of a small amount (0.76 ha) of suitable habitat for this species. However the species is well represented in other parts of the NWGC and the removal of linear patches of native vegetation is not considered likely to have a significant impact to the species. The offsetting of large areas of key habitat for this species is considered appropriate for providing for its long term conservation.

C.4.2 Pultenaea parviflora

Pultenaea parviflora is a threatened pea-shrub that is endemic to the Cumberland Plain.

This species is known to occur within Cooks River Castlereagh Ironbark Forest or Shale Gravel Transition Forest on laterised clays or tertiary alluvium and in open habitats. No individuals of this species were recorded within the Field Assessment Area for the preferred alignment. However, a population of approximately 20+ plants was recorded whilst surveying alternative options along Camberwell Road and suitable habitat for this species occurs within the Field Assessment Area and may be removed by the Proposal.

Significant Impact Criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of an important population of a species*

No important populations occur within the Field Assessment Area. The population along Camberwell Road occur is not considered to be an important population and the removal

of nearby potential habitat is not likely to lead to a long-term decrease in the size of an important population of the species. Key populations do occur nearby in areas that are being set aside for conservation. The species is well represented within the wider NWGC, particularly at Shanes Park off Stony Creek Road.

- *reduce the area of occupancy of an important population*

As above, no important populations occur within the Field Assessment Area.

- *fragment an existing important population into two or more populations*

The species is well represented within the NWGC, particularly at Shanes Park off Stony Creek Road. No important populations occur in the Field Assessment Area. Therefore the Proposal is unlikely to fragment an existing important population into two or more populations.

- *adversely affect habitat critical to the survival of a species*

This species is known to occur within Cooks River Castlereagh Ironbark Forest or Shale Gravel Transition Forest on laterised clays or tertiary alluvium and in open habitats. 0.19 ha of potential habitat for this species will be removed. This habitat is not critical to the survival of the species.

- *disrupt the breeding cycle of an important population*

The Proposal is unlikely to disrupt the breeding cycle of an important population as no important populations are known from the Field Assessment Area.

- *modify, destroy, move, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

Some suitable habitat will be removed (0.19 ha of Shale Gravel Transition Forest). The habitat within the Field Assessment Area is not considered to be important to the long-term survival of the species however and its removal is unlikely to cause the species to decline.

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

Generally, the vegetation follows road sides and creek lines with narrow linear remnant vegetation. The condition of these areas is typically low and heavily impacted by weeds, soil modification and dumping. The clearing of vegetation will result in the removal of some actual and potential habitat which is highly disturbed. It is unlikely that the species will rely on such habitat for recovery. Offsetting large areas of native vegetation for conservation is likely to reduce impacts on this species in the long-term.

- *introduce disease that may cause the species to decline, or*

The Proposal is unlikely to introduce disease that may cause the species to decline as the Proposal generally involves the removal of vegetation along heavily disturbed roadsides and creek-lines that have been subject to edge effects for long periods of time. Additionally, key populations occur outside of the Field Assessment Area.

- *interfere substantially with the recovery of the species*

The Proposal is unlikely to interfere with the recovery of the species as important populations occur outside of the Field Assessment Area.

Conclusion

The Proposal would involve clearing 0.19 ha of suitable habitat for this species. This is unlikely to cause a significant impact to the species and the species is well represented within the wider NWGC.

C.5 Fauna

There are five nationally listed threatened fauna species that are considered to have some suitable habitat occurring within the Field Assessment Area, which have the potential to be impacted by the Proposal:

- Swift Parrot (*Lathamus discolor)* (Endangered under the EPBC and TSC Acts)
- Regent Honeyeater (*Anthochaera phrygia*) (Endangered under the EPBC Act and the TSC Acts)
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable under the EPBC Act and the TSC Acts)
- Grey-headed Flying-fox (*Pteropus poliocephalus*) (Vulnerable under the EPBC Act and the TSC Act)
- Green and Golden Bell Frog (Littoria aurea) ((Vulnerable under the EPBC Act and Endangered under the TSC Act)

Another eight fauna species listed as Migratory and /or Marine under the EPBC Act are also considered:

- Latham's Snipe (*Gallinago hardwickii*)
- Fork-tailed Swift (*Apus pacificus*)
- Cattle Egret (*Ardea ibis*)
- White-throated Needletail (*Hirundapus caudacutus*)
- Rainbow Bee-eater (*Merops ornatus*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Rufous Fantail (*Rhipidura rufifrons*)
- Satin Flycatcher (*Myiagra cyanoleuca).*

C.5.1 Nectivorous Birds

- Swift Parrot (*Lathamus discolor)*
- Regent Honeyeater (*Anthochaera phrygia*)

The Swift Parrot is listed as Endangered under the EPBC Act. The parrot breeds in Tasmania only and migrates to south-eastern Australia from March to October. In NSW they are found in dry sclerophyll eucalypt forests and woodlands with a particular liking to spotted gum and swamp mahogany forest. The species has also been found occasionally in wet sclerophyll forest vegetation. The bird is semi nomadic in winter and generally found in Victoria and New South Wales with other populations found in south-eastern Queensland. The timing of their migration causes a heavy reliance on winter flowering eucalypts: *Eucalyptus robusta, Corymbia maculata, C. gummifera, E. sideroxylon,* and *E. albens*. The species has high site fidelity and returns to sites on a cyclic basis. However, this site fidelity depends on availability of foraging resources.

NSW NPWS atlas database searches recorded the Swift Parrot within the NWGC. However these occurrences are not located within the Field Assessment Area. Due to the semi nomadic nature of the Swift Parrot when visiting the mainland, an assessment of significance must be completed to included losses to foraging habitat.

The Regent Honeyeater is listed as Endangered and Migratory under the EPBC Act. The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years non-breeding flocks converge on flowering coastal woodlands and forests.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of a population*

It is unlikely that these species rely heavily on the structural and floristic elements within the Field Assessment Area due to their generally low condition and the existence of large areas of winter flowering eucalypts in the locality.

- *reduce the area of occupancy of the species*

The Proposal will result in the removal of up to 2.65 ha of forest/woodland providing suitable foraging habitat for these species. However, the majority of this habitat occurs as remnants along roadsides and cleared land, and whilst these areas can provide some habitat for these species, they are unlikely to provide optimal habitat and therefore their removal is unlikely to reduce the area of occupancy of these species.

- *fragment an existing population into two or more populations*

No populations have been recorded within the Field Assessment Area

- *adversely affect habitat critical to the survival of a species*

The lack of records found during NSW NPWS atlas database searches and more specifically the absence of records within the proposed pipeline corridors may suggest a lack of habitat suitability or preference to higher quality habitat elsewhere. Coupled with the known site fidelity habit of the species it is unlikely that the removal of generally modified, degraded vegetation will adversely affect habitat critical to the survival of the Swift Parrot and Regent Honeyeater.

- *disrupt the breeding cycle of a population*

The Swift Parrot breeds only in Tasmania. Regent Honeyeater breeding is confined to two main areas in NSW, at Capertee Valley and the Bundarra-Barraba region and surrounding fragmented woodlands. Thus, the breeding cycles of both species will not be adversely affected.

- *modify, destroy, move, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

It is possible that the vegetation proposed to be cleared would incorporate some foraging habitat. The species are known to feed on lerp and nectar from *E. pilularis* and *E. moluccana* which occur within vegetation proposed to be removed. However, currently no records of Swift Parrot or Regent Honeyeater exist within the Field Assessment Area. In general there are a low number of records for these species within the NWGC. It is assumed that this lack of records suggests the species do not rely on the elements within the Field Assessment Area for habitat. It is unlikely that the removal of vegetation will result in the decline of the species.

- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*

Weed invasion is unlikely to affect the species becoming established as mature trees provide hollows for shelter and flowers for food. Weed invasion typically out-competes native species present in mid and lower stratums. Where possible the Proposal should avoid the removal of mature eucalypts and more specifically winter flowering species. Common garden birds that may compete for resources are already fully established in the area.

- *Introduce disease that may cause the species to decline, or*

Beak and Feather Disease is common among the Psittacidae family. Factors such as habitat alteration and diminishing food supply can increase susceptibility to the disease. The disease is spread from infected avian species via faeces, feather dust, blood and crop contents, even clothing can transfer the disease. It is unlikely that the Proposal will introduce the diseases as the disease is spread from contact with infected carriers.

- *interfere with the recovery of the species*

Narrow, linear areas of potential habitat for these species will be removed under the Proposal, which is not considered to interfere with the recovery of the species'.

Conclusion

The Proposal will result in the removal of narrow linear areas of potential forage and shelter habitat (including native vegetation, hollow-bearing trees and dead trees) for these species (up to 2.65 ha). None of these sites are considered to provide significant habitat for these species however and larger, better quality areas of suitable habitat for these species will remain intact adjacent to the Field Assessment Area and in the wider locality.

The Proposal is not likely to have a significant impact on either of the threatened nectivorous birds discussed above.

C.5.2 Large-eared Pied Bat (Chalinolobus dwyeri)

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under the EPBC Act.

The large-eared Pied Bat is a medium sized insectivorous bat with long prominent ears and glossy black fur. It is generally rare in NSW but found from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. With a preference to sandstone formations the species roosts near the entrances of caves, in crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin. The species portray high fidelity to roost sites. The species forages below the canopy of well timbered areas with gullies. The species has been found in the following threatened ecological communities: Cumberland Plain Woodland, Shale/Sandstone Transition Forest and Turpentine-Ironbark Forest in the Sydney Basin Bioregion.

Two occurrences have been recorded in the NWGC in the NSW NPWS atlas database searches[12].

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species

Few records occur for this species within the NWGC and no important populations have been identified.

- *reduce the area of occupancy of an important species*

The Proposal will result in the loss of up to 2.65 ha of potential forest/woodland foraging habitat. It is unlikely the Proposal will reduce the area of occupancy of the species with only two occurrences of the species being recorded previously within the NWGC. The habitat within the Field Assessment Area is considered marginal, with the species preferring wooded gullies and sandstone formations.

- *fragment an existing important population into two or more populations*

No important populations are known to occur within the NWGC and the Proposal is unlikely to fragment any important populations.

- *adversely affect habitat critical to the survival of a species*

The species has been found in the following threatened ecological communities: Cumberland Plain Woodlands, Shale/Sandstone Transition Forest and Turpentine-Ironbark Forest in the Sydney Basin Bioregion. However, generally it forages below the canopy of well timbered areas with gullies, none of which occur within the Field Assessment Area. No habitat critical to the survival of a species occurs within or adjacent to the Field Assessment Area.

- *disrupt the breeding cycle of an important population*

No known important populations occur within the NWGC

- *modify, destroy, move, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

This species prefers sandstone outcrops and man-made habitats for roosting and has a low occurrence within the NWGC so is unlikely to be impacted on through the loss of woodland as a result of the Proposal.

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

As above, the species has a low occurrence in the NWGC in general and the Field Assessment Area does not provide optimal habitat, therefore the Proposal is unlikely to result in invasive species that are harmful to this species becoming established in its habitat.

- *introduce disease that may cause the species to decline, or*

The Proposal is unlikely to introduce a disease that may cause the species to decline

- *interfere substantially with the recovery of the species*

The NWGC is generally outside the species distribution and removal of vegetation in the Field Assessment Area is unlikely to interfere with the recovery of this species.

Conclusion

In general, the Proposal will result in the removal of narrow linear areas of potential forage habitat for this species. None of these sites are considered to provide significant or optimal habitat for these species and therefore the Proposal is unlikely to have a significant impact on these species.

C.5.3 Grey-headed Flying-fox (Pteropus poliocephalus)

The Grey-headed Flying-fox (*Pteropus poliocephalus*) is listed as Vulnerable under the EPBC Act.

The Grey-headed Flying-fox is the largest Australian bat. Their distribution is large, ranging from Bundaberg, Queensland to Melbourne, Victoria. The species occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. The Grey-headed Flying-fox feeds on nectar, pollen and fruits. The species has high site fidelity of camps and travels large distances (up to 50km) to forage each night. The species is known to forage widely across western Sydney.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of an important population of a species*

No known important populations/roosting camps occur with the Field Assessment Area. It is unlikely that the Proposal will lead to the long-term decrease in the size of an important population.

- *reduce the area of occupancy of an important population*

No known important populations or roosting camps occur within the Field Assessment Area

- *fragment an existing important population into two or more populations*

No known important populations or roosting camps occur within the Field Assessment Area.

- *adversely affect habitat critical to the survival of a species*

The Proposal is not likely to adversely affect habitat critical to the species survival. No camps have been identified to occur within the Field Assessment Area. The removal of vegetation will reduce potential foraging habitat although this impact will be negligible as the species has a large home range and is known to fly up to 50km to forage each night. The removal of vegetation is not likely to affect habitat critical to the survival of the species.

- *disrupt the breeding cycle of an important population*

No Grey-headed Flying-fox camps were detected in the Field Assessment Area and no known camps occur nearby. Therefore the Proposal is unlikely to disrupt the breeding cycle of an important population.

- *modify, destroy, move, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

The Proposal will remove up to 8.18 ha of forest/woodland and potential Grey-headed Flying-fox foraging habitat, largely in narrow linear strips. Given that the species is highly mobile and travels great distances in response to food availability, the Proposal will not significantly affect the habitat to the extent the species will decline.

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

The vegetation within the Field Assessment Area generally occurs in areas that are already disturbed and inhabited by invasive species and the Proposal is unlikely to result in the influx of an invasive species that does not occur there already to the extent that it would affect habitat for this species.

- *introduce disease that may cause the species to decline, or*

As above, the Proposal is unlikely to introduce a disease that causes this species to decline.

- *interfere substantially with the recovery of the species*

The Grey-headed Flying-fox is wide ranging and forages over large home ranges. No flying-fox camps occur within the Field Assessment Area and therefore the Proposal is unlikely to interfere with the recovery of this species.

Conclusion

The Field Assessment Area would only provide a small portion of the species potential foraging habitat and therefore a significant impact is not predicted on this species.

C.5.4 Green and Golden Bell Frog

The Green and Golden Bell Frog (*Litoria aurea*) is listed as Vulnerable under the EPBC Act.

The Green and Golden Bell Frog occurs mainly along coastal lowland areas of eastern NSW and Victoria. In NSW the Bell Frog is regarded as rare. Most populations consist of few than 20 adults. However, there are populations of over 100 animals at Captain's Flat and over 1,000 at Kooragang Island, Broughton Island and Homebush[35]. A small population is known to occur at Riverstone, centred around a private property.

In NSW, the habitat for this species includes disturbed, still or slow-flowing waterbodies. Breeding habitat tends to consist of shallow or ephemeral ponds that are free of Mosquito Fish (*Gambusia holbrooki*), unshaded with emergent vegetation[35]. The species may disperse up to several kilometres during breeding.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of an important population of a species*

It is unlikely that the Proposal will lead to the long-term decrease in the size of an important population. Whilst records for the Riverstone population occur nearby, the area of potential habitat within the Field Assessment Area is unlikely to be suitable for breeding as it contains little emergent vegetation and the banks are shaded by planted Casuarinas. Therefore, the Proposal will impact on a narrow linear corridor of potential foraging and shelter habitat, which also occurs across a large area adjacent to the Field Assessment Area.

- *reduce the area of occupancy of an important population*

A small area of potential habitat occurs within the Field Assessment Area and its removal is unlikely to reduce the area of occupancy of the Riverstone Population as other suitable habitat occurs adjacent to the Field Assessment Area and nearby.

- fragment an existing important population into two or more populations

The Proposal is unlikely to fragment an existing population. The population occurs outside of the Field Assessment Area.

- *adversely affect habitat critical to the survival of a species*

The habitat on site is not considered critical to the survival of the species and does not provide primary breeding habitat for this species. The removal of vegetation will cause a minor reduction in potential foraging and sheltering habitat although this impact will be negligible as similar habitat exists immediately adjacent to that being removed.

- *disrupt the breeding cycle of an important population*

As noted above, the habitat is not considered to provide primary breeding habitat for the species and the Proposal is unlikely to disrupt the breeding cycle of the nearby population.

- *modify, destroy, move, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

The Proposal will remove up to 0.04 ha of wetland habitat and some surrounding potential foraging and shelter habitat, which represents a very small proportion of the potential habitat available to this species in the general area. Therefore its removal is unlikely to significantly affect the habitat to the extent the species will decline.

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

Whilst *G. holbrooki* (predatory fish) were not observed in the waterbody during survey, it is likely that the species already occurs there as it tends to inhabit disturbed water bodies such as the one in the Field Assessment Area, which is also linked to several other disturbed sites. The Proposal is unlikely to exacerbate the spread of *G. holbrooki*.

- *introduce disease that may cause the species to decline, or*

As above, the Proposal is unlikely to introduce a disease that causes this species to decline (such as Chytrid fungus) as it is a disturbed site linked to other disturbed sites and the Proposal is unlikely to significantly increase disturbance. Mitigation measures recommended in this report include pre-clearance frog surveys in this area and all surveyors will need to follow the guidelines that will be outlined in the Flora and Fauna Management Plan for minimising spread of the disease (including washing footwear before going on site, using separate buckets for each individual collected etc).

- *interfere substantially with the recovery of the species*

The Proposal will not interfere with the recovery of this species as it will not remove known breeding habitat and the removal of a small amount of potential foraging and shelter habitat is unlikely to affect the species or the Riverstone population as a whole.

Conclusion

The Field Assessment Area represents a small portion of the species potential foraging and shelter habitat and therefore a significant impact is not predicted on this species. Despite the potential impacts to this species considered to be very low, because of the proximity of the Field Assessment Area to the known population, mitigation measures have been recommended to minimise any individual frogs being harmed during construction works. This is considered adequate to manage any potential impacts to frogs that may be foraging or sheltering in the area.

C.5.5 Other EPBC Act Listed Migratory/Marine Species

The following species are listed as both Migratory and Marine under the EPBC Act: None of them are known from the Field Assessment Area but have potential habitat occurring there.

- Latham's Snipe (*Gallinago hardwickii*)
- Fork-tailed Swift (*Apus pacificus*)
- Cattle Egret (*Ardea ibis*)
- White-throated Needletail (*Hirundapus caudacutus*)
- Rainbow Bee-eater (*Merops ornatus*)

- Rufous Fantail (*Rhipidura rufifrons*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Satin Flycatcher (*Myiagra cyanoleuca)*

The Latham's Snipe is a non-breeding visitor to south-eastern Australia. The species has been recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia. The range extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales. It is widespread in Tasmania and found in all regions of Victoria except for the north-west. Most birds spend the non-breeding period at sites located south of the Richmond River in New South Wales[19]

The Fork-tailed Swift is a non-breeding visitor to south-eastern Australia. The Fork-tailed Swift is almost exclusively aerial, flying from less then 1 m to at least 300 m above ground and probably much higher. In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities[16].

The Cattle Egret is widespread and common according to migration movements and breeding localities surveys. Two major distributions have been located; from north-east Western Australia to the Top End of the Northern Territory and around south-east Australia. In Western Australia and the Northern Territory, the Cattle Egret is located from Wyndham to Arnhem Land. In south-east Australia it is found from Bundaberg, inland to Roma, Thargominda, and then down through Inverell, Walgett, Nyngan, Cobar, Ivanhoe, Balranald to Swan Hill, and then west to Pinnaroo and Port Augusta.

In Australia, the White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. Because they are aerial, it has been stated that conventional habitat descriptions are inapplicable[17] but there are, nevertheless, certain preferences exhibited by the species. Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland[17].

The Rainbow Bee-eater is distributed across much of mainland Australia, and occurs on several near-shore islands. Populations that breed in southern Australia are migratory. The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. The nest is located in an enlarged chamber at the end of long burrow or tunnel that is excavated in flat or sloping ground, in the banks of rivers, creeks or dams, in roadside cuttings, in the walls of gravel pits or quarries, in mounds of gravel, or in cliff-faces[20].

The Black-faced Monarch is found along the coast of eastern Australia, becoming less common further south. It is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.

The Rufous Fantail is found in northern and eastern coastal Australia, being more common in the north. It is also found in New Guinea, the Solomon Islands, Sulawesi and Guam. The Rufous Fantail is found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats or urban areas.

The Satin Flycatcher inhabits heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occurs in coastal forests, woodlands, mangroves and drier woodlands and open forests

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- *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 important habitat for migratory or marine species occurs within the Field Assessment Area. Only marginal habitat for these species will be cleared.

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

As above, no important habitat occurs in the Field Assessment Area for these species.

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

These species are migratory and wide-ranging and not reliant on habitat within the Field Assessment Area for breeding. The Proposal is unlikely to disrupt the lifecycle of these species as it does not form important habitat for them.

Conclusion

The Field Assessment Area does not provide important habitat for these species. Although some small areas of potential habitat occur, the linear nature of much of the Proposal and the wide range and migratory nature of these species make them unlikely to be adversely affected by the Proposal.

C.6 Conclusion on impacts to all MNES

The Proposal is considered unlikely to have any significant impacts on the vegetation community or any of the threatened species listed as MNES that do or have the potential to occur in the Field Assessment Area. The strategic review of the Growth Centres may streamline the approval process for major projects such as this. However, until an outcome for the strategic review is announced it is recommended that a conservative approach be undertaken and the project be referred to SEWPaC for an independent review of impacts to MNES.

Appendix D

Detailed Vegetation Maps of Field Assessment Areas

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Field Assessment Area
- Certified Land
- Waterways

Vegetation Community

- Cumberland Plain Woodland (TSC Act)
- Cumberland Plain Woodland (EPBC Act)
- Shale Gravel Transition Forest (TSC Act)
- Shale Gravel Transition Forest (EPBC Act)
- River Flat Eucalypt Forest (TSC Act)
- Castlereagh Ironbark Forest (TSC Act)

Threatened Species

Current Survey

- *Grevillea juniperina*
- *Pultenaea parviflora*

Grid North

CUMBERLAND ECOLOGY

I:\...\9094\Figures\First Release Precinct-Riverstone\Report Figures_20111216\

Figure D.1. DETAILED MAP OF THE FIELD ASSESSMENT AREA A

100 0 100 200 300 400 m

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Field Assessment Area
- Certified Land
- Waterways

Vegetation Community

- Cumberland Plain Woodland (TSC Act)
- Cumberland Plain Woodland (EPBC Act)
- Shale Gravel Transition Forest (TSC Act)
- Shale Gravel Transition Forest (EPBC Act)
- River Flat Eucalypt Forest (TSC Act)

N
Grid North

CUMBERLAND ECOLOGY

I:\...\19094\Figures\First Release Precinct-Riverstone\Report Figures_20111216\

Figure D.2. DETAILED MAP OF THE FIELD ASSESSMENT AREA B

100 0 100 200 300 400 m

Coordinate System: MGA Zone 56 (GDA 94)

Grid North

KILLARNEY CHAIN OF PONDS

OLD PITT TOWN RD

Vineyard

SP1154 Site Options

Rising Pipeline 4

Box Hill

Wellington St water pipeline

Rising Pipeline 3

KILLARNEY CHAIN OF PONDS

KILLARNEY CHAIN OF PONDS

HAMILTON STREET

LOFTUS STREET

HOBART STREET

Riverstone West

WW L4-6 Loftus to Hobart Street

Box Hill Industrial

Sydney St water pipeline

Crown St water pipeline

Riverstone

WINDSOR RD

EDMUND STREET

Marsden Park North

GARFIELD RD EAST

Riverstone East

FIRST PONDS OF CREEK

Area

Legend

- Growth Centre Boundary
- Precincts
- Field Assessment Area
- Waterways

Other pipelines that have been assessed

- Drinking water pipeline
- Wastewater pipeline
- Rising main option

Original pipelines (already approved)

- Drinking water pipeline

SP1154 site options

- SP1154 options

CUMBERLAND ECOLOGY

I:\...\9094\Figures\First Release Precinct-Riverstone\Report Figures_20111206\

Figure D.3. ADDITIONAL AREAS SURVEYED THAT DID NOT FORM PART OF THE FINAL PREFERRED OPTION

500 0 500 1000 1500 2000 m

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Field Assessment Area
- Certified Land
- Existing Native Vegetation (as mapped in the draft Growth Centres Conservation Plan)
- Waterways

Vegetation Community

- Cumberland Plain Woodland (TSC Act)
- Cumberland Plain Woodland (EPBC Act)
- Shale Gravel Transition Forest (TSC Act)
- Shale Gravel Transition Forest (EPBC Act)
- River Flat Eucalypt Forest (TSC Act)
- Castlereagh Ironbark Forest (TSC Act)

Threatened Species

Current Survey

- *Grevillea juniperina*
- *Pultenaea parviflora*

N
Grid North

CUMBERLAND ECOLOGY

I:\...\9094\Figures\First Release Precinct-Riverstone\Report Figures_20120320\

Figure D.4. DETAILED MAP OF EXISTING NATIVE VEGETATION IN THE FIELD ASSESSMENT AREA A

100 0 100 200 300 400 m

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Field Assessment Area
- Certified Land
- Existing Native Vegetation (as mapped in the draft Growth Centres Conservation Plan)
- Waterways

Vegetation Community

- Cumberland Plain Woodland (TSC Act)
- Cumberland Plain Woodland (EPBC Act)
- Shale Gravel Transition Forest (TSC Act)
- Shale Gravel Transition Forest (EPBC Act)
- River Flat Eucalypt Forest (TSC Act)

N
Grid North

CUMBERLAND ECOLOGY

I:\...\9094\Figures\First Release Precinct-Riverstone\Report Figures_20120321\

Figure D.5. DETAILED MAP OF EXISTING NATIVE VEGETATION IN THE FIELD ASSESSMENT AREA B

100 0 100 200 300 400 m

Appendix E

Impacts by Individual Carrier/Infrastructure Site

Table E.1 BREAKDOWN OF DIRECT IMPACTS BY CARRIER – CERTIFIED FIELD ASSESSMENT AREA

Carrier	Vegetation Community	EPBC Act Listed	Only TSC Act Listed	TOTAL
Drinking Water Pipeline				
Edmund Street Carrier	Shale Gravel Transition Forest		0.004	0.004
	Total		0.004	0.004
Rising Main Option				
Rising Main 3	Cumberland Plain Woodland		0.009	0.009
	Shale Gravel Transition Forest	0.184	0.005	0.188
	Total	0.184	0.014	0.198
Wastewater Pipeline				
Boring Pits	Cumberland Plain Woodland	0.012		0.012
	Total	0.012		0.012
Wastewater lead-in mains L4-6	Cumberland Plain Woodland	0.092	0.088	0.179
	Total	0.092	0.088	0.179
Wastewater lead-in main L7	Cumberland Plain Woodland		0.016	0.016
	Total		0.016	0.016
Grand Total		**0.287**	**0.123**	**0.410**

Table E.2 BREAKDOWN OF DIRECT IMPACTS BY CARRIER – NON-CERTIFIED FIELD ASSESSMENT AREA

Carrier	Vegetation Community	EPBC Act Listed	Only TSC Act Listed	TOTAL
Drinking Water Pipeline				
Edmund Street Carrier	River Flat Eucalypt Forest		0.048	0.048
	Shale Gravel Transition Forest		0.003	0.003
	Total		0.051	0.051
SP1154 Site option				
SP1154 Site option D	Cumberland Plain Woodland		0.041	0.041
	Total		0.041	0.041
Wastewater Pipeline				
Boring Pits	Cumberland Plain Woodland	0.047		0.047
	Total	0.047		0.047
Wastewater lead-in mains L4-6	Cumberland Plain Woodland	0.169	0.082	0.250
	Total	0.169	0.082	0.250
Realignment a	Cumberland Plain Woodland		0.010	0.010
	River Flat Eucalypt Forest		0.151	0.151
			0.160	0.160
Realignment c	River Flat Eucalypt Forest		0.118	0.118
	Total		0.118	0.118
Grand Total		**0.216**	**0.452**	**0.668**

Table E.3 BREAKDOWN OF DIRECT IMPACTS - ENV CERTIFIED VEGETATION

Carrier	Vegetation Community	EPBC Act Listed	Only TSC Act Listed	TOTAL
Drinking Water Pipeline				
Edmund Street Carrier	Shale Gravel Transition Forest		0.004	0.004
	Total		0.004	0.004
Rising Main Options				
Rising Main 3	Cumberland Plain Woodland		0.009	0.009
	Shale Gravel Transition Forest	0.184	0.005	0.188
	Total	0.184	0.014	0.198
Wastewater Pipeline				
Boring Pits	Cumberland Plain Woodland	0.012		0.012
	Total	0.012		0.012
Wastewater lead-in mains L4-6	Cumberland Plain Woodland	0.092	0.088	0.191
	Total	0.092	0.088	0.191
Grand Total		**0.276**	**0.106**	**0.393**

Table E.4 BREAKDOWN OF DIRECT IMPACTS - ENV NON-CERTIFIED VEGETATION

Carrier	Vegetation Community	EPBC Act Listed	Only TSC Act Listed	TOTAL
Drinking Water Pipeline				
Edmund Street Carrier	River Flat Eucalypt Forest		0.048	0.048
	Shale Gravel Transition Forest		0.003	0.003
	Total		0.051	0.051
Wastewater Pipeline				
Boring Pits	Cumberland Plain Woodland	0.047		0.047
	Total	0.047		0.047
Wastewater lead-in mains L4-6	Cumberland Plain Woodland	0.169	0.082	0.251
	Total	0.169	0.082	0.251
Realignment a	Cumberland Plain Woodland		0.010	0.010
	River Flat Eucalypt Forest		0.151	0.151
	Total		0.161	0.161
Realignment c	River Flat Eucalypt Forest		0.118	0.118
	Total		0.118	0.118
SP1154 Site Option				
SP1154 Option D	Cumberland Plain Woodland		0.041	0.041
	Total		0.041	0.041
Grand Total		**0.216**	**0.452**	**0.668**

Table E.5 CARRIERS WITH NO NATIVE VEGETATION OCCURRING WITHIN THE DIRECT IMPACT ZONE

Carrier
Chain of Ponds Carrier
Realignment b
Realignment d

Table E.6 OTHER AREAS ASSESSED - CERTIFIED

Carrier	Vegetation Community	EPBC Act Listed	Only TSC Act Listed	TOTAL
Drinking Water Pipeline				
Crown Street	Shale Gravel Transition Forest	0.010		0.010
	Total	0.010		0.010
Hamilton Street Carrier	Cumberland Plain Woodland	0.021		0.021
	Total	0.021		0.021
Sydney Street Carrier	Cumberland Plain Woodland	0.018		0.018
	Shale Gravel Transition Forest	0.043		0.043
	Total	0.061		0.061
Wellington Street Carrier	Cumberland Plain Woodland		0.178	0.178
	Total		0.178	0.178
SP1154 Options				
SP1154 Option A	Cumberland Plain Woodland	0.022		0.022
	Total	0.022		0.022
Wastewater Pipeline			0.049	0.049
Camberwell Road Carrier	Castlereagh Ironbark Forest		0.005	0.005
	Total		0.005	0.005
Hamilton Street Carrier	Castlereagh Ironbark Forest		0.033	0.033
	Shale Gravel Transition Forest		0.011	0.011
	Total		0.043	0.043
Grand Total		**0.114**	**0.227**	**0.341**

Table E.7 OTHER AREAS ASSESSED – NON-CERTIFIED

Carrier	Vegetation Community	EPBC Act Listed	Only TSC Act Listed	TOTAL
Drinking Water Pipeline				
Sydney Street Carrier	Cumberland Plain Woodland	0.205		0.205
	Shale Gravel Transition Forest	0.120		0.120
	Total	0.325		0.325
Rising Main Option				
Rising Main 4	River Flat Eucalypt Forest		0.003	0.003
	Total		0.003	0.003
SP1154				
SP1154 Option A	Cumberland Plain Woodland	0.226		0.226
	Total	0.226		0.226
SP1154 Option B	Cumberland Plain Woodland	0.279		0.279
	Total	0.279		0.279
SP1154 Option C	Cumberland Plain Woodland	0.009	0.146	0.155
	Total	0.009	0.146	0.155
Wastewater Pipeline		0.263		0.263
Wastewater lead-in mains L4-6	Cumberland Plain Woodland	0.263		0.263
	Total	0.263		0.263
Grand Total		**1.102**	**0.150**	**1.252**