

Appendix D – Biodiversity Assessment Report

Albion Park Rail bypass

September 2017



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Biodiversity Assessment Report

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ACRONYMS AND ABBREVIATIONS

BBAM	BioBanking Assessment Methodology
BCC	BioBanking Credit Calculator
BOS	Biodiversity Offset Strategy
Cwth	Commonwealth
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Cwth)</i>
EP&A Act	<i>Environmental Planning and Assessment Act 1979 (NSW)</i>
FBA	Framework Biodiversity Assessment
FM Act	<i>Fisheries Management Act 1994 (NSW)</i>
GGBF	Green and Golden Bell Frog
GHFF	Grey-headed Flying-fox
ha	hectares
KFH	Key Fish Habitat
km	kilometres
m	Metres
MNES	Matters of National Environmental Significance
Noxious Weeds Act	<i>Noxious Weeds Act 1993 (NSW)</i>
NSW	New South Wales
OEH	(NSW) Office of Environment and Heritage (formerly DECCW)
PCTs	Plant Community Types
RMS	Roads and Maritime Services, Roads and Maritime
SEARs	Secretary Environmental Assessment Requirements
SCIVI	Southeast NSW Native Vegetation Classification and Mapping
SEPP	State Environmental Planning Policy (NSW)
sp/spp	Species/multiple species
TSC Act	<i>Threatened Species Conservation Act 1995 (NSW)</i>

EXECUTIVE SUMMARY

Roads and Maritime Services (Roads and Maritime) is planning for a 9.8 kilometre extension of the Princes Motorway between Yallah and Oak Flats to bypass Albion Park Rail. The motorway would complete the 'missing link' for a motorway standard road between Sydney and Bomaderry. It would provide easy access to Dapto, Albion Park and Oak Flats, have two lanes in each direction with median separation and have capacity for additional lanes. It would be signposted at 100 km/h.

This Biodiversity Assessment Report (BAR) has been prepared by NGH Environmental on behalf of the Hyder and Cardno Joint Venture, who were appointed by Roads and Maritime to develop a concept design for the project. The BAR has been updated from the BAR that was publicly exhibited with the environmental impact statement between 28 October and 27 November 2015 to include assessment of design refinements. The design refinements have been developed in response to:

- Consultation with the community during the Environmental Impact Statement (EIS) exhibition period
- Submissions received during and following the EIS exhibition period
- Landowner discussions
- Further concept design review of the EIS design.

The aim of this BAR is to address the Secretary's Environmental Assessment Requirements (SEARs) (Appendix D) and the Framework for Biodiversity Assessment (FBA), developed for Major Projects as part of the Biodiversity Offsets Policy for Major Projects assessed under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The FBA underpins the Biodiversity Offsets Policy for Major Projects. It contains the assessment methodology that is adopted by the policy to quantify and describe the impact assessment requirements and offset guidance that applies to Major Projects. This report follows the BAR format required by the FBA.

Field surveys in the study area identified three Endangered Ecological Communities (EECs) listed under the *Threatened Species Conservation Act 1995* (TSC Act): Illawarra Lowlands Grassy Woodland (ILGW), Swamp Oak Floodplain Forest (SOFF) and Freshwater Wetlands on Coastal Floodplains (FWCF). In September 2016, the Threatened Species Scientific Committee declared Illawarra and South Coast Lowland Forest and Woodland (ISCLFW) as a Critically Endangered Ecological Community (CEEC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This community corresponds closely with the TSC Act listed ILGW community in the study area (Threatened Species Scientific Committee 2016). The project would result in the removal of 7.22 ha of ILGW EEC (which corresponds with 7.22 ha of EPBC Act listed ISCLFW CEEC). This EEC provides habitat for the Eastern Flame Pea population, of which approximately 518 individuals were recorded within the study area, with 115 of those individuals within the development footprint. Approximately 0.55 ha of SOFF EEC and 7.20 ha of FWCF EEC would also be impacted by the project.

Seven threatened fauna species were identified within the study area:

- Large-eared Pied Bat (*Chalinolobus dwyeri*) (possible identification only)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
- Eastern Freetail-bat (*Mormopterus norfolkensis*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (possible identification only)
- Varied Sittella (*Daphoenositta chrysoptera*)

Two of the recorded threatened fauna species are also listed as Matters of National Environmental Significance (MNES) under the EPBC Act. Additional species listed on the EPBC Act occur or have the potential to occur within the development footprint. Impact assessments were undertaken for these species, concluding a very low likelihood of significant impact. An impact assessment for the listed ISCLFW community took a precautionary approach and in consideration of the available information concluded that a significant impact is likely. An EPBC Act referral for this project has been prepared.

According to the FBA, impacts requiring further consideration include impacts to native vegetation within 20 m of waterways associated with Macquarie Rivulet (5th order stream) and Frazers Creek (4th order stream). No other impacts were identified in the SEARs or during the assessment that require further consideration.

Consideration has been given to avoiding and minimising impacts to biodiversity throughout each phase of the project to date, since its inception in the mid-1990s. Route and interchange options have been assessed against key environmental, social and economic criteria, with several alignment and interchange options being eliminated due to their impact on environmental values; notably on EECs, threatened species habitat and wetlands. The rigorous option selection process has ensured the greatest avoidance and minimisation of impacts on biodiversity whilst considering the project constraints.

Mitigation and management measures have been identified and would be implemented to adequately address impacts associated with the project, both direct and indirect.

According to the requirements of the FBA, offset requirements have been identified and calculated for residual impacts on:

- Woollybutt – White Stringybark – Forest Red Gum grassy woodland EEC (361 credits) (ILGW EEC)
- Swamp Oak Floodplain Forest EEC (19 credits) (SOFF EEC)
- Coastal Freshwater Lagoons EEC (293 credits) (FWCF EEC)
- Eastern Flame Pea (1,725 credits).

Offsets for the ILGW would incorporate offset requirements for the EPBC Act listed ISCLFW.

The primary assumptions and limitations of this assessment are:

- The project conforms to the definition of a “*linear shaped development*” according to the FBA; “*a development that is generally narrow in width and extends across the landscape for a distance greater than 3.5 kilometres in length*”. The linear landscape assessment methodology, in accordance with the FBA for major projects, has been used in the assessment.
- Planted and regrowth areas unable to be easily attributed to a native vegetation community occur in areas of impact. They are noted as being in disturbed and weedy condition although they do retain some habitat values. They have been assigned to the closest biometric vegetation type in the BioBanking Credit Calculator (BCC) calculations (Derived Forest Red Gum – Thin-leaved Stringybark Grassy Woodland) to determine if they generate credits requiring offsets. It is noted these areas of vegetation would not be considered EECs and did not generate any threatened species credits. Therefore, in accordance with the FBA methodology, they are not required to be offset.

Consultation was undertaken with NSW Department of Primary Industries (DPI) (Fisheries) to discuss aquatic impacts not assessed by the FBA for which offsets may be required. Appropriate mitigation measures have been prescribed by DPI (Fisheries) for impacts to Duck Creek, Macquarie Rivulet and Frazers Creek 3 (creek relocation) and have been included in this report.

A Biodiversity Offset Strategy (BOS) has been provided as a separate document. The BOS demonstrates how the project would meet the offset requirements calculated for the project. It details the biodiversity values at the candidate offset sites, the process of seeking suitable direct offsets, consideration of supplementary measures where direct offsets could not be met, and the path forward to securing and managing the final offset package post-approval, in accordance with the FBA.

1 INTRODUCTION

Roads and Maritime Services (Roads and Maritime) propose to build a 9.8 kilometre extension of the Princes Motorway between Yallah and Oak Flats that would bypass Albion Park Rail (Figure 1-1).

Key features of the project include:

- Two lanes in each direction divided by a median (with capacity to upgrade to three lanes in each direction in future)
- Three interchanges provided at Yallah, Albion Park and Oak Flats would connect the local road network with the motorway
- Bridges to carry the motorway over Duck Creek, Macquarie Rivulet and Frazers Creek
- Bridges to carry the motorway over the Princes Highway and Tongarra Road
- A bridge to carry the motorway over the South Coast Rail Line
- Improved pedestrian and cycle connections
- Improvements to directly impacted sporting facilities at the Croom Regional Sporting Complex and changes to the southern access.

An Environmental Impact Statement (EIS) was prepared by Roads and Maritime to assess the potential impacts of the proposal. The EIS was publicly exhibited by the Department of Planning and Environment between 28 October and 27 November 2015.

Following the EIS display, a review of the design was undertaken in response to feedback following stakeholder consultation. As a result of this review process, Roads and Maritime has refined a number of aspects of the project as exhibited in the EIS. Design refinements have been developed to minimise EIS impacts where possible and in response to:

- Consultation with the community during the EIS exhibition period
- Submissions received during and following the EIS exhibition period
- Landowner discussions
- Further concept design review of the EIS design.

The key design refinements proposed include:

- Reconfiguration of the central interchange to minimise the impact on agricultural land
- Reduction in the project footprint within agricultural land
- Some refinements to intersection arrangements in response to further detailed traffic modelling.

Roads and Maritime has prepared a Submissions and Preferred Infrastructure Report (SPIR) to respond to issues raised in submissions received during the exhibition of the EIS. It also describes and assesses the proposed design refinements. This BAR forms an appendix to the SPIR Report.

The project is located within the Wollongong City Council Local Government Area (LGA) and the Shellharbour City Council LGA and extends over a distance of approximately 9.8 km, running north to south.

This BAR has been updated following public exhibition to reflect the final project design. This updated BAR addresses the impacts of all design modifications and responds to submissions made by stakeholders.

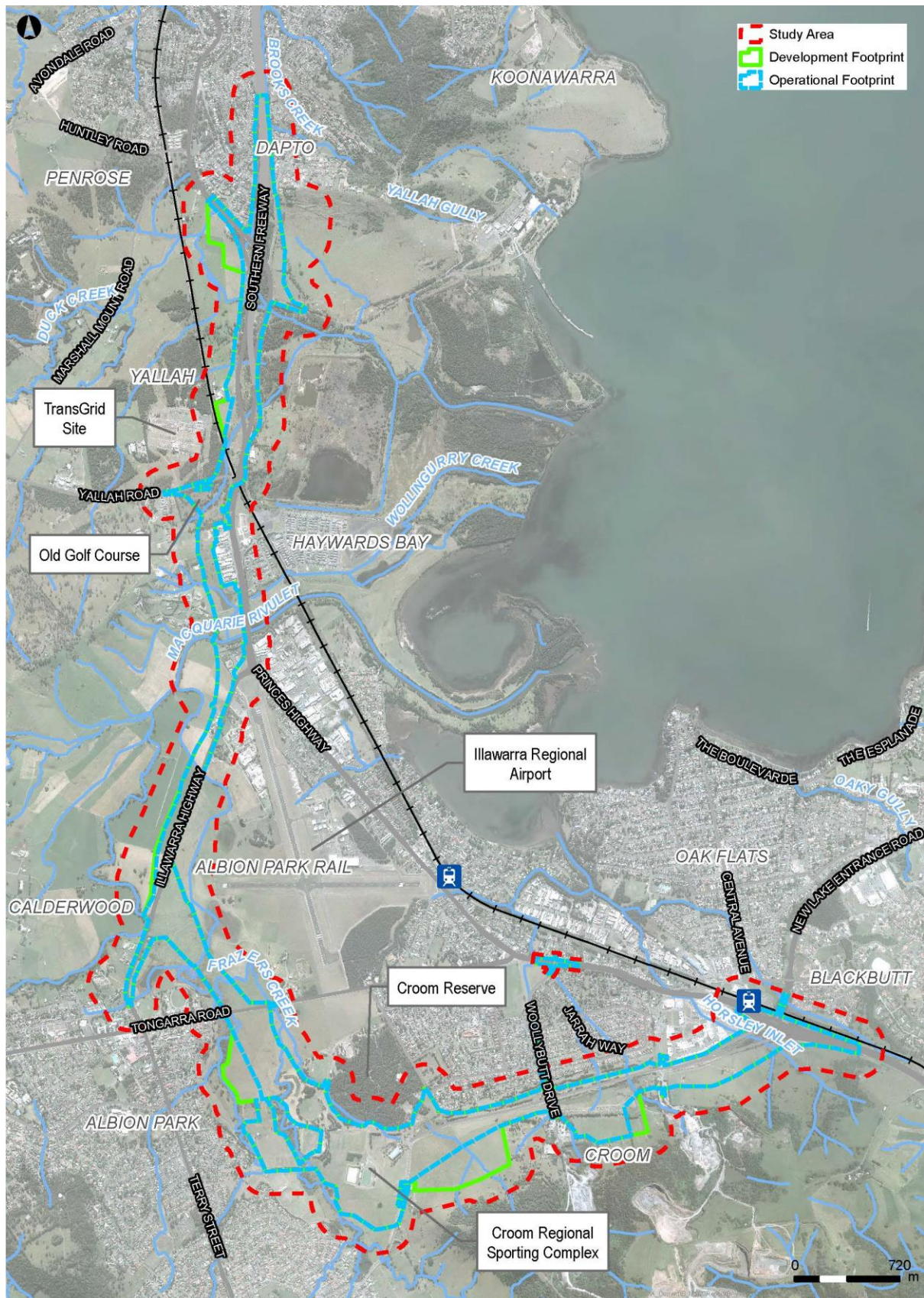


Figure 1-1 Site context

1.1 STUDY AIMS

This Biodiversity Assessment Report (BAR) has been prepared by NGH Environmental on behalf of the Hyder and Cardno Joint Venture, who were appointed by Roads and Maritime to develop a concept design for the project.

The aim of this BAR is to address the requirements of the Framework for Biodiversity Assessment (FBA), developed for Major Projects, and to address the biodiversity matters raised in the Secretary's Environmental Assessment Requirements (SEARs).

Secretary's Environmental Assessment Requirement	Where addressed
- An assessment of the potential ecological impacts of the proposal, with specific reference to vegetation and habitat clearing, connectivity, edge effects, weed dispersal, riparian and aquatic habitat impacts, soil and water quality impacts and operational impacts. The assessment must: - Make specific reference to impacts on landscape values, biodiversity values of native vegetation and threatened species or populations, including worst case estimates of vegetation clearing and operational impacts - Demonstrate a design philosophy of impact avoidance on ecological values, and in particular, ecological values of high significance, and be consistent with the 'avoid, minimise or offset' principle - Be undertaken in accordance with the Framework for Biodiversity Assessment (Office of Environment and Heritage 2014) and the <i>NSW Biodiversity Offsets Policy for Major Projects</i> (Office of Environment and Heritage 2014), and by a person accredited in accordance with section 142B(1)(c) of the <i>Threatened Species Conservation Act 1995</i>. Impacts on species, populations and ecological communities that will require further consideration and provision of information specified in section 9.2 of the Framework for Biodiversity Assessment include those identified by the Office of Environment and Heritage. Species specific surveys shall be undertaken for those species and in accordance with the survey requirements specified by the Office of Environment and Heritage (including during further consultation with the Office of Environment and Heritage) - In relation to aquatic biodiversity be consistent with the draft Policy and <i>Guidelines for Fish Habitat Conservation and Management – Update 2013</i> (Department of Primary Industries, 2013) - Consider impacts to the Croom Voluntary Conservation Agreement - Where there are potential impacts to the Office of Environment and Heritage estate reserved under the National Parks and Wildlife Act 1974 or where the proposal is located upstream of Office of Environment and Heritage estate, an assessment of the matters to be considered outlined in the <i>Guidelines for developments adjoining land and water managed by Department of Environment, Climate Change and Water</i> (Department of Environment, Climate Change and Water 2010).	Section 5 Sections 5 and 6 Sections 5.1.1, 5.2.1 and 6.5 Sections 1.2, 4 and 6 Section 8 Sections 2.7 and 5.5 Not applicable

1.2 REPORT STRUCTURE

This BAR follows the reporting requirements of the FBA and includes the following:

- Identification of biodiversity values subject to the proposed major development (the project) – Chapter 2 (Landscape Features), Chapter 3 (Native Vegetation), Chapter 4 (Threatened Species).
- Impacts of the project on biodiversity as part of an application for approval to undertake the Major Project under NSW planning legislation - Chapter 5 (Avoid and Minimise Impacts), Chapter 6 (Impact Summary).
- Quantification and description of biodiversity offsets required for the unavoidable impacts of the project on biodiversity values - Chapter 7 (Biodiversity Credit Report), Chapter 8 (Other Offset Considerations).
- *Environment Protection and Biodiversity Conservation Act 1999* considerations – Chapter 9 (EPBC Act Considerations)

Conservation measures proposed to offset the unavoidable impacts of the project are detailed in a separate Biodiversity Offset Strategy provided as a separate document.

1.3 DEFINITIONS

Study area

The study area is defined as the area directly or indirectly affected by the development and any additional areas likely to be affected by the development, such as noise and dust (Figure 1-2 and Figure 1-3). A buffer of approximately 200 m around the development footprint has been applied to allow for indirect impacts.

The study area is wholly contained within the Wollongong City Council Local Government Area (LGA) and the Shellharbour City Council LGA and extends over a distance of approximately 9.8 km, running north to south.

Development footprint

The development footprint is defined as the area of land that is directly impacted on by the project. The total development footprint is approximately 300.41 ha and comprises all areas that would be disturbed during construction. This includes interchanges, cuttings and embankments, drainage structures and bridge footprints, ancillary activities such as erosion and sediment controls, compound sites, permanent works on private and Roads and Maritime land, temporary works and local road works (Table 1-1). The development footprint has been defined in a precautionary manner, in that it is a 'worst case' area; some areas within it may not be required to be impacted during construction. The development footprint would include more area than the eventual operational footprint.

Table 1-1 Area of permanent and temporary impacts due to the project

Property Type	Area (Ha)
Permanent Works (Operational)	268.09
Temporary Works (Construction)	32.32
TOTAL	300.41

Operational footprint

The operational footprint includes all areas used in the operational phase of the project and does not include temporary works for the project or areas that would be rehabilitated as part of the construction phase. The operational footprint includes the permanent works on both Roads and Maritime land and private land, covering a total area of 268.09 ha (Table 1-1). This area includes Croom Regional Sporting Complex, but excludes local road works.

1.4 SOURCES OF INFORMATION USED

The following information sources were used in the preparation of this report:

- Aerial maps, proposal layers and environmental layers provided by Hyder Cardno, local council (Shellharbour Council) and OEH.
- Bangalay Botanical Surveys (2005). Croom Regional Sports Complex and Reserve, Croom – Bushfire Management Plan Final Draft Report.
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- NSW OEH's BioBanking credit calculator
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- NSW OEH's threatened species database
<http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>.
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- NSW Scientific Committee (2011). Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing - final determination.
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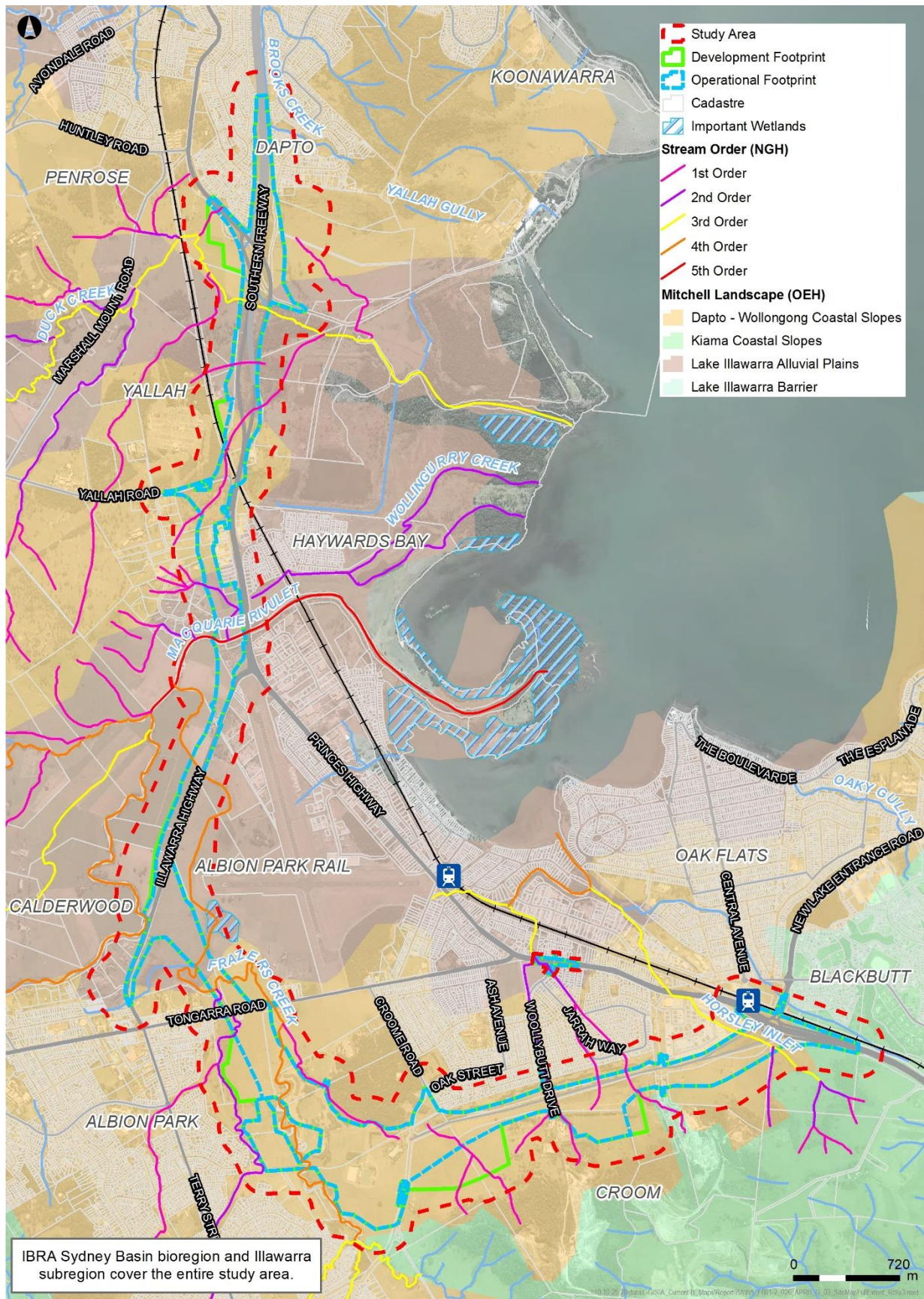


Figure 1-2 Site Map (for detailed maps see Appendix A)

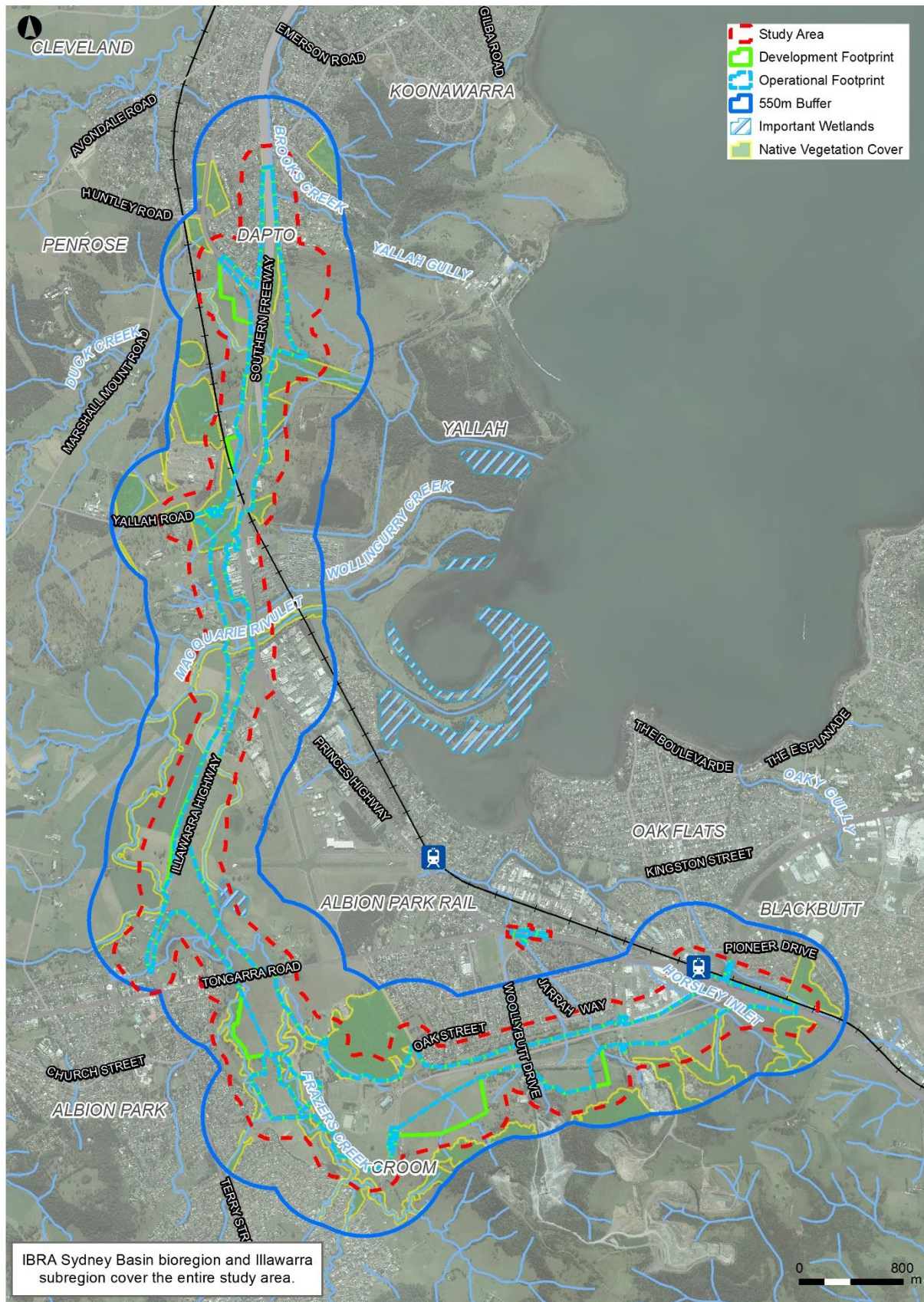


Figure 1-3 Location Map (for detailed maps see Appendix B)

2 LANDSCAPE FEATURES

2.1 IBRA BIOREGIONS AND SUBREGIONS

The project is located within the Sydney Basin Bioregion and the Illawarra Subregion (IBRA v.7 2012). Bioregions are large, geographically distinct areas of land with common characteristics such as geology, landform patterns, climate, ecological features and plant and animal communities. The geology of the region is Permian to Middle Triassic (240 million years) in age, with landforms described as mountain ranges, dissected plateaus, hills, and undulating plains. The dominant pre-European vegetation type is considered to be Illawarra Sydney Blue Gum moist shrub forest, dominated by *Eucalyptus saligna*, *Eucalyptus quadrangulata* and *Syncarpia glomulifera* (ASRIS accessed 15/10/13).

The dominant IBRA subregion affected by the project is the Illawarra Subregion. This was entered in the BioBanking Credit Calculator (BCC) for the project.

2.2 NSW LANDSCAPE REGIONS (MITCHELL LANDSCAPES)

Two Mitchell Landscapes occur within the study area; Dapto-Wollongong Coastal slopes and Lake Illawarra Alluvial Plains (Table 2-1) (Figure 1-2).

- Dapto-Wollongong Coastal Slopes occur in the more elevated areas, in the north and south of the project. The per cent cleared estimate for this landscape is currently 71% (OEH, 2007).
- Lake Illawarra Alluvial Plains occur in the centre of the development footprint where tributaries such as Macquarie Rivulet feed into Lake Illawarra. The per cent cleared estimate for this landscape is currently 87% (OEH, 2007).

The Mitchell Landscape descriptions are provided below.

Table 2-1 Descriptions of Mitchell Landscapes relevant to the project (DECC, 2002)

Mitchell Landscape
Dapto-Wollongong Coastal slopes (10216)
Hilly forestland lying between the steep rubble slopes of the escarpment and valley floors or coastal barriers. A narrow landscape lying between the coast and the escarpment. Formed on Permian sandstone and shale with areas of interbedded basalt. Slopes range from 3 to 270 m in elevation within stony soils on crests and upper slopes. Deeper well-structured red and red brown loam and clay loam with some areas of mellow texture-contrast soils of high fertility high and good water holding capacity on mid and lower slopes. Yellow solodic soils with bleached A2 horizons common on the lowest slopes and stream terraces. Open forest dominated by Forest Red Gum (<i>Eucalyptus tereticornis</i>), Yellow Stringybark (<i>Eucalyptus muelleriana</i>), Gully Gum (<i>Eucalyptus smithii</i>), stringybark with rainforest elements along streamlines. Extensively cleared, former areas of coastal brush may be indicated by remnant Cabbage-tree Palms (<i>Livistona australis</i>) and Port Jackson Figs (<i>Ficus rubiginosa</i>).

Mitchell Landscape

Lake Illawarra Alluvial Plains (10586)

Quaternary sand, silt and clay of the floodplain and alluvial fans of streams entering Lake Illawarra, general elevation 0 to 40m, local relief <10m. Soils differ with sediment type but are generally uniform sandy loam with high organic content, and humic podsols on some older dunes. Most of the plains are cleared but originally had Forest Red Gum (*Eucalyptus tereticornis*), Woollybutt (*Eucalyptus longifolia*), White stringybark (*Eucalyptus globoidea*), Thin-leaved Stringybark (*Eucalyptus eugenioides*), Cabbage Gum (*Eucalyptus amplifolia*) and extensive stands of Swamp Oak (*Casuarina glauca*), Prickly Paperbark (*Melaleuca styphelioides*) and decorative paperbark (*Melaleuca sp.*) on brackish wet ground near creeks. River Oak (*Casuarina cunninghamiana*) on fresh water streams.

The dominant Mitchell Landscape affected by the project is Lake Illawarra Alluvial Plains. Lake Illawarra Alluvial Plains was entered into the BCC for the project.

2.3 NATIVE VEGETATION EXTENT

Using GIS, a 550 m buffer was established around the boundary of the main infrastructure elements.

The total area of the buffer, including the development footprint, is 1,670.35 ha (Figure 1-3).

The total area of native vegetation mapped within the buffer, *including the development footprint*, is 238.64 ha (Figure 1-3).

Native vegetation mapping used overstorey as a surrogate for native vegetation cover, and is considered conservative as this would include non-native vegetation that may still provide some habitat value. The local area's native vegetation is derived from woodland; no natural grasslands are relevant to the study area.

2.4 CLEARED AREAS

Cleared areas in the development footprint are primarily used for agriculture or grazing and provide very little in terms of fauna habitat. These areas provide suitable foraging habitat for raptors, and introduced species such as cats, foxes and rabbits. Approximately 259.14 ha within the development footprint is cleared land and built environment.

2.5 RIVERS AND STREAMS

The project crosses three sub-catchments within the Illawarra Catchment from north to south, including Duck Creek, Macquarie Rivulet and Horsley Inlet. Duck Creek, Macquarie Rivulet and Horsley Inlet drain into Lake Illawarra, a large coastal lagoon (approximately 8 km long and 5 km wide) with an estuary at Windang, which supports a wide range of waterbirds and other fauna. A description for each of the rivers and streams in the study area is included in Table 2-2.

Table 2-2 Rivers and streams within the study area

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
Duck Creek	Duck Creek	Yes	Type 1-3	No	Class 2 – Moderate fish habitat	3	38	Duck Creek in the study area is a permanent waterway that runs west to east. It is crossed by the Princes Highway and a local road at three locations (bridge crossings). The creek is around 5 m wide bank to bank. Riparian vegetation present around 20 m wide and composed of a mix of native and exotic species. The banks are generally stable, either as a result of the riparian vegetation or from the grasses and herbs where riparian vegetation does not occur. Aquatic habitats present include emergent vegetation, pools and large woody debris. The creek is considered to be in good condition.
	Duck Creek tributary 1	No	N/A	No	Class 3 – Minimal fish habitat	1	32	Duck Creek tributary 1 in the study area is an intermittent waterway that runs west to east. It is crossed by the Princes Highway and a local road at four locations (culvert crossings). The creek is around 2 m wide bank to bank. Riparian vegetation is not present except on the eastern side of the

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
								Princes Highway where riparian vegetation is more than 20 m wide and is composed of a mix of native and exotic species. The banks are generally stable, either as a result of the riparian vegetation or from the grasses and herbs where riparian vegetation does not occur. There are minimal aquatic habitats present except for emergent vegetation. The creek is considered to be in fair condition.
	Duck Creek tributary 2	No	N/A	No	Class 3 – Minimal fish habitat	1	34	Duck Creek tributary 2 in the study area is an intermittent waterway that runs west to east. It is crossed by the Princes Highway at two locations (culvert crossings). The creek is around 3 m wide bank to bank except at the location of the wetlands where it becomes wider. Sparse semi-continuous riparian vegetation composed of a mix of native and exotic species is present. It feeds wetland areas located east, west and between the north and south bound carriageways of the Princes Highway.

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
								The banks are generally stable as a result of the dense grasses and herbs present. Aquatic habitats present include emergent vegetation, in particular in the wetland areas (See below) and long pools. The creek is considered to be in fair condition.
Macquarie Rivulet	Macquarie Rivulet tributary	No	N/A	No	Class 3 – Minimal fish habitat	2	24	The Macquarie Rivulet tributary in the study area is an intermittent waterway that runs north to south and connects the wetlands identified above with Macquarie Rivulet. The waterway is around 2 m wide bank to bank. Riparian vegetation is not present. The banks are generally stable as a result of the dense grasses and herbs present. Aquatic habitats present include emergent vegetation. The creek is considered to be in poor condition.
	Macquarie Rivulet (Plot MR1)	Yes	Type 3	No	Class 1 – Major fish habitat	5	N/A	Macquarie Rivulet in the study area is a permanent waterway that runs west to east. The rivulet is around 30 m wide bank to bank.

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
								Sparse riparian vegetation is present on the northern bank and more continuous riparian vegetation on the southern bank composed of a mix of native and exotic species. The riparian vegetation is less than 5 m wide and is composed of a single row of trees where present. Bank scouring and instability was recorded along the length of this section of the waterway, in particular along the northern bank where limited riparian vegetation was observed and where stock had access. No highly or moderately sensitive aquatic habitats were recorded.
	Frazers Creek 1 (Plot FC1)	Yes	Type 1-3	No	Class 2 – Moderate fish habitat	4	23	Frazers Creek at this location within the study area is an intermittent waterway that runs south east to north west. It is crossed by the Illawarra Highway (culvert crossing). The creek is around 2 m wide bank to bank. Based on field observations and review of aerial photographs, the section of creek north of the highway seems to have been highly modified and is unlikely to represent the

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
								original location of this section of the creek. Riparian vegetation is not present. The banks are generally stable as a result of the dense grasses and herbs present. There is minimal aquatic habitats present except for emergent vegetation. This section of creek is considered to be in poor condition.
	Frazers Creek 2	Yes	Type 1-3	No	Class 2 – Moderate fish habitat	4	29	Frazers Creek at this location is intermittent and runs through an agricultural landscape and connects with the wetlands identified above. It generally runs south to north. It is around 3-5 m wide from bank to bank. Riparian vegetation is either not present or is sparse and semi-continuous and composed of a mix of native and exotic species. The riparian vegetation is less than 5 m wide and is composed of a single row of trees where present. The banks are generally stable as a result of the dense grasses and herbs present.

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
								Aquatic habitats present include emergent vegetation and pools. This section of the creek is considered to be in fair condition.
	Frazers Creek 3	Yes	Type 1-3	No	Class 2 – Moderate fish habitat	4	35	Frazers Creek at this location is intermittent and meanders south to north. It is around 3-5 m wide from bank to bank. Riparian vegetation is continuous and composed of a mix of native and exotic species. The riparian vegetation is between 5 m to around 20 m wide. The banks are generally stable due to the riparian vegetation though frequent bank undercutting were recorded along this section of the creek. Aquatic habitats present include submerged, emergent and floating vegetation, riffles, large woody debris and pools. However, heavy siltation of the creek was also observed in some locations. This section of the creek is considered to be in good condition.

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
	Unnamed waterway 1	No	N/A	No	Class 3 – Minimal fish habitat	1	23	This unnamed waterway is intermittent and runs south to north. It is crossed by the East-West Link (culvert crossing). The waterway ends at a wetland north of the road (see below). It does not have defined banks and runs through an agricultural zone. Riparian vegetation is not present. The banks are generally stable as a result of the dense grasses and herbs present. There is no to minimal aquatic habitat present. The creek is considered to be in poor condition.
	Horsley Inlet tributary 1	No	N/A	No	Class 3 – Minimal fish habitat	2	24	This unnamed waterway is intermittent and runs south to north in the study area. It is crossed by the East-West Link (culvert crossing). The waterway is highly modified. North of the highway it runs through an urban area as a depression in a grassed area. South of the road, the section of creek within the study area has also been highly modified and the banks are undefined. These become more defined just outside the study area to the south where it is located near a

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
								quarry. Land use also includes agriculture and stock access. Riparian vegetation is not present. The banks are generally stable as a result of the dense grasses and herbs present. There is no to minimal aquatic habitat present. The creek is considered to be in poor condition.
	Horsley Inlet tributary 2	No	N/A	No	Class 3 – Minimal fish habitat	1	24	This unnamed waterway is intermittent and runs south to north in the study area. It is crossed by the East-West Link (culvert crossing). The waterway is highly modified. North of the highway it runs through an urban area as a depression in a grassed area. South of the road, it immediately joins with the unnamed drainage line (see below). Land use also includes agriculture and stock access. Riparian vegetation is not present. The banks are generally stable as a result of the dense grasses and herbs present. There is no to minimal aquatic habitat present.

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
								The creek is considered to be in poor condition.
Horsley Inlet	Horsley Inlet tributary 3	No	N/A	No	Class 3 – Minimal fish habitat	1	23	This unnamed waterway is intermittent and runs south to north in the study area. It is crossed by the East-West Link (culvert crossing). The waterway is highly modified. North of the highway it runs through an urban area as a depression in a grassed area. A wetland is located just south of the road (see below), while further south the section of creek within the study area has also been highly modified and the banks are undefined. These become more defined just outside the study area to the south where it is located near a quarry. Land use also includes agriculture and stock access. Riparian vegetation is not present. The banks are generally stable as a result of the dense grasses and herbs present. There is no to minimal aquatic habitat present. The creek is considered to be in poor condition.

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
	Unnamed drainage line	No	N/A	No	Class 3 – Minimal fish habitat	N/A	23	This intermittent man made drainage line runs parallel to the East West Link on its southern side and connects the Horsley Inlet wetlands to Horsley Inlet tributaries 1 and 2. Land use is rural in nature. Riparian vegetation is not present. The banks are generally stable as a result of the dense grasses and herbs present. Aquatic habitats present include emergent vegetation and pools.
	Horsley Inlet	Yes	Type 1-3	No	Class 3 – Minimal fish habitat	3	30	Horsley Inlet within the study area is intermittent and located at the intersection of the East West Link with the Princes Highway and runs in a northerly direction. The inlet is crossed by the East West Link (culvert crossing). The culvert extends from the southern side of the East-West Link to Pioneer Drive running below an industrial zone (around 800 m long). South of the East-West Link the creek runs through an agricultural landscape with stock access. Riparian vegetation is either not present or is sparse and semi-continuous and composed of a mix of

Catchment	Waterway (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge 2003)	Stream order (according to Strahler 1952)	Riparian, Channel, Environment (RCE) score	Comments
								native and exotic species. The riparian vegetation is less than 5 m wide and is generally composed of a single row of trees where present. Bank scouring and instability was recorded along the length of this section of the waterway likely as a result of limited riparian vegetation and stock had access. Aquatic habitats present include emergent vegetation and pool and riffle habitat. This section of the creek is considered to be in fair condition.

2.6 WETLANDS

Due to the low-lying nature of the landscape, numerous wetlands are found within and surrounding the study area. The Illawarra Biodiversity Strategy identifies four Nationally Important Wetlands occurring in the Illawarra region near the development footprint (Illawarra Councils, 2011). The Illawarra Regional Airport contains a small wetland area approximately 180 m to the east of the development footprint. Lake Illawarra lies approximately two kilometres to the east of the development footprint. Nearby is the State Environmental Planning Policy No. 14 – Coastal Wetlands (SEPP 14 Wetland) approximately 55 m to the east of the development footprint. Frazer's Creek feeds into this wetland, which was observed to contain a good diversity of native aquatic and riparian flora species, and may provide foraging habitat for migratory wading birds. This wetland is also considered an Important Wetland in New South Wales (Environment Australia, 2001).

Other SEPP 14 coastal wetlands occur further to the east, on the edge of Lake Illawarra and further to the south-east near Shellharbour Train Station. Haywards Bay and Koona Bay are both part of Lake Illawarra. Minnamurra River Estuary Complex and Killalea Lagoon lie approximately 4.5 km to the south-east of the development footprint. Finally, Coomadatchy Lagoon lies approximately 10.5 km to the north-east of the development footprint (Figure 1-2 and Figure 1-3). Including a 50 m buffer around these wetlands, no State or Nationally Important Wetlands would be impacted by the project. A description of each of the wetlands within the study area is included in Table 2-3.

Table 2-3 Wetlands within the study area

Catchment	Wetland (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge, 2003)	Stream order (according to Strahler, 1952)	Riparian, Channel, Environment (RCE) score	Comments
Duck Creek	Duck Creek tributary 2 wetlands	Yes	Type 1-3	Yes, Freshwater wetlands on coastal floodplains EEC	N/A	N/A	N/A	These wetlands are located adjacent to Duck Creek tributary 2. They cover an area around 1 ha in size. It is located in an undeveloped area in close proximity to the Princes Highway. Aquatic habitats include emergent, submerged and floating aquatic vegetation as well as open water. Vegetation is a mix of exotic and native species. Native species diversity was moderate. The wetland is considered to be in moderate - good condition.
	Council dams	No	N/A	No	N/A	N/A	N/A	Three constructed dams are located west of the Princes Highway just north of industrial land uses in the Old Golf Course site. The land surrounding the dams is undeveloped and vegetated. The dams are 0.22, 0.09 and 0.36 ha in size. Aquatic habitats include emergent, submerged and floating aquatic vegetation as well as open water. Vegetation is a mix of exotic and native species. Native species diversity was low.

Catchment	Wetland (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge, 2003)	Stream order (according to Strahler, 1952)	Riparian, Channel, Environment (RCE) score	Comments
Macquarie Rivulet	Macquarie Rivulet tributary wetlands (plots FW 1, 2, 3)	Yes	Type 1-3	Yes, Freshwater wetlands on coastal floodplains EEC	N/A	N/A	N/A	These wetlands are located west of the Princes Highway along the Macquarie Rivulet tributary. They cover an area of around 3.2 ha in size. They are located in a disturbed area including agricultural uses (stock) and in proximity to industrial land uses. Aquatic habitats include emergent, submerged and floating aquatic vegetation as well as open water. Vegetation is a mix of exotic and native species. Native species diversity was low. The wetland is considered to be in moderate - good condition.
	Frazers Creek wetland complex (plots FW 6, 7, 8)	Yes	Type 1-3	Yes, Freshwater wetlands on coastal floodplains EEC	N/A	N/A	N/A	These wetlands are located along Frazers Creek south of the Illawarra Highway. They cover an area around 11 ha in size (not including the SEPP 14 wetland described below). They are located in a disturbed area used for grazing. Aquatic habitats include emergent, submerged and floating aquatic vegetation as well as open water. Vegetation is a mix of exotic and native species. Native species diversity was moderate.

Catchment	Wetland (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge, 2003)	Stream order (according to Strahler, 1952)	Riparian, Channel, Environment (RCE) score	Comments
								The wetlands are considered to be in moderate - good condition.
	SEPP 14 wetlands (part of Frazers Creek wetland complex; plots FW 4, 5)	Yes	Type 1-3	Yes, Freshwater wetlands on coastal floodplains EEC	N/A	N/A	N/A	This wetland is part of the Frazers Creek wetland complex (see above). It is around 4.96 ha in size. It is located in a disturbed area used for grazing. Aquatic habitats include emergent, submerged and floating aquatic vegetation as well as open water. Vegetation is a mix of exotic and native species. Native species diversity was moderate. The wetland is considered to be in moderate - good condition.
Horsley Inlet	Unnamed waterway 1 wetland	Yes	Type 1-3	Yes, Freshwater wetlands on coastal floodplains EEC	N/A	N/A	N/A	This wetland is located immediately north of the East West Link at the end of an unnamed waterway (see above). It is around 0.2 ha in size. It is located in a disturbed semi urban area. Aquatic habitats include emergent, submerged and floating aquatic vegetation as well as open water. Vegetation is a mix of exotic and native species. Native species diversity was moderate. The wetland is considered to be in moderate - good condition.

Catchment	Wetland (from north to south)	Key Fish Habitat as per DPI (Fisheries) mapping and/or definition?	Type (i.e. sensitivity) of key fish habitat present in accordance with DPI (Fisheries) guidelines ^{*1}	Endangered Ecological Community?	Waterway classification (according to Fairfull and Witheridge, 2003)	Stream order (according to Strahler, 1952)	Riparian, Channel, Environment (RCE) score	Comments
	Horsley Inlet wetlands	Yes	Type 1-3	Yes, Freshwater wetlands on coastal floodplains EEC	N/A	N/A	N/A	This wetland is located immediately south of the East West Link and on the Horsley Inlet tributary 3. It is around 0.4 ha in size. It is located in a disturbed area including agricultural uses (stock) and a quarry is located upstream. Aquatic habitats include emergent, submerged and floating aquatic vegetation as well as open water. Vegetation is a mix of exotic and native species. Native species diversity was moderate. The wetland is considered to be in moderate condition.

2.7 STATE OR REGIONALLY SIGNIFICANT BIODIVERSITY LINKS

State Significant Biodiversity Links and Regionally Significant Biodiversity Links are defined in the FBA. To date, no biodiversity corridor plans have been approved by the Chief Executive of the OEH.

Under the FBA, the SEPP 14 Wetland in the Frazers Creek wetland complex including a 50 m buffer area is classed as a State Significant Biodiversity Link. However, the wetland occurs approximately 55 m from the development footprint, which is therefore outside the identified State Significant Biodiversity Link buffer. This link, and the SEPP 14 wetland itself, would not be directly impacted by the project.

Under the FBA, riparian buffers 20 m either side of a 4th or 5th order stream constitute Regionally Significant Biodiversity Links. One 4th order stream occurs within the development footprint, being Frazer's Creek which constitutes a Regionally Significant Biodiversity Link. This creek is crossed a number of times by the development footprint. One 5th order stream also occurs within the development footprint, being the Macquarie Rivulet, however this stream has less than a 20 m riparian buffer and is therefore not considered a Regionally Significant Biodiversity Link. Waterways, particularly where the vegetation is more structurally complex (such as at Macquarie Rivulet and the southern section of Frazer's Creek), provide riparian habitat for a range of fauna species, and act as natural movement corridors through highly modified landscapes. East-west wildlife connectivity through the development footprint is mostly provided by the Yallah – Marshall Mount Biodiversity Corridor, however it is also provided by the Macquarie Rivulet. Although useful for some fauna types as a connective corridor, these riparian habitats do not provide linkage to large tracts of vegetation. Duck Creek (and its tributaries), provides minimal wildlife connectivity.

No other State or Regionally Significant Biodiversity Links occur within or near the development footprint.

Croom Reserve has been listed in the Illawarra Biodiversity Strategy as a 'highest priority site for investment'. This is due to it having priority vegetation, good connectivity, large patch size and a management regime with qualified bush regenerators (Illawarra Councils, 2011). However, Croom Reserve is not recognised as a local area biodiversity link as it is less than the required 250 ha in the FBA. Croom Reserve contains approximately 46.66 ha of native open woodland vegetation. The project would involve some clearing of vegetation on the edge of Croom Reserve (0.15 ha), which is part of a 21.94 ha area that is protected through a voluntary conservation agreement (VCA) between Shellharbour City Council and the NSW Minister for the Environment. This VCA has been in place since 2002. Impacts to a small area of Croom Reserve VCA land are discussed in Section 5.5. The remainder of Croom Reserve has been proposed as a potential offset site and is discussed further in the Biodiversity Offset Strategy. Some local biodiversity linkage occurs between Croom Reserve and Blackbutt Reserve.

Two mapped biodiversity corridors occur within the development footprint, the Yallah-Marshall Mount Biodiversity Corridor and the Tongarra-Stockyard Mountain Biodiversity Corridor (Figure 2-1).

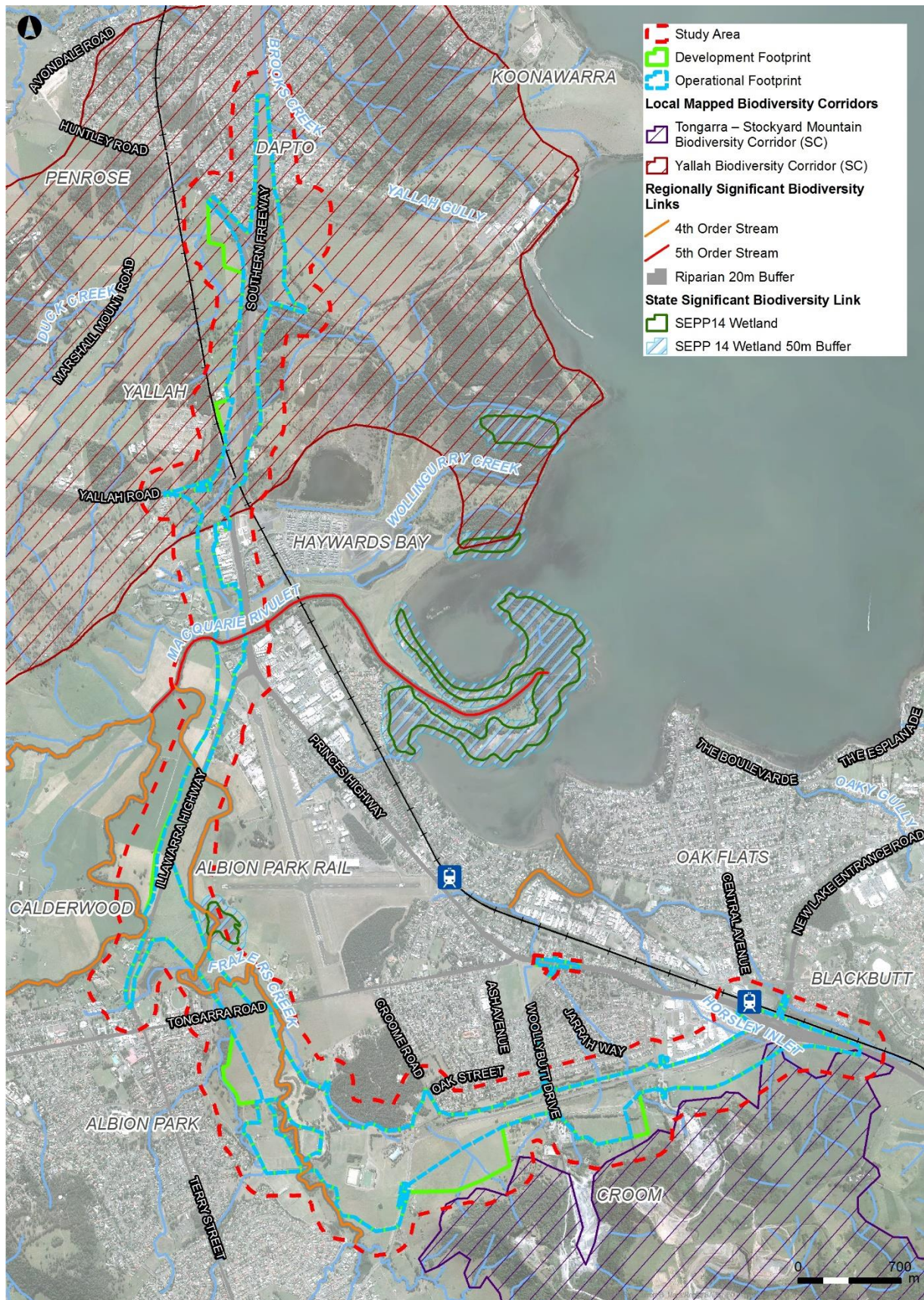


Figure 2-1 Regionally and State Significant Biodiversity Links and Local Mapped Biodiversity Corridors within the study area

The Yallah-Marshall Mount Biodiversity Corridor runs across the north of the development footprint from the Illawarra Escarpment to Lake Illawarra. It is the only remaining set of closely spaced woodland remnants linking the escarpment to the vegetation on the shores of Lake Illawarra. Despite being isolated and disturbed, these grassy woodland remnants (including the majority of the Illawarra Lowlands Grassy Woodland in the Illawarra region) have been found to have similar levels of species richness and diversity as undisturbed environments within the Wollongong LGA. These woodland remnants, as well as wetlands, provide fauna linkage habitat, known as the Yallah-Calderwood Fauna Linkage. The high proportion of the landscape that remains vegetated is the most important feature of this linkage (NPWS, 2002).

The Tongarra-Stockyard Mountain Biodiversity Corridor runs across the south of the development footprint from the Illawarra Escarpment to the foothills near Croom and Blackbutt in the Shellharbour LGA. It contains important forest habitat for forest dwelling threatened fauna and threatened flora species (Illawarra Councils, 2011).

2.8 LANDSCAPE VALUE SCORE COMPONENTS

A BioBanking credit assessment was completed for this project, selected as 'Major Project'. The proposal ID for the original assessment was 144/2014/1295D Version 4. A revision of the infrastructure footprint was completed in February 2017 by which time substantial changes (including the integration of the linear assessment) had been made to the BCC. A new BCC file was therefore created to ensure any BCC updates were considered in the revised calculations. A new linear assessment was undertaken based on the February 2017 infrastructure footprint. This section summarises the values entered into the Landscape values section of the BCC assessment in February 2017. The proposal ID for the revised assessment is 0035/2017/4182MP Version 1.

2.8.1 Method applied

The project conforms to the definition of a *linear shaped development* according to the FBA; *a development that is generally narrow in width and extends across the landscape for a distance greater than 3.5 kilometres in length*. The linear landscape assessment methodology, in accordance with FBA for major projects, has been used in the assessment. At the time the calculations were completed, this method had not been incorporated into the BCC. Appendix 5 of the FBA was undertaken manually and the resulting landscape assessment score was then entered into the BCC by manipulating the Landscape Assessment section of the BCC, in consultation with OEHS¹ in 2015. A revision of the infrastructure footprint was completed in February 2017 at which time the linear assessment had been incorporated into the BCC. The assessment was redone using the online BCC linear assessment without further OEHS consultation.

The project contains vegetation that is likely to have been planted but which still contains habitat values. These areas of vegetation were assigned to the nearest biometric vegetation type in order that their value to threatened species would be accounted for.

¹ Alana Burley, OEHS BioBanking team, 8 May 2015 (email).

Consultation was undertaken with OEH regarding the use of the BCC and FBA methodology. This was not project-specific, but focussed on the application of the tool as follows:

- The OEH BioBanking team were consulted in June 2015 regarding adding threatened species to the Threatened Species Survey Results tab (two species were added that were detected onsite but not generated by the BCC) and deleting ecosystem species from the Site Survey Details tab (0 species were deleted after consideration of the low impact of deleting the species).

Email correspondence regarding these queries has been retained.

2.8.2 Percent native vegetation cover in the landscape

The following steps were completed in accordance with Appendix 5 of the FBA.

Assessing percent current extent of native vegetation cover

Using GIS, a 550 m buffer was established around the boundary of the main infrastructure elements.

- The total area of the buffer, including the development footprint, is 1,670.35 ha.
- The total area of native vegetation mapped within the buffer, including the development footprint, is 238.64 ha.
- Current native vegetation cover is therefore 14%.

Assessing percent future extent of native vegetation cover

Using GIS, a 550 m buffer was established around the boundary of the main infrastructure elements.

- The total area of the buffer, including the development footprint, is 1,670.35 ha.
- The area of native vegetation mapped within the buffer, excluding the development footprint, is 206.04 ha.
- Future native vegetation cover is therefore 12%.

2.8.3 Connectivity value

A connecting link is when native vegetation on the site adjoins native vegetation surrounding the site and the native vegetation:

- is in moderate to good condition, and
- has a patch size >1 ha, and
- is separated by a distance of <100 m (or <30 m for non-woody ecosystems), and
- is not separated by a large water body, dual carriageway, wider highway or similar hostile link.

With reference to Table 17 of the FBA (below), the development footprint affects the following link:

- A 4th order stream, more than 20 m riparian buffer would be affected = a score of 10 is recorded.

Note:

- A 5th order stream occurs but has less than 20 m riparian buffer and therefore does not contribute to this score.
- No other links occur as affected remnant vegetation patches (even where they extend beyond the buffer) are less than 200 ha.

Extract from the FBA Table 17: Connectivity value scores for linear shaped developments or development that has multiple fragmentation impacts.

Category of connecting link	Definition of connecting link	Score
Regionally significant biodiversity link	An area identified by the assessor as being part of a regionally significant biodiversity link and in a plan approved by the Chief Executive, OEH OR A riparian buffer 20 m either side of a 4th or 5th order stream OR A riparian buffer 30 m around a regionally significant wetland	10

2.8.4 Patch size

For a development that is linear shaped or a multiple fragmentation development, the assessor must assess the patch size for each Mitchell landscape in which the development occurs. The results are as follows:

Mitchell landscape 1:

Lake Illawarra Alluvial Plains 87% cleared

Largest patch size: >100 ha

Table 18 score: 12.5

Mitchell landscape 2:

Dapto Wollongong Coastal Slopes 71% cleared

Largest patch size: >100 ha

Table 18 score: 12.5

The final patch size score, found by averaging those scores, is 12.5.

Extract from the FBA Table 18: Criteria for assessing patch size Patch size class.

Patch size class	Percent native vegetation cleared in each Mitchell landscape in which the Major Project occurs				Patch size (score)
	<30%	30–70%	>70–90%	>90%	
Extra large	>1000 ha	>200 ha	>100 ha	>50 ha	12.5
Very large	>500 – 1000 ha	>100 – 200 ha	>50 – 100 ha	>20 – 50 ha	10
Large	>200 – 500 ha	>50 – 100 ha	>20 – 50 ha	>10 – 20 ha	7.5
Medium	>100 – 200 ha	>20 – 50 ha	>10 – 20 ha	>1 – 10 ha	5
Small	≤100 ha	≤20 ha	≤10 ha	≤1 ha	2.5
nil	0	0	0	0	0

2.8.5 Area to perimeter ratio

Six patches (A-F) within the buffer would be affected by the project (Figure 2-2). Each patch is made up of a number of polygons (named 1-n). The area and perimeter ratio before development is shown below.

Patch A	Area (ha)	Perimeter (m)
1	0.5	424.3
2	5.0	3,201.5
3	4.8	3,399.1
4	16.6	2,954.5
5	1.0	394.1
6	4.0	1,318.3
7	7.1	4,346.8
Patch B	Area (ha)	Perimeter (m)
1	13.8	1,579.3
2	0.9	505.3
3	1.0	785.7
4	4.9	1,420.4
5	2.2	722.4
6	9.0	1,213.8
7	1.9	639.3
8	7.6	1,080.7
Patch C	Area (ha)	Perimeter (m)
1	3.7	1,372.8
2	20.3	12,532.7

Patch D	Area (ha)	Perimeter (m)
1	5.9	2714.4
2	1.6	924.1
Patch E	Area (ha)	Perimeter (m)
1	19.3	8210.2
2	1.0	675.7
3	0.3	216.0
4	33.7	3078.0
5	3.0	1051.2
6	5.0	1245.0
7	3.1	1024.1
Patch F	Area (ha)	Perimeter (m)
1	9.1	2500.0
2	6.5	1642.8
Totals:	192.8	61,172.5
Area m² / Perimeter m	31.5	

The current area to perimeter ratio is 31.5.

The effect of the development is to increase the number of polygons in some patches and to reduce their area. Taking into account the development, the future area and perimeter ratio after development is shown below. Note, as above, Patch A1 is excluded but Patch A5 is included from the sum total.

Patch A	Area (ha)	Perimeter (m)
1	0.0	0.0
2a	0.8	1,242.1
2b	0.0	100.0
3a	0.5	1,113.7
3b	0.0	130.5
4	16.4	2,914.4
5	0.5	332.5
6	0.0	0.0
7	2.1	2,284.2
Patch B	Area (ha)	Perimeter (m)
1	13.8	1,579.3
2	0.9	505.3
3	1.0	785.7
4	3.9	1,340.4

Patch B	Area (ha)	Perimeter (m)
5	2.0	701.5
6a	0.3	267.4
6b	2.7	693.7
6c	0.0	95.3
7	1.8	640.3
8	7.6	1,080.7
Patch C	Area (ha)	Perimeter (m)
1	3.7	1,372.8
2a	16.2	9,379.1
2b	2.9	2,421.5
Patch D	Area (ha)	Perimeter (m)
1	5.8	2675.2
2	1.6	924.1
Patch E	Area (ha)	Perimeter (m)
1a	0.6	426.7
1b	3.5	1,230.5
1c	11.7	5,634.3
2	0.74	655.0
3	0.0	0.0
4	32.7	2,948.6
5	3.0	1,051.2
6	5.0	1,245.0
7	3.1	1,024.1
Patch F	Area (ha)	Perimeter (m)
1	8.9	2462.9
2	6.5	1642.8
Totals:	160.2	50,900.8
Area m² / Perimeter m	31.5	

The future area to perimeter ratio after development is 31.5.

The area / perimeter score is 1.

The proportional change in area to perimeter ratio is 0.



Figure 2-2 Native vegetation extent patch calculations

2.9 LANDSCAPE VALUE SCORE

The assessor must calculate the change in landscape value score for the development footprint using Equation 4 in Appendix 1 of the FBA.

$$\begin{array}{lcl} \text{Impact of} & = & \text{CURRENT} & - & \text{FUTURE} \\ \text{development on} & & (A+B +C+D+E) & & (A+B) \\ \text{landscape scale} & & & & \\ \text{attributes} & & & & \end{array}$$

Where:

A = score for percent extent native vegetation cover in accordance with Appendix 5

B = for linear shaped or multiple fragmentation development, this will be zero

C = area to perimeter ratio of all patch size areas within the buffer area surrounding the development footprint for a development assessed in accordance with Appendix 5

D = connectivity value score for the Major Project determined in accordance with Appendix 5

E = total patch size score determined in accordance with Appendix 5.

This has been completed as part of the BCC calculations. The landscape value score is 23.5.

3 NATIVE VEGETATION

3.1 PLANT COMMUNITY TYPES

3.1.1 Vegetation communities

Six distinct Plant Community Types (PCTs) were observed in the study area. These include:

1. Woollybutt – White Stringybark – Forest Red Gum Grassy Woodland (PCT 1326)
2. Swamp Oak-Prickly Tea Tree – Swamp Paperbark swamp forest on coastal floodplains (PCT 1232) qualifies as EEC
3. Coastal Freshwater Lagoons (PCT 781) qualifies as EEC
4. *Derived Forest Red Gum – Thin-leaved Stringybark Grassy Woodland (PCT 838)
5. *Disturbed riparian vegetation:
 - a. Derived Swamp Mahogany Swamp Sclerophyll Forest (PCT 1231),
 - b. Derived River Oak open forest of major streams (PCT 1105),
 - c. Derived Swamp Oak - Prickly Tea-tree - Swamp Paperbark swamp forest on coastal floodplains (PCT 1232)
6. Non-indigenous vegetation.

* It is noted that the *Derived Forest Red Gum – Thin-leaved Stringybark Grassy Woodland* and the *Disturbed riparian vegetation* are highly modified regrowth and planted areas. While they were not able to be easily attributed to a native vegetation community, they have been assigned to the closest PCT in order to assess if they provide important threatened species habitat and generate threatened species credits in the BCC calculations.

It is also noted that *Swamp Oak - Prickly Tea-tree - Swamp Paperbark swamp forest on coastal floodplains* (PCT #1232) was not able to be selected as a vegetation zone in the BCC. It was not an option in the vegetation type drop down when entering vegetation zones. Therefore, *Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion* (PCT #1616) was selected as the closest match. As the latter formation occurs close to the coast and in association with estuaries, it is considered suitable and not likely to inappropriately affect the results of the calculations. This zone reflects a highly modified version of the natural vegetation type and therefore some latitude here is considered justifiable.

The derived vegetation types do not qualify as EEC vegetation. Under the FBA, the only way they would generate a credit requirement is if they provided habitat for threatened species. Including them in the credit calculations ensures that this aspect of the assessment has been considered.

Non-indigenous vegetation is not considered to provide habitat to native species and has not been included in the BCC calculations in accordance with the FBA.

Woollybutt – White Stringybark – Forest Red Gum grassy woodland (PCT 1326)

Within the study area, Plant Community Type (PCT) 1326 occurred in the TransGrid site, Croom Reserve, northern road corridor and the Old Golf Course. This vegetation community is listed as an Endangered Ecological Community (EEC) known as Illawarra Lowlands Grassy Woodland (ILGW) under the TSC Act.

Where undisturbed remnant patches of PCT 1326 occur, the vegetation is a diverse and well-structured community that is dominated by Woollybutt (*Eucalyptus longifolia*), Forest Red Gum (*E. tereticornis*), Thin-leaved Stringybark (*E. eugenioides*), and White Feather Honey-myrtle (*Melaleuca decora*). The understorey is generally open, with scattered shrubs such as Prickly Beard-heath (*Leucopogon juniperinus*) and Cassinia (*Cassinia* sp.) present alongside the relatively abundant Straight Wattle (*Acacia stricta*) and Falcate Wattle (*Acacia falcata*). Some areas, even within the less-disturbed patches, contain dense patches of Lantana thickets, underneath which there are few native groundcover species. Elsewhere, groundcovers include a diverse array of native forbs and grasses, such as Kidney Weed (*Dichondra repens*), Tiger Orchid (*Diuris sulphurea*), Devil's Twine (*Cassytha* sp.), Purple Pratia (*Lobelia purpurascens*), Wallaby Grass (*Rytidosperma* sp.), Wiry Panic (*Entolasia stricta*), Right-angle Grass (*E. marginata*), Blady Grass (*Imperata cylindrica*), and Weeping Grass (*Microlaena stipoides*). The Eastern Flame Pea is also relatively abundant in this community, and is generally found where there is an open canopy or understorey, or where patches meet more open environments along their edges (Table 3-1). Where patches of thick, introduced grasses such as Kikuyu (*Pennisetum clandestinum*) dominated, the Eastern Flame Pea was rare (such as in the Old Golf Course).

In areas where this community has been cleared but has begun to regrow, the vegetation has been considered to form part of this community, as per the final determination of the NSW Scientific Committee. In such areas, the understorey may be dominated by exotic species, and frequently contains a dense mat of Kikuyu (*Pennisetum clandestinum*). Better-quality patches of this community occur within Croom Reserve, Hargraves Avenue Reserve, the Illawarra Light Rail Museum Society land, and the TransGrid property. Of these locations, Croom Reserve and the TransGrid property would be impacted by the project.

Table 3-1 Summary of the Woollybutt – White Stringybark – Forest Red Gum grassy woodland vegetation community (PCT 1326) in the development footprint.

Woollybutt – White Stringybark – Forest Red Gum grassy woodland		
Vegetation formation	Grassy woodlands	
Vegetation class	Coastal valley grassy woodlands	
Vegetation type	Plant Community Type (PCT) ID	1326
	Biometric Vegetation Type ID	SR669
	Common Community Name	Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
Approximate extent within project (ha)	This vegetation community covers approximately 7.22 ha in the development footprint, most of which occurs at the northern end of the study area (Figure 3-1). An additional 104.81 ha of this community is found in the surrounding locality outside the development footprint.	
Condition	Moderate to Good. Generally, a well-structured community with few disturbances in remnants, although some patches have dense Lantana thickets present. Vegetation condition may be lower in places where historical clearing or other disturbances have taken place, such as sections of the Council land to the south of the TransGrid property (as shown in Figure 1-3), however all areas of this community were in varying states of Moderate to Good condition.	
BioMetric Site Value Scores (/100)	TransGrid Site (Plots TG1 – 2) – Site Value Score (SVS) average = 67.11 Road Reserve North (Plot RRN1) – SVS average = 31.55 Croom Reserve (Plot CR1) – SVS average = 47.23 Old Golf Course (Plots GC1 – 2) – SVS average = 28.95 Borg (Plot ILGW1) – SVS average = 53.85	
Survey Effort	26 biometric plots (approximately 26 hours) (a minimum of 3 biometric plots are required by the FBA BCC)	
Conservation Status	This vegetation community is listed as an endangered ecological community (EEC) known as Illawarra Lowlands Grassy Woodland under the TSC Act. In 2016, the Threatened Species Scientific Committee declared Illawarra and South Coast Lowland Forest and Woodland (ISCLFW) as a critically endangered ecological community (CEEC) under the EPBC Act. This community corresponds closely with the TSC Act listed ILGW community in the study area. Vegetation surveys were conducted in 2016 to determine the presence and distribution of the EPBC Act listed ISCLFW CEEC in the study area. The project would result in the removal of 7.22 ha of ILGW EEC (which corresponds to 7.22 ha of EPBC Act listed ISCLFW CEEC).	
Estimate of percent cleared	95%	
Threatened plant species habitat	This community provides good quality habitat for threatened flora species, including the Eastern Flame Pea and the Illawarra Greenhood Orchid. There is some potential for Curved Rice-flower to be found in high quality patches of this community, and the species has been found in Croom Reserve and the Illawarra Light Rail Museum Society land to the north of Croom Reserve.	
Equivalent vegetation types	Most vegetation mapping schemes contain two similar vegetation communities that fall under the definition of the threatened Illawarra Lowlands Grassy Woodland. These communities intergrade (transition into one another) in many places and can be difficult to delineate effectively. The SCIVI mapping (Tozer <i>et al.</i> 2010) calls these map units (GW p3) <i>South Coast Lowland Swamp Woodland</i> , which is the community found within the development footprint, and (GW p34) <i>South Coast Grassy Woodland</i> , which is not found within the development footprint.	

Woollybutt – White Stringybark – Forest Red Gum grassy woodland	
	The BioMetric database calls these communities <i>Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin and South East Corner</i> ; and <i>Forest Red Gum – Thin-leaved Stringybark grassy woodland on coastal lowlands, southern Sydney Basin</i> respectively. <i>Woollybutt – White Stringybark – Forest Red Gum grassy woodland</i> has also been mapped as <i>Lowland Woollybutt – Melaleuca Forest</i> or <i>Red Gum – Paperbark Forest</i> in some databases.
Fauna Habitat	This vegetation community provides numerous habitat types for fauna. Canopy trees provide foraging and nesting/resting for birds and arboreal fauna. The mid-storey (if present) provides foraging and nesting for smaller birds, as well as refuge for small-medium sized mammals and reptiles. Ground plants, logs and fallen leaves provide shelter and foraging for terrestrial fauna as well. Where hollow-bearing trees are present, it may provide daytime resting habitat for bats and mammals, and roosting habitat for birds.
Example	 Figure 3-1 Example of Woollybutt – White Stringybark – Forest Red Gum grassy woodland in the study area.

Swamp Oak-Prickly Tea Tree – Swamp Paperbark swamp forest on coastal floodplains, (PCT 1232)

There are two areas within the development footprint that contain PCT 1232 which falls under the definition of the EEC known as *Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (Swamp Oak Floodplain Forest EEC). There are three vegetation communities within the Southern Rivers Catchment Management Authority that are associated with this EEC, including *Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion*, *Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion*, *Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion*.

One patch of Swamp Oak Floodplain Forest EEC occurs adjacent to Croom Reserve, within the Croom Regional Sporting Complex. The vegetation in the riparian zone has been previously mapped as 'Swamp

Oak Forest' by Shellharbour City Council. This was confirmed during the survey as being Swamp Oak Floodplain Swamp Forest, Sydney Basin Bioregion and South East Corner Bioregion (PCT 1232). Although weeds were present, the vegetation was relatively intact. For the majority of the vegetation, the canopy was dominated by *Casuarina glauca*. *Melaleuca* and *Eucalypt* species also occurred sparsely within the vegetation, especially towards the periphery. These species likely represented integration with a once adjacent community. However, the dominance of *Casuarina glauca* and the presence of a number of other species listed in the NSW Scientific Committee - final determination (OEH, 2011) meant that the vegetation met the requirements for Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC (TSC Act).

The vegetation on both the northern and southern sides of Macquarie Rivulet were inspected in October 2016 and February 2017 to confirm the status of the community present. Two vegetation patches on the northern bank (only one is within the development footprint) were confirmed as the EEC Swamp Oak Floodplain Swamp Forest, Sydney Basin Bioregion and South East Corner Bioregion (PCT 1232). Although the mid storey and ground layer are relatively weedy, the canopy of the vegetation patches on the northern bank are intact and dominated by Swamp Oak (*Casuarina glauca*). Therefore, the vegetation on the northern bank meets the requirements for Swamp Oak Floodplain Forest EEC (TSC Act). The vegetation on the southern bank of the river is weedier and has a less intact canopy than the vegetation on the northern bank. Noxious weeds include Lantana (*Lantana camara*), Wandering Jew (*Tradescantia fluminensis*), and Small-leaf Privet (*Ligustrum sinense*). As a result, the vegetation on the southern bank has been referred to as Derived Swamp Oak-Prickly Tea Tree – Swamp Paperbark swamp forest on coastal floodplains (PCT 1232), and does not meet the requirements of the EEC.

Table 3-2 Summary of Swamp Oak Floodplain Forest EEC (PCT 1232) in the development footprint.

Swamp Oak Floodplain Forest		
Vegetation formation	Forested wetlands	
Vegetation class	Coastal floodplain wetlands	
Vegetation type	Plant Community Type (PCT) ID	1232
	Biometric Vegetation Type ID	SR649
	Common Community Name	Swamp Oak-Prickly Tea Tree – Swamp Paperbark swamp forest on coastal floodplains, Sydney Basin Bioregion and South East Corner Bioregion
Approximate extent within project	This vegetation community covers approximately 0.55 ha in the development footprint, all of which is considered an endangered ecological community. This community is rare within the study area as it has been historically cleared. Approximately 1.8 ha of this community occurs adjacent to or within the development footprint.	
Condition	Moderate to Good. Despite the presence of some common exotic species, greater than 50% of the understorey is native.	
BioMetric Value (/100)	Site Scores	Macquarie Rivulet (Plot MR2) - SVS average = 83.3 Plot MR2 - SVS average = 24.48 Plot MR3 SVS average = 37.5 Croom (Plot Croom Regional Sporting Complex 1) - SVS average= 82.8
Survey Effort	4 biometric plots (3.5 hours). A minimum of 1 biometric plot is required by the FBA BCC.	

Swamp Oak Floodplain Forest	
Conservation Status	Swamp Oak-Prickly Tea Tree – Swamp Paperbark swamp forest on coastal floodplains, Sydney Basin Bioregion and South East Corner Bioregion in the study area forms part of the endangered ecological community known as Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions . This EEC is listed under the TSC Act but not the EPBC Act.
Estimate of percent cleared	95%
Threatened plant species habitat	This community provides only marginal quality habitat for threatened flora species, and it is unlikely that any threatened species would become established in the community.
Equivalent vegetation types	The SCIVI (Tozer <i>et al.</i> , 2010) map unit that corresponds best to this vegetation type is FOW p105 (Floodplain Swamp Forest).
Fauna Habitat	This community sometimes provides food resources for the Glossy Black Cockatoo (<i>Calyptorhynchus lathami lathami</i>), and Yellow-tailed Black Cockatoo (<i>Calyptorhynchus funereus</i>) (Marchant and Higgins, 1990). The fauna of Swamp Oak Floodplain Forest also includes the Squirrel Glider (<i>Petaurus norfolcensis</i>) and several species of frogs in the families Myobatrachidae (southern frogs) and Hylidae (tree frogs).
Example	 Figure 3-2 Example of Swamp Oak Floodplain Forest EEC at Croom Regional Sporting Complex

Coastal Freshwater Lagoons (PCT 781)

Where waterbodies on floodplains in the study area form part of a freshwater wetland, they fall under the definition of the EEC known as *Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*. In the Southern Rivers Catchment Management Authority, the EEC is classed as Coastal freshwater lagoons of the Sydney Basin and South East Corner (SR536) under the BioMetric database classification (Table 3-3). Examples of this include the SEPP 14 wetland (Figure 3-3) and associated areas located on private property in the study area. There are also more degraded wetland areas to the north of the Macquarie Rivulet.

The understorey and groundlayer composition varies substantially between and even within freshwater wetland areas, but often contains a mix of native and exotic grasses and forbs, as well as sedges. Native species may include Water Primrose (*Ludwigia peploides*), Nardoo (*Marsilea mutica*), Slender Knotweed (*Persicaria decipiens*), a Rush (*Juncus usitatus*), Tufted Sedge (*Carex appressa*), Buttercup (*Ranunculus* sp.), Swamp Dock (*Rumex brownii*), Common Reed (*Phragmites australis*) and Cumbungi (*Typha orientalis*). Where sites are more disturbed or degraded, the exotic weed species listed above also occur in high densities.

When calculating extents of this community, the entire surface area/waterbody of wetlands containing standing open water is considered part of the EEC.

Table 3-3 Summary of Freshwater Wetland on Coastal Floodplains in the project.

Coastal Freshwater Lagoons		
Vegetation formation	Freshwater wetlands	
Vegetation class	Coastal freshwater lagoons	
Vegetation type	Plant Community Type (PCT) ID	781
	Biometric Vegetation Type ID	SR536
	Common Community Name	Coastal freshwater lagoons of the Sydney Basin and South East Corner
Approximate extent within project	This vegetation community covers approximately 7.20 ha in the development footprint, all of which is considered an EEC. This community is often connected to the same community outside the development footprint which has not been included in the total area within the project. Approximately 28.69 ha of this community occurs adjacent to or within the development footprint.	
Condition	Moderate to Good. Despite the presence of some common exotic forbs at many sites, some locations have a high diversity of native riparian and aquatic flora species.	
BioMetric Value (/100)	Site Scores	Macquarie Rivulet wetland (Plots FW 1-3) SVS Average = 83.3 Frazer's Creek wetland (Plot FW6) – SVS average = 82.8
Survey Effort	12 biometric plots (12 hours). A minimum of 3 biometric plots are required by the FBA BCC.	
Conservation Status	Coastal freshwater lagoons in the study area form part of the EEC known as <i>Freshwater Wetlands on Coastal Floodplains in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i> . This EEC is listed under the TSC Act but not the EPBC Act. One wetland area adjacent to the development footprint is also listed as a coastal wetland under the State Environmental Planning Policy No 14 – Coastal Wetlands.	

Coastal Freshwater Lagoons	
Estimate of percent cleared	70%
Threatened plant species habitat	This community provides only marginal quality habitat for threatened flora species, and it is unlikely that any threatened species would become established in the community. There is a small chance of the White-flowered Wax Plant occurring in this vegetation type but it was not observed during recent or historical surveys.
Equivalent vegetation types	The SCIV (Tozer <i>et al.</i> , 2010) map unit that corresponds best to this vegetation type is FrW p313 (Coastal Freshwater Lagoon), although elements of the Forested Wetlands map units are also present along larger creeklines and rivulets.
Fauna Habitat	Aquatic vegetation provides foraging and refuge for amphibians, aquatic reptiles and birds, and fish and aquatic invertebrates. Logs and rocks on aquatic banks provide refuge and bathing for amphibians and reptiles.
Example	 Figure 3-3 Example of native-dominated freshwater wetland vegetation in the study area.

Derived Forest Red Gum – Thin-leaved Stringybark grassy woodland (PCT 838)

This vegetation type was observed mainly in road reserves and places where road upgrades have occurred in the past twenty years, such as along the EastWest Link towards the southern end of the project and along private property boundaries (Figure 3-4). The dominant trees in the community consisted of Wattles (*Acacia* spp.), Forest Red Gum (*Eucalyptus tereticornis*), Bangalay (*E. botryoides*), and Willow-leaved Hakea (*Hakea salicifolia*). Common shrubs included Wattles, Honey-myrtles (*Melaleuca* spp.), and introduced species such as Lantana (*Lantana camara*). The groundcovers consisted largely of exotic weedy grasses and forbs, including Couch (*Cynodon dactylon*), Coolatai Grass (*Hyparrhenia hirta*), Kikuyu (*Pennisetum clandestinum*), Crofton Weed (*Ageratina adenophora*), Petty Spurge (*Euphorbia peplus*), and Plantain (*Plantago lanceolata*).

This community is not considered Illawarra Lowlands Grassy Woodland EEC.

Table 3-4 Summary of Derived Forest Red Gum – Thin-leaved Stringybark grassy woodland in the project.

Derived Forest Red Gum – Thin-leaved Stringybark Grassy Woodland		
Vegetation formation	Grassy woodlands	
Vegetation class	Coastal valley grassy woodlands	
Vegetation type	Plant Community Type (PCT) ID	838
	Biometric Vegetation Type ID	SR545
	Common Community Name	Forest Red Gum – Thin-leaved Stringybark grassy woodland
Approximate extent within project	This vegetation community covers approximately 23.12 ha in the development footprint, and is widespread within road corridors, and on private property within the region.	
Condition	Moderate – Good. Has a history of disturbance or being planted and has a dominance of exotic species in the groundlayer.	
Survey Effort	4 biometric plots (3 hours). A minimum of 4 biometric plots are required by the FBA BCC.	
Conservation Status	This vegetation community is not considered to be an EEC under either the TSC or EPBC Acts.	
Estimate of percent cleared	85%	
Threatened plant species habitat	This community provides only marginal quality habitat for threatened flora species, and it is unlikely that any threatened species would become established in the community.	
Equivalent vegetation types	The SCIVI mapping (Tozer <i>et al.</i> , 2010) for the region does not contain an equivalent vegetation type, but may incorporate this community into the areas mapped as cleared or exotic-dominated.	
Fauna Habitat	Although low in vegetation condition, this vegetation community provides numerous habitat types for fauna. Canopy trees provide foraging and nesting/resting for birds and arboreal fauna. No hollow-bearing trees were present in this community, due to young age of planted vegetation. The mid-storey (if present) provides foraging and nesting for smaller birds, as well as refuge for small-medium sized mammals and reptiles. Ground plants, logs and fallen leaves provide shelter and foraging for terrestrial fauna as well.	

Derived Forest Red Gum – Thin-leaved Stringybark Grassy Woodland

Example



Figure 3-4 Example of Derived Forest Red Gum – Thin-leaved Stringybark grassy woodland in the study area.

Disturbed riparian vegetation (Derived Swamp Mahogany swamp sclerophyll forest, Derived River Oak open forest of major streams and Derived Swamp Oak - Prickly Tea-tree - Swamp Paperbark swamp forest) (PCT 1231, 1105 & 1232)

Waterbodies present in the development study area included creeks, rivulets, drainage lines, dams, and natural wetlands. The historical disturbances that most of these areas have experienced have led to numerous similarities between them, despite the pre-European vegetation likely being considerably different. In some cases, these areas can be considered to be exotic dominated, whereas some, such as in places along the Macquarie Rivulet outside the development footprint, have a relatively intact (albeit thin) native overstorey, although usually with a strong weed component. Where an overstorey is present, trees may consist of Rough-barked Apples (*Angophora floribunda*), Swamp Oaks (*Casuarina glauca*), Sweet Pittosporum (*Pittosporum undulatum*), or exotic Coral Trees (*Erythrina x sykesii*) and Tobacco Trees (*Solanum mauritianum*). Areas where this overstorey is not present (such as parts of Frazer's Creek, the Macquarie Rivulet and Duck Creek in the study area) were probably derived from Swamp Mahogany swamp sclerophyll forest (PCT 1231). Some small areas of this riparian vegetation in the development footprint may also be derived River Oak open forest of major streams (PCT 1105) or Swamp Oak – Prickly Tea-tree – Swamp Paperbark swamp forest on coastal floodplains (PCT 1232). Whilst two areas within the development footprint have been identified as belonging to the EEC known as *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions*, the remainder are too degraded/modified and are not considered to be representative of this EEC. Where the overstorey contains Bangalay (*Eucalyptus botryoides*), the community may have been derived from the EEC, but is currently too degraded to meet the definition of the EEC. Generally, the understorey in these areas has become dominated by exotic weeds such as Lantana (*Lantana camara*), Mistflower (*Ageratina riparia*), Scarlet Pimpernel (*Anagallis arvensis*), Spear Thistle (*Cirsium vulgare*), Plantain (*Plantago lanceolata*), Fireweed (*Senecio madagascariensis*), and Trad (*Tradescantia fluminensis*), or adaptable native species such as Black Wattle (*Acacia mearnsii*).

Table 3-5 Summary of disturbed riparian vegetation in the project.

Disturbed Riparian Vegetation		
Vegetation formation	Forested wetlands	
Vegetation class	Coastal Floodplain Wetlands or Coastal Swamp Forests	
Vegetation type	Plant Community Type (PCT) ID	1231, 1232 or 1105.
	Biometric Vegetation Type ID	SR 650 or SR 648
	Common Community Name	Swamp Mahogany swamp sclerophyll forest, Swamp Oak - Prickly Tea-tree - Swamp Paperbark swamp forest on coastal floodplains, or River Oak open forest of major streams.
Approximate extent within project	This vegetation community covers approximately 2.97 ha in the development footprint, of which 0 ha forms part of an EEC. It occurs in all riparian zones including Macquarie Rivulet, Frazer's Creek, Horsley Inlet, Duck Creek and other unnamed tributaries.	
Condition	Moderate to Good. Despite the presence of some common exotic shrubs and forbs at many sites, some locations have a moderate diversity of native riparian and aquatic flora species. The canopy cover is generally in poor condition and only loosely representative of these communities.	
Survey Effort	5 biometric plots (1 Frazer's Creek, 4 – differing locations along Macquarie Rivulet) (4 hours). A minimum of 5 biometric plots are required by the FBA BCC.	
Conservation Status	Some locations in the study area (e.g. Macquarie Rivulet) may potentially have been derived from <i>Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions</i>. These areas do not meet the definition for the community due to their highly modified nature and scarce native canopy cover. Some locations in the study area (e.g. Frazer's Creek) may potentially have been derived from <i>Swamp Sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions</i>. These areas do not meet the definition for the community due to their highly modified nature and lack of native canopy cover.	
Estimate of percent cleared	Swamp Mahogany swamp sclerophyll forest – 50% Swamp Oak - Prickly Tea-tree - Swamp Paperbark swamp forest on coastal floodplains – 95% River Oak open forest of major streams – 40%	
Threatened plant species habitat	This community provides only marginal quality habitat for threatened flora species, and it is unlikely that any threatened species would become established in the community. There is a small chance of the White-flowered Wax Plant occurring in this vegetation type but it was not observed during recent or historical surveys.	
Equivalent vegetation types	Elements of the Forested Wetlands map units from the SCIVI mapping (Tozer <i>et al.</i> 2010) are likely to correspond best with the vegetation types that are present along larger creeklines and rivulets.	
Fauna Habitat	This vegetation community provides numerous habitat types for fauna. Canopy trees provide foraging and nesting/resting for birds and arboreal fauna. Hollow bearing trees, which are largely absent from the project, may provide habitat for arboreal mammals, parrots and owls. The mid-storey (if present) provides foraging and nesting for smaller birds, as well as refuge for small-medium sized mammals and reptiles. Ground plants, logs and fallen leaves provide shelter and foraging for terrestrial fauna as well. Aquatic vegetation provides foraging and refuge for amphibians, aquatic reptiles and birds, and fish and aquatic invertebrates. Logs and rocks on aquatic banks provide refuge and basking locations for amphibians and reptiles.	

Disturbed Riparian Vegetation

Example



Figure 3-5 Example of disturbed riparian vegetation in the study area.

Non-indigenous vegetation

This highly disturbed or modified vegetation community is found where there is a prevalence of exotic or planted non-local flora species that make up both the overstorey and the lower vegetation layers (Figure 3-6). Non-indigenous vegetation covers more than 30 ha within the development footprint, making it the most abundant community in the area. The overstorey was often absent, but where it was present trees generally included species such as Queensland Brush Box (*Lophostemon confertus*), Tallowwoods (*Eucalyptus microcorys*), or Pines (*Pinus* sp.). An understorey may be present, consisting of exotics such as Small-leaved Privet (*Ligustrum sinense*) and Blackberry (*Rubus fruticosus*). The groundlayer is almost completely exotic with common species including Fleabane (*Conyza* sp.), Plantain, Brome (*Bromus* sp.), Kikuyu, African Lovegrass (*Eragrostis curvula*), Coolatai Grass, and Perennial Ryegrass (*Lolium perenne*).

As this vegetation often lacked a native canopy cover and was either cleared or had over 50 % exotic species composition in the ground cover, then according to the FBA, this vegetation community does not need to be assessed further.



Figure 3-6 An example of exotic-dominated vegetation along the Illawarra Highway in the study area.

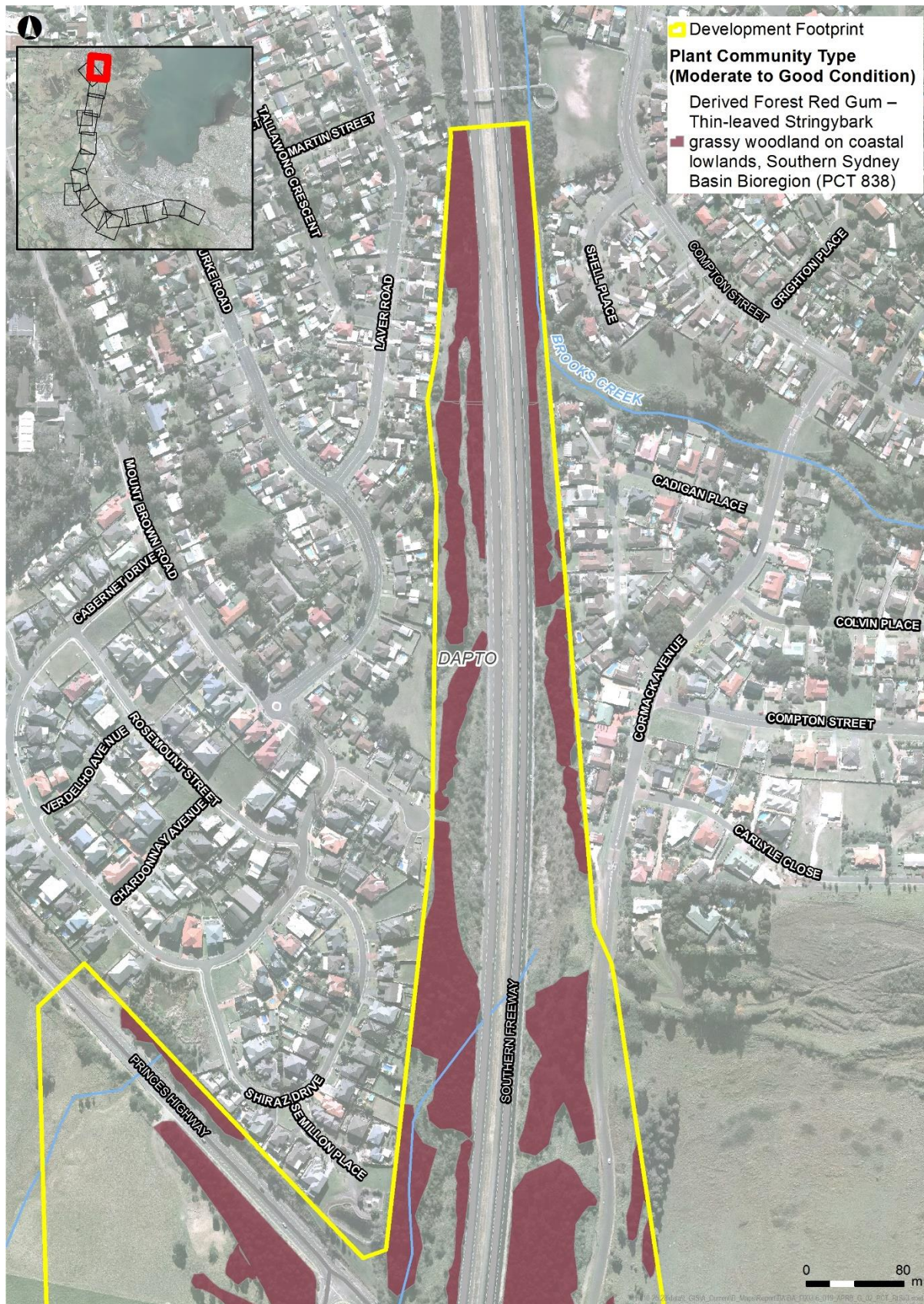


Figure 3-7a PCTs within the development footprint

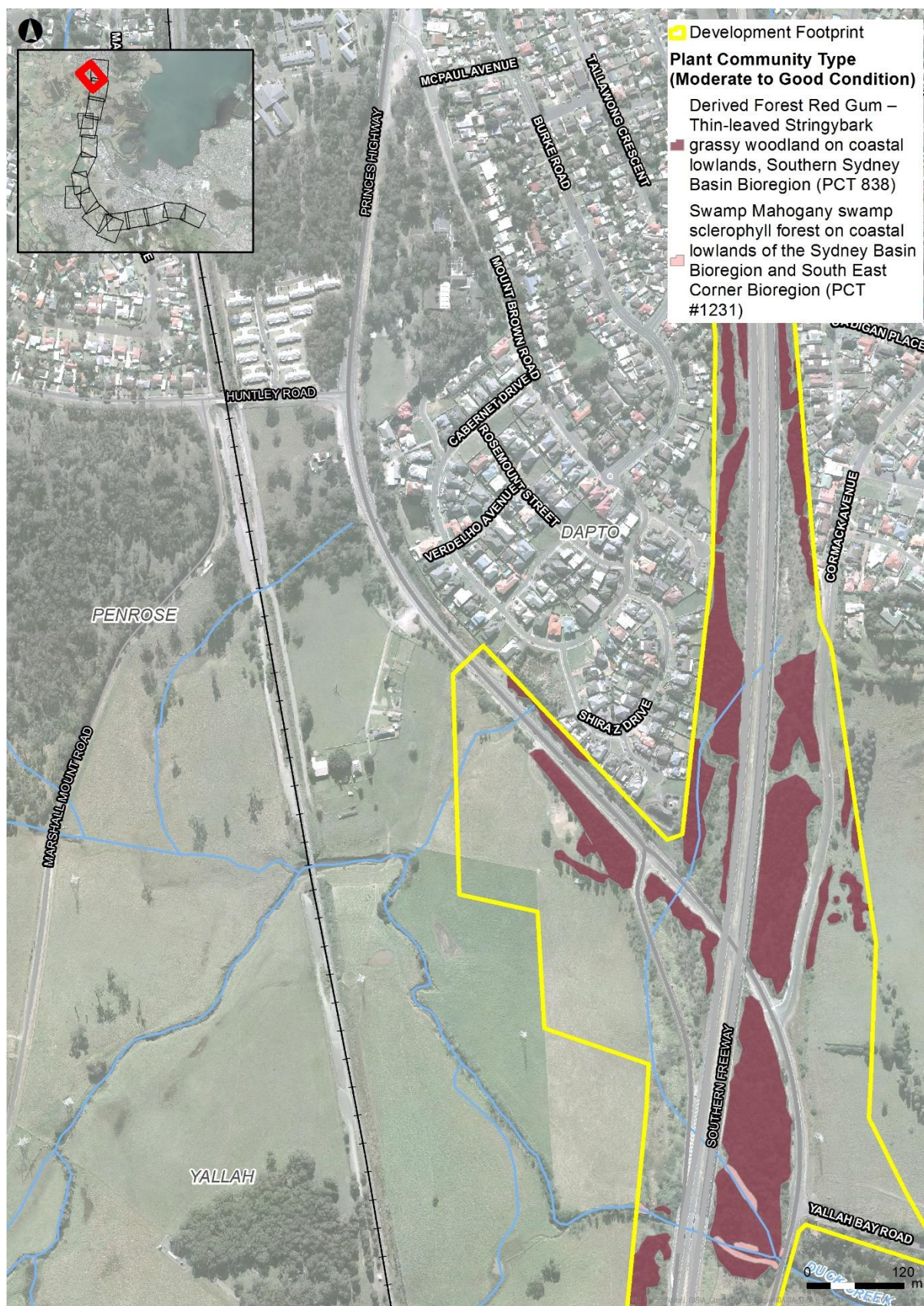


Figure 3-6b

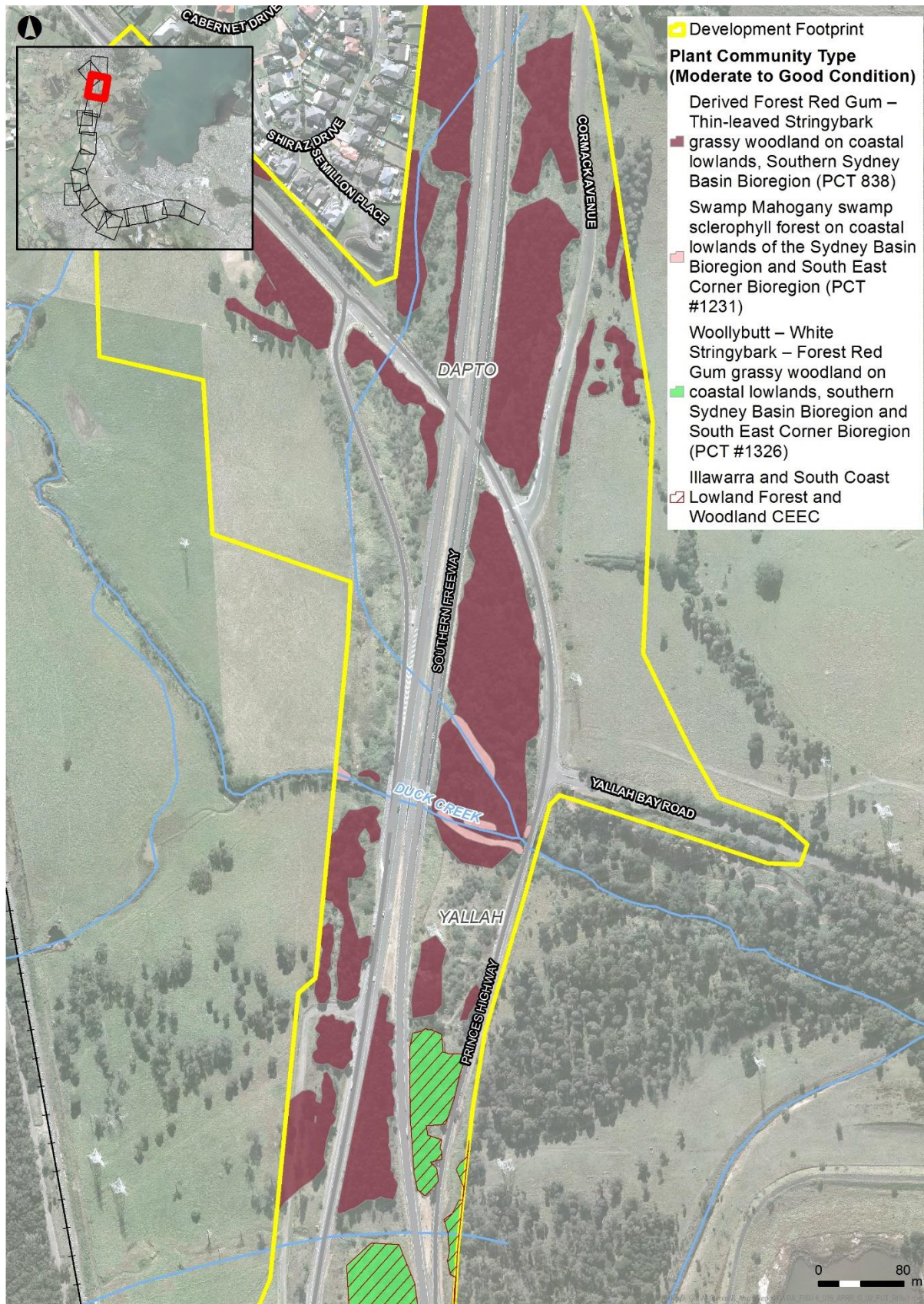


Figure 3-6c

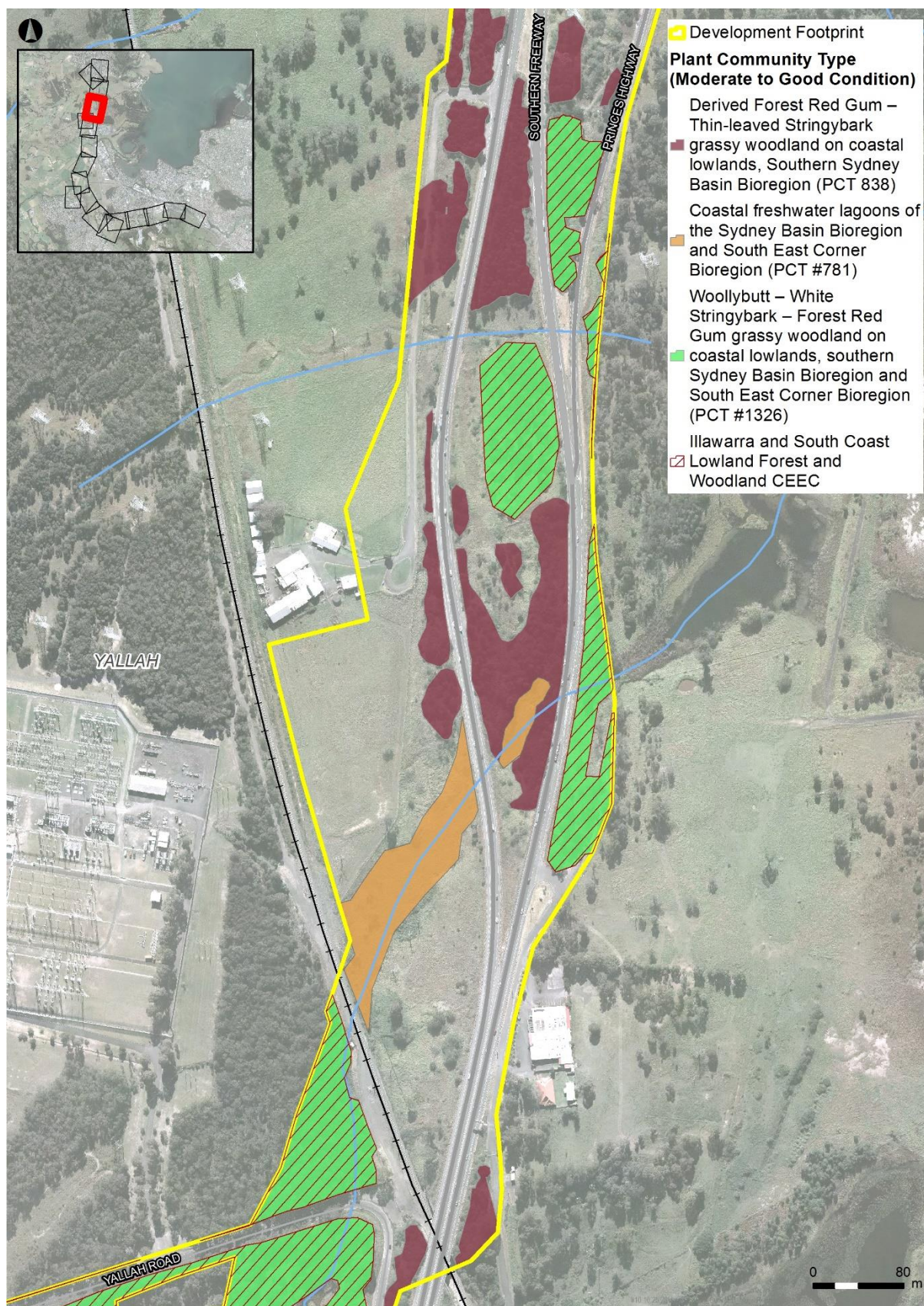


Figure 3-6d

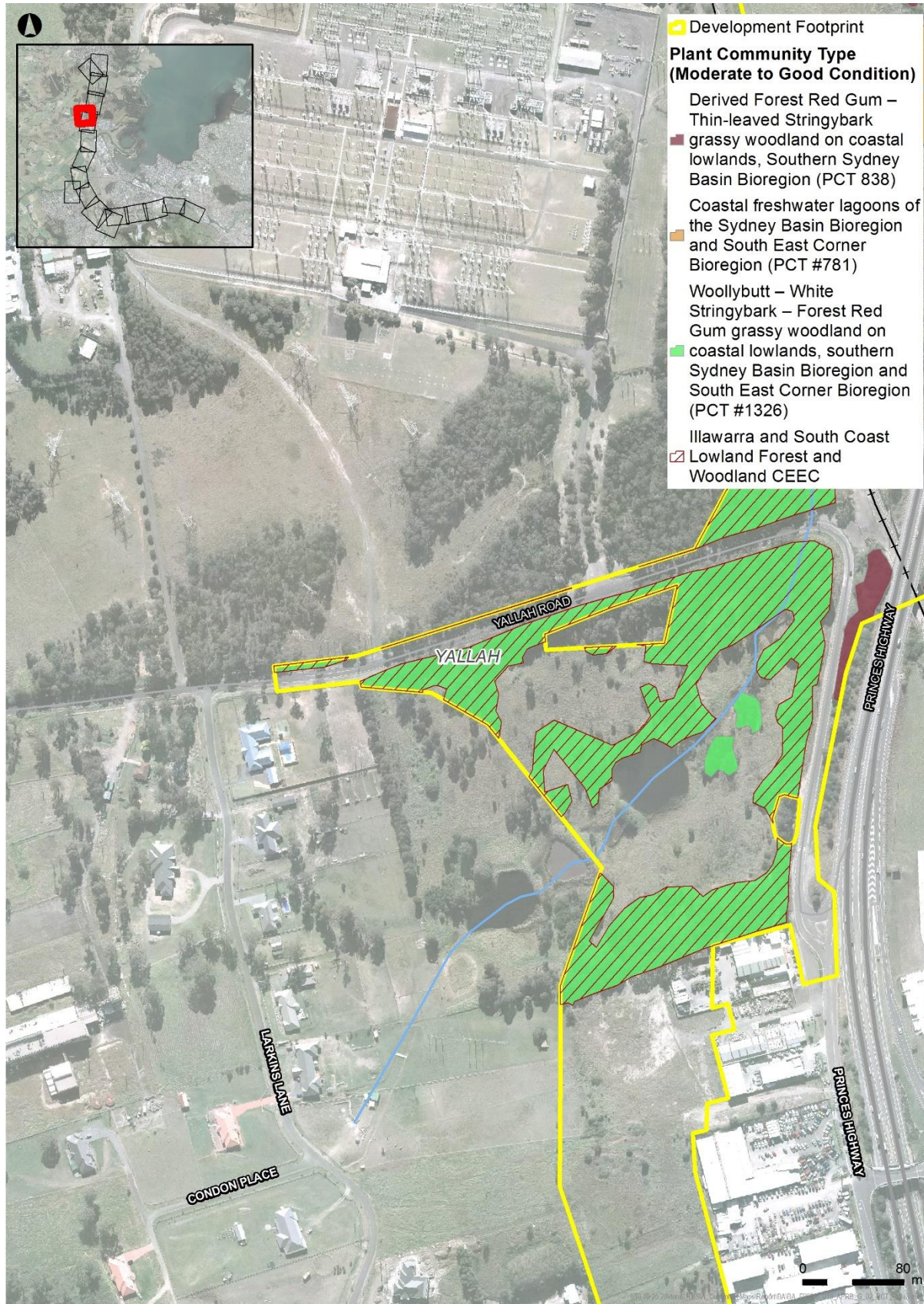


Figure 3-6e

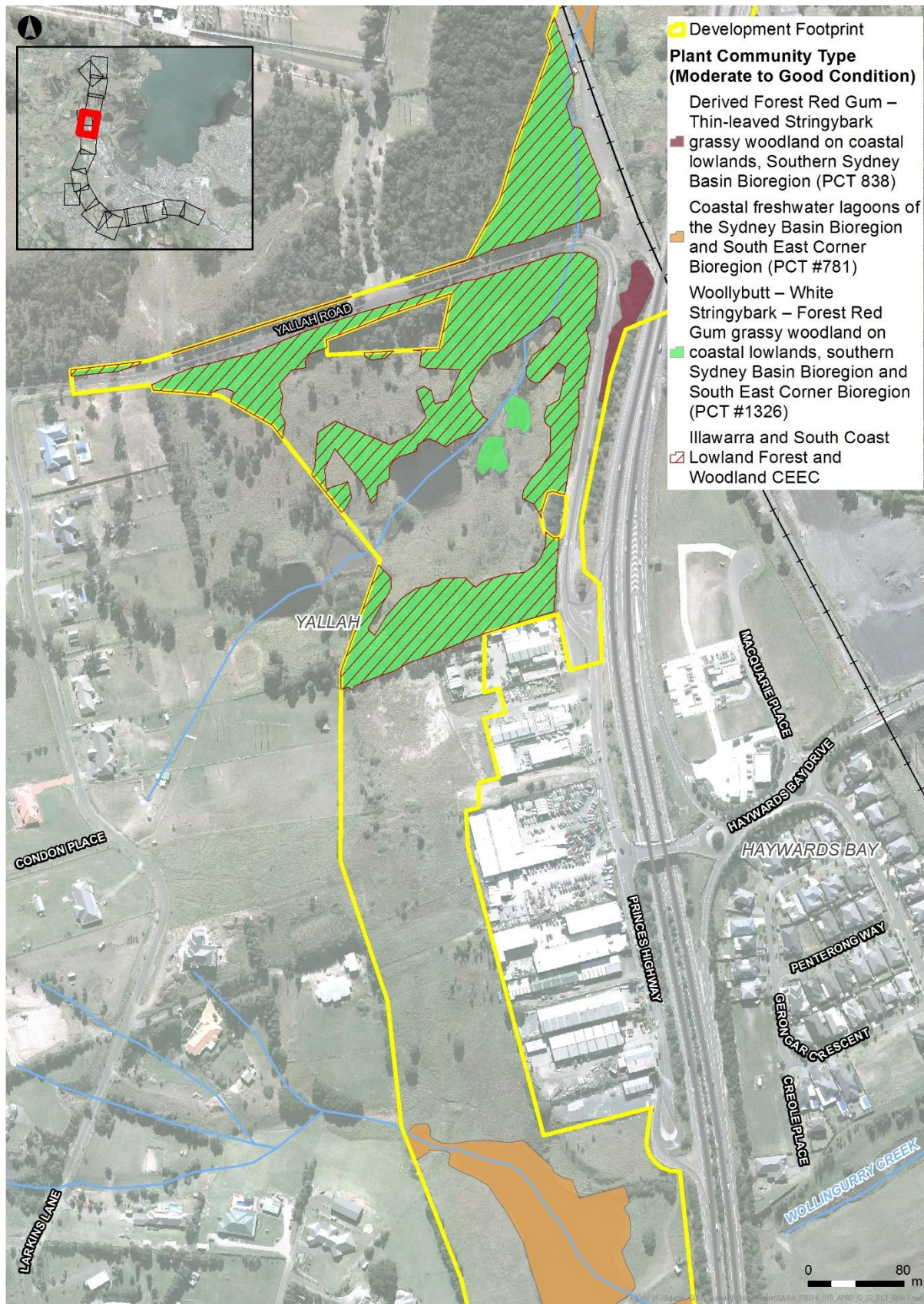


Figure 3-6f

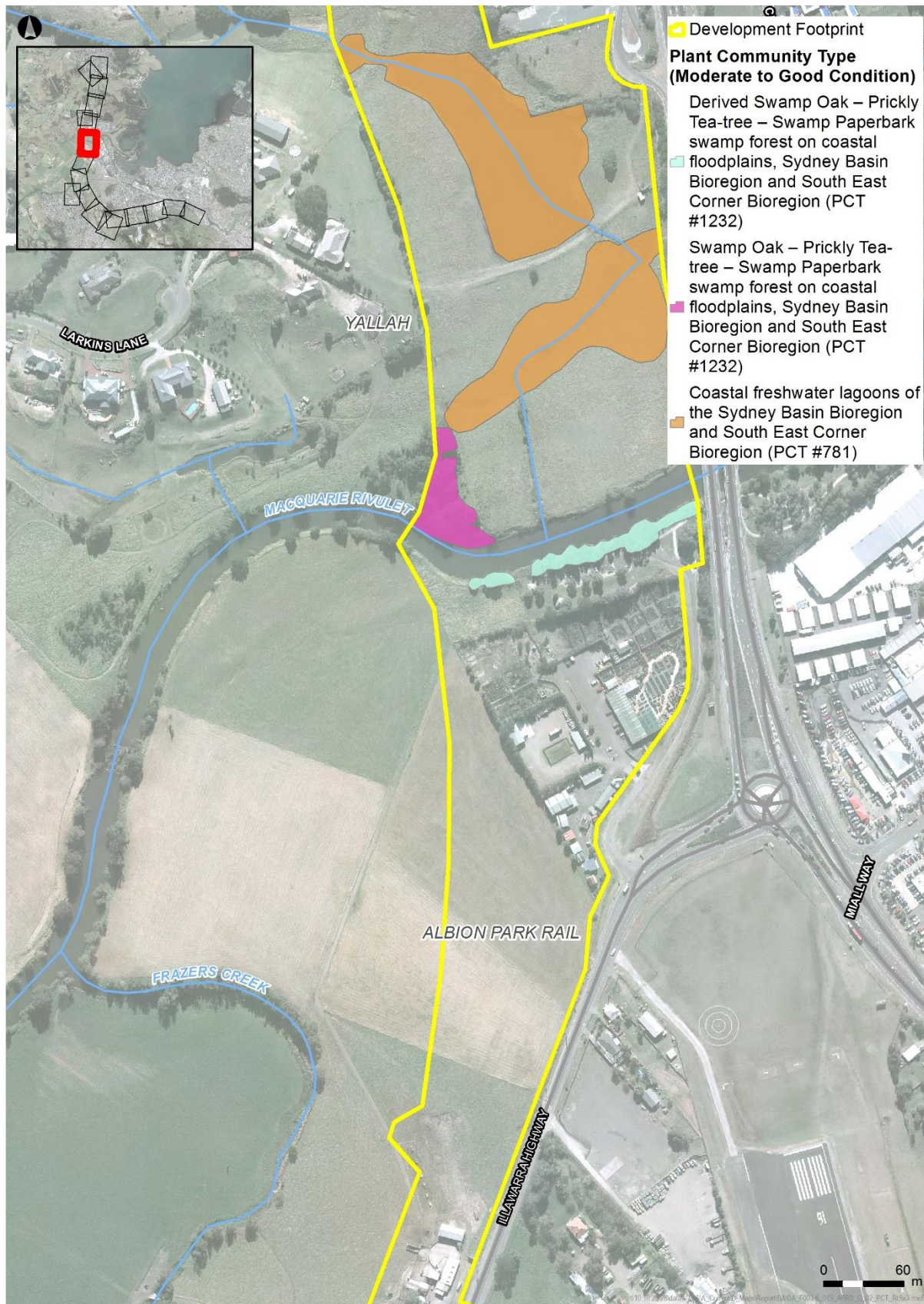


Figure 3-6g

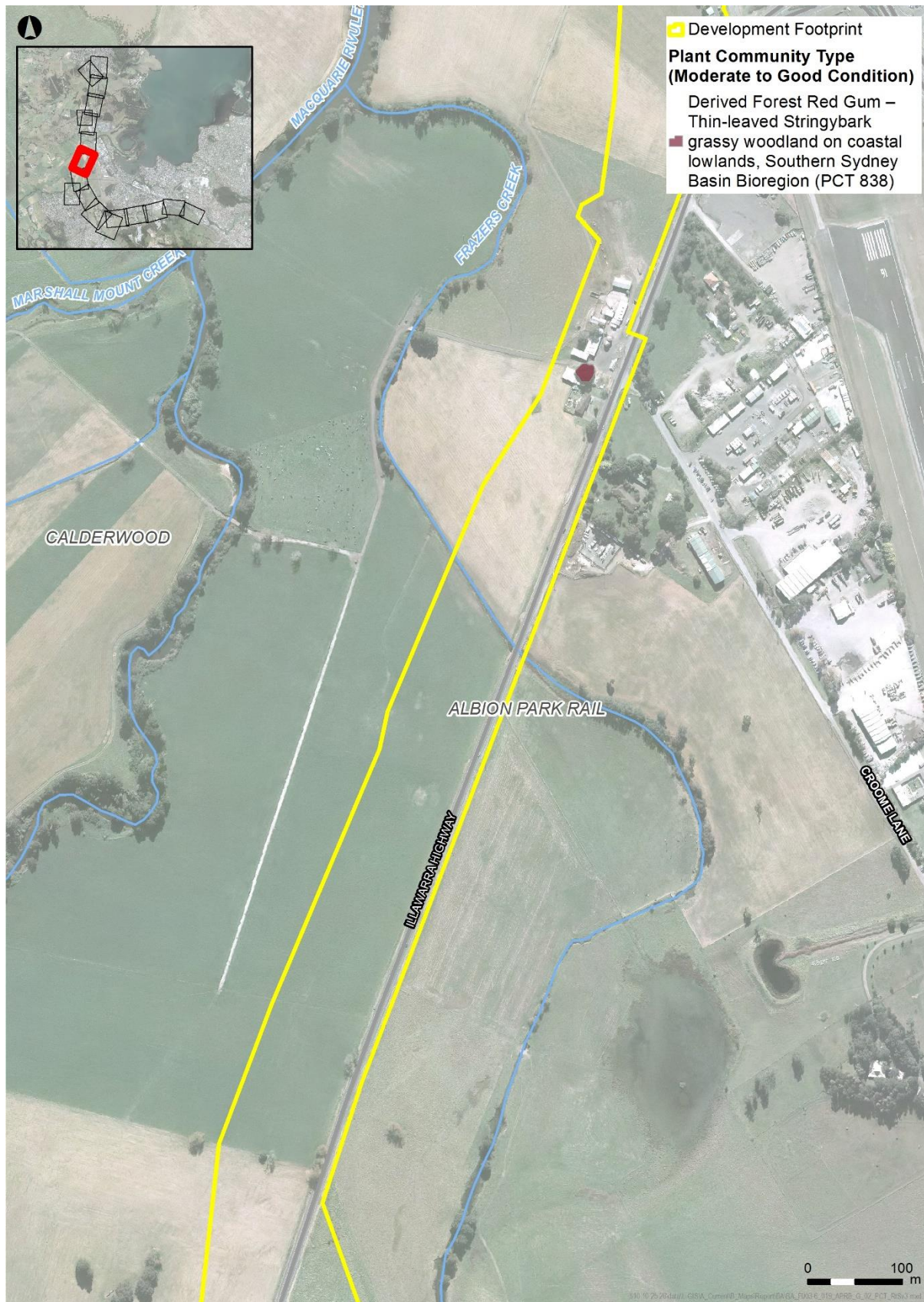


Figure 3-6h

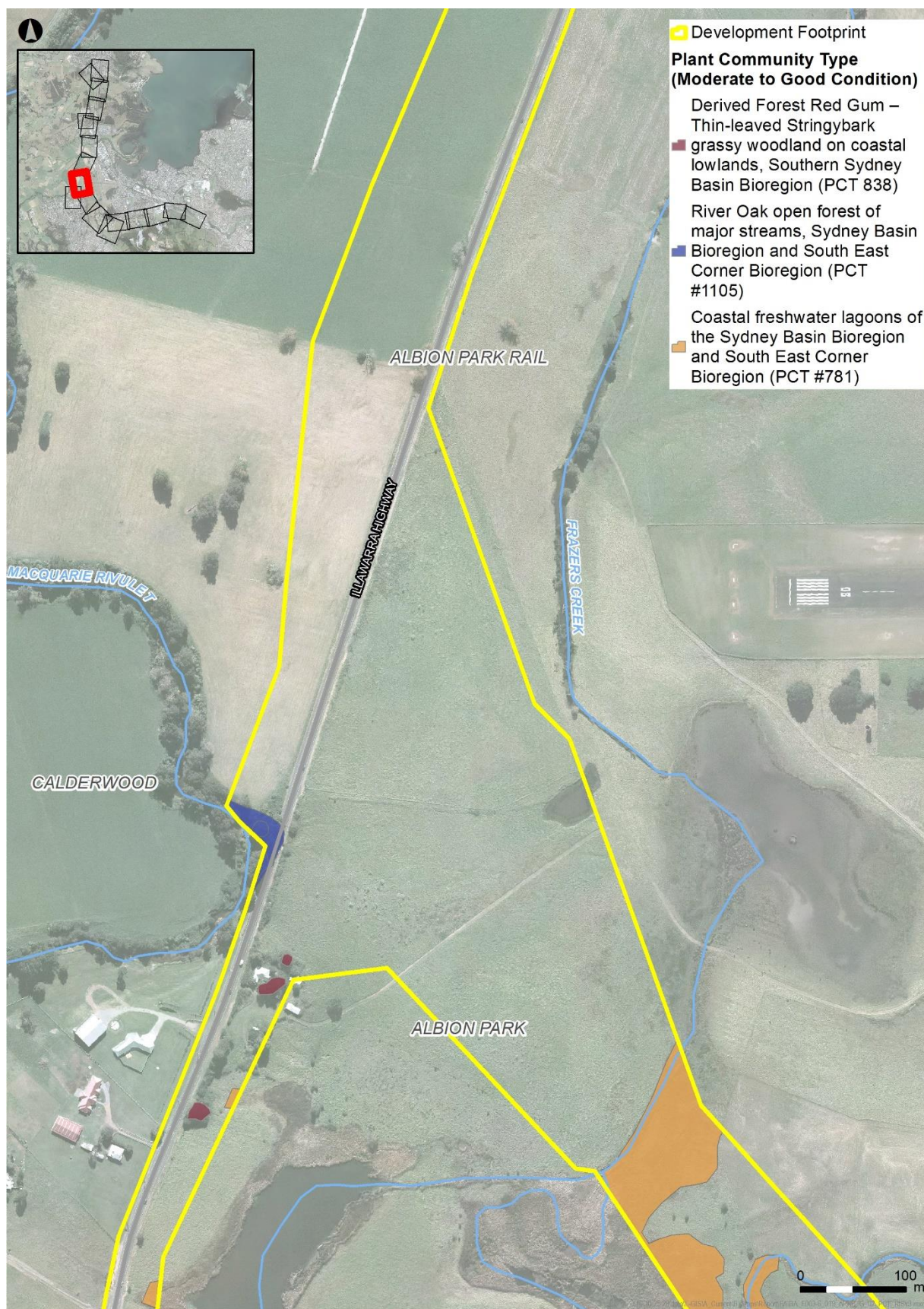


Figure 3-6i

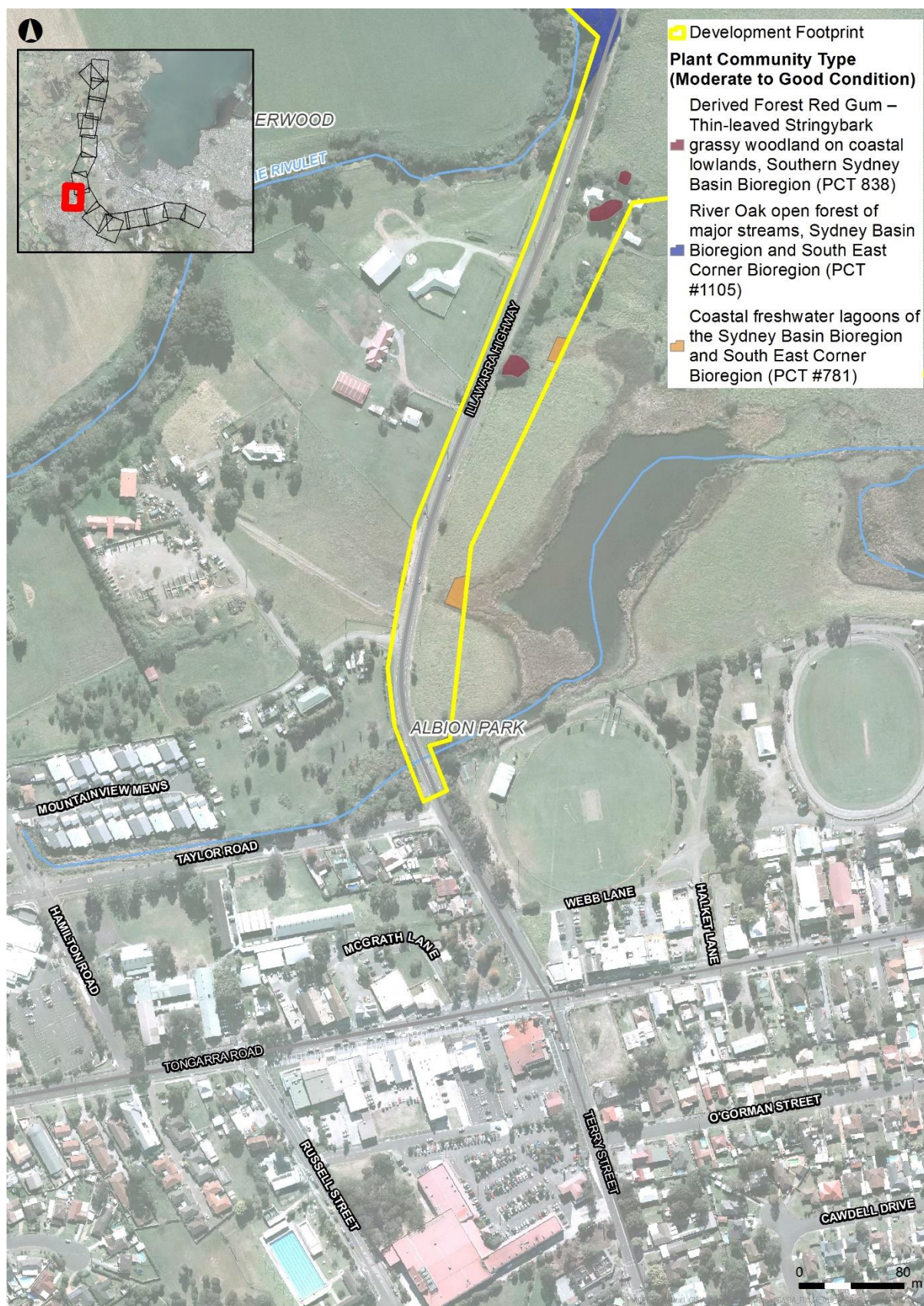


Figure 3-6j