ENVIRONMENTAL REVIEW

METROPOLITAN REGION SCHEME AMENDMENT 1188/57

WELLARD URBAN PRECINCT EAST

Invitation to make a submission

The Western Australian Planning Commission (WAPC) invites people to make a submission on this proposal. Both electronic and hard copy submissions are most welcome.

Wellard Landowners' Group proposes an amendment of the Metropolitan Region Scheme to Urban for land to the east of Bollard Bulrush Swamp. In accordance with the *Environmental Protection Act 1986* (EP Act), an Environmental Review (ER) has been prepared which describes this proposal and its likely effects on the environment. The ER is available for a public review period of 60 days from 18 June 2013 closing on 23 August 2013.

After receipt of comments from Government agencies and from the public, the WAPC will forward submissions to the Environmental Protection Authority (EPA). The EPA will prepare an Assessment Report with recommendations to the Government, taking into account issues raised in public submissions. Any environmental conditions, which may be set from this process, will be required to be incorporated into the MRS Amendment.

Why write a submission?
A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach.

It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the WAPC will be acknowledged. Submissions will be treated as public documents and may be quoted in full or in part in each report. Submissions may be fully or partially utilised in compiling a summary of the issues raised or where complex or technical issues are raised, a confidential copy of the submission (or part of it) may be sent to the proponent.

A summary of issues is normally included in the EPA's Assessment Report.

Why not join a group?
If you prefer not to write your own comments, it may be worthwhile joining a group interested in making a submission on similar issues.

Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information.

If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the ER or the specific proposal. It helps if you give reasons for your conclusions, supported byways to make the proposal more environmentally acceptable.

When making comments on specific elements of the Environmental Review:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the ER;
- if you discuss different sections of the ER, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- address; and
- date.

Please present your comments on the WAPC submission form (Form 57) provided. It is attached to this report, the planning Amendment Report, and is also available from the display locations and the PlanningWA internet site www.planning.wa.gov.au

Alternatively, written submissions can be posted to:

Secretary
Western Australian Planning Commission
Locked Bag 2506
PERTH WA 6001

or hand delivered to:

Secretary
Western Australian Planning Commission
140 William Street
PERTH WA 6000

The closing date for submissions is: 23 August 2013.

Planning and Development Act 2005

Section 57 Amendment (Minor)
Form 57

Submission

Metropolitan Region Scheme Amendment 1188/57

Wellard Urban Precinct (East)

OFFICE USE ONLY

SUBMISSION NUMBER
RLS/0388

To: Secretary
Western Australian Planning Commission
Locked Bag 2506
PERTH WA 6001

Name .....
(PLEASE PRINT CLEARLY)

Address ..... Postcode .....

Contact phone number ..... Email address .....

Submission (Please attach additional pages if required. It is preferred that any additional information be loose rather than bound)

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(Submission continued. Please attach additional pages if required)

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You should be aware that:

- The WAPC is subject to the *Freedom of Information Act 1992* and as such, submissions made to the WAPC may be subject to applications for access under the act.
- In the course of the WAPC assessing submissions, or making its report on these submissions, copies of your submission or the substance of that submission, may be disclosed to third parties.

To be signed by person(s) making the submission

Signature …… Date ……

Note: Submissions MUST be received by the advertised closing date, being close of business (5pm) on 23 August 2013. Late submissions will NOT be considered.

ENVIRONMENTAL REVIEW

METROPOLITAN REGION SCHEME AMENDMENT 1188/57

WELLARD URBAN PRECINCT EAST

Prepared for:

Wellard Landowner's Group

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Job Number:	*10.127*
Report Number:	*11/079*
Prepared by:	*Kate Thomson*
Status:	*Final*
QA Review:	*Damian Buller*
Technical Review:	*Karen Godridge*
Content Review:	*Peter Jobson*
Date:	*04/06/2013*

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STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV. Australia Pty Ltd (ENV) ("scope of services"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, ENV has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to ENV.

Environmental Conclusions

In accordance with the scope of services, ENV has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions. Also it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. ENV assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of ENV or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

ENV will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

EXECUTIVE SUMMARY

ENV. Australia (ENV) was commissioned by Greg Rowe and Associates on behalf of the Wellard Landowners Group to undertake this Environmental Review in support of the rezoning of the subject land from Rural to Urban Deferred under the Metropolitan Region Scheme (MRS).

The application of the MRS Amendment (1188/57) was referred to the EPA where the level of assessment was set at a formal assessment with the following objectives identified:

- To maintain the integrity, ecological functions and environmental values of wetlands;
- To maintain the integrity, ecological functions and environmental values of fauna habitat; and
- To maintain the integrity, ecological functions and environmental values of waterways.

This report covers the following issues:

- Regional and local context;
- Flora, vegetation, fauna and habitat;
- Wetland value, functions and boundary;
- Groundwater and surface water quality and quantity; and
- Legislation and Planning.

The report identifies all environmental factors and their management in relation to potential impacts, management objectives and proposed mitigation and management actions. The Environmental Management Framework outlines the following necessary environmental plans:

- Construction Environmental Management Plan;
- Wetland Management Plan; and
- Water Management Plans.

1 INTRODUCTION

ENV. Australia (ENV) was commissioned by Greg Rowe and Associates on behalf of the Wellard Landowners Group to undertake this Environmental Review in support of the rezoning of the subject site from 'Rural' to 'Urban Deferred' under the Metropolitan Region Scheme (MRS).

1.1 LOCATION AND CURRENT LAND USE

The site is located in the suburb of Wellard in the Town of Kwinana, and is situated approximately 35 km south of the Perth CBD (see Figure 1). The land is located on the eastern side of Bollard Bulrush Swamp and is bound by Bertram Road and Tamblyn Place to the north, Johnson Road to the east, and the Peel Main Drain to the west and south.

The subject site consists of the following land parcels in Wellard:

- Lot 1 Johnson Road;
- Lot 6 Johnson Road;
- Lot 86 Johnson Road;
- Lot 4 Tamblyn Place;
- Lot 5 Tamblyn Place;
- Lot 74 Tamblyn Place;
- Lot 76 Tamblyn Place;
- Lot 67 Bertram Road;
- Lot 68 Bertram Road;
- Lot 72 Bertram Road;
- Lot 1338 Bertram Road;
- Unallocated Crown Land 44 in Wellard; and
- Unallocated Crown Land 1336 in Wellard.

The western portion of the site includes parts of Bollard Bulrush Swamp itself, and although the site is largely cleared, there are vegetated areas remaining within the wetland itself. The cleared areas are currently used predominantly for cattle grazing.

1.2 DESCRIPTION OF AMENDMENT

The site is zoned 'Rural' under both the MRS and the Town of Kwinana Town Planning Scheme No. 2 (TPS2) (see Figure 2). MRS Amendment 1188/57 proposes rezone the site from 'Rural' to 'Urban Deferred'. Following the eventual lifting of Urban deferment,

structure planning and subdivision approval will facilitate the ultimate urban development of the site.

Table 1: Key characteristics

AMENDMENT DETAIL	CHARACTERISTICS
Purpose	To develop the land for residential use
Land Area	Wetland Area: 32.3 ha Wetland Buffer: 9.4 ha Developable Area: 57.5 ha
Local Government	Town of Kwinana
Existing Land Uses	Farming and grazing
Existing Zoning	Rural
Proposed Zoning	Urban Deferred
Environmental Factors	Wetlands, fauna and water (surface and groundwater)
Proposed Environmental Management Measures	Preparation and implementation of the following management plans: • Construction Environmental Management Plan, • Wetland Management Plan, • District Water Management Strategy, • Local Water Management Strategy, and • Urban Water Management Plan,

1.3 PURPOSE OF THIS ENVIRONMENTAL REVIEW

The application for amendment of the MRS (Amendment 1188/57) was referred to the Environmental Protection Authority (EPA) under section 48A of the *Environmental Protection Act 1986* (EP Act) to set the level of assessment for the proposal.

The EPA concluded that this amendment should be formally assessed (Assessment 1830), and issued instructions under section 48C(1)(a) of the EP Act. The EPA identified the most relevant 'Environmental Factors' as identified in Table 2 (please note that the wetland management categories have been amended subsequently to the table of Environmental Factors being released).

Table 2: Environmental Factors Relevant to the Scheme

CONTENT		SCOPE OF WORK	
Factors	**Site Specific**	**EPA Objectives**	**Work required for the environmental review**
BIOPHYSICAL			
Wetlands	Bollard Bulrush Swamp	To maintain the integrity, ecological functions and environmental values of wetlands	*Regional and Local Context* Describe the extent of the relevant wetland suite. What is the significance (percentage and area representation) of the Bollard Bulrush Swamp in relation to the wetland suite? What is the ecological linkage value of Bollard Bulrush Swamp? *Wetland Value and Functions* The Bollard Bulrush Swamp is currently identified as *Conservation Category (UFI 15866), Resource Enhancement* (UFI 15867) and *Multiple Use* (UFI 13327) management category in the Department of Environment and Conservation's (DEC) *Geomorphic Wetlands Swan Coastal Plain* dataset. The Environmental Review should review the classification of Bollard Bulrush to ensure that the current attributes of the wetland reflect the management category. Confirm the wetland management category with DEC. This should be done in accordance with the *Protocol for proposing modifications to the Geomorphic Wetlands Swan Coastal Plain dataset* (2006). Map the boundary of the EPP 1992 boundary and hydric soils overlaying on an aerial photograph. A portion of Bollard Bulrush Swamp is protected from unauthorized activities under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (Lakes EPP 1992).* Map and describe vegetation types (overlaid on aerial photography) and condition (using the *Bush Forever* scale) in accordance with *Guidance Statement No 51. Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia.*

CONTENT		SCOPE OF WORK	
Factors	**Site Specific**	**EPA Objectives**	**Work required for the environmental review**
			Wetland Boundary Identification of a wetland boundary is reliant upon hydrology, hydric soils and wetland vegetation. Wetland vegetation is a reliable indicator of a wetland boundary. When the vegetation has been cleared, hydric soils may be the only indicator remaining. *Determination of Buffer Width* The purpose of a wetland buffer is to safeguard and maintain the functions and processes of a wetland and protect the wetland from potential adverse impacts. The buffer around Bollard Bulrush Swamp should be based on the appropriate distance required to separate the environmental values (vegetation, roosting, summer refuge, nesting, nursery and feeding) from the land uses permitted by the proposed amendment. The EPA expects that a minimum 50 metre buffer be provided (Guidance Statement No 33). Matters to be considered in the Environmental Review should include: • Description of the potential direct and indirect impacts that may result from use or development, including use for drainage purposes, allowed by the Amendment; and • Determination of the appropriate buffer distance required to protect the environmental values and functions of Bollard Bulrush Swamp from these potential impacts using the EPA *Guidance Statement No. 33 Environmental Guidance for Planning and Development* (available from www.epa.wa.gov.au) and Western Australian Planning Commission's *Guidelines for the Determination of Wetland Buffer Requirements* (available at www.planning.wa.gov.au) .

CONTENT		SCOPE OF WORK	
Factors	**Site Specific**	**EPA Objectives**	**Work required for the environmental review**
			The Environmental Review should demonstrate how the proposed buffer will protect and maintain the values of Bollard Bulrush Swamp.
Fauna	Bollard Bulrush Swamp	To maintain the integrity, ecological functions and environmental values of fauna habitat	Fauna survey of Bollard Bulrush Swamp in accordance with the EPA's *Guidance Statement No. 56 Terrestrial Fauna for Environmental Impact Assessment in Western Australia* (available at www.epa.wa.gov.au). Use the outcomes of the fauna survey to determine the habitat values (roosting, summer refuge, nesting and feeding) and defining an appropriate buffer to determine the buffer requirements of Bollard Bulrush Swamp.
POLLUTION MANAGEMENT			
Water	Surface groundwater quality and quantity	To maintain the integrity, ecological functions and environmental values of waterways	*How will the Amendment ensure that surface and groundwater quality and quantity is not adversely affected as a result of any use or development allowed by the Amendment?* Demonstrate that the proposal complies with the *Jandakot Structure Plan* (Government of Western Australia; 2007) and the *Jandakot Water Resource Management Strategy* (Department of Water). Both policies require that future development within this catchment does not impact on the quality of water entering Jandakot water resources. Demonstrate that the proposal complies with the objectives of the EPA's "*Draft Water Quality Improvement Plan*" (WQIP) for the Peel Harvey Coastal Plain Catchment (2007). Document how stormwater management will be implemented in accordance with the Department of Water's *Stormwater Management Manual* including the following: • Provide a site specific profile of the maximum groundwater level across the wetland and details of site drainage. • Assess the impact of residential development will have on local surface and ground water quality, including the risk of acid sulfate soils, salinity problems, and surface and groundwater quantity.

CONTENT		SCOPE OF WORK	
Factors	**Site Specific**	**EPA Objectives**	**Work required for the environmental review**
			Detail measures proposed to: • Ensure the quality and quantity of surface and ground water is maintained so that existing and potential uses, including ecosystem maintenance are protected; and • Management impacts. Describe management measures, including: • Effluent disposal; and • Drainage and nutrient management, to be implemented to reduce the quantity of drainage runoff from the site and to prevent impacts on water quality.

The purpose of this report is to fulfil the instructions of the EPA in the investigation, definition and proposal of management measures for the environmental constraints to development of the site. The commitments outlined in this document will become statutory obligations for the client to ensure that long term environmental protection and management of the site is fulfilled.

2 LEGISLATIVE AND POLICY CONTEXT

2.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Commonwealth legislation relating to the protection of the environment and the conservation of biodiversity. The EPBC Act defines Matters of National Environmental Significance (NES), which include World and National Heritage sites, wetlands of international importance, threatened species and communities, migratory species and Commonwealth marine areas. Proposals which may have a significant impact on Matters of NES should be referred to the federal Department of Sustainability, Environment, Water, Populations and Communities. Proposals deemed to be Controlled Actions require assessment and approval under the EPBC Act.

2.1.1 THREATENED SPECIES OF FLORA AND FAUNA PROTECTED UNDER THE EPBC ACT

Section 179 of the EPBC Act identifies the categories for threatened flora and fauna species, as listed in Table 3 below.

Table 3: Federal Threatened Flora and Fauna Categories

CATEGORY	DESCRIPTION
Extinct	There is no reasonable doubt that the last member of the species has died
Extinct in the Wild	Either the species: • is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or • it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	The species is facing an extremely high risk of extinction in the wild in the immediate future
Endangered	The species is not critically endangered; and it is facing a very high risk of extinction in the wild in the near future
Vulnerable	The species is not critically endangered or endangered; and it is facing a high risk of extinction in the wild in the medium term future
Conservation Dependent	The species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered

2.1.2 THREATENED ECOLOGICAL COMMUNITIES

Threatened species and ecological communities listed under the EPBC Act are recognised as Matters of NES. Therefore, any actions that are likely to significantly impact on a listed species or community will require an environmental assessment and approval process.

2.1.3 MIGRATORY SPECIES

All migratory species protected under the Bonn Convention, the Japan-Australia Migratory Bird Agreement, the China-Australia Migratory Bird Agreement, or any other approved international agreement, are protected under the EPBC Act.

2.2 ENVIRONMENTAL PROTECTION ACT 1986

The *Environmental Protection Act 1986* (EP Act) empowers the EPA to act to prevent, control or abate pollution and environmental harm, and to ensure the conservation, preservation, protection, enhancement and management of the environment.

Part V of the EP Act also provides for the declaration of Environmentally Sensitive Areas (ESA's) for which there is a presumption against clearing of native vegetation. Values such as Declared Rare Flora (DRF), habitat for Threatened Fauna, Threatened Ecological Communities (TEC's) and Conservation Category Wetlands are deemed to be Environmentally Sensitive Areas under the Act.

Clearing of native vegetation requires permission under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Exemptions for a clearing permit under the *Regulations* do not apply in an ESA.

2.3 WILDLIFE CONSERVATION ACT 1950

The *Wildlife Conservation Act 1950* (WC Act) provides for the conservation and protection of native flora and fauna, including rare flora and fauna, primarily through the gazettal of a DRF species list and a Specially Protected Fauna species list. Any action that will result in the 'taking' of a listed species must be licensed under the Act.

2.3.1 RARE FLORA

Section 23F of the act provides for the publishing of the W*ildlife Conservation (Rare Flora) Notice* in the Government Gazette. Rare Flora may fall under either of the following two categories described in Table 4.

Table 4: Management Categories for Flora Protected under the WC Act

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Schedule 1	**S1**	Taxa that are extant and considered likely to become extinct or rare
Schedule 2	**S2**	Taxa that are presumed to be extinct in the wild

2.3.2 SPECIALLY PROTECTED FAUNA

Section 14(2) of the WC Act provides for the publishing of the *Wildlife Conservation (Specially Protected Fauna) Notice* in the Government Gazette. Specially Protected Fauna may fall under any of the following categories described in Table 5.

Table 5: Management Categories for Fauna Protected under the WC Act

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Schedule 1	**S1**	Fauna that is rare or likely to become extinct
Schedule 2	**S2**	Fauna that is presumed to be extinct
Schedule 3	**S3**	Birds that are protected under an international agreement
Schedule 4	**S4**	Other fauna in need of protection

2.4 PRIORITY FLORA AND FAUNA LISTS - DEPARTMENT OF ENVIRONMENT AND CONSERVATION

The Department of Environment and Conservation (DEC) maintains lists of priority flora and fauna which are under consideration for inclusion in the formal WC Act lists, but are in need of further survey.

The priority levels of the flora species are defined in Table 6 below.

Table 6: Priority Flora Management Categories

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Priority 1	**P1**	Taxa with few (generally less than 5) occurrences which are under threat. These taxa are under consideration for declaration as Rare Flora, but are in urgent need of further study.
Priority 2	**P2**	Taxa with few (generally less than 5) occurrences, at least some of which are not under immediate threat. These taxa are under consideration for declaration as Rare Flora, but are in urgent need of further study.
Priority 3	**P3**	Taxa known from several populations which are not believed to be under immediate threat. These taxa are under consideration for declaration as Rare Flora, but are in need of further study.
Priority 4	**P4**	Taxa which have been adequately surveyed, and which while rare are not under current threat. These taxa require monitoring.

The priority levels of the fauna species are defined in Table 7 below.

Table 7: Priority Fauna Management Categories

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Priority 1	**P1**	Taxa with few, poorly known populations on threatened lands. They require urgent survey and evaluation.
Priority 2	**P2**	Taxa with few, poorly known populations on conservation lands. They require urgent survey and evaluation of conservation status.
Priority 3	**P3**	Taxa with several, poorly known populations, some on conservation lands. They require urgent survey and evaluation of conservation status.
Priority 4	**P4**	Taxa which have been adequately surveyed, and are usually represented on conservation lands. They are not under current threat, but could become threatened should circumstances change. These taxa require monitoring.
Priority 5	**P5**	Conservation dependent taxa which although not currently threatened, would become so within 5 years should their specific conservation program cease.

2.5 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES LISTS - DEPARTMENT OF ENVIRONMENT AND CONSERVATION

There is no mechanism available for the formal listing of ecological communities under the WC Act, however the DEC maintains a list of threatened and priority ecological communities, which are classified as described in Table 8 and Table 9, below.

Table 8: Threatened Ecological Communities Management Categories

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Presumed Totally Destroyed	**PD**	A community which has been adequately searched for, but for which no representative occurrences have been located.
Critically Endangered	**CR**	A community which has been adequately surveyed and found to be facing extremely high risk of extinction in the near future.
Endangered	**EN**	A community that has been adequately surveyed and found to be facing high risk of extinction in the near future.
Vulnerable	**VU**	A community which has been adequately surveyed and found to be facing high risk of total destruction or significant modification in the medium to long-term future.

Table 9: Priority Ecological Communities Management Categories

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Priority 1	**P1**	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation, for which current threats exist.
Priority 2	**P2**	Ecological communities that are known from few, small occurrences, all or most actively managed for conservation and not under imminent threat of destruction.
Priority 3	**P3**	Communities that are known from: • Several to many occurrences, a significant number of which are not under threat of habitat destruction or degradation; • A few widespread occurrences, which are large or in significant remaining habitat, in which other occurrences may survive, much of which is not under imminent threat; or • Large and/or widespread occurrences (that may or may not be represented in the reserve system) but are under threat of modification across much of their range.
Priority 4	**P4**	Communities that are adequately known, rare but not threatened, or meet the criteria for Near threatened, or have been recently removed from the threatened list.

2.6 GEOMORPHIC WETLANDS OF THE SWAN COASTAL PLAIN DATASET - DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Classifications and management objectives for wetlands of the Swan Coastal Plain (from Gingin to Dunsborough) have been identified and are held in a database maintained by the DEC. The wetland classification system defines wetlands in terms of their geomorphic character and inundation patterns (see Table 10), while the management category of a wetland is based on its condition and function, and defines objectives for their future management (see Table 11) (EPA 2008a).

Table 10: Geomorphic Wetland Classification System

WATER LONGEVITY	LANDFORM				
	Basin	**Channel**	**Flat**	**Slope**	**Highland**
Permanent inundation	Lake	River	-	-	-
Seasonal inundation	Sumpland	Creek	Floodplain	-	-
Intermittent inundation	Playa	Wadi	Barlkarra	-	-
Seasonal Waterlogging	Dampland	Trough	Palusplain	Paluslope	Palusmont

Table 11: Wetland Management Categories

MANAGEMENT CATEGORY	GENERAL DESCRIPTION	MANAGEMENT OBJECTIVES
Conservation	Wetlands which support a high level of attributes and functions	Highest priority wetlands. Objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including: ▪ reservation in national parks, crown reserves, and State owned land, ▪ protection under Environmental Protection Policies, and ▪ wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.

MANAGEMENT CATEGORY	GENERAL DESCRIPTION	MANAGEMENT OBJECTIVES
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions	Priority wetlands. Ultimate objective is to manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category. This can be achieved by restoring their wetland function, structure and biodiversity.
Multiple Use	Wetlands with few remaining important attributes and functions	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through land care.

2.7 ENVIRONMENTAL PROTECTION (SWAN COASTAL PLAIN LAKES) POLICY 1992

Environment Protection (Swan Coastal Plain Lakes) Policy 1992 (EPP Lakes) is a policy under Part III of the EP Act which aims to protect the environmental values of lakes on the Swan Coastal Plain through the prevention of filling, excavation and discharge into these lakes (unless authorised by the EPA).

2.8 WETLANDS CONSERVATION POLICY FOR WESTERN AUSTRALIA

The Wetlands Conservation Policy for Western Australia (Government of Western Australia 1997) provides recognition of wetland values and commits the State Government to identifying, maintaining and managing the State's wetland resource, including the full range of wetland values, for the long term benefit of the people of Western Australia.

2.9 PLANNING AND DEVELOPMENT ACT 2005

The *Planning and Development Act 2005* is an Act to provide for a system of land use planning and development in Western Australia.

The Act establishes the framework for preparation, amendment and function of Regional Planning Schemes and Local Planning Schemes. It also provides statutory procedures for the preparation and adoption of State Planning Policies (SPPs) by the Western Australian Planning Commission. SPPs are developed by the State Government to provide strategic guidance in land use planning decision making.

2.10 METROPOLITAN REGION SCHEME

The Metropolitan Region Scheme (MRS) guides land use in the Perth Metropolitan Region, which consists of a number of local government areas, including the Town of Kwinana. The MRS defines the use of land, dividing it into broad zones and reservations.

2.11 TOWN OF KWINANA TOWN PLANNING SCHEME NO 2

The Town of Kwinana Town Planning Scheme No. 2 outlines reserving and zoning of land in the Town and provides for the control of land use and development for the purposes of orderly and properly planned use and development of land to occur.

The policy provides the framework for the mapping, classification and categorisation for the State's wetland resources.

3 EXISTING ENVIRONMENT

3.1 CLIMATE

Perth enjoys a warm Mediterranean climate, with an average maximum summer temperature of 28.3°C and an average minimum winter temperature of 10.9°C (BOM 2010). The region receives an average annual rainfall of 765.3 mm, with the majority of precipitation occurring in winter (see Figure 3, below) (BOM 2010).

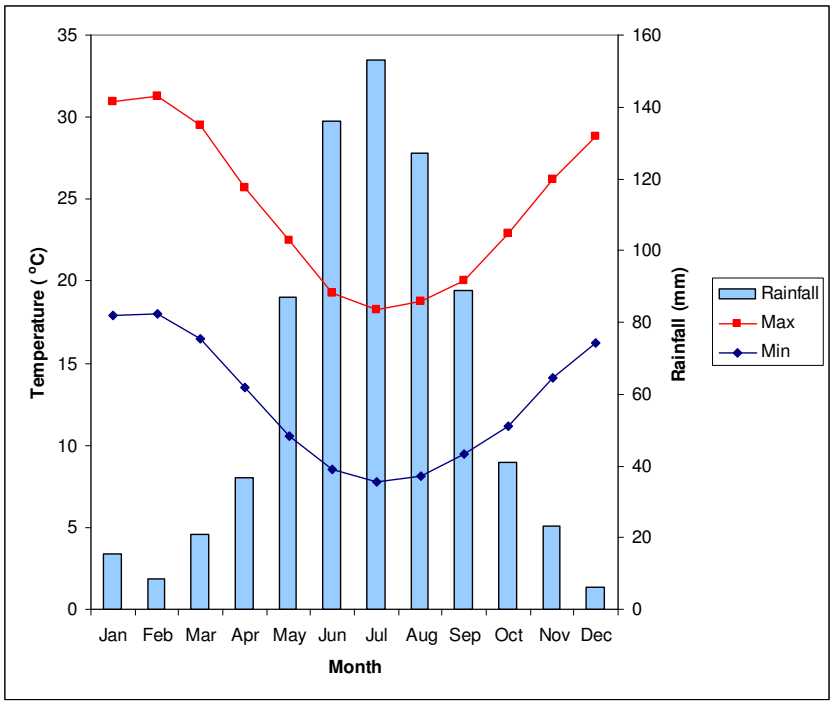

Figure 3: Temperature and Rainfall (BOM 2010)

3.2 SOILS AND GEOLOGY

Bollard Bulrush Swamp is part of the Beeliar Chain of Wetlands that represents the divide between the Bassendean Dune System to the east and the Spearwood Dune System to the west. Bassendean sands are generally white to grey, fine to medium-grained, quartz-based sands of an Aeolian origin, while Spearwood sands are calcareous and derived from Tamala limestone (Gozzard 1983). The sands have a yellowish to brown colour and a medium to coarse grain size.

The soils of the Beeliar Wetlands are of a lacustrine origin, being formed by sedimentation in lakes, and comprise of dark brownish-grey sandy silts with disseminated fine grains of quartz and variable organic matter content (Gozzard 1983).

3.3 ACID SULPHATE SOILS

The site is mapped almost entirely as 'high to medium risk of acid sulphate soils within 3m of the natural soil surface' (see Figure 4) (WAPC 2003).

3.4 ABORIGINAL HERITAGE SITES

The Department of Indigenous Affairs' Aboriginal Heritage Enquiry System identified a number of Aboriginal heritage surveys that have been conducted in the area encompassing the site. However, according to the enquiry system no Aboriginal Heritage Sites were found in the development area (DIA 2010).

3.5 FLORA AND VEGETATION

ENV was commissioned in 2010 to undertake a flora and vegetation assessment for the Bollard Bulrush East survey area. Included below is a summary of the Assessment, the complete Draft report is available in Appendix A.

3.5.1 METHODOLOGY

A thorough desktop review was conducted, including a DEC database search for Threatened Flora and the WA Herbarium (DEC 2010b), NatureMap (DEC 2010a), Department of Sustainability, Environment, Water, Population and Communities Protected Matters Search Tool (DSEWPAC 2010a) and previous flora surveys (completed by other consultants and the DEC). This was supplemented by a vegetation survey completed in September 2010 by an ENV botanist which included 10 m x 10 m quadrats, one relevé, photographs and samples (see Appendix A).

3.5.2 RESULTS

Vegetation Complex

Heddle *et al.,* (1978) mapped the area as containing one Swan Coastal Plain vegetation complex which is related to the underlying soil profile:

- Herdsman Complex: Vegetation consists of sedgelands and fringing woodland of Eucalyptus rudis - Melaleuca spp.

The EPA Guidance Statement 10 estimates the percentage of each mapped vegetation complex that remains on the Swan Coastal Plain compared to its pre-European extent. Complexes with 10-30% remaining are considered regionally significant, and complexes with 10% or less remaining in constrained areas may be formally assessed by the EPA (EPA 2006).

Across its extent 34.6% of the Herdsman Complex is estimated to remain (EPA 2006), with 31% remaining within protected Bush Forever sites across the Swan Coastal Plain (Government of Western Australia 2000). Based on the EPA Guidance Statement 10, the vegetation complex is unlikely to be considered regionally significant.

Flora

Sixteen families, twenty two genera and twenty three taxa were recorded in the survey area (seven native flora taxa and sixteen introduced)(see Appendix A for complete flora list). An average of thirteen species was recorded within each quadrat.

Vegetation Condition

The majority of vegetation onsite is considered to be Degraded, with a range of conditions from Completely Degraded to Good occurring on the site (Figure 5). This is in contrast to the condition of the other side of Bulrush Swamp as delineated in a 2008 survey undertaken for Dev-X Pty Ltd (shown in Appendix B).

Disturbances onsite include invasive weeds, livestock grazing and trampling and historical clearing. The high level of disturbance within the subject site and the high diversity and cover of invasive species indicates that the native species have been displaced.

Vegetation Unit

One vegetation unit was identified within the survey area:

MpEr Low Woodland of *Melaleuca rhaphiophylla, Eucalyptus rudis* subsp*. rudis*, **Rubus anglocandicans, *Zantedeschia aethiopica,*Paspalum dilatatum, *Holcus lanatus, Centella asiatica, *Rumex crispus* and *Baumea articulata.*

In addition, stands of native trees including *Eucalyptus rudis* subsp*. rudis* and *Melaleuca preissiana* were recorded (Figure 6). No native understorey species were recorded under these trees and thus, they have not been discussed as vegetation units.

Floristic Community Type

Due to the low native species diversity and the degraded condition of the site, ENV is unable to confidently infer a specific Floristic Community Type (FCT). The vegetation has been assessed as representing a highly disturbed example of FCT SCP 17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands' as several common and typical species of FCT SCP 17 are absent from the site.

The species richness recorded at the subject site has been influenced by the high diversity of introduced species recorded (which incorporated 69% of the total taxa recorded). Introduced species dominate the middle storey and understorey.

Protected Flora

A database search of the Wellard area resulted in ten Declared Rare and eight Priority Flora species being identified as potentially occurring in the subject area. Additionally the desktop search identified five Threatened Ecological Communities and three Priority Ecological Communities within a 5km radius of the site, also identifying these as potentially occurring on the site (Appendix A).

No Threatened species pursuant to the EPBC Act, no plant taxa gazetted as Declared Rare pursuant to the WC Act and no Priority Flora listed by the DEC were recorded in the survey area.

Climatic factors may have influenced the emergence of flora, such as annuals. However ENV considers it to be very unlikely that the subject site supports flora of conservation significance or provides the appropriate habitat for conservation significant flora and that, as such, the potential for Threatened, Declared Rare or Priority Flora is low.

The vegetation has been assessed as representing a highly disturbed example of FCT SCP 17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands' as several common and typical species of FCT SCP 17 are absent from the site. This FCT is not representative of any TEC or PEC complexes.

Introduced Species

The field survey identified sixteen dominant weed species listed in the Environmental Weed Strategy for Western Australia. The majority of these are common agricultural, bushland or wetland weeds in the region, but three of them are rated as High by the Environmental Weed Strategy for Western Australia (CALM 1999) (refer to Appendix A for ranking criteria). These are *Cortaderia selloana*, *Typha orientalis*, and *Zantedeschia aethiopica*.

Two of these species are listed as Declared Plants on the Swan Coastal Plain (DAFWA 2010); Arum Lily (**Zantedeschia aethiopica*); and Blackberry (**Rubus anglocandicans*). The level of infestation of both species was considered to be high, as a result of the wide distribution and high number of individuals within the survey area (see Figure 7). Arum Lily and Blackberry are both listed as Priority 1 for the whole State and require management strategies to reduce their distribution.

3.6 FAUNA

The EPA's instructions defined the fauna habitat values of the site as a factor to be assessed in this Environmental Review. In accordance with Guidance Statement 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment* (EPA 2004), ENV was commissioned in June 2010 to undertake a Level One fauna and fauna habitat

assessment, including targeted trapping, for the subject site. Included below is a summary of the assessment, the complete (draft) report is available in Appendix C.

3.6.1 METHODOLOGY

A thorough desktop review was conducted and included a DEC database search for Threatened and Priority Fauna (DEC 2010c), Western Australian Museum (WAM) & NatureMap (DEC 2010a), DSEWPaC Protected Matters Search Tool (DSEWPaC 2010a), Birds Australia's Birdata (Birdata 2010), previous surveys/reports (from ENV, other consultants and DEC reports) and discussions with important stakeholders. This was supplemented with a field survey conducted by a qualified Zoologist on the 30th September 2010. During the assessment only vegetated areas were assessed for fauna habitat, and fauna were opportunistically observed and recorded including scats, tracks, burrows and other evidence of animal presence. Conservation significant species were located and coordinates recorded with a GPS. Refer to Appendix C for a detailed methodology.

3.6.2 RESULTS

Habitat

One potential habitat type was identified onsite: *Melaleuca* Dampland, which covered approximately 22.7 ha (32%) of the site (Figure 8). The remaining of the site is in Degraded or Completely Degraded condition, and is considered to provide limited or no habitat value for fauna species.

The *Melaleuca* Dampland is characterised by Swamp Paperbark (*Melaleuca rhaphiophylla*), Flooded Gum (*Eucalyptus rudis* subsp. *rudis*), **Paspalum dilatatum*, Yorkshire Fog (**Holcus lanatus*), *Centella asiatica*, Curled Dock (**Rumex crispus*) and Jointed Rush (*Baumea articulata*). The Dampland is in Good-to-Degraded Condition however the midstorey and understory are heavily disturbed and dominated by weed species such as Blackberry and Arum Lily.

The *Melaleuca* Dampland within the subject site is degraded with limited midstorey and understorey species and a high level of weed infestation; consequently it is considered unlikely to support any species of conservation significance. The remainder of the site is considered to be of low value to fauna due to the lack of microhabitats and clearing of the site for grazing domestic animals creating a highly fragmented habitat.

Ecological Linkage

Ecological connectivity facilitates many life-history functions of fauna, and the ability to utilise connected habitats is integral to the life histories of a broad spectrum of species, with connectivity between habitats being crucial to important functions such as

breeding. Where undeveloped areas provide ecological connectivity, this can increase their ability to support fauna species.

Although the wetland on the site comprises only half of Bollard Bulrush Swamp, the link to the western side is disjointed partially by the Peel Main Drain running through the centre of the wetland. The wetland as a whole remains within a highly fragmented setting, with little habitat connectivity with the surrounding area. This reduces the value and functionality of the survey area to fauna, particularly those that require larger areas or home ranges.

Despite the nearby occurrence of Bush Forever Site 349 (Leda and adjacent bushland) to the south-west of the survey area, the site remains relatively isolated from other similar habitats in the local vicinity. This is largely due to its location between residential housing to the west and pastoral land to the east.

Fauna

In previous surveys two hundred and eleven species of fauna have been recorded in the vicinity of the subject site. During the Level One fauna survey conducted by ENV in 2010, 29 terrestrial vertebrate fauna were recorded. A summary of both is detailed below (for complete lists refer to the full Fauna Report in Appendix C):

- One amphibian species;
- One reptile species;
- 25 native bird species and one introduced bird species; and
- One native mammal species and one introduced mammal species.

All fauna identified during the field survey are commonly encountered on the Swan Coastal Plain.

Conservation Significant Fauna

A search of State and Federal databases for the area resulted in 28 conservation significant fauna species identified as potentially occurring.

Based on the ecological requirements, known distributions and the type and quality of fauna habitats, only two species listed were considered as 'Likely' to occur within the subject site. These being bird species, the Cattle Egret and Eastern Great Egret. These two bird species may not be impacted by potential development as they are highly mobile and can easily move to other areas.

The Southern Brown Bandicoot was recorded on site, and there is a long historical presence of the species on the Swan Coastal Plain. The survey area is not considered to be capable of supporting a large population due to the lack of native understorey species and the inundation of low lying areas during rain events.

3.7 WETLANDS - BOLLARD BULRUSH SWAMP

The subject site includes part of the eastern portion of Bollard Bulrush Swamp, extending as far west as the Peel Main Drain, which bisects the Swamp. This wetland is identified in both the Geomorphic Wetlands Swan Coastal Plain dataset, and the Environmental Protection (Swan Coastal Plains Lakes) Policy, discussed below.

The wetland is one of the 19 wetlands that form the Bibra Suite, which occur in depressions of the Spearwood and Bassendean Dunes (Hill *et al* 1996). Bollard Bulrush swamp comprises an area of 185.9 ha according to Hill *et al* (1996), out of a total area of 696 ha of sumplands in the Bibra Suite (26.7%). Its environmental values at the time of the Hill *et al* (1996) assessment led to it being assigned a percentile ranking of 58, indicating that it is below the 60th percentile of examples of Bibra suite sumplands. It is also indicated that Bollard Bulrush Swamp is in the bottom 20% of Bibra Suite sumplands on the basis of vegetation cover (percentile ranking 16). It should be noted that the condition and extent of the wetland represented in the Hill *et al* report is 16 years old, and may not reflect the current status of the wetland.

Hydric soils analysis of soil profiles at groundwater bore locations show that three of the locations display hydric properties (evidence of soil features produced under waterlogged conditions) and three do not (see Appendix D and Figure 9). However, while hydric soil properties demonstrate that an area is a wetland, or has been one in the past, they do not contribute to an assessment of management category. Given that most of the site is classified as wetland (Conservation category, Resource Enhancement and Multiple Use), it is to be expected that a large area of the site display hydric soils properties. The construction of the Peel Main Drain through the centre of this wetland, also means that it is likely that there are relic soils present on the site from a time prior to this major alteration of the hydrological regime, unrelated to the current regime.

Historically the site has been farmed since the 1920's, and large areas have previously been cleared. From 1973 until the present, grazing has occurred throughout the wetland. Vegetation has regenerated in recent years in the central part of the wetland as stock has been less frequently permitted to graze the wetland. The wetland habitat type is considered to be of low value to fauna within the survey area.

3.7.1 GEOMORPHIC WETLANDS SWAN COASTAL PLAIN DATASET

The DEC maintains a database of wetlands on the Swan Coastal Plain which includes:

- location and boundary of the wetland;
- wetland type / geomorphic classification (see Table 10); and
- management category (see Table 11).

Bollard Bulrush Swamp is classified by the DEC geomorphic wetland system as a Sumpland, which means that its character is that of a basin, and it is seasonally inundated with water.

Bollard Bulrush Swamp has areas classified under three of the management categories described by the DEC; the central area of the wetland is classified as a Conservation category wetland area (Unique Feature Identifier 15866), a small area is classified as Resource Enhancement Category wetland (Unique Feature Identifier 15867), and the outer area is classified as a Multiple Use Category wetland (Unique Feature Identifier 13327) (see Figure 10).

Management objectives for Conservation category wetlands is preservation of the wetland attributes and functions – these are the highest priority wetlands. Resource Enhancement category wetlands objectives encourage their management, restoration and protection with the aim of achieving Conservation category status. The management objectives of Multiple Use category wetlands allows for development within them, provided that planning for the development incorporates ecologically sustainable design principles. This may include such measures as nutrient, sediment and drainage management; fire management; and weed control.

Recent Vegetation Assessment

The three wetland areas currently identified by the DEC Geomorphic Wetlands Swan Coastal Plain dataset as occurring within the survey, support vegetation that is regarded as representative of wetland communities. However, the condition of this vegetation varies. The Conservation category and Resource Enhancement wetland areas within the survey area represent the core of the wetland vegetation. The high level of disturbance has reduced the ecological value of the vegetation in the area identified as Multiple Use wetland - it is Completely Degraded, as this area has been cleared and utilised for agricultural purposes.

3.7.2 ENVIRONMENTAL PROTECTION (SWAN COASTAL PLAINS LAKES) POLICY 1992

Bollard Bulrush Swamp is also protected under the *Environment Protection (Swan Coastal Plain Lakes) Policy 1992* (Lakes EPP) (see Figure 11). The Lakes EPP aims to protect the environmental values of lakes on the Swan Coastal Plain and does not allow filling with materials, clearing, excavation or discharge into lakes (amongst other activities) (EPA 1992).

The mapped boundaries of the Geomorphic Wetlands Swan Coastal Plain dataset do not correspond with the mapped EPP lake boundary.

Interpretation of Wetland Boundary in relation to the Environmental Protection (Swan Coastal Plain Lakes) Policy, 1992

Under the 1992 Lakes EPP, a lake was identified if it contained an area of standing water of more than 1000 square metres as at 1 December 1991. Evidence in the form of historical photographs suggests the original EPP policy criteria of standing water no longer applies to Bollard Bulrush Swamp, and has not applied for many years, even at the key date in 1991.

A photograph taken of Bollard Bulrush Swamp when the EPP Lakes Policy came into effect is shown in Figure 12. The photograph was taken 22 November 1991 which is closest to the 1 December 1991 that Landgate (Western Australian Land Information Authority) could supply. Figure 13 has the 1991 aerial with the EPP Lakes boundary overlayed. No standing water is observable in the aerial photograph, and the EPP boundary extends far beyond the vegetated wetland area.

While Bollard Bulrush Swamp is a wetland, the boundary of the EPP Lake appears to be inaccurate; it does not represent standing water in the aerial photography at the time of the Policy's inception. Appendix E contains historical aerial photographs of Bollard Bulrush Swamp starting from 1953 and continuing on through to the present year. These photographs clearly show the years when the area is inundated with water. Table 12 below lists the years the photographs were taken and if open water was present.

Table 12: Historical Aerial Photograph Inventory for Appendix E

Photograph Year	Month	Water Present
1953	November	Yes
1965	March	No
1974	September	Yes
1977	June	No
1981	August	No
1985	June	No
1991	November (Figure 12)	No
1995	February	No
2000	February	No
2001	January	No
2003	January	No
2004	December	No
2006	March	No
2008	July	No
2010	November	No

On this basis, it can be reasonably concluded that the EPP mapping is incorrect in this case. Hence, a case exists for the EPP delineation to be amended to a more reasonable boundary. Strategies for the future management of the wetland in light of these issues are discussed in Section 4.1.

3.8 GROUNDWATER

ENV has installed groundwater monitoring bores at six locations within the site to monitor groundwater levels and groundwater quality. Monitoring bore locations are shown on Figure 14. Water levels in the bores were first measured on the 3rd October 2006. An eighteen month water monitoring program including monthly monitoring of water levels and quarterly monitoring of water quality commenced on the 1st July 2010. To date, ENV has undertaken 10 occasions of groundwater levels monitoring and three occasions of groundwater quality monitoring, capturing two "winter" (peak water level) periods. The results of this monitoring undertaken to date are summarised below. More detailed analysis can be found in Appendix F, which contains a short letter report from December 2010 on the results of the monitoring program.

3.8.1 GROUNDWATER LEVELS

Average Annual Maximum Groundwater Levels (AAMGLs) have been calculated for the site using the water levels recorded from the bores on 3 October 2006 and the historical record of water levels for DoW bore T-250. The AAMGLs for each bore and the depth to AAMGL from ground surface are shown in Table 13 below.

Table 13: Average Annual Maximum Groundwater Levels (AAMGL) and Depth to AAMGL for each Bore.

Bore Name	AAMGL (m AHD)	Depth to AAMGL (m)
MW1-E	5.918	0.953
MW2-E	4.636	-0.227
MW3-E	5.737	0.645
MW4-E	4.362	-0.283
MW5-E	4.256	-0.390
MW6-E	4.332	0.463

The AAMGL for the site varied between 4.256 m AHD at MW5-E and 5.918 m AHD at MW1-E. The depth from the surface to AAMGL varied between -0.39m at MW5-E and 0.953 m at MW1-E. The negative depth to AAMGL at MW2-E, MW4-E and MW5-E indicates that these areas could expect to be waterlogged or inundated at the surface during winter in an average year. MW5-E is within the Conservation category area and is

consequently not being considered for development. The bores MW2-E and MW4-E roughly represent the lowest areas that will be developed under the current proposal. The AAMGLs in these areas are between 0.227 and 0.283 m above the natural surface. Groundwater contours for the site are shown in Figure 14.

Groundwater flow is expected to be generally south-westerly, towards the Peel Main Drain (DoW 2009) and this is confirmed by the recorded groundwater results from the site. However, groundwater levels and flow directions on the site will be affected by the Peel Main Drain. When the groundwater levels are higher than the drain, groundwater will flow towards the drain. When the water level in the drain is higher than the groundwater, the drain will recharge the groundwater.

3.8.2 GROUNDWATER QUALITY

The full set of groundwater quality results for the site is contained in Table 14.

Field pH measurements indicate groundwater was close to neutral (6.3 to 7.6) in all bores located within the site (Table 14). Some of the lower pH's recorded at the site are slightly below the ANZECC (2000) default trigger value for slightly disturbed wetlands (7.0 to 8.5). This may be due to the presence of tannins which can cause pHs as low as 4.5 in highly coloured wetlands (ANZECC 2000). Some of the higher pHs are slightly above the target range stated in the Jandakot Drainage and Water Management Plan (DWMP) (5.2 to 7.3) but within the ANZECC trigger values (DoW 2009).

Electrical conductivity (EC) levels measured in the bores indicate that groundwater at the site ranges from being fresh to brackish (307 to 1856 mg/L calculated TDS). Some of the higher salinities recorded at the site were slightly above the ANZECC (2000) trigger values (300 to 1500 us/cm EC) but were within the range stated in the Jandakot DWMP (up to 5 000 mg/L TDS). Higher salinities were generally recorded in early winter, closer to the drain and in areas with a shallow water table, indicating the likely cause of the brackish groundwater is the higher concentration of salts caused by evaporation and transpiration.

Water quality sampling indicates that nitrogen and phosphorus are elevated in groundwater below the site, probably due to the historical agricultural use at the site. Total Nitrogen (TN) levels were up to 13 times above the Swan Canning Cleanup Program (SCCP) Long-Term target of 1 mg/L in all of the samples collected. Total Nitrogen (TN) levels were also above the ANZECC (2000) trigger value of 1.5 mg/L in eight of the 12 of the samples collected (by up to 8.7 times). However, the TN levels recorded at the site were within the range of concentrations outlined in the Jandakot DWMP (DoW 2009) (<1 to 123.7 mg/L). Four of the 12 concentrations were greater than 3 mg/L, hence above typical values for the area. The breakdown of nitrogen in Table 14 indicates that the predominant form of nitrogen at groundwater at the site is organic nitrogen, as given by the low proportion of nitrate and nitrite (NOx).

Total Phosphorus (TP) levels were above both the Swan Canning Cleanup Program (SCCP) Long-Term target of 0.1 mg/L in just over three quarters of the samples collected, by up to 13 times. TP concentrations also exceeded the ANZECC (2000) trigger value of 0.06 mg/L in all but one of the samples collected, by up to 22 times. All TP levels recorded on the site were within the range of concentrations outlined in the Jandakot DWMP (DoW 2009) (0.01 to 34.7 mg/L). Five of the 12 concentrations were greater than 0.5 mg/L, hence above typical values for the area. In all of the bores, except MW1-E, phosphate (PO_4^{3-}) concentrations were negligible. This suggests that phosphorus in groundwater across most of the site exists predominantly in a particulate form and therefore is likely to present less of a risk to aquatic life.

Metals also occur in the groundwater at concentrations above ANZECC (2000) trigger values. For the July 2010 water quality sampling event only copper and zinc exceeded the trigger values of 0.0014 mg/L and 0.008 mg/L, by less than three times. Metal concentrations were higher in the October 2010 and January 2011 sampling rounds with arsenic, chromium, copper, lead, nickel, zinc and mercury all exceeding the trigger values by more than four times. In all bores aside from MW5, copper concentrations had increased by between ten and 100 fold and were up to 321 times higher than the trigger value. Lead and nickel concentrations also exceeded the NHMRC (2004) Australian Drinking Water Guidelines (ADWGs) of 0.01 mg/L and 0.02 mg/L by up to 18 and 5.5 times respectively. The source of the elevated metals could be infiltration of stormwater from the surrounding urban development which would explain the increase in concentrations from July to October. The historical agricultural use could also be a contributing source.

Table 14: Water Quality

Date	Bore ID	Field pH	Field EC uS/cm	Calculated TDS (mg/L)	Total N mg/L	TKN mg/L	NO3+NO2 mg/L	NO3-N mg/L	NO2-N mg/L	NH3-N mg/L	Total P mg/L	PO4 mg/L	Arsenic mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Mercury mg/L	Nickel mg/L	Zinc mg/L
8/07/10	MW1E	7.0	690	442	3.8	3.0	NA	0.72	0.039	0.02	1.3	0.25	0.001	<0.0001	<0.005	0.003	0.001	<0.0001	0.003	<0.01
	MW2E	7.4	1150	736	1.1	1.1	NA	0.01	<0.005	0.57	0.58	<0.005	<0.001	<0.0001	<0.005	0.003	0.001	<0.0001	0.002	<0.01
	MW4E	7.6	1620	1037	2.3	2.1	NA	0.14	0.023	0.53	0.46	<0.005	<0.001	<0.0001	<0.005	0.002	<0.001	<0.0001	0.003	<0.01
	MW5E	7.3	1690	1082	1.7	1.6	NA	0.07	0.036	0.37	0.38	<0.005	<0.001	<0.0001	<0.005	0.002	<0.001	<0.0001	0.004	<0.01
	MW6 (New)	6.8	2900	1856	13	10.0	NA	1.50	1.500	1.10	0.88	<0.005	0.002	<0.0001	<0.005	0.001	<0.001	<0.0001	0.007	0.003
	MW6	6.3	1570	1005	12	7.8	NA	4.00	0.220	0.28	0.38	<0.005	0.002	<0.0001	<0.005	0.004	<0.001	<0.0001	0.005	0.01
28/10/10	MW1E	6.6	480	307	1.3	1.2	0.092	NA	NA	0.02	1.3	0.3	<0.01	<0.002	0.04	0.057	0.067	0.003	0.006	0.02
	MW2E	7.2	1080	691	1.3	1.2	0.008	NA	NA	0.64	0.12	0.005	0.02	<0.002	0.028	0.033	0.013	<0.0001	0.006	<0.01
	MW4E	7.6	840	538	1.7	1.6	0.033	NA	NA	0.53	0.15	<0.005	0.1	<0.002	0.18	0.024	0.024	0.0004	0.05	0.02
	MW5E	7.1	580	371	1.3	1.3	0.031	NA	NA	0.19	0.12	0.008	<0.01	<0.002	0.006	<0.005	<0.001	<0.0001	<0.005	<0.01
	MW6 (New)	6.4	2190	1402	2.7	2.4	0.36	NA	NA	0.36	0.03	<0.005	0.07	<0.002	0.26	0.45	0.18	<0.0001	0.074	0.16
	MW6	6.4	580	371	3.3	3.1	0.18	NA	NA	0.56	0.07	<0.005	0.05	<0.002	0.12	0.046	0.086	0.0003	0.043	0.16
20/01/11	MW1E	6.5	670	429	3.7	0.9	2.8	NA	NA	0.05	0.79	0.17	0.004	<0.002	0.032	0.079	0.017	0.0002	<0.005	0.03
	MW2E	7.4	520	333	1.7	1.4	0.28	NA	NA	0.65	0.21	0.03	0.091	<0.002	0.048	0.059	0.004	0.0001	0.01	0.06
	MW4E	7.5	790	506	7.2	6.9	0.26	NA	NA	0.75	0.12	0.03	0.62	0.003	0.081	0.019	0.008	0.001	0.014	0.06
	MW5E	7.3	1400	896	7.2	6.9	0.31	NA	NA	1.00	0.3	0.03	0.41	0.006	0.35	0.13	0.02	0.0004	0.11	0.11
	MW6 (New)	7.5	1200	768	8.3	7.6	0.72	NA	NA	0.49	0.091	0.05	0.13	0.002	0.25	0.32	0.17	0.0002	0.063	0.14
	MW6	7.3	1700	1088	7.1	6.7	0.4	NA	NA	0.26	0.08	0.03	0.059	<0.002	0.047	0.036	0.014	0.0001	0.017	0.08
SCCP Long Term Target[1]					1						0.1									
ANZECC Trigger Value[2]		7.0 – 8.5	300 – 1500		1.5		0.1			0.04	0.06	0.03	0.024	0.0002	0.01	0.0014	0.0034	0.00006	0.011	0.008
Drinking Water Guideline[3]								11.3					0.007	0.002	0.05	2	0.01	0.001	0.02	3*

3.9 SURFACE WATER HYDROLOGY

Surface water exists seasonally at the site as Bollard Bulrush Swamp and as the Peel Main Drain, an artificial drainage line. The Peel Main Drain is a rural drain which runs through the Bollard Bulrush Swamp area and forms part of the regional drainage network. The drain is located within the catchment of the Serpentine River which eventually discharges into the Peel Harvey Estuary.

Coincident with the groundwater monitoring program outlined previously, ENV has undertaken eight occasions of surface water level measurement at four surface water monitoring locations. Inundation of Bollard Bulrush Swamp is monitored at two locations (SW1E and SW2E) and water levels in the Peel Main Drain upstream and downstream of the site is monitored at the other two locations (Culvert North and Culvert South).

Surface water quality monitoring of Bollard Bulrush Swamp could not be undertaken because the two surface water sites were dry throughout the monitoring period as detailed below.

3.9.1 SURFACE WATER LEVELS

Bollard Bulrush swamp inundation is caused by direct runoff from the local catchment area and tailwater conditions in the Serpentine River. During periods of high rainfall causing floodwaters from the Serpentine River flood the Peel Main Drain and in turn, inundate the surrounding low lying areas of Bollard Bulrush Swamp. Maximum Surface Water Levels (MSWL) recorded from the site are presented in Table 15, below.

Table 15: Maximum Surface Water Levels

MONITORING LOCATION	MSWL (m AHD)
SW1	dry
SW2	dry
Culvert North	7.19
Culvert South	3.95

The results indicate that surface water inundation did not occur to the east of the main drain during the monitoring period. It is likely that this is due to below average rainfall during this time. Water levels in the Peel Main Drain at the time of sampling were over 0.7 m below the 10 Year ARIs presented in Table 16.

3.9.2 ESTIMATED FLOOD CHARACTERISTICS

As shown on Figure 15 the site is partially located within the flood fringe of the Peel Main Drain (DoW 2009). The floodway, or area of fast flowing water, is limited to the Peel Main Drain itself.

The Jandakot DWMP (DoW 2009) provides flood levels for the Peel Main Drain at Bollard Bulrush. These are summarised in Table 16 below.

Table 16: Peel Main Drain Flows (DoW 2009)

Location	Peak Flows (m3/s)		Peak levels (m AHD)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Peel Main Drain at Bertram Road	3.25	3.82	7.9	8.2
Bollard Bulrush Swamp (the site)	3.38	4.00	4.82	5.61
Peel Main Drain at Millar Rd	4.38	5.06	4.70	5.59

The 1 in 100 year Average Recurrence Interval (ARI) flood level for Bollard Bulrush Swamp is given as 5.6 m AHD in the DWMP (DoW 2009). Approximately 1,900 ML of storage is currently provided within Bollard Bulrush's flood fringe in the 1 in 100 year flood level (DoW 2009). Bollard Bulrush Swamp is the largest storage location in the northern part of the Peel Main Drain. The total flood area at Bollard Bulrush is estimated at 149 Ha. Of this, less than 10 ha (or 10%) is considered to be within the subject site.

3.9.3 WATER BALANCE

An estimate of the pre-development quantity of water that either drains from the site or infiltrates was made based on an infiltration rate of 15% of rainfall. This value was compared to an estimate of the post-development drainage and infiltration quantities. The post-development values were determined using standard water use figures for each of the land uses in the development. This information is provided in Table 17 and shows that post-development, there will be a 250% increase in discharge. This is typical of developments of this density.

Table 17: Pre and Post-Development Water Balance

Pre-Development	Drainage and Infiltration (ML/yr)
Pre Development	**92.59**

Post-Development	Drainage and Infiltration (ML/yr)
Groundwater Input	
Low Density	131.89
Medium Density	126.54
School recharge from rainfall &irrigation	25.50
POS recharge from rainfall &irrigation	17.62
Drainage areas and roads	54.05
Total Input	**355.61**
Groundwater Extraction	
Low Density	-29.31
Medium Density	0.00
Groundwater for School irrigation	0.00
Groundwater for POS irrigation	0.00
Total Extraction	**-29.31**

Total recharge to groundwater and drainage leaving site	**326.29**

Extra volume recharge/outlfow	**233.71**

% increase of recharge/outflow	**252%**

4 ENVIRONMENTAL FACTORS AND MANAGEMENT

The instructions from the EPA on the scope and content of this Environmental Review have led to further environmental research and investigation in order to quantify the environmental assets of the site. The risks posed to these assets by the development of the Wellard Urban Precinct East have been identified and defined, and are discussed in detail. Management responses to these risks have been defined as part of an overall environmental management framework for the development.

The key environmental issues requiring a management response during the development of the Wellard Urban Precinct East are identified by the EPA as follows:

- Wetlands: Bollard Bulrush Swamp;
- Fauna: the fauna of Bollard Bulrush Swamp; and
- Water: particularly surface and groundwater quality and quantity.

4.1 WETLAND

Bollard Bulrush Swamp is recognised in the DEC's *Geomorphic Wetlands of the Swan Coastal Plain* dataset (as a mixture of Conservation category, Resource Enhancement and Multiple Use), and as an EPP Lake under the *Environmental Protection (Swan Coastal Plains Lakes) Policy 1992*. These classifications afford varying levels of protection to the wetland. The floristic community of the wetland is "*M. rhaphiophylla – Gahnia trifida* seasonal wetlands".

4.1.1 POTENTIAL SOURCES OF IMPACT

Residential development in proximity to the Swamp may result in both positive and negative modifications. On the positive side, there is likely to be more passive surveillance of the site, which should lead to less uncontrolled access by mountain bike riders and walkers, which is noted as a highly destructive practise. However, residents living nearby may seek to gain access themselves to the naturalistic environment preserved in the wetland, leading to potential negative impacts on vegetation, fauna and fauna habitat, and the physical structure of the shore and swamp through increased pedestrian traffic (in the case of uncontrolled access).

Potential threats to wetlands in association with the change in land use to Urban/Residential are identified as follows:

- alteration to the water regime;
- habitat modification;
- inappropriate recreational usage;
- weed invasion; and
- diminished water quality.

4.1.2 MANAGEMENT OBJECTIVES

The management objectives recognised by the State Government for Multiple Use wetlands are to allow for "*Use, development and management…in the context of ecologically sustainable development and best management practice catchment planning through landcare*" (EPA 2008a).

The management objectives for Resource Enhancement wetlands "*to manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category status. This can be achieved by restoring their wetland function, structure and biodiversity."* (EPA 2008a).

The management objectives for Conservation category wetlands is the "*preservation of wetland attributes and functions through various mechanisms including:*

- reservation in national parks, crown reserves and State owned land,
- protection under Environmental Protection Policies, and
- wetland covenanting by landowners.

These are the most valuable wetlands and the Commission will oppose any activity that may lead to further loss or degradation. No development." (EPA 2008a).

4.1.3 PROPOSED MITIGATION AND MANAGEMENT ACTIONS

The effective mitigation and management actions for Bollard Bulrush Swamp rely on an approach which will provide a consolidated wetland area for conservation into the future.

In 2012, staff from Strategen attended the site and took a series of photographs from points surrounding the wetland (these are provided in Appendix G). This process was used by Strategen to re-define the functional boundary of the wetland (Figure 16 - Strategen). Figure 16 has been developed in consultation with the EPA based on the extent and condition of existing vegetation as determined by aerial photographs and site assessment.

Determination of Wetland Buffer

It is relevant to note that there is an area surrounding the Conservation category and Resource Enhancement Wetland areas that is categorised as Multiple-Use. The Multiple-Use portion of the wetland is degraded and severely infested with weeds and therefore ENV considers that a portion of it should be used as a separation area to protect the attributes of the other portion.

This buffer will protect the vegetation and fauna values of the wetland, and provide areas for roosting, nesting, feeding and refuge. This separation from the urban land use will reduce the impact of human activities on both the vegetation and fauna of the wetland area. This will occur through limiting exposure to the following:

- Passive and active recreation by nearby residents which have the potential to disturb waterbirds and vegetation of the wetland;
- Domestic animals;
- Construction effects such as noise and vibration; and
- Effects of housing such as noise, movement and light.

The WAPC draft *Guideline for the Determination of Wetland Buffer Requirements* (2005) recommends a 50 m buffer, but this may vary depending on the threatening processes. A buffer distance of 50m is considered as appropriate to adequately protect the wetland function area and wetland habitat from further weed infestation and from inappropriate recreational uses (see Figure 16 for the outline of the wetland function area and buffer as defined by Strategen).

This will result in a manageable, cohesive wetland area, which encompasses the important features of the wetland and can be rehabilitated to provide net benefit in terms of the enhancement of native vegetation, fauna habitat, and aesthetics.

Subdivision Design

The subdivision design has been carefully considered in order to provide appropriate planning and environmental outcomes (Figure 17 – Greg Rowe and Associates).

Appropriate development setbacks will be incorporated into subdivision design and the Wetland Management Plan. Details of landscaping and design interface solutions, such as protective fencing and creation of a hard edge to the agreed wetland area, will also be included in a Wetland Management Plan.

Management Control

The effectiveness of management of the wetland area will be greatly enhanced through its transfer from fragmented, private ownership, to a cohesive unit under public ownership. The consolidation and rehabilitation of a central conservation area which

encapsulates the wetland function area will provide a more cohesive vegetated area and habitat.

Urbanisation of the adjacent area will provide the opportunity to exclude grazing and uncontrolled access to the swamp. This will in turn allow the rehabilitation and recovery of the wetland core vegetation (where the key environmental values are located), and reduce the threats posed by increased nutrient loading. Provision of formal, controlled public access to the swamp will increase the amenity and recreation values available to the surrounding community.

A Construction Environmental Management Plan will be implemented during development, and this will include management strategies to reduce the likelihood of the Priority 1 weeds on the site spreading further within the site, or to other sites.

A Wetland Management Plan will be developed to manage the impacts of the proposed development on the wetland, and its flora and fauna values. The implementation of the Wetland Management Plan will allow progress towards the enhancement of the wetland core habitat, vegetation and function, including the reduction of weed dominance. This will lead to a greatly improved environmental outcome which is otherwise unlikely to be achieved under current conditions, in the absence of any formal management.

4.2 FAUNA

The fauna survey of the subject site found fauna typical of a highly disturbed wetland environment on the Swan Coastal Plain. Two migratory bird species listed under the EPBC Act were considered to be likely to occur in the wetland portion of the site (the Cattle Egret and Eastern Great Egret), and evidence of the presence of one conservation significant Priority Four species (the Southern Brown Bandicoot).

4.2.1 POTENTIAL SOURCES OF IMPACT

The primary sources of impact on migratory birds utilising the wetland environment as a result of the project would most likely stem from altered hydrological regimes impacting on the wetland, the continued degradation of the wetland vegetation as a result of uncontrolled access and further weed dominance, and the possibility of predation by feral animals such as the black rat, the domestic cat, and the domestic dog.

4.2.2 MANAGEMENT OBJECTIVES

Management of the wetland should aim to protect the fauna present, particularly migratory birds, and the Southern Brown Bandicoot. This is most likely to be achieved through the rehabilitation of the potential fauna habitat represented by the site.

4.2.3 PROPOSED MITIGATION AND MANAGEMENT ACTIONS

Design

The design of the wetland interface will allow a greater level of control of access by feral animals and control for weed infestation. In combination with revegetation and weed control actions, this will encourage the recovery of fauna habitat in the agreed wetland area.

Management Control

Revegetation of the wetland area can focus on the creation of appropriate habitat for the Southern Brown Bandicoot, the Cattle Egret, and the Eastern Great Egret. Improvement of the quality of the habitat will serve to encourage use by all native fauna, including conservation significant fauna.

4.3 SURFACE WATER

4.3.1 POTENTIAL SOURCES OF IMPACT

Change of land use from rural to urban can result in an increase in the surface run-off from the development area due to an increase in non-permeable surfaces. Urban development may also increase the volume of pollutants, both chemical and physical, which are transported by that run-off.

4.3.2 MANAGEMENT OBJECTIVES

Surface water management is not only about restricting the increase in runoff due to development but must also manage and restore desirable environmental flows where potential impacts on significant ecosystems are identified; in this case Bollard Bulrush Swamp. The potential movement of pollutants from the site in stormwater also needs to be addressed. Appropriate management intervention can facilitate improvements in surface water quality post-development.

4.3.3 PROPOSED MITIGATION AND MANAGEMENT ACTIONS

Surface Water - Design and Management Control

Surface water management in the subject site will:

- Ensure that adequate protection is provided to buildings and infrastructure against flooding;
- Ensure downstream flood risks are mitigated;

- Maintain catchment runoff within the development are to pre-development peak flow velocities;
- Maintain sub-catchment discharge point flow velocities to pre-development peak flow velocities;
- Promote on-site retention of events up to the one–year–one–hour average recurrence interval; and
- Minimise the release of anthropogenic pollutants from the subject site.

Flooding - Design and Management Control

GHD was commissioned in 2010 to undertake flood modelling for the Bollard Bulrush Swamp. The full report undertaken by GHD is provided in Appendix H. The model was based on the model conducted for the Jandakot Drainage and Water Management Plan (DoW 2009). The Bollard Bulrush model reflected the proposed development of the area, hence used increased percentage of impermeable area. This will give a worst case scenario of the likely impact because urban sensitive design was not factored into the model.

The results indicate that the maximum water level within the Bollard Bulrush Swamp changes by less than 100 mm for the 100 year ARI event and that levels both upstream and downstream of the Peel Main Drain remain relatively unchanged during such a storm. Results are presented in Table 18.

Table 18: Modelling of Full Extent of Proposed Development (GHD 2010)*

LOCATION	TOP WATER LEVEL (m AHD)		PEAK FLOW (m^3/S)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Bollard Bulrush Swamp	4.85 *(+ 30 mm)*	5.65 *(+ 4 0mm)*	3.38 *(no change)*	4.00 *(no change)*
Peel Main Drain and Bertram Rd	7.90 *(no change)*	8.20 *(no change)*	3.25 *(no change)*	3.82 *(no change)*
Peel Main Drain at Millar Rd	4.72 *(+ 20 mm)*	5.62 *(+ 30 mm)*	4.73 *(+ 350 L/s)*	5.77 *(+ 710 L/s)*

** brackets indicate change from Jandakot DWMP modelling results*

To protect against flooding, the site will be filled to achieve finished floor levels at least 0.5 m above the 100 year peak water level. Preliminary estimates indicate up to 1.5 m of fill is required for house pads in the area adjacent to the wetland (below the 5.6 m AHD contour) to meet requirements for flooding. The fill requirements for flooding are greater than the requirements for groundwater separation, as discussed previously.

A water balance model was prepared to compare flows discharged from the site pre-development and post-development. Model inputs and assumptions were obtained from the MRS Amendment report and GHD Flood Modelling study.

An increase in recharge volume of approximately 250% is estimated post-development as shown in Appendix H. The pre-development recharge is estimated at 93 ML/year. Water balance calculations indicate that approximately 233 ML/yr additional recharge will occur on site once developed. This expected increase in recharge is a direct result of the increase in impervious area associated with development of residential and school areas.

Conceptual Stormwater Management System

The environmental flow objectives of the *Water Quality Improvement Plain (WQIP) for the Rivers and Estuary of the Peel-Harvey System* (EPA 2008b) are to maintain natural flow variability, protect wetlands and floodplains (mimic natural inundation and drying patterns) and minimise the effect of dams on water quality (mimic natural frequency, duration and seasonal flow).

Stormwater design will aim to achieve these objectives via the following:

- Retention of the 1 in 1 year ARI storm on site;
- Detention of flow to pre-development discharge for events up to the 1-year-1-hour average recurrence interval; and
- Maintenance of the hydrological regime of the wetlands.

Details to achieve this will be provided in a Local Water Management Plan (LWMS).

Surface Water Quality Best Management Practices

Surface water quality management within the site will aim to achieve phosphorus reductions and meet water quality targets specified in EPA (2008b) WQIP including a mean phosphorus concentrations of 0.1 mg/L in streams in winter. Both structural and non-structural Best Management Practices (BMP's) will be implemented to improve the quality of drainage from the development. The selection of BMPs will be guided by the Department of Water's *Stormwater Management Manual* (2004-2007) and the recommendations within the *Jandakot Water Resource Management Strategy* (DoW 2004).

Structural BMP's to be implemented will include:

- Water sensitive urban design to promote infiltration and treat stormwater before its discharge into waterways;
- Stormwater basins and swales to minimise sediment and pollutant movement;
- Subsoil drainage outlet points will run into a swale or bioretention area;
- Separation of stormwater from clean sources (such as roofs) from 'dirty' sources such as roads and industrial areas into separate basins; and
- Revegetation of cleared areas following construction, except where there will be buildings, paving or detention basins, where possible.

Non-structural BMP's will include:

- Various Environmental Management Plans will be prepared and implemented that present details of stormwater management during both the construction and operational stages;
- Inclusion of stormwater and spill management and environmental awareness training for construction staff; and
- Community education.

Stormwater management system design and proposed BMPs will be detailed in the LWMS and Urban Water Management Plans (UWMP's).

Post-development Surface Water Monitoring

Post development monitoring should be for 3 years from 80% completion of the development include sampling of surface water for pH, electrical conductivity, nutrients and metals.

The post-development monitoring program will follow the program summarised in Table 19.

Table 19: Post-Development Surface Water Monitoring Program

Frequency	Parameters to be Monitored
Site Specific	Water Levels
Quarterly	*In Situ*: pH, EC, Temperature TSS, Total N, Total P, NH_3, NO_3, NO_2, TKN, SRP/FRP

A site specific contingency action plan with associated trigger values based on the predevelopment monitoring results must be developed and presented in the Local Water Management Strategy. When trigger values are breached, communication must occur with the department of water and the Town of Kwinana as per the Jandakot DWMP (DoW 2009).

4.4 GROUNDWATER

4.4.1 POTENTIAL SOURCES OF IMPACT

Changes to the water that result from development may include alterations to the groundwater level or quality. Reduction of groundwater levels as a result of development have the potential to negatively impact on groundwater dependent ecosystems. Conversely, increases in groundwater level have the potential to increase the risk to infrastructure and assets from flooding, as well as promote transportation of nutrients and other pollutants held in the soil.

Changes in land use may also bring about changes to the groundwater quality of an area – often the quality of the groundwater may improve. The subject site also occurs within an area of high risk for Acid Sulfate Soils (ASS). Dewatering, soil disturbance, compaction or lateral displacement in areas of ASS during residential development can result in the contamination of soil and groundwater.

4.4.2 MANAGEMENT OBJECTIVES

The key objectives for groundwater management outlined in the Jandakot DWMP are:

- Protection of infrastructure and assets from flooding and inundation by high seasonal groundwater levels, perching and/or soil moisture;
- Protection of groundwater- dependent ecosystems from the impacts of urban runoff or water table decline; and
- Managing and minimising changes in groundwater levels and groundwater quality following development/redevelopment (DoW 2009).

4.4.3 PROPOSED MITIGATION AND MANAGEMENT ACTIONS

Groundwater Level Management

Groundwater levels will be maintained post-development through the use of imported fill and subsoil drainage where required. Filling to protect against flooding should also provide sufficient clearance to maximum groundwater, making any dewatering at the site highly unlikely to be necessary.

Groundwater Quality Management

Groundwater quality will be maintained to pre-development levels (median winter concentrations) and if possible improve the quality leaving the development area, which will be facilitated through the urban development of the site. The following best management measures will be implemented to manage groundwater quality as per the EPA (2008b) WQIP, the *Jandakot Structure Plan* (WAPC 2007) and the DoW's *Jandakot Water Resource Management Strategy* (DoW 2004):

- Urban fertiliser management, including limiting the use of fertilisers in Public Open Space (POS), promotion of fertiliser wise gardens and public education;
- Incorporation of soil amendments, swales and infiltration basins and irrigated POS, where required.
- Encouragement of soil amendments in residential lawns and gardens via Waterwise landscaping packages.
- Where groundwater is extracted for irrigation, extract that portion of the shallow groundwater that is enriched with nutrients.
- Connection of the development to reticulated sewage as detailed in Section 5.5.3.

Groundwater management system design will be detailed in the LWMS and UWMPs.

Post-development Groundwater Monitoring

Post development monitoring should be for 3 years from 80% completion of the development include sampling of groundwater for pH, electrical conductivity, nutrients and metals.

Groundwater bores will be sampled across the site in the post-development monitoring program ensuring in bores located at the upstream side of the development and bores at the downstream side of the development.

The post-development monitoring program will follow the program summarised in Table 20.

Table 20: Post-Development Groundwater Monitoring Program

Frequency	Parameters to be Monitored
Quarterly	Water Levels
	In Situ: pH, EC, Temperature TSS, Total N, Total P, NH_3, NO_3, NO_2, TKN, SRP/FRP
Annually	Heavy Metals

A site specific contingency action plan with associated trigger values based on the predevelopment monitoring results must be developed and presented in the Local Water Management Strategy. When trigger values are breached, communication must occur with the department of water and the Town of Kwinana as per the Jandakot Drainage and Water Management Plan (DoW 2009).

Acid Sulphate Soils Management

Dewatering, soil disturbance, compaction or lateral displacement in areas of ASS during residential development of the site will be avoided where possible. The design of the development is highly likely to involve the importation of fill during development to achieve the required separation from groundwater levels, and to reduce flooding risk. This will reduce the likelihood of disturbing ASS through reducing the need for dewatering and large-scale excavations.

Should design development later in the planning process involve the disturbance or dewatering of any areas of potential ASS, a compliant investigation will be undertaken and an Acid Sulfate Soils and Dewatering Management Plan will be implemented for the site as a condition of subdivision.

Management of Effluent Disposal

Because of the high groundwater levels on the site and the size of residential lots, the use of on-site wastewater systems is not considered appropriate. The EPA (2008) WQIP states that all new developments in the Peel-Harvey Catchment are to be connected to reticulated sewage or Alternative Treatment Units (ATU's). The development will therefore be connected to the urban sewerage system.

5 ENVIRONMENTAL MANAGEMENT FRAMEWORK

5.1 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

The Construction Environmental Management Plan will provide a series of guidelines which will address the following issues during the construction phase of the future development of the site:

- Clearing protocols;
- Protection of wetland values;
- Protection of any native fauna present on the site;
- Reduction of noise pollution caused increased large vehicle traffic in the area, as well as construction noise and vibration;
- Spill mitigation and management in terms of chemicals and fuels either kept onsite or used onsite;
- Dust management during site clearing activities;
- Dieback management;
- Provision of a hygiene station to wash vehicles down prior to leaving the site to reduce the likelihood of spread of declared weed plants;
- Minimisation of disturbance of any Acid Sulphate Soils that occur on the site; and
- Revegetation and rehabilitation of preserved areas of native vegetation, and restriction of public access to rehabilitation and vegetated areas to reduce further degradation.

5.2 WETLAND MANAGEMENT PLAN

A Wetland Management Plan will be prepared at the subdivision stage of the development, outlining specific strategies for the preservation of the agreed area of Bollard Bulrush Swamp. This plan will detail the following:

- How preservation of the hydrological regime will be achieved; and
- How the vegetation and ecological values of the agreed portion of the wetland will be maintained and enhanced, including interface management.

The wetland management plan will include:

- A specific vision to ensure the wetland's values and attributes are conserved and enhanced;
- Outline of the existing environment;
- Identification of potential threats and sources of impacts;
- Outline current management issues;
- Specify management undertaken to date;
- Identify new management strategies, including;
    - Detail of the interface between the development and the wetland, and how this will assist in the control of weed infestation;
    - Rehabilitation works to be undertaken in the agreed wetland area and buffer (see Figure 16), including planting of appropriate native plant species and wetland-sensitive weed treatments;
    - Location and details of any infrastructure proposed to protect wetland values, such as fencing, paths, boardwalks and signposting;
    - Control of direct public access to the wetland, possibly through the installation of pathways or boardwalks to allow passive recreation;
    - Location and detail of interpretive signage;
    - Description of community education program, which may include provision of educational materials to residents; and
    - Any fauna relocation (if necessary);
- An implementation plan, including definition of responsible parties; and
- Guidelines for future monitoring programs, including methodology, performance criteria, and contingency measures.

5.3 WATER MANAGEMENT PLANS

A series of reports focussing on total water cycle management for the site will be produced in concert with further development planning of the site. These will provide an increasing level of detail in support of each stage of the planning process, as required by *Better Urban Water Management* (WAPC 2008).

5.3.1 DISTRICT WATER MANAGEMENT STRATEGY

A District Water Management Strategy (DWMS) will be prepared to accompany any future application for lifting of Urban deferment for the site. This will be based upon the guidelines presented in *Better Urban Water Management* (WAPC 2008) and will include the following:

- Design and management objectives;
- A summary of the pre-development environment including a summary of any previous studies; in particular the modelling work completed for this Environmental Review, and the analysis and management options contained within it;
- An analysis of potential development impacts and options for enhancing water conservation in future development at the site;
- A presentation of the site water balance and a discussion on fit-for-purpose water source planning, including allocation of water for different uses and any existing and required infrastructure;
- A water management strategy; including a presentation of the stormwater model and a discussion on the appropriate management of surface water, groundwater, wastewater and drinking water management and how to enhance water efficiency at the site; and
- An Implementation framework.

5.3.2 LOCAL WATER MANAGEMENT STRATEGY

A Local Water Management Strategy consistent with the requirements of *Better Urban Water Management* (WAPC 2008) will be prepared alongside the Local Structure Plan for the development. This Strategy will include the following sections:

- Principles and objectives of total water cycle management;
- Details of the proposed development;
- Design criteria;
- A description of the pre-development environment;
- Average Annual Maximum Groundwater Levels based on groundwater monitoring;
- Minimum floor levels to provide protection from the groundwater table and local flood levels;
- Description of the conceptual stormwater water modelling;
- Detail structural and non-structural controls for stormwater quality to be used in the development;
- An assessment of potential potable water conservation measures for the site; and
- Guidance on future management of the site including requirements for monitoring, roles, responsibilities and construction.

5.3.3 URBAN WATER MANAGEMENT PLAN

In line with *Better Urban Water Management* (WAPC 2008) and the *Urban Water Management Plan Guidelines* developed by DoW (2008), an Urban Water Management Plan will be produced alongside the subdivision application for the development, and will include:

- A summary of the pre-development environment including a summary of previous studies;
- Design objectives for water management;
- Pre and post-development water balances and a discussion of how the potable water management strategies will be met;
- Summary of the stormwater design undertaken by project engineers to demonstrate that the design complies with Department of Water and Town of Kwinana requirements and accompanying engineer's drawings;
- A groundwater management plan to demonstrate protection of groundwater resources;
- Specific design information regarding engineering design and landscape architecture in the UWMP;
- Proposed nutrient management approaches, including both structural and non-structural controls;
- A plan for management of subdivision works;
- Design of a post-development monitoring programme; and
- An implementation plan.

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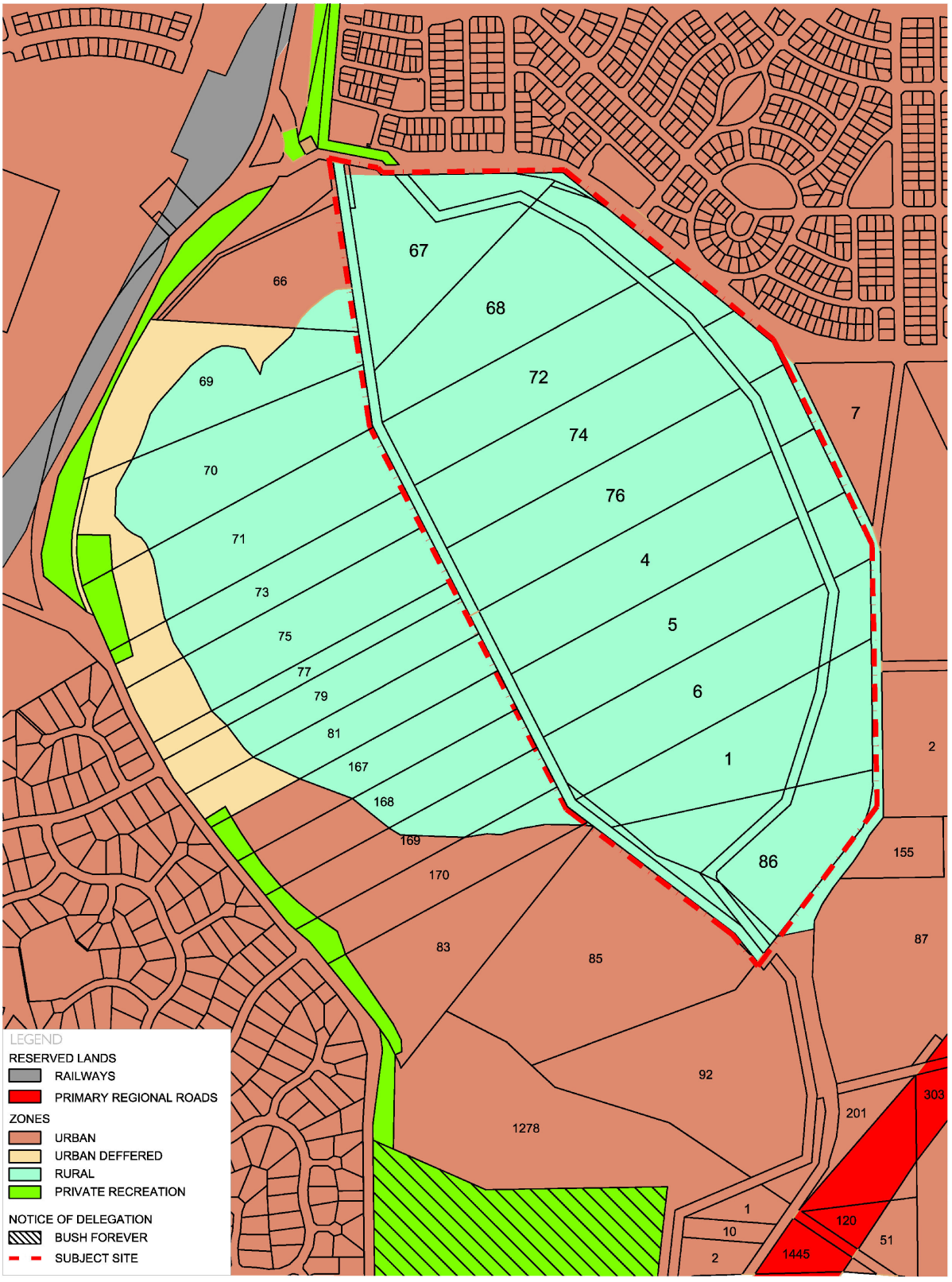
FIGURES

CLIENT: Wellard Landowner's Group
JOB NO.: 10.127
AUTHOR: K. Thomson
DRAWN: T. Ellis
DATE: 9-03-2011
SCALE: 1:8,000 @ A4
PROJECTION: GDA94 MGA50

Location Map

Wellard Urban Precinct East
Environmental Review

FIGURE 1



N:\Town Planning\4000-4999\4759\Drafting

PROJECT MANAGEMENT

URBAN DESIGN

MASTER PLANNING

TOWN PLANNING

date 20 August 2012 job no. 4759
scale 1: 10,000 e-ref 081201
designer D Evans prepared by D McCulloch
client projection mga 50 gda 94
perth Level 3, 369 Newcastle Street, Northbridge, Western Australia, 6003
email gra@greg-rowe.com web www.greg-rowe.com
tel +618 9221 1991 fax +618 9221 1919

title existing metropolitan region scheme
address lots 86, 1, 6, 5, 4, 76, 74, 72, 68, 67 tamblyn place wellard

PERTH • PEEL / SOUTH WEST • MID WEST • PILBARA

GREG ROWE & associates
FOCUSED ON ACHIEVEMENT

Source: Greg Rowe & Associates

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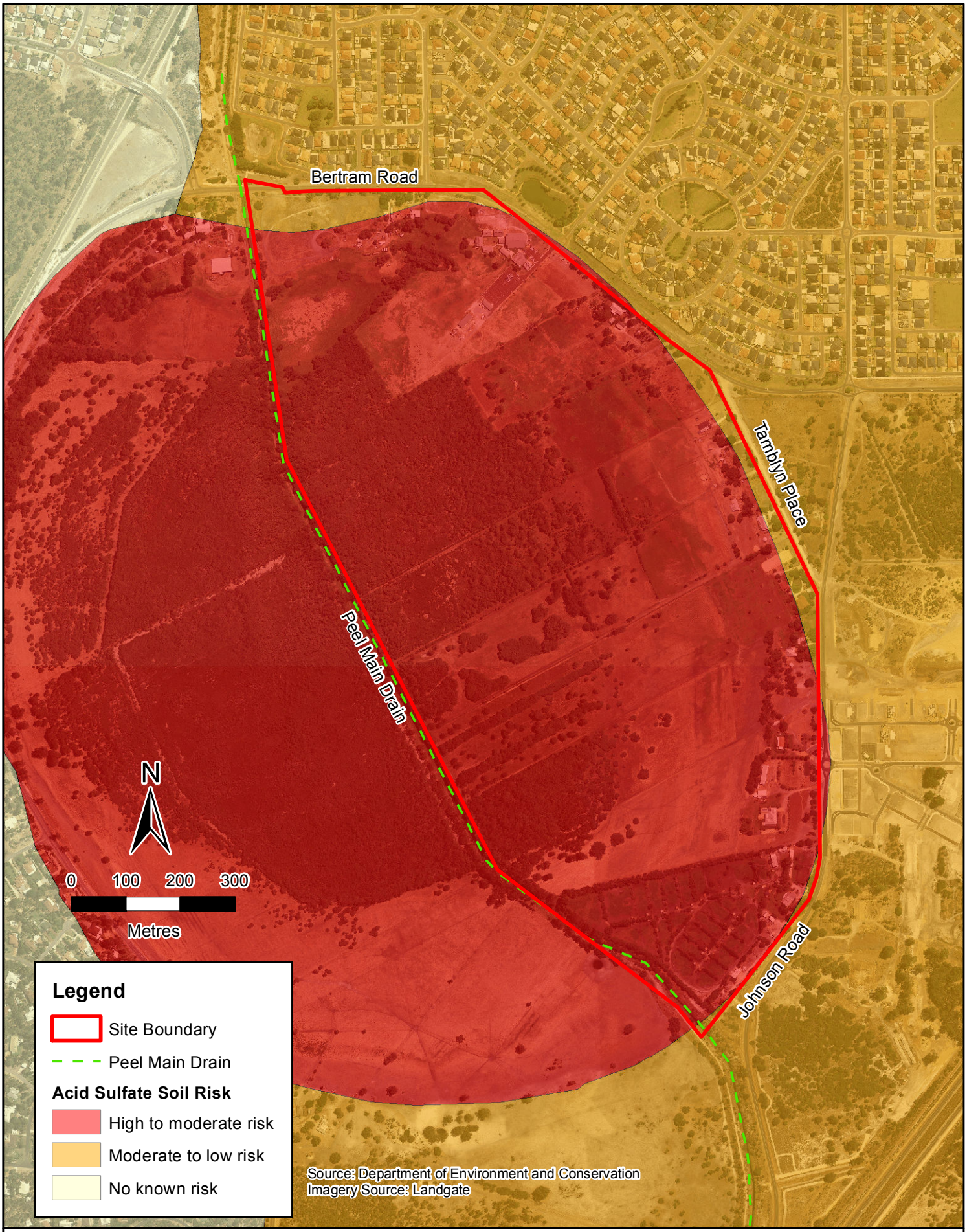
Existing Zoning Plan

Wellard Urban Precinct East
Environmental Review

FIGURE 2



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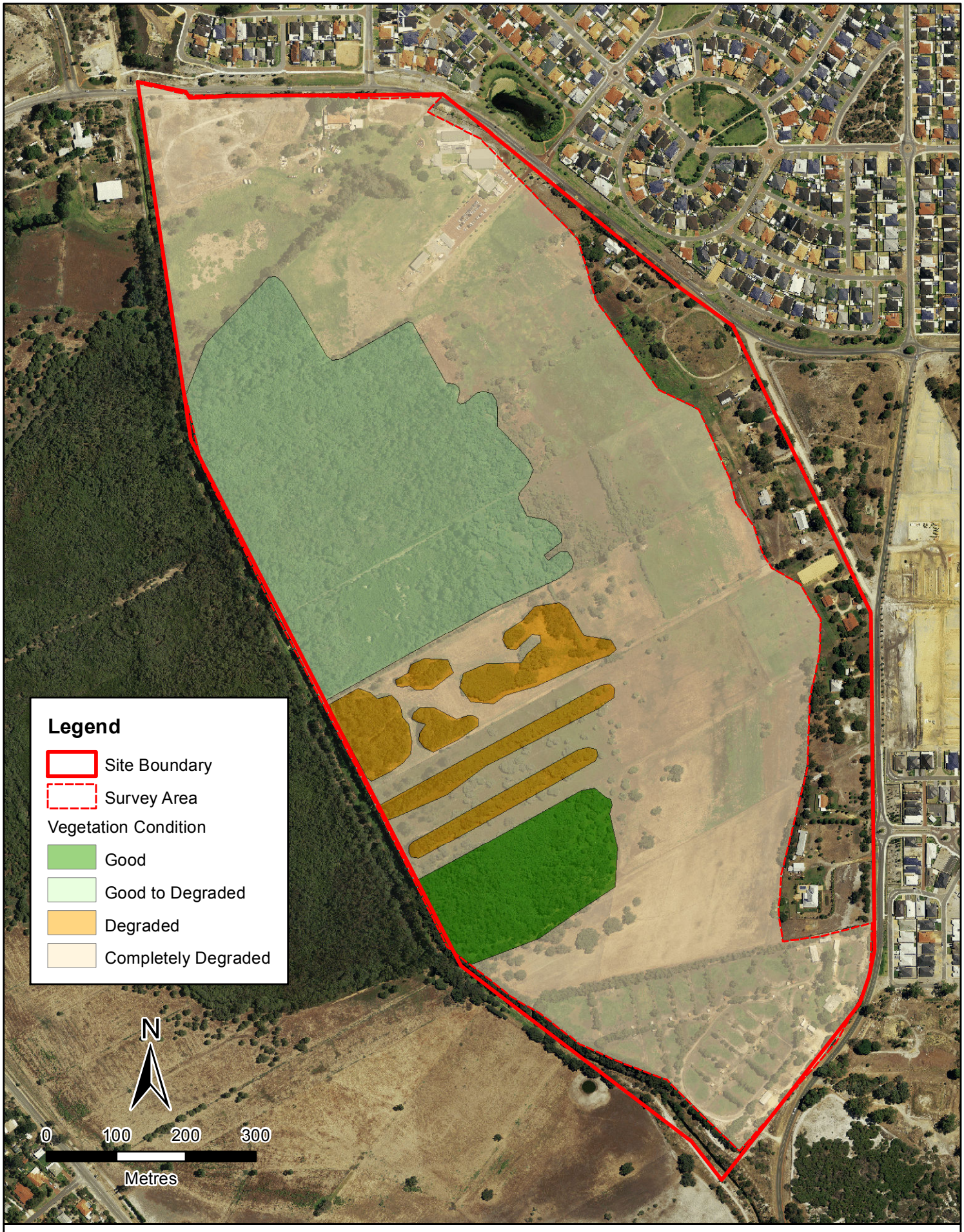
Acid Sulfate Soil Risk Mapping

Wellard Urban Precinct East
Environmental Review

FIGURE 4



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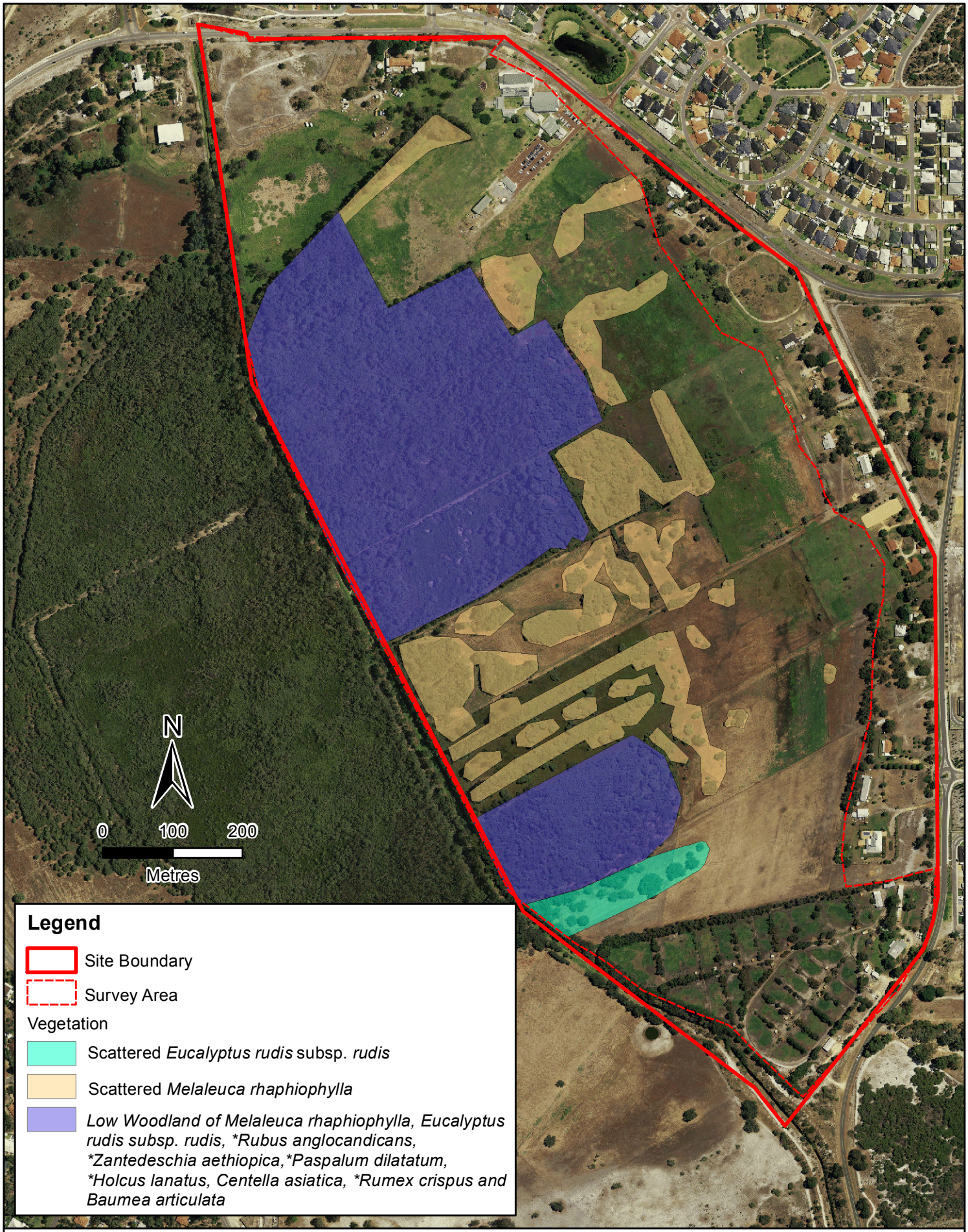
Vegetation Condition

Wellard Urban Precinct East
Environmental Review

FIGURE 5



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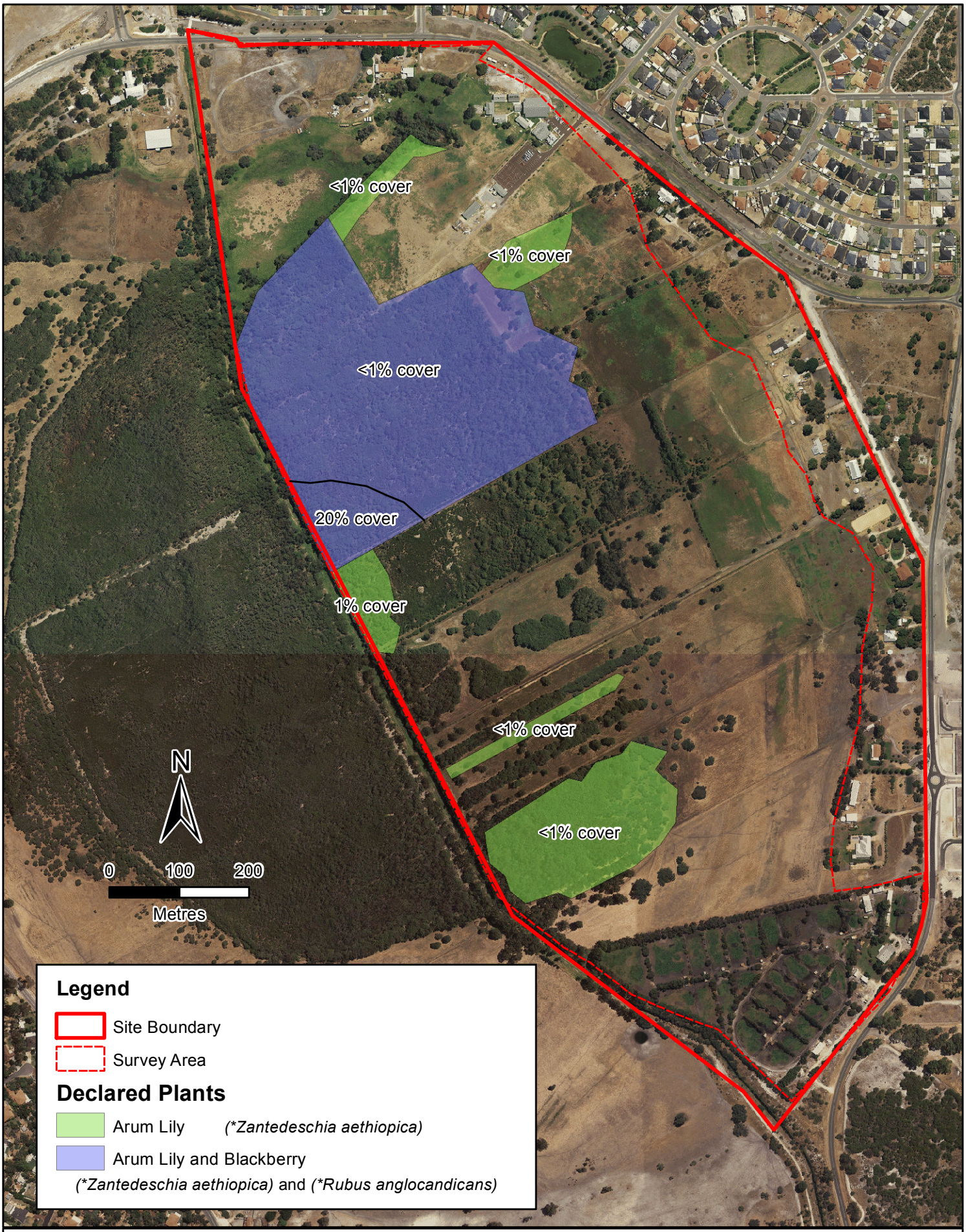
Vegetation Complex

Wellard Urban Precinct East
Environmental Review

FIGURE 6



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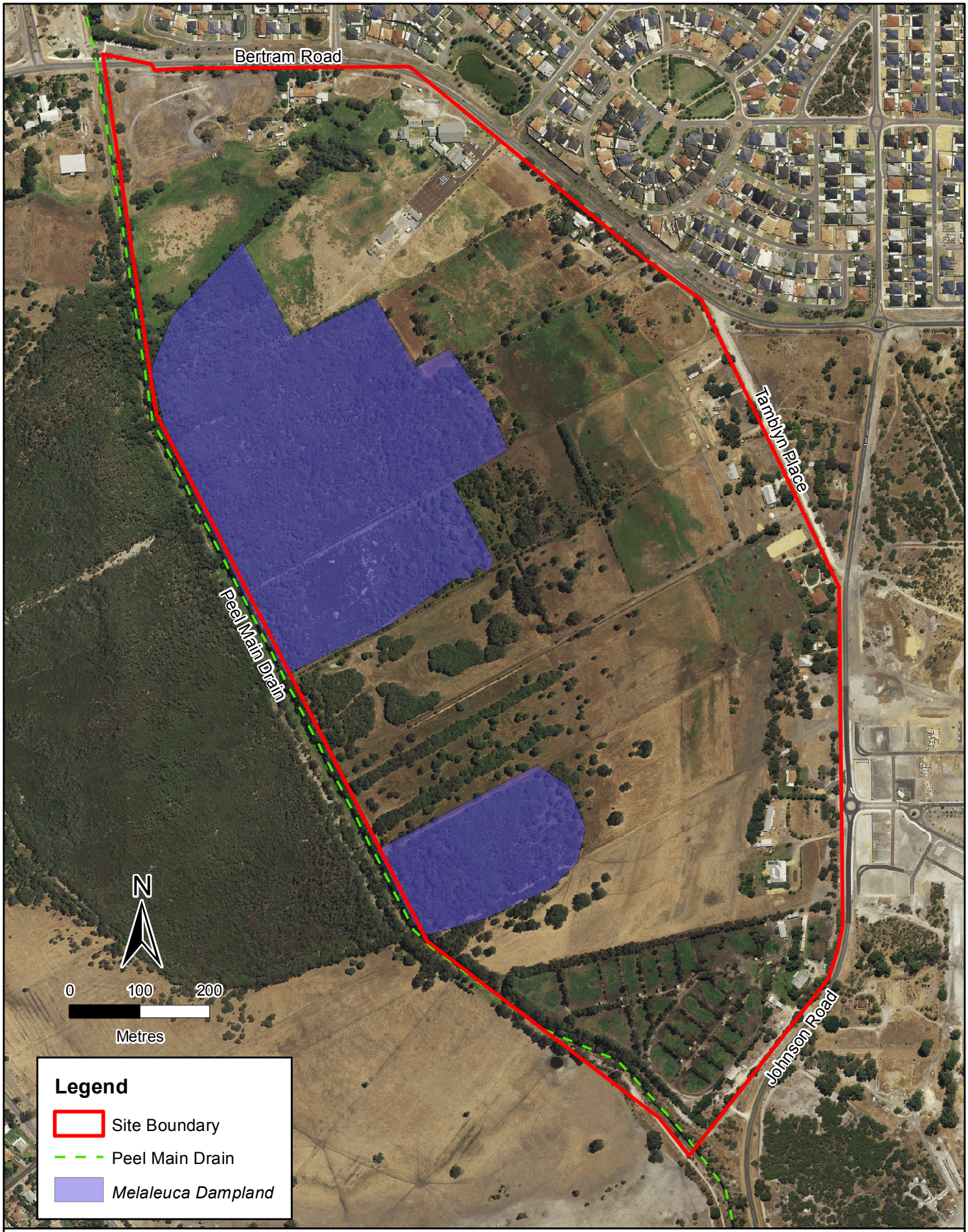
Location of Declared Plants

Wellard Urban Precinct East
Environmental Review

FIGURE 7



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AUTHOR
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T. Ellis

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Fauna Habitat

Wellard Urban Precinct East
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FIGURE 8

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Hydric Soils Distribution

Wellard Urban Precinct East
Environmental Review

FIGURE 9

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Geomorphic Wetlands

Wellard Urban Precinct East
Environmental Review

FIGURE 10

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EPP Lakes

Wellard Urban Precinct East
Environmental Review

FIGURE 11

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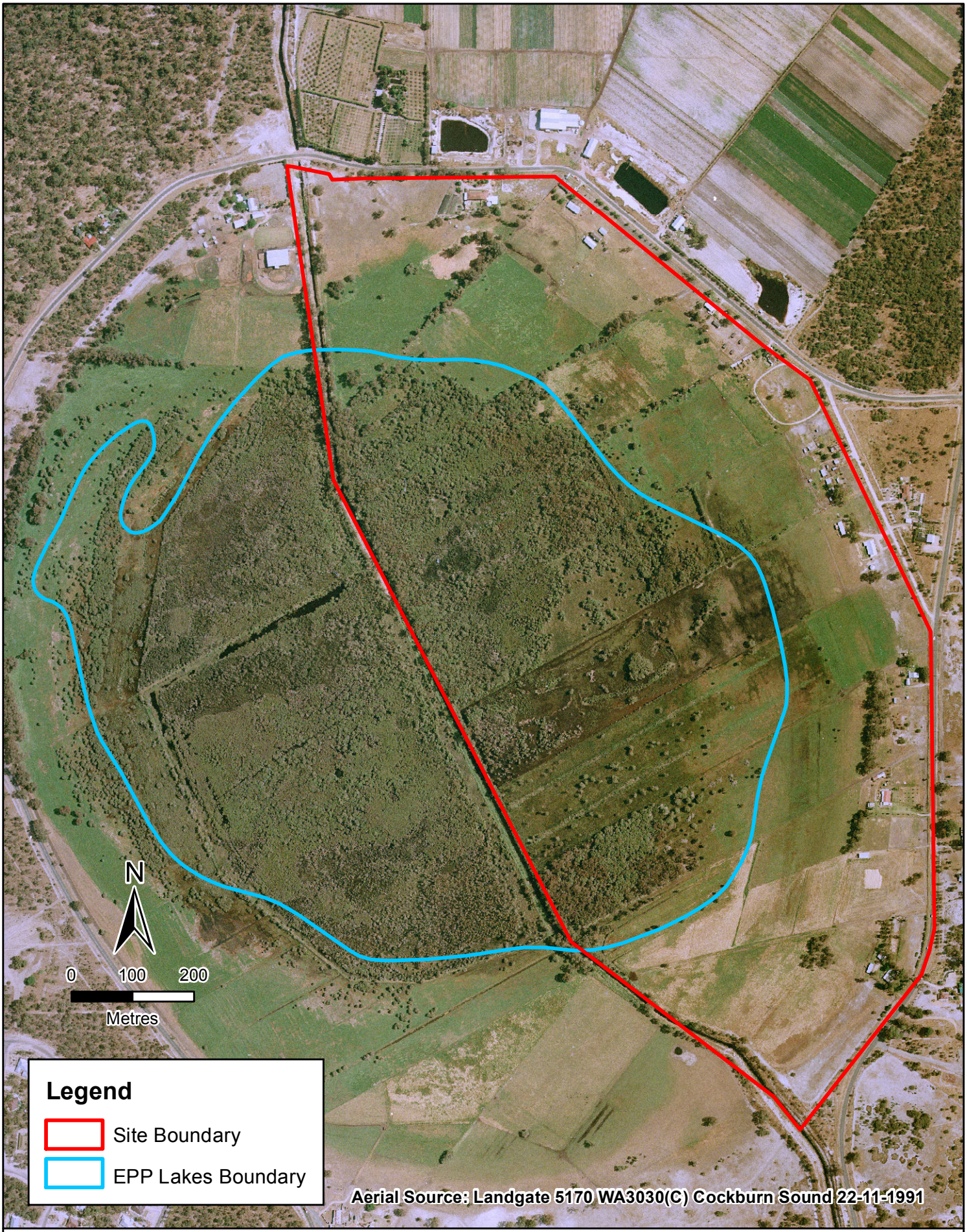
Aerial Photograph 22-11-1991

Wellard Urban Precinct East
Environmental Review

FIGURE 12



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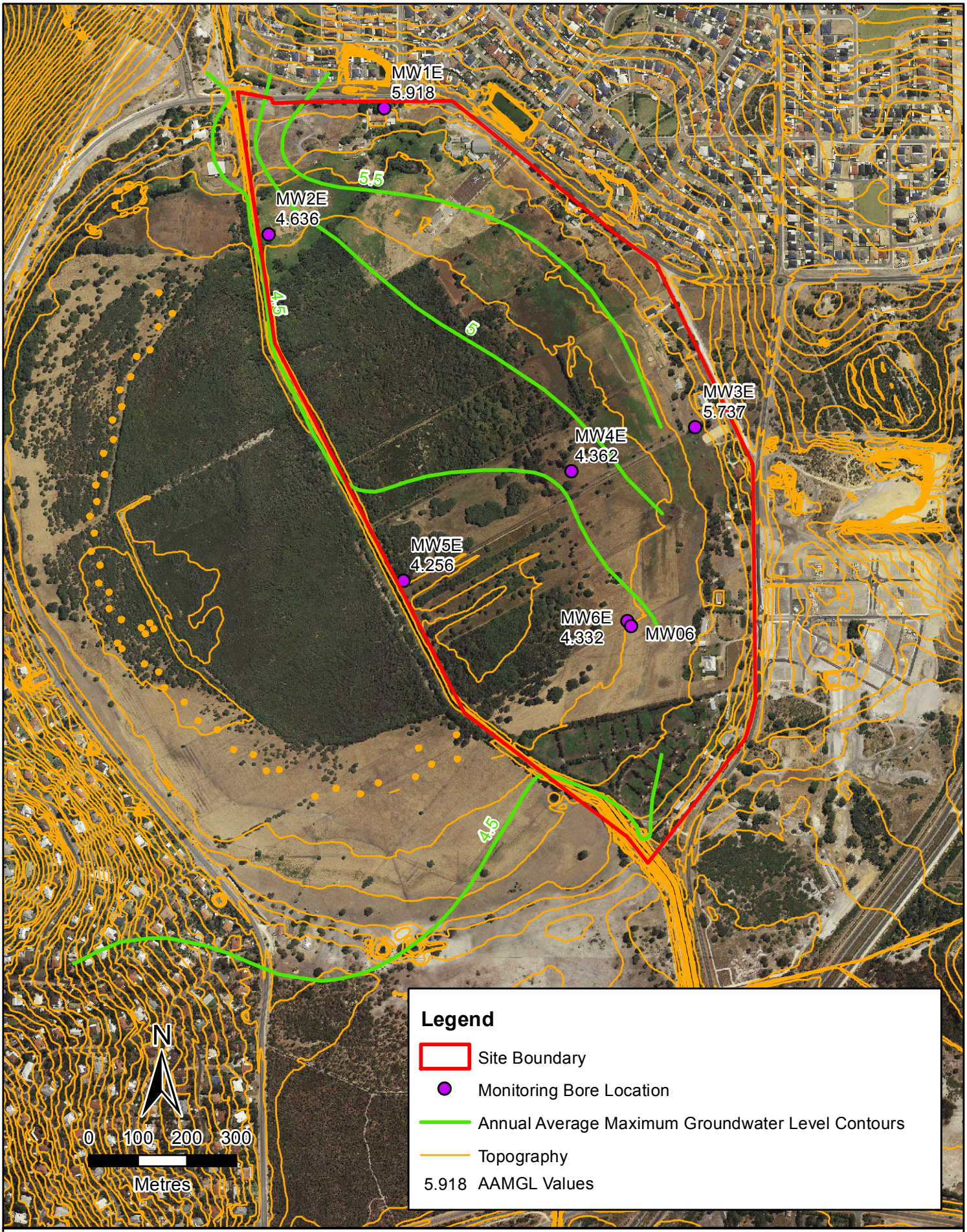
AUTHOR	DRAWN	DATE	
K. Thomson	T. Ellis	12-09-2012	
SCALE	PROJECTION		
1:8,000 @ A4	GDA94 MGA50		

EPP Mapping 22-11-1991

Wellard Urban Precinct East
Environmental Review

FIGURE 13



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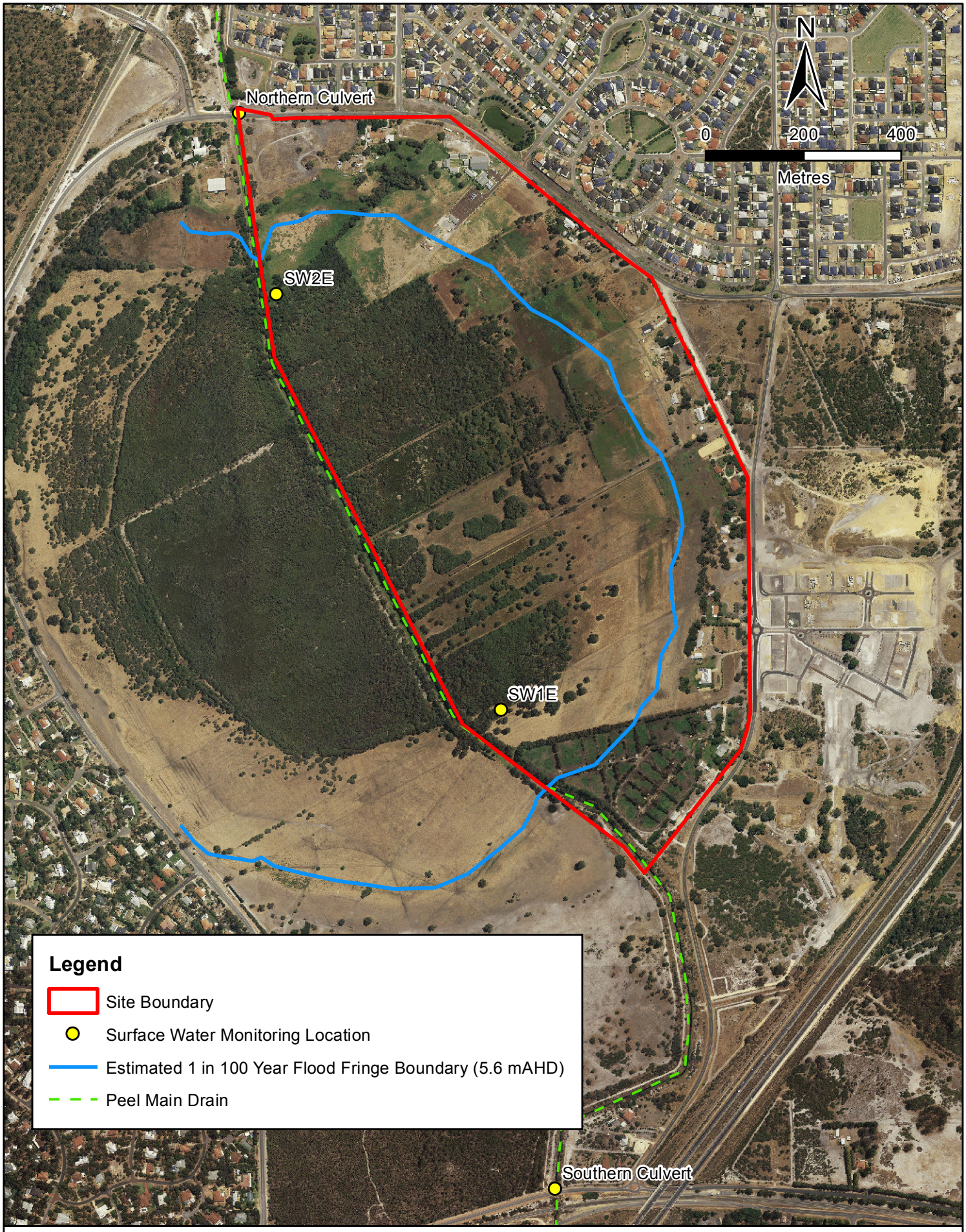
Wellard Landowner's Group		10.127
AUTHOR	DRAWN	DATE
B. Woodward	S. Rho	12-09-2012
SCALE	PROJECTION	
1:10,000@ A4	GDA 94 MGA 50	

Groundwater Plan

Wellard Urban Precinct East
Environmental Review

FIGURE 14



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B. Woodward / S. Rho	12-09-2012
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Surface Water Plan

Wellard Urban Precinct East
Environmental Review

FIGURE 15

Sketch 2 Wetland boundary and 50m buffer boundary

Legend
- Wetland boundary
- Wetland buffer (50m)

STRATEGEN
info@strategen.com.au
www.strategen.com.au

Scale
0 80 160
metres

1:8,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 23/02/2012
Author: JCrute

Source: Imagery sourced from Nearmap, 08/01/2012.
Cadastre sourced from SLIP WMS service, courtesy of Landgate.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\GRA\GRA11202\ArcMap_Documents\Working\GRA11202_SK002_Wetland_50mBuffer.mxd

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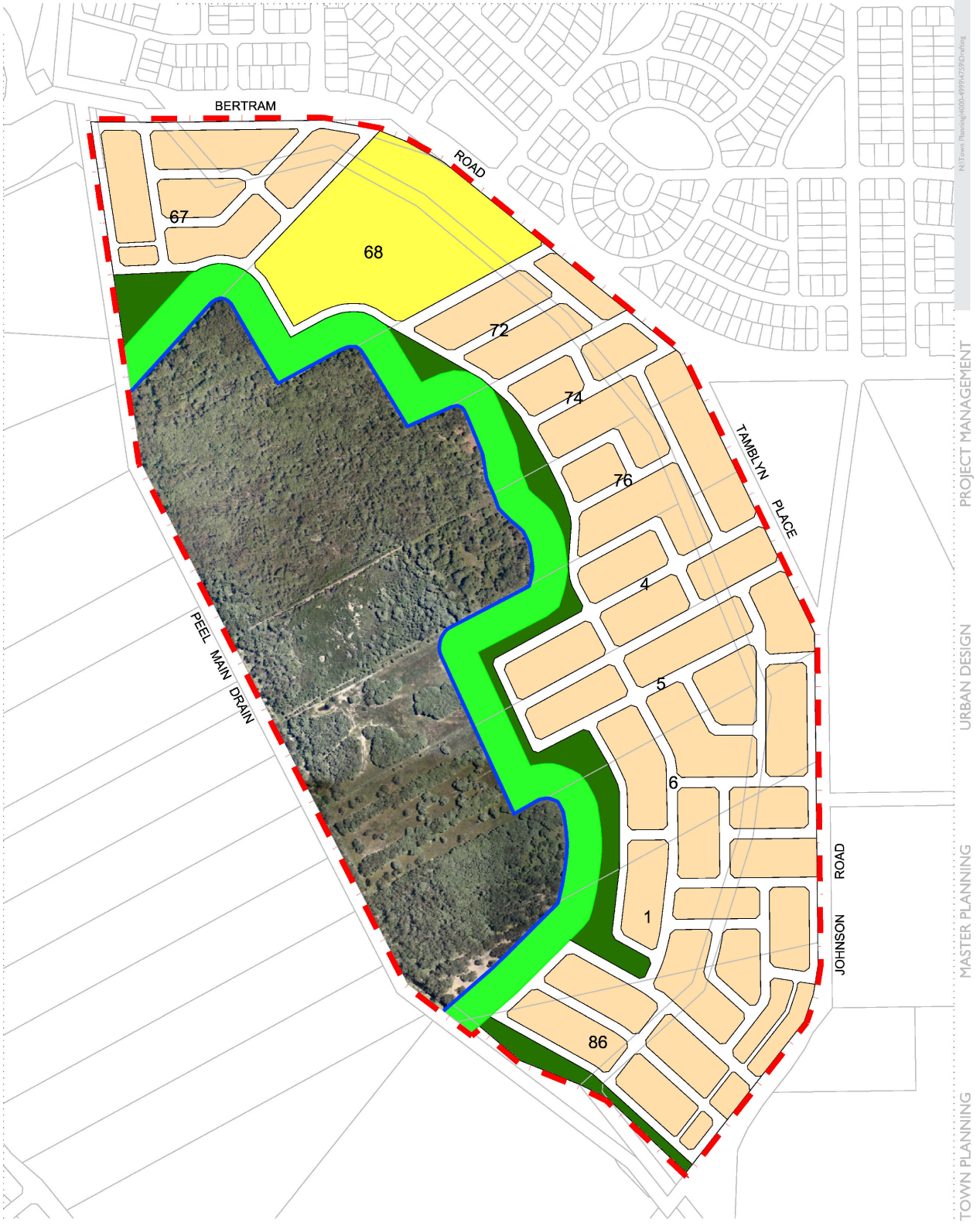
B. Woodward	S. Rho	12-09-2012
SCALE	**PROJECTION**
1:10,000 @ A4	GDA 94 MGA 50

Wetland Boundary and 50m Buffer (Strategen)

Wellard Urban Precinct East Environmental Review

FIGURE 16



LEGEND

- RESIDENTIAL
- PRIVATE SCHOOL
- PUBLIC OPEN SPACE
- WETLAND
- WETLAND BUFFER
- WETLAND BOUNDARY
- EXISTING LOT BOUNDARY
- 86 EXISTING LOT NUMBER
- SUBJECT SITE

date 04 April 2012 | job no. 4759
scale 1:5000 @ A3 | a-ref 04 | 202
designer D Evans | prepared by K Trenberth
client | projection MGA50 GDA94

title concept structure plan
address lots 86, 1, 6, 5, 4, 76, 74, 72, 68, 67 johnson road, tamblyn place wellard

perth
Level 3, 369 Newcastle Street, Northbridge, Western Australia, 6003
email gra@greg-rowe.com web www.greg-rowe.com
tel +618 9221 1991 fax +618 9221 1919

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CLIENT Wellard Landowner's Group

JOB NO. 10.127

AUTHOR B. Woodward

DRAWN S. Rho

DATE 12-09-2012

SCALE 1:10,000 @ A4

PROJECTION GDA 94 MGA 50

Concept Structure Plan (Greg Rowe)

Wellard Urban Precinct East Environmental Review

FIGURE 17

APPENDIX A

BOLLARD BULRUSH EAST FLORA AND VEGETATION ASSESSMENT

BOLLARD BULRUSH EAST

FLORA AND VEGETATION ASSESSMENT

BOLLARD BULRUSH EAST
FLORA AND VEGETATION ASSESSMENT

Prepared for

WELLARD LANDOWNERS GROUP

Prepared by

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Job Number:	*10/127*
Report Number:	*10/214*
Prepared by:	*Ciaran Sgherza*
Status:	*Final*
QA Review:	*Bridget Watkins*
Technical Review:	*Narelle Whittington*
Content Review:	*Teresa Gepp*
Date:	*29 July 2011*

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STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ('the report') has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) ('scope of services'). In some circumstances the scope of services may have been limited by factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, ENV has relied on data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ('the data'). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or in part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, unavailable, misrepresented or otherwise not fully disclosed to ENV.

Environmental Conclusions

In accordance with the scope of services, ENV has relied on the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, express or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and for no other party. ENV assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including, without limitation, matters arising from any negligent act or omission of ENV or for any loss or damage suffered by any other party relying on the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions, and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

ENV will not be liable to update or revise the report to take into account any events or circumstances occurring or facts becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report, nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

EXECUTIVE SUMMARY

ENV.Australia Pty Ltd was commissioned in June by Greg Rowe and Associates, on behalf of the Wellard Landowners Group, in 2010 to undertake a flora and vegetation assessment for the Bollard Bulrush East site within the Town of Kwinana. The survey area is approximately 73 hectares in size and consists of cleared agriculture land and remnant vegetation.

The purpose of this assessment is to provide information on the significance of the flora and vegetation present within the survey area.

The field survey was conducted on the 29th September and recorded 23 taxa from 16 families and 22 genera.

No plant species listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999*, as Declared Rare pursuant to the *Wildlife Conservation Act 1950* or as Priority species listed by the Department of Environment and Conservation were located during the survey. The survey area is highly disturbed and ENV considers that it is unlikely that the Bollard Bulrush East survey area supports species of conservation significance.

Sixteen introduced species were identified during the survey. The majority of the introduced species present are typical bushland weeds. Two Declared Plants were recorded within the survey area, Arum Lily (**Zantedeschia aethiopica*) and Blackberry (**Rubus anglocandicans*). Both of these species require management in accordance with the *Agriculture and Related Resources Protection Act 1976.*

The Bollard Bulrush East survey area is mapped as the Herdsman Complex: Vegetation consists of sedgelands and fringing woodland of *Eucalyptus rudis* - *Melaleuca* species. This complex exceeds the 10% recommended retention status for the Bush Forever study area.

One vegetation unit was identified within the survey area, Low Woodland of *Melaleuca rhaphiophylla* and *Eucalyptus rudis* subsp. *rudis*. This unit was described as being in Good to Degraded and therefore it could not be confidently inferred to a Floristic Community Type. However, the vegetation was considered to be similar to the Floristic Community Type: SCP17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands'. This Floristic Community Type is not listed as a Threatened Ecological Community under Federal or State legislation or a Priority Ecological Community by the Western Australian Department of Environment and Conservation.

The remnant vegetation within the survey area is described as being in Good to Completely Degraded condition. Disturbances to the vegetation include clearing, invasion by introduced species as well as grazing and trampling by domestic livestock (cattle).

The Department of Environment and Conservation's Geomorphic Wetlands Dataset identifies two wetlands within the survey area; one Resource Enhancement and Multiple Use wetland. In addition the Bollard Bulrush Swamp is listed as a wetland of high ecological value under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992*.

1 INTRODUCTION

ENV.Australia Pty Ltd ('ENV') was commissioned in June by Greg Rowe and Associates, on behalf of the Wellard Landowners Group, in 2010 to undertake a flora and vegetation assessment for the Bollard Bulrush East site ('the survey area').The site consists of Lots 1, 4, 5, 6 and 86 Johnson Road and Lots 67, 68, 72 and 74 Bertram Road. The survey area is approximately 73 hectares (ha) in size and consists of remnant vegetation within cleared paddocks.

The purpose of this assessment is to provide information on the significance of the flora and vegetation present within the survey area.

1.1 LOCATION

The survey area is located approximately 35 kilometres (km) south of Perth CBD, in the suburb of Wellard, in the Town of Kwinana. The survey area is bound by private property on its northern, eastern and southern sides. The Peel Harvey Main Drain is located on the western boundary of the survey area (Figure 1).

1.2 CLIMATE

The climate of this region is warm Mediterranean, with an average maximum summer temperature of 28.3°C and an average minimum winter temperature of 10.9°C (Bureau of Meteorology (BoM) 2010). The region receives an average annual rainfall of 765.3 mm, with the majority of precipitation occurring in winter (BOM 2010) (Figure 2).

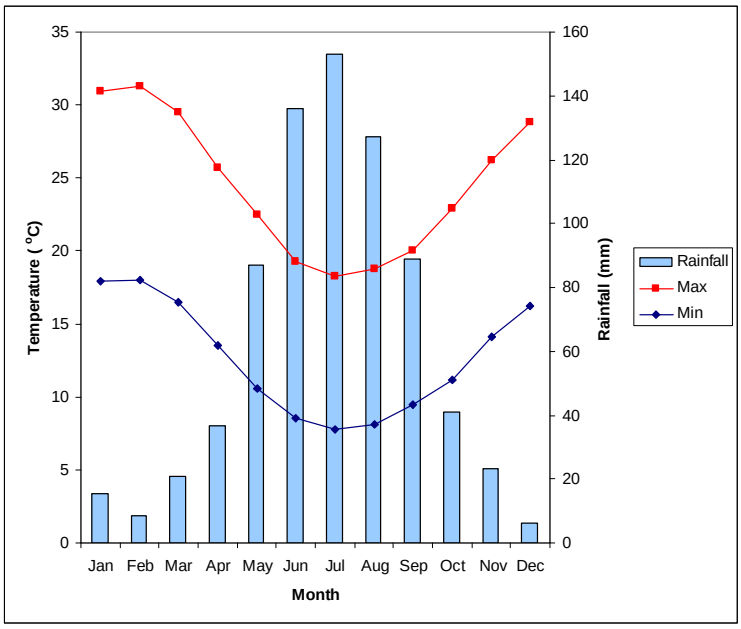

Figure 2: Average Monthly Rainfall and Maximum and Minimum Temperatures at Medina Research Station (1983-2010) (BoM 2010)

1.3 REGIONAL SOILS, LANDFORMS AND VEGETATION

For a development proposal to be assessed in terms of the flora and vegetation values that may be impacted upon, an understanding of the vegetation communities at the site in question is required. In Western Australia, there are various reports that detail a region's botanical values.

A widely-used vegetation classification system that maps and describes vegetation communities in south-west Western Australia is *Vegetation of the Darling System* in the *Atlas of Natural Resources, Darling System, Western Australia* (Department of Conservation and Environment 1980). This document describes vegetation communities as vegetation complexes, and maps the distribution of each complex.

Vegetation complexes are defined as a combination of distinct site vegetation types, usually associated with a particular geomorphic, climatic, floristic and vegetation structural association. Vegetation complexes are based on the pattern of vegetation at a regional scale, as it reflects the underlying key determining factors of landforms, climate and soils.

The soils and landform unit, as well as the vegetation complex supported by the survey area, are described below:

1.3.1 Soils and Landforms

The survey area occurs on the Swan Coastal Plain portion of the Darling System (Churchward & McArthur 1978). The Swan Coastal plain consists of aeolian and fluviatile deposits, specifically the site is on:

- Herdsman unit: Peaty swamps associated with Bassendean and Karrakatta units.

1.3.2 Beard Vegetation Mapping

The survey area is in the South West Botanical Province and the Darling Botanical District (Beard 1990). This region typically consists of forest country with related woodlands and is divided into four subregions or botanic subdistricts.

The survey area is within the Swan Coastal Plain Subregion of the Drummond Botanical Subdistrict (Beard 1990). The Drummond Botanical Subdistrict consists mainly of the following vegetation communities:

- *Banksia* Low Woodland on leached sands and *Melaleuca* Swamps in poorly drained areas;
- Woodland of Tuart (*Eucalyptus gomphocephala*); and
- Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) woodlands on the less leached soils (Beard 1990).

1.3.3 Vegetation Complex Mapping

Heddle *et al*., (1978) mapped the area as containing one Swan Coastal Plain vegetation complex which is related to the underlying soil profile:

- Herdsman Complex: Vegetation consists of sedgelands and fringing woodland of *Eucalyptus rudis* - *Melaleuca* spp.

The Environmental Protection Authority's (EPA) document *Levels of Assessment for Proposals Affecting Natural Areas Within System 6 Region and Swan Coastal Plain Portion of the System 1 Region* (EPA 2006) gives an estimate of the percentage of each complex that remains compared to its pre-European settlement extent, so an estimate of the scarcity of each complex can be determined.

Across its extent 34.6% of the Herdsman Complex is estimated to remain (EPA 2006). Within the Bush Forever project area, which covers the Swan Coastal Plain portion of the Perth Metropolitan Area (PMA), 31% of the Herdsman Complex is estimated to remain (Government of Western Australia 2000).

The EPA recognises vegetation complexes that are not well represented in reserves as being significant. Vegetation complexes which have 10%-30% remaining may be considered regionally significant. Proposals that would impact on a vegetation complex with 10% or less remaining may be formally assessed by the EPA (EPA 2006).

1.4 PROTECTION OF FLORA AND VEGETATION

Flora species are protected formally and informally by various legislative and non-legislative measures, which are as follows:-

Legislative Protection

- *Environment Protection and Biodiversity Conservation Act 1999* (Cth): a Federal Act;
- *Wildlife Conservation Act 1950* (WA): a State Act; and
- *Environmental Protection Act 1986* (WA): a State Act.

Non-Legislative Protection

- Western Australian Department of Environment and Conservation (DEC) Priority lists for flora and vegetation; and
- informal recognition of locally significant populations

A short description of these measures is given below, and definitions of the species conservation codes and ecological community categories they use, and those used by the DEC, are provided in Appendix A.

Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) ('the EPBC Act') aims to protect matters of national environmental significance, which are detailed in Appendix A.

Under the EPBC Act, the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities ('SEWPAC') lists threatened species and Threatened Ecological Communities (TECs) in certain categories determined by criteria set out in the Act (*www.environment.gov.au/epbc/index.html*).

The Act provides for substantial penalties for any unauthorised actions likely to adversely affect matters of national environmental significance. It also provides for a national environmental assessment and approvals process for proposed actions likely to affect the prescribed matters of national environmental significance. If a proposed action is approved subject to certain conditions, the proponent does not contravene the Act if the action is carried out in accordance with the conditions imposed.

Projects likely to cause impacts on matters of national environmental significance (as defined in the EPBC Act – see Appendix A) should be referred to SEWPAC for assessment under the EPBC Act.

Wildlife Conservation Act 1950 (WA)

The Western Australian DEC recommends flora taxa for listing under the provisions of the *Wildlife Conservation Act 1950* (WA) ('WC Act') as protected according to its need for protection (see Appendix A).

Flora species are given Declared Rare status when their populations are geographically restricted or are threatened by local processes. In addition, under the WC Act, by Notice in the Western Australian Government Gazette of 9 October 1987, all native flora (spermatophytes, pteridophytes, bryophytes and thallophytes) is protected throughout the State.

The Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the Act.

Environmental Protection Act 1986 (WA)

Declared Rare Flora (DRF) and TECs are given special consideration in environmental impact assessment, and are Environmentally Sensitive Areas (ESAs) under the *Environmental Protection Act 1986* ('EP Act') and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

The protection of DRF and TECs is a 'clearing principle' for assessing applications for permits to clear native vegetation, where exemptions for a clearing permit under the

Environmental Protection (Clearing of Native Vegetation) Regulations 2004 do not apply. There are substantial penalties (financial and/or imprisonment) for unlawfully damaging ESAs.

DEC Priority Lists

The DEC lists 'Priority' flora species that have not been assigned statutory protection under the WC Act, but which are under consideration for declaration as 'Rare Flora' under the Act. Species assessed as Priorities 1-3 (see Appendix A) are in urgent need of further survey, whilst Priority 4 species require monitoring every 5-10 years (see Appendix A for definitions).

In addition, the DEC maintains a list of Priority Ecological Communities (PECs) which identifies those communities that need further investigation before possible nomination for TEC status.

Although DEC Priority species and communities have no formal protection, they are under consideration for legislative protection. Sensitivities to harm can therefore be expected to be heightened.

Informal Recognition of Flora and Vegetation

Certain populations or communities may be of local significance or interest because of their patterns of distribution and abundance. For example, flora may be locally significant because they are range extensions to the previously-known distribution or are newly-discovered taxa (and therefore have the potential to be of more than local significance). In addition, many species are in decline as a result of threatening processes (primarily land clearing), and relict populations of such species assume local importance.

Despite the lack of any formal protection for species in this category, project proponents are strongly advised to be aware of and be sensitive to community concerns as to locally significant species or communities.

1.5 INTRODUCED SPECIES

The Environmental Weed Strategy for Western Australia (Department of Conservation and Land Management 1999) contains criteria for the assessment and ranking of weeds in terms of their environmental impact on biodiversity (Appendix B). The Strategy defines environmental weeds as 'plants that establish themselves in natural ecosystems and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade.'

Plants may also be 'Declared' by the Agriculture Protection Board under the *Agriculture and Related Resources Protection Act 1976* (WA) ('ARRP Act'). Declared Plants are gazetted under five categories (P1-P5), which define the action required. Details of the

definitions of these categories are provided in Appendix B. A declaration may apply to the whole State, to districts, individual properties or even to single paddocks. If a plant is Declared, landholders are obliged to control that plant on their properties (Department of Agriculture and Food 2010).

1.6 WETLAND CLASSIFICATIONS

1.6.1 Geomorphic Wetlands

In an effort to protect wetlands on the Swan Coastal Plain, the DEC developed a dataset, mapping the location, type and management category of wetlands on the Swan Coastal Plain (DEC 2010a). A management category is assigned to each wetland which provides guidance on the nature of the management and protection the wetland should be afforded.

Table 1: Wetland Management Categories

Management Category	General Description	Management Objectives
Conservation	Wetlands which support a high level of ecological attributes and functions.	Highest priority wetlands. Objective is to preserve and enhance the conservation values of the wetlands, through various mechanisms, including reservation in national parks, Crown reserves and State-owned land, protection under Environmental Protection Policies, and wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands, and any activity that may lead to further loss or degradation is inappropriate. The EPA urges that all CCWs and their buffers be fully protected. A minimum buffer of 50 m from the edge of wetland-dependent vegetation is typically allocated to CCWs. However, the policy is that the buffer be determined on a case-by-case basis.

Management Category	General Description	Management Objectives
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions.	Priority wetlands. The ultimate objective is to manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category. This can be achieved by restoring wetland function, structure and biodiversity. Protection is recommended through a number of mechanisms. The EPA urges that all reasonable measures be taken to minimise the potential impacts on REWs and their buffers. A minimum buffer of 50 m from the edge of wetland-dependent vegetation is typically allocated to REWs.
Multiple Use	Wetlands with few remaining important attributes and functions	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare. The EPA urges that all reasonable measures be taken to retain the wetland's hydrological functions (including onsite water infiltration and flood detention) and, where possible, other wetland functions. There is usually no minimum buffer requirement allocated to Multiple Use Wetlands.

(After: EPA 2008)

The DEC position on buffers is that they should be maintained in their current state and/or rehabilitated to native vegetation, and that no development (e.g. drainage basins, lawn area, active recreation space) should occur within the buffer zone.

The DEC Geomorphic Wetlands Dataset identifies two wetlands as occurring within the survey area. One of these wetlands (UFI 6730) has a Resource Enhancement management category and the other (UFI 13327) has a Multiple Use management category (Figure 3).

1.6.2 Environmental Protection Policy Wetlands

To protect and conserve the remaining wetlands on the Swan Coastal Plain, the EPA developed the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP) under section 26 of the EP Act. EPP Lakes are managed by the EPA and amendments require approval under the EP Act. The Bollard Bulrush Swamp is listed under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (Figure 3).

1.7 BUSH FOREVER

Bush Forever is a State Government Policy and program which identifies 51,200 ha of regionally significant bushland for protection, covering 26 vegetation complexes. This amounts to about 18% of the original vegetation on the Swan Coastal Plain portion of the PMA, and excludes local conservation reserves.

Regionally significant bushland has been identified on the basis of criteria relating to its conservation value. Important among these criteria is the achievement, where possible, of a comprehensive representation of all the ecological communities originally occurring in the region, principally through protecting a target of at least 10 per cent of each vegetation complex (Government of Western Australia 2000).

The Government of Western Australia has endorsed Bush Forever as the means of seeking the appropriate protection and management of areas of regionally significant bushland on the Swan Coastal Plain Portion of the PMA and a balance between environmental, social and economic objectives. As an endorsed government policy it is used as a basis for decision-making and an agreed framework for the protection and management of Bush Forever Sites through the implementation mechanisms identified in the plan (Government of Western Australia 2000).

The survey area has not been identified as being required to meet the Bush Forever biodiversity retention targets within Western Australia.

2 SCOPE OF WORK

The flora and vegetation assessment undertaken within the survey area specifically included:

- a desktop assessment of relevant literature and databases to determine Threatened Flora and Ecological Communities that may occur in the area;
- a flora and vegetation field survey, incorporating a search for conservation significant flora and the establishment of two permanent quadrats;
- a review of data collected against criteria established in Federal and State processes for species conservation;
- the production of vegetation mapping and vegetation condition mapping;
- interim identification and mapping of any TECs, PECs and any other areas of ecological importance (e.g. Wetlands, ESAs); and
- the production of a technically sound report presenting the results of the survey and recommendations.

3 METHODS

All flora surveys undertaken by ENV are designed to be consistent with the EPA requirements for the environmental surveying and reporting of flora surveys in Western Australia, as set out in the following documents:

- *Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas, Position Statement No. 2* (EPA 2000); and
- *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

ENV then assesses and reports the results of its surveys with particular regard to the provisions of the EPBC Act, WC Act and EP Act.

The methodology for the work involved the following key steps:

3.1 DESKTOP SURVEY

A request for a database search was submitted to the DEC to obtain a list of Declared Rare and Priority Flora species, TECs and PECs in the area of Wellard. The search area included a 5 km radius around the following coordinates; 32° 15' 32" S - 115° 50' 31" E (GDA94) (DEC 2010b).

A desktop review was undertaken of the following databases and documents:

- DEC combined biological database NatureMap (DEC 2010c);
- SEWPAC Protected Matters Search Tool (SEWPAC 2010), also known as an EPBC search; and
- previous flora surveys (e.g. previous consultants reports, DEC reports).

3.2 FIELD SURVEY

On the 29th September 2010 an ENV botanist visited the site and conducted a vegetation survey by traversing the property on foot. Data was collected from quadrats in the survey area, and geographic coordinates noted for changes in vegetation units[1]. Three 10 m x 10 m quadrats and one relevé were assessed in the vegetation unit. At each site a photograph was taken, the vegetation unit was described and a condition statement

[1] For the purposes of this flora and vegetation assessment, a vegetation unit is described on a fine scale (intra-locality), intermediate-scale (locality or inter-locality) or broad-scale (local to region).

made. The sampling intensity was selected in consideration of the landforms, habitat, vegetation structure, diversity and seasonality. Refer to Appendix C for the Flora Field Data Sheets and Site Photographs and Appendix D for the Vegetation Condition Scale.

During the field survey, plants that were suspected as being significant were described and their geographic coordinates noted.

3.2.1 Taxonomy

Where field identification of plant taxa was not possible, specimens were collected systematically for later identification at the Western Australian Herbarium (WAH) by use of identification keys and by comparison with the reference collection.

3.2.2 Vegetation Mapping

Vegetation unit descriptions were tabulated, and their boundaries were mapped. The vegetation descriptions for the units across the survey area were referenced against Gibson *et al.,* (1994) to determine the Floristic Community Types ('FCTs') present and the consequent potential for the survey area to support TECs or PECs. FCTs were defined according to Gibson *et al.,* (1994) on the basis of Multivariate Analysis of quadrat data, species composition, soils and topography.

The Multivariate Analysis of the quadrat data involved transformation (presence-absence) and computation of a similarity matrix based on Bray-Curtis similarity. The matrix allows for comparison of the vegetation within the study area with Gibson *et al.,* (1994) FCT data. This allows determination of the similarity between the vegetation communities mapped and TECs or PECs.

3.3 FLORA SURVEY LIMITATIONS AND CONSTRAINTS

It is important to note the specific constraints imposed on individual surveys. Constraints are often difficult to predict, as is the extent to which they influence survey effort. Survey variables concerning the flora and vegetation survey are detailed in Table 2.

Table 2: Limitations and Constraints Associated with the Flora and Vegetation Survey

Variable	Impact on Survey Outcomes
Access Problems	No access problems were encountered.
Experience levels	The botanists who executed the work were practitioners suitably qualified in their respective fields. • Coordinating Botanist: Ciaran Sgherza (Environmental Scientist/ Botanist); • Field Staff: Ciaran Sgherza; • Taxonomy: Peter Jobson (Senior Botanist / Taxonomist); and • Data Interpretation: Ciaran Sgherza.
Timing [2], weather, season in relation to Flora	The survey was undertaken in spring on the 29th September 2010. The area had received 455.4 millimetres (mm) of rain in the year to date (January to September) which is significantly below the long term average of 604.7 mm for the same period (1983 – 2007) (BOM 2010). Flora composition changes over time, with flora species having specific growing periods, especially annuals and ephemerals (some plants lasting for a markedly brief time, some only a day or two). Therefore the results of future botanical surveys in this location may differ from the results of this survey.
Completeness	Species that were insufficiently mature or dead were identified in the field to genus or family level only (where possible). A comprehensive species list has not been prepared for areas that do not constitute a natural vegetation area, such as gardens or areas that have been totally cleared.

[2] EPA Guidance Statement 51 (2004) stipulates that flora and vegetation surveys should be undertaken following the season that contributes the greatest rainfall in the region. In the South-west Province the main rain is in winter, requiring surveys to be undertaken in spring. Short-term variations in normal weather patterns (e.g. drought) may necessitate supplementary survey work at other times of year or in later years to take into account temporal changes in diversity.

Variable	Impact on Survey Outcomes
Determination	This survey makes inferences about vegetation types that have the potential to be TECs. However, a decision as to the presence or absence of TECs at the site remains the responsibility of the DEC's Species & Communities Branch. The taxonomy and conservation status of the Western Australian flora are dynamic. This report was prepared in reliance on taxonomy and conservation current at the time issuing, but it should be noted this may change.

3.4 PERMITS

Specimens collected during the survey were taken by permit of and subject to the conditions of the following licences issued under sections 23C and 23F of the WC Act:

- SL008481 (General Scientific Licence) and 73-0910 (DRF Licence) issued to Ciaran Sgherza.

4 RESULTS

4.1 DESKTOP SURVEY

The desktop database search of the Wellard area resulted in ten Declared Rare and eight Priority Flora species being identified as potentially occurring in the area. For a list of species found during the desktop survey search, please refer to Appendix E.

The Desktop survey determined that five TECs and three PECs are known to occur within a 5 km radius of the survey area. Refer to Appendix E for the full list.

4.2 FIELD SURVEY - FLORA

4.2.1 Flora

Sixteen families, 22 genera and 23 taxa were recorded in the survey area (seven native flora taxa and 16 introduced), refer to Appendix F for the flora species list.

The plant families most frequently recorded from the survey were as follows;

- Poaceae five species:
- Myrtaceae three species; and
- Asteraceae two species.

An average of 13 species was recorded in each of the three quadrats conducted within the survey area; refer to Appendix G for the Matrix of Taxa by Site.

4.2.2 Protected Flora

No Threatened species pursuant to the EPBC Act were located during the survey.

No plant taxa gazetted as Declared Rare pursuant to the WC Act were located in the survey area.

No Priority Flora species listed by the DEC were located in the survey area.

4.2.3 Introduced Flora

The table below contains the dominant weed species identified during the field survey, with their ratings and criteria according to the Environmental Weed Strategy for Western Australia (refer to Appendix B for the criteria used for ranking).

Table 3: Weed Species Identified

Taxon	Common Name	Criteria			
		Rating	Invasiveness	Distribution	Impacts
**Cortaderia selloana*	Pampas Grass	High	Yes	Yes	Yes
**Typha orientalis*	Bulrush	High	Yes	Yes	Yes
**Zantedeschia aethiopica*	Arum Lily	High	Yes	Yes	Yes
**Briza maxima*	Blow fly grass	Moderate	Yes	Yes	-
**Cirsium vulgare*	Slender Thistle	Moderate	Yes	Yes	-
**Ficus carica*	Fig	Moderate	Yes	-	Yes
**Gomphocarpus fruticosus*	Cotton Bush	Moderate	Yes	Yes	-
**Holcus lanatus*	Yorkshire Fog	Moderate	Yes	Yes	-
**Paspalum dilatatum*	Paspalum	Moderate	Yes	Yes	-
**Sonchus oleraceus*	Common Sowthistle	Moderate	Yes	Yes	-
**Rumex crispus*	Curled Dock	Mild	-	Yes	-
**Prunella vulgaris*	Self Heal	Low	-	-	-
**Lolium perenne* x *rigidum*	-	TBA	-	-	-
**Schinus terebinthifolius*	-	TBA	-	-	-
**Livistona australis*	-	Not Listed	-	-	-
**Rubus anglocandicans*	Blackberry	Not Listed	-	-	-

Two species listed as Declared Plants on the Swan Coastal Plain were located during the survey (DAFWA 2010) (Figure 4). These are:

- Arum Lily (**Zantedeschia aethiopica*) (Plate 1) listed as P1 for the whole State; and
- Blackberry (**Rubus anglocandicans*) (Plate 2) listed as P1 for the whole State.

Plate 1: Arum Lily (**Zantedeschia aethiopica*)

Plate 2: Blackberry (**Rubus anglocandicans*)

4.3 FIELD SURVEY - VEGETATION

4.3.1 Vegetation

One vegetation unit was identified within the survey area (Figure 5):

MpEr Low Woodland of *Melaleuca rhaphiophylla, Eucalyptus rudis* subsp*. rudis*, **Rubus anglocandicans, *Zantedeschia aethiopica,*Paspalum dilatatum, *Holcus lanatus, Centella asiatica, *Rumex crispus* and *Baumea articulata.*

In addition stands of native trees including *Eucalyptus rudis* subsp. *rudis* and *Melaleuca preissiana* have been indentified in Figure 5. No native understorey species were recorded under these trees and thus, they have not been discussed as vegetation units.

Refer to Appendix C for site photographs. For further discussion and interpretation of the site floristics, refer to Section 5.

4.3.2 Floristic Community Types

The FCT represented by the vegetation unit within the survey area was inferred by statistical analysis, along with dominant species presence and distribution, as set out in Table 5 below.

Table 5: Floristic Community Type Analysis

Vegetation Type	Floristic Community Type	Percentage Similarity (%)	Comments	Inferred Floristic Community Type
Low Woodland of *Melaleuca rhaphiophylla* and *Eucalyptus rudis* subsp. *rudis*	SCP 17 – '*M. rhaphiophylla* – *Gahnia trifida* seasonal wetlands'	21	ENV considers that the vegetation unit is most similar to FCT SCP17 based on species present and location in the landscape. However, due to the low native species diversity and the condition of the vegetation the FCT is not able to be confidently inferred.	SCP 17 – '*M. rhaphiophylla* – *Gahnia trifida* seasonal wetlands'
	SCP 13 – 'Deeper wetlands on heavy soils'	14		
	SCP 14 'Deeper wetlands on sandy soils'	13		

4.3.3 Priority and Threatened Ecological Communities

FCT SCP 17 '*M. rhaphiophylla* – *Gahnia trifida* seasonal wetlands' is well reserved and considered to be at Low risk (Gibson *et al.,* 1994). Therefore, no Threatened or Priority Ecological communities are present within the Bollard Bulrush East survey area.

4.3.4 Vegetation Condition

The vegetation condition within the site varied from Good to Completely Degraded (Figure 6). All vegetation within the survey area had been disturbed. Disturbances included invasion by introduced species, grazing and trampling by domestic livestock (cattle) and historical clearing. Many of the lots within the survey area are still utilised for cattle grazing.

4.3.5 Wetlands

The Resource Enhancement wetland (UFI 6730) identified by the DEC Geomorphic Wetlands Dataset is described as being in Good to Degraded condition. The Multiple Use wetland (UFI 13327), identified by the DEC Geomorphic Wetlands, is described as being in Completely Degraded condition as it has been historically cleared and used for agricultural purposes. Both of the wetlands identified by the DEC supported vegetation that is representative of a wetland.

5 DISCUSSION

Flora

The average flora species richness per quadrat recorded during this survey, 13 species per quadrat, is similar to the species richness of wetland communities recorded by Gibson *et al.,* (1994). For example, Gibson *et al.,* (1994) recorded mean species richness of 13.6 species within SCP17 and a mean species richness of 17.4 within SCP13. However, the flora species richness recorded within the Bollard Bulrush East survey area has been influenced by the high diversity of introduced species recorded, 69% of the total taxa. Therefore, it is not an accurate representation of the native flora diversity within the survey area. Currently, the vegetation does not support a native middle or understorey. Both of these layers within the vegetation are dominated by introduced species and thus the diversity of native species has been reduced.

Threatened, Declared Rare and Priority Flora

No Threatened species pursuant to the EPBC Act, no plant taxa gazetted as Declared Rare pursuant to the WC Act and no Priority Flora listed by the DEC were recorded in the survey area.

ENV considers it to be very unlikely that the survey area supports flora of conservation significance. The survey was undertaken at the appropriate time of year (spring) and the entire survey area was adequately searched for species of conservation significance. The low rainfall experienced during the winter of 2010 may have affected the emergence of some species of conservation significance, in particular orchid species (*Drakaea elastica* and *Drakaea micrantha*). Thus, these species may not have been present or identifiable at the time of the survey. Despite this, the survey area is not considered to support appropriate habitat for flora of conservation significance, as a result of the reduced condition of the vegetation as well as trampling and grazing by cattle. ENV considers that the potential for the survey area to contain Threatened, Declared Rare or Priority Flora is low.

Weeds

Sixteen introduced species were recorded within the survey area. The majority of these are considered to be common agricultural (**Lolium perenne x rigidum*) and bushland weeds (**Briza maxima* and **Sonchus oleraceus*) in the region (Hussey *et al.,* 2007). Two species, **Cortaderia selloana* and **Typha orientalis*, are common wetland weeds and are rated as High by the Environmental Weed Strategy for Western Australia (Department of Conservation and Land Management 1999).

Two Declared Plants were recorded within the survey area: Arum Lily (**Zantedeschia aethiopica*); and Blackberry (**Rubus anglocandicans*). The level of infestation of these species within the survey area was considered to be high, as a result of the wide

distribution and high number of individuals within the survey area. Arum Lily and Blackberry are both listed as P1 for the whole State and require management strategies to reduce their distribution. A management plan including a hygiene station to wash vehicles down prior to leaving the site during development would address this requirement.

Vegetation Condition

The condition of the vegetation with the survey area has been reduced by agricultural land uses. The clearing of land and the presence of cattle has facilitated the invasion of introduced species within the site. The high diversity (approximately 69% of the species recorded) and cover of introduced species indicates that native species have been displaced. The presence of cattle within the survey area has also reduced the condition of the vegetation by grazing and trampling of the soil.

Floristic Community Types

The vegetation within the survey area is considered to be most similar to FCT SCP 17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands'. However, as a result of the low native species diversity and the reduced condition of the vegetation it is difficult to confidently infer it to any FCT. The vegetation within the survey area has been assessed as representing a highly disturbed example of SCP 17. Several of the common and typical species of this FCT, as defined by Gibson *et al.,* (1994) are absent from the vegetation, such as *Gahnia trifida, Lobelia alata* and *Lepidosperma longitudinale*. However, the presence of the overstorey species, *Melaleuca rhaphiophylla* and *Eucalyptus rudis* subsp. *rudis*, and the percentage similarity (21%) result in the allocation of the of the vegetation unit to FCT SCP 17.

The vegetation community recorded within the survey area is not listed as a TEC by Federal or State legislation or on the DECs PEC database. Thus, it is not representative of a TEC or PEC.

Vegetation Complexes

The survey area is mapped as the Herdsman Complex: Vegetation consists of sedgelands and fringing woodland of *Eucalyptus rudis - Melaleuca* species, which has an estimated 31% remaining in the Bush Forever project area (Government of Western Australia 2000).

This complex exceeds the 10% recommended retention status for Western Australia by the *EPA's Position Statement No. 2* and targets set under Bush Forever. Therefore it is considered to be adequately represented within the Bush Forever study area.

Wetlands

The two wetlands identified by the DEC as occurring within the survey supported vegetation that is representative of wetland communities, however, the condition of this vegetation varied. The Resource Enhancement wetland (UFI 6730) within the survey area represents the core of the wetland vegetation within the survey area. The high level of disturbance to this vegetation, however, has reduced the ecological value of the vegetation. The area identified as a Multiple Use wetland (UFI 13327) is Completely Degraded, as this area has been cleared and utilised for agricultural purposes. However, the Bollard Bulrush East survey area is listed as a wetland of high ecological value and protected under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992.*

6 SUMMARY AND CONCLUSION

The flora and vegetation survey undertaken by ENV.Australia determined that:

- Twenty-three taxa, including seven native flora taxa and 16 introduced taxa, were recorded within the Bollard Bulrush East survey area;
- No plant species listed as Threatened pursuant to the EPBC Act, as Declared Rare pursuant to the WC Act or as Priority by the DEC were located during the survey and it is considered unlikely that the survey area supports species of conservation significance;
- One vegetation community representative of wetland vegetation, Low Woodland of *Melaleuca rhaphiophylla* and *Eucalyptus rudis* subsp. *rudis*, was recorded within the survey area;
- The vegetation within the survey area is described as being in Good to Completely Degraded condition;
- The vegetation within the survey area is considered to be similar to the FCT SCP 17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands'. However, it should be noted that an FCT can not be confidently inferred to the vegetation as a result of the low native species diversity and the reduced condition of the vegetation; and
- The vegetation community recorded during the survey is not listed as a TEC or PEC by the SEWPAC or by the DEC.

No species or vegetation of conservation significance were identified within the survey area. The survey was undertaken at an appropriate time and methods allow for the conclusion that no species or vegetation of conservation significance potentially occurs within the Bollard Bulrush East survey area. Therefore, no flora or vegetation values that require protection were identified during the survey.

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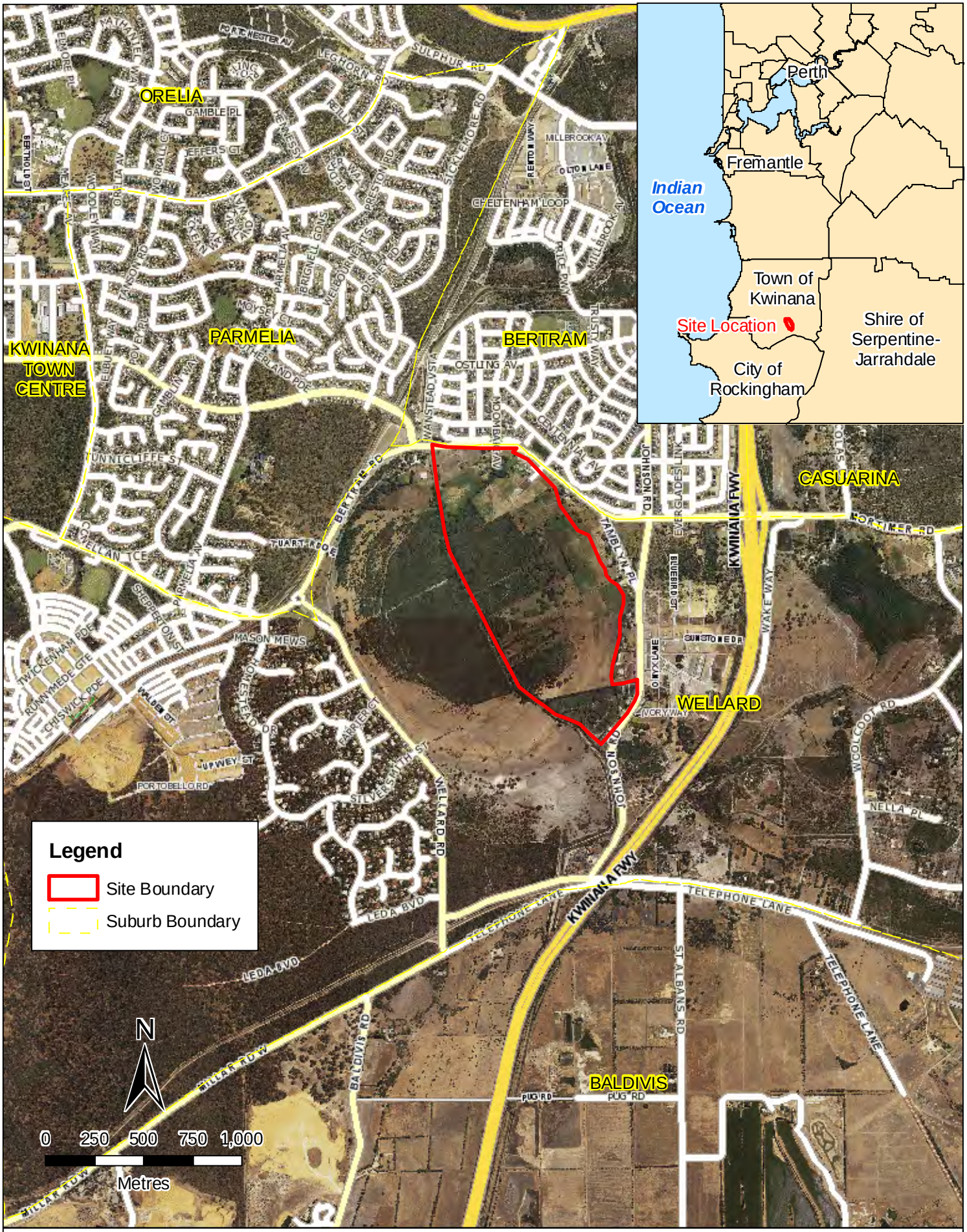
FIGURES

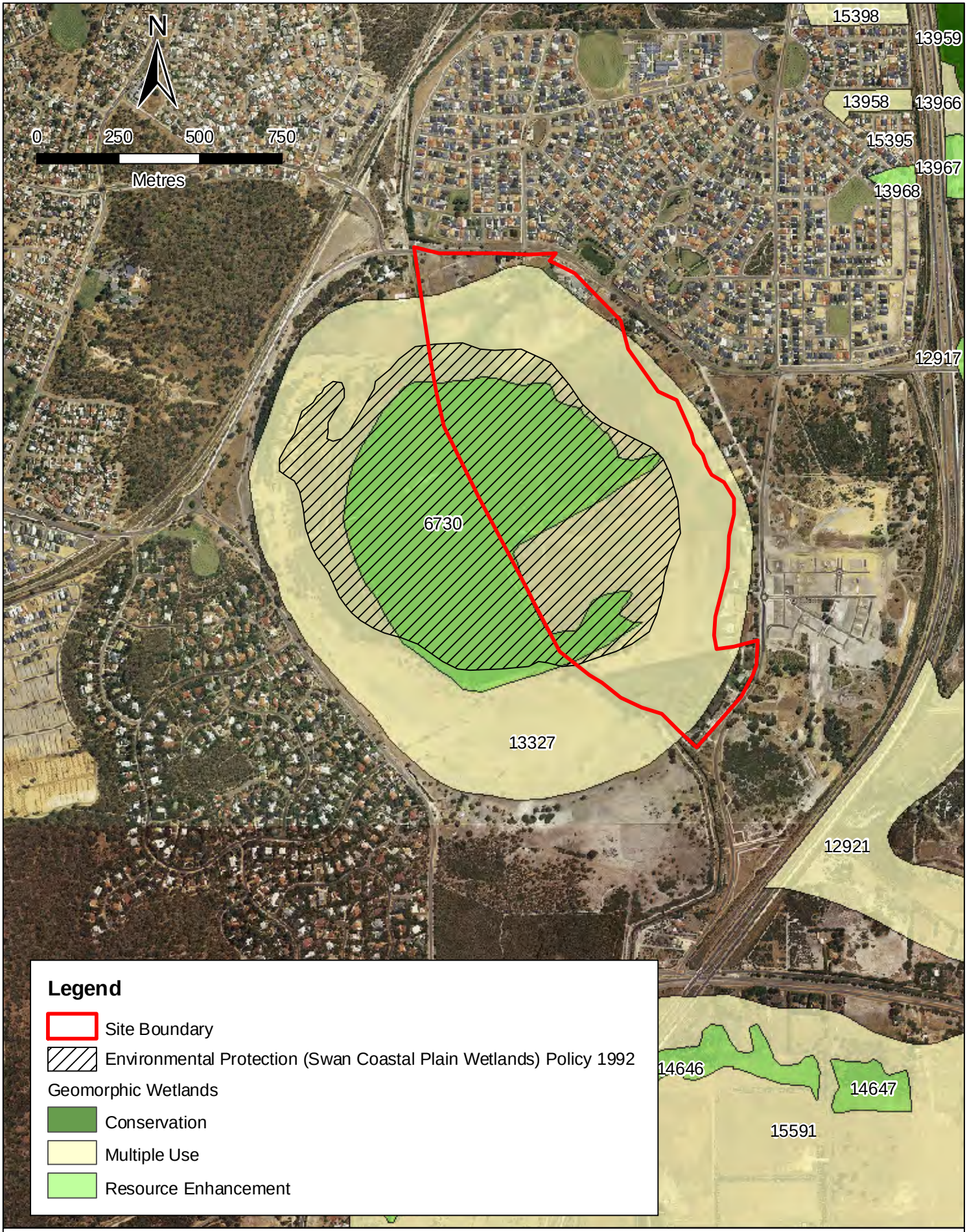


CLIENT: Wellard Landowners Group		JOB NO.: 10.127	
AUTHOR: C. Sgherza	DRAWN: S. Rho	DATE: 25-10-2010	
SCALE: 1:25,000 @ A4	PROJECTION: GDA 94 MGA 50		

Location Map

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 1



CLIENT: Wellard Landowners Group
JOB NO.: 10.127
AUTHOR: C. Sgherza
DRAWN: T. Ellis
DATE: 25-10-2010
SCALE: 1:15,000@ A4
PROJECTION: GDA 94 MGA 50

Wetlands

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 3

CLIENT: Wellard Landowners Group

JOB NO.: 10.127

AUTHOR: C. Sgherza

DRAWN: T. Ellis

DATE: 25-10-2010

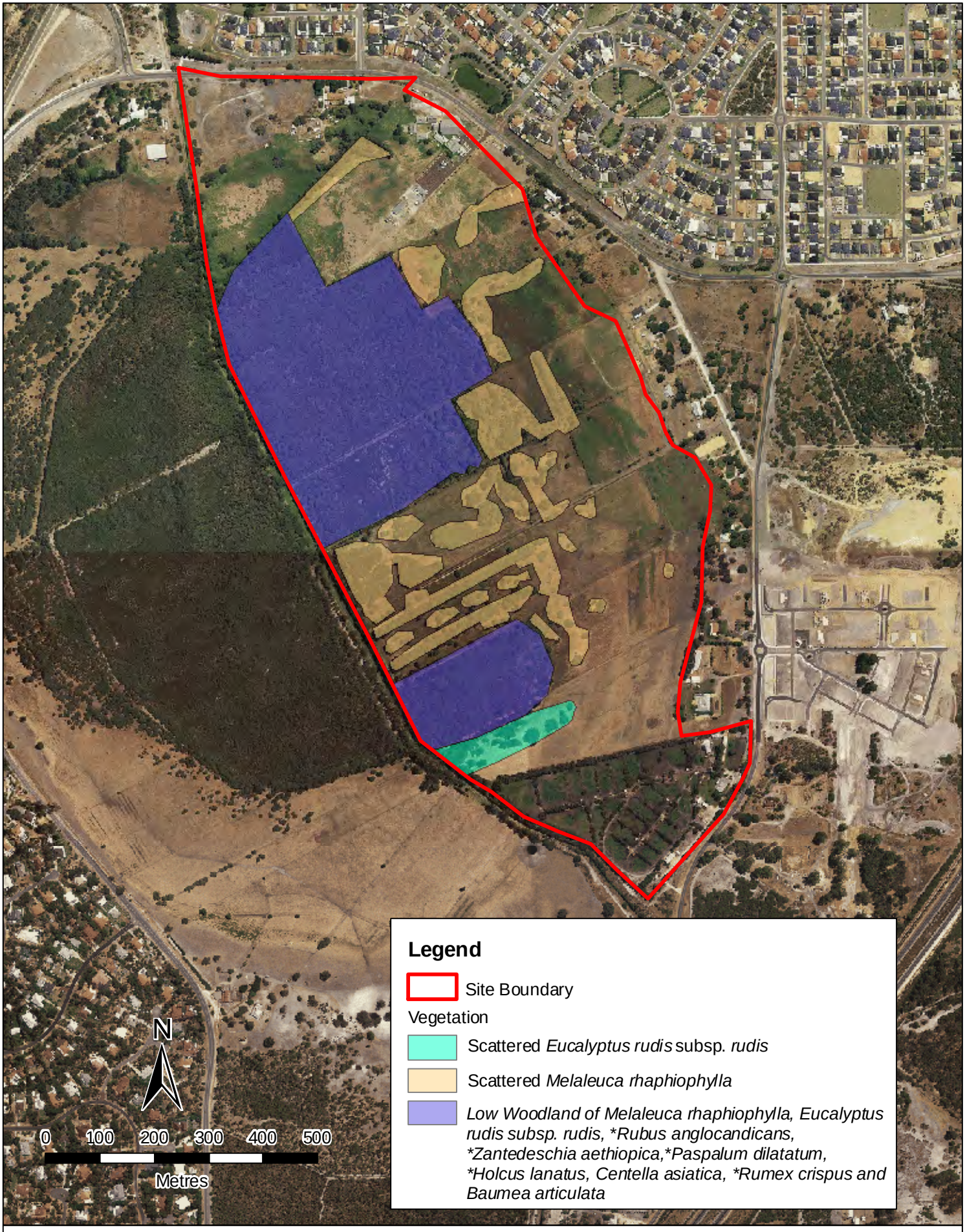
SCALE: 1:9,000 @ A4

PROJECTION: GDA 94 MGA 50

Location of Declared Plants

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 4



CLIENT: Wellard Landowners Group

JOB NO.: 10.127

AUTHOR: C. Sgherza

DRAWN: T. Ellis

DATE: 25-10-2010

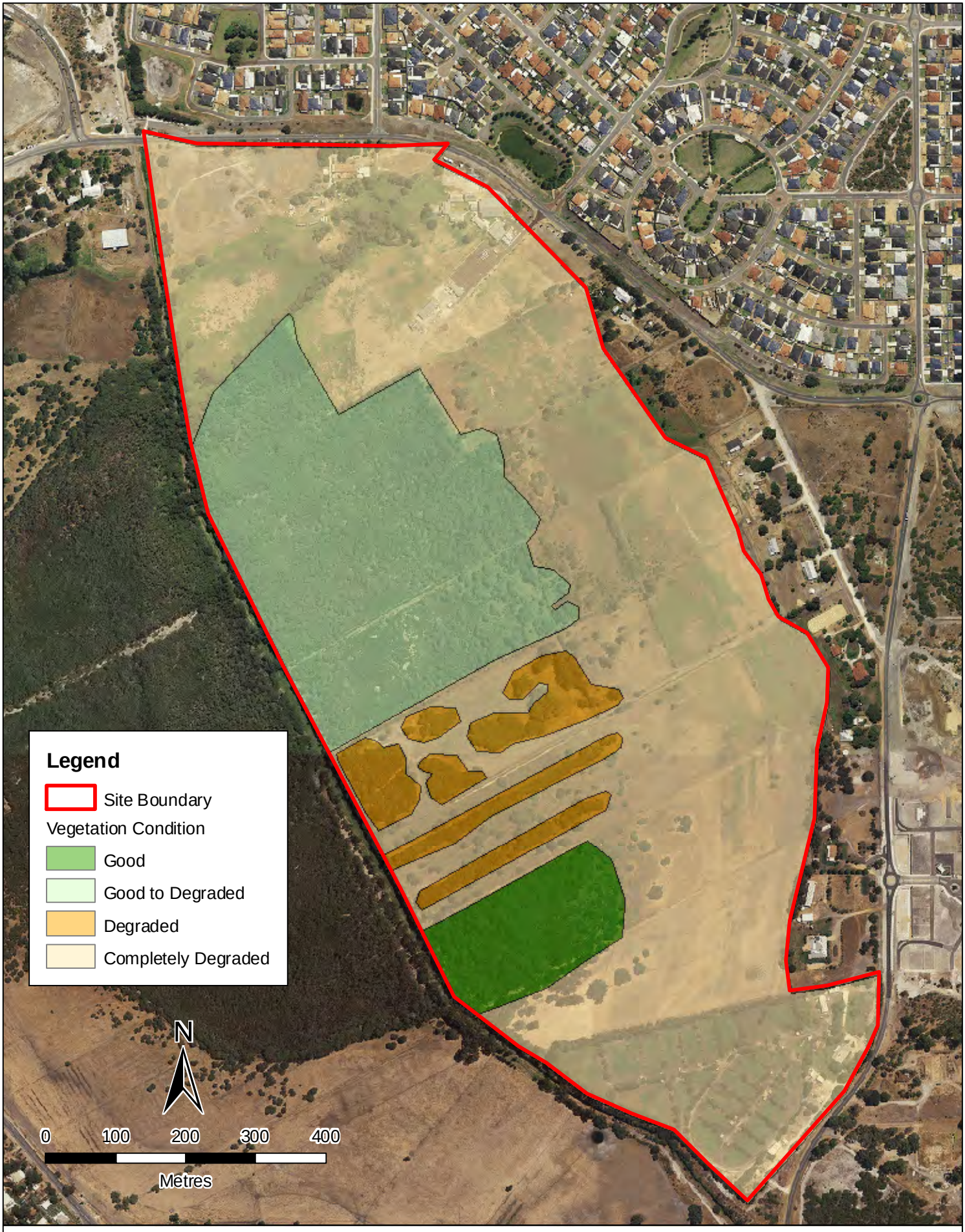
SCALE: 1:9,000 @ A4

PROJECTION: GDA 94 MGA 50

Vegetation

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 5



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JOB NO.: 10.127
AUTHOR: C. Sgherza
DRAWN: T. Ellis
DATE: 27-10-2010
SCALE: 1:7,000 @ A4
PROJECTION: GDA 94 MGA 50

Vegetation Condition

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 6

APPENDIX A

DEFINITIONS OF DECLARED RARE / PRIORITY / THREATENED FLORA AND THREATENED / PRIORITY ECOLOGICAL COMMUNITIES

APPENDIX A

DEFINITIONS OF DECLARED RARE / PRIORITY / THREATENED FLORA AND THREATENED / PRIORITY ECOLOGICAL COMMUNITIES

A1: Categories of Declared Rare and Priority Flora

Conservation Code	Category
X	**Declared Rare Flora - Presumed Extinct Taxa** Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
R	**Declared Rare Flora - Extant Taxa** Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such.
P1	**Priority One - Poorly Known Taxa** Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
P2	**Priority Two - Poorly Known Taxa** Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
P3	**Priority Three - Poorly Known Taxa** Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but need further survey.
P4	**Priority Four - Rare Taxa** Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Source: Department of Environment and Conservation (2010). *Western Australian Flora Conservation Codes*. Department of Environment and Conservation, Perth, Western Australia. Online: http://florabase.calm.wa.gov.au.

A2: Categories of Threatened Flora Species

Category Code	Category
Ex	**Extinct** Taxa which at a particular time if, at the time, there is no reasonable doubt that the last member of the species has died**.**
ExW	**Extinct in the Wild** Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered** Taxa which at a particular time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Source: *Environment Protection and Biodiversity Conservation Act 1999*

A3: Definitions of Threatened Ecological Communities

Presumed Totally Destroyed (PD)

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B);

A) Records within the last 50 years have not been confirmed despite thorough searches or known or likely habitats **or**

B) All occurrences recorded within the last 50 years have since been destroyed.

Critically Endangered (CR)

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and **either or both** of the following apply (i or ii)

   i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 5 years)

   ii) modification throughout its range is continuing such that in the immediate future (within approximately 5 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, and **one or more** of the following apply (i, ii or iii):

   i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 5 years)

   ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes

   iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes

C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the immediate future (within approximately 5 years)

Endangered (EN)

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 70% and **either or both** of the following apply (i or ii)

   i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term (within approximately 10 years)
   ii) modification throughout its range is continuing such that in the short term future (within approximately 10 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, and **one or more** of the following apply (i, ii or iii):

   i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 10 years)
   ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes
   iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes

C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the short term future (within approximately 10 years).

Vulnerable (VU)

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction in the medium to long term future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences which are likely to be capable of being substantially restored or rehabilitated.
B) The ecological community can be modified or destroyed and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.
C) The ecological community may still be widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Source: Department of Environment and Conservation (2010). *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*. Department of Environment and Conservation, Perth, Western Australia. Online: www.naturebase.net/

A4: Definitions of Priority Ecological Communities

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly known ecological communities Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly known ecological communities. Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation.

Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:

(ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;

(iii) Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities. Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Source: Department of Environment and Conservation (2010). *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*. Department of Environment and Conservation, Perth, Western Australia. Online: www.naturebase.net/

APPENDIX B
ENVIRONMENTAL WEEDS AND DECLARED PLANT CATEGORIES

APPENDIX B

ENVIRONMENTAL WEEDS AND DECLARED PLANT CATEGORIES

B1: Criteria used for Ranking Environmental Weeds

The Environmental Weed Strategy for Western Australia (CALM 1999) contains criteria for the assessment and ranking of weeds in terms of their environmental impact on biodiversity. These criteria are as follows:

- **Invasiveness –** ability to invade bushland in good to excellent condition or ability to invade waterways. (Score as yes or no).
- **Distribution** – wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world. (Score as yes or no).
- **Environmental Impacts** – ability to change the structure, composition and function of ecosystems. In particular an ability to form a monoculture in a vegetation community. (Score as yes or no).

The rating of each weed is determined by the following scoring system:

- **High** - a weed species would have to score yes for all three criteria. Rating a weed species as high would indicate prioritising this weed for control and/or research i.e. prioritising funding to it.
- **Moderate** -a weed species would have to score yes for two of the above criteria. Rating a weed species as moderate would indicate that control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).
- **Mild** – a weed species scoring one of the criteria. A mild rating would indicate monitoring of the week and control where appropriate.
- **Low** – a weed species would score none of the criteria. A low ranking would mean that this species would require a low level of monitoring.

Source: Department of Conservation and Land Management (1999). *Environmental Weed Strategy for Western Australia*. Department of Conservation and Land Management, Perth, Western Australia.

B2: Standard Meanings of Declared Plant Categories

P1

Prohibits movement.

The movement of plants or their seeds is prohibited within the State.

This prohibits the movement of contaminated machinery and produce including livestock and fodder.

P2

Aim is to eradicate infestation.

Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.

P3

Aims to control infestation by reducing area and/or density of infestation.

The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.

Treat to destroy and prevent seed set all plants:

* Within 50m inside of the boundaries of the infestation;

* within 50m of roads and high water mark on waterways;

* within 50m of sheds, stock yards and houses.

Treatment must be done prior to seed set each year.

Properties with less than 20ha of infestation must treat the entire infestation.

Additional areas may be ordered to be treated.

P4

Aims to prevent infestation spreading beyond existing boundaries of infestation

The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.

Treat to destroy and prevent seed set all plants:

* within 50m inside of the boundaries of the infested property for one-leaf and 20m for two-leaf;

* within 50m of roads and high water mark on waterways;

* within 50m of sheds, stock yards and houses.

Treatment must be done prior to seed set each year. Properties with less than 20ha of infestation must treat the entire infestation.

Additional areas may be ordered to be treated.

Special considerations.

In the case of P4 infestations where they continue across property boundaries there is no requirement to treat the relevant part of the property boundaries as long as the boundaries of the infestation as a whole are treated. There must be agreement between neighbours in relation to the treatment of these areas.

P5

Aims to control infestations on public lands.

Source: Department of Agriculture and Food (2010). *List of Declared Plants*. Department of Agriculture and Food, Western Australia. Online: http://www.agric.wa.gov.au/.

APPENDIX C
FLORA SURVEY FIELD DATA SHEETS AND SITE PHOTOGRAPHS

APPENDIX C

FLORA SURVEY FIELD DATA SHEETS AND SITE PHOTOGRAPHS

Site Q01

Described by NW

Location Wellard

MGA Zone50 390520mE 6430676mN

Habitat Dampland

Soil Wet brown loam

Rock Type

Vegetation Low Open Forest of *Melaleuca rhaphiophylla, Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum, *Holcus lanatus, Centella asiatica, *Rumex crispus, Baumea articulata, Typha* sp. and **Cortaderia selloana*.

Veg Condition Good

Fire Age Young

Notes Aspect: N/A.
Bare ground: 1%.
Litter cover: 1% Logs; 1% Twigs; 15% Lvs.
Disturbance type: Weeds.

SPECIES LIST:

Name	Cover	Height	Specimen	Notes
Baumea articulata	5%	0.9m	01.03	
Cassytha racemosa	+	CR	01.04	
Centella asiatica	30%	0.2m	01.05	
**Cirsium vulgare*	+	0.4m	NC	
**Cortaderia selloana*	1%	4m	NC	
Eucalyptus rudis subsp. *rudis*	+	9m	01.12	
**Ficus carica*	+	0.4m	01.01	
**Holcus lanatus*	10%	0.3m	01.06	
**Livistona australis*	+	0.1m	NC	
Melaleuca rhaphiophylla	40%	7m	NC	
**Paspalum dilatatum*	40%	0.3m	01.09	
**Rubus anglocandicans*			NC	Associated Species
**Rumex crispus*	1%	0.3m	01.07	
**Schinus terebinthifolius*	+	3m	01.02	
**Typha orientalis*	3%	1m	NC	
**Zantedeschia aethiopica*	+	0.4m	NC	

Site Q02

Described by NW

Location Welland

MGA Zone 50 390881 mE 6430533mN

Habitat Dampland

Soil Wet brown loam

Rock Type

Vegetation Low Open Woodland of *Melaleuca rhaphiophylla, Eucalyptus rudis* subsp. *rudis,* Paspalum dilatatum, *Holcus lanatus, Centella asiatica,* Zantedeschia aethiopica, *Rumex crispus* and *Baumea articulata.*

Veg Condition Good to Degraded

Fire Age Old

Notes Aspect: N/A.
Bare ground: 5%.
Litter cover: 1% Logs; 13% Twigs; 20% Lvs.
Disturbance type: Weeds and clearing.

SPECIES LIST:

Name	Cover	Height	Specimen	Notes
Baumea articulata	1%	0.6m	01.03	
Cassytha racemosa	+	CR	01.04	
Centella asiatica	60%	0.25m	01.05	
**Cirsium vulgare*	+	0.3m	NC	
Eucalyptus rudis subsp. *rudis*	2%	6m	NC	
**Gomphocarpus fruticosus*	+	0.1m	NC	
**Holcus lanatus*	1%	0.5m	01.06	
Melaleuca lateritia	+	1m	02.06	
Melaleuca rhaphiophylla	6%	5m	NC	
**Paspalum dilatatum*	2%	0.4m	02.04	
**Prunella vulgaris*	+	0.3m	02.02	
**Rumex crispus*	1%	0.4m	02.03	
**Zantedeschia aethiopica*	2%	0.5m	NC	

Site Q03

Described by NW

Location Wellard

MGA Zone 50 390936mE 6429912mN

Habitat Dampland

Soil Wet brown loam

Rock Type

Vegetation Low Woodland of *Eucalyptus rudis subsp. rudis, Melaleuca rhaphiophylla, Centella asiatica* and *Baumea articulata.*

Veg Condition Good to Degraded

Fire Age Old

Notes Aspect: N/A.
Bare ground: 2%.
Litter cover: 2% Logs; 15% Twigs; 30% Lvs.
Disturbance type: Weeds and clearing.

SPECIES LIST:

Name	Cover	Height	Specimen	Notes
Baumea articulata	30%	1m	01.03	
**Briza maxima*	+	0.4m	NC	
Cassytha racemosa	+	CR	01.04	
Centella asiatica	20%	0.2m	01.05	
Eucalyptus rudis subsp. *rudis*	20%	10m	NC	
**Holcus lanatus*	+	0.2m	01.06	
**Lolium perenne* x *rigidum*	+	0.4m	03.01	
Melaleuca rhaphiophylla	5%	6m	NC	
**Sonchus oleraceus*	+	0.1m	03.02	
**Zantedeschia aethiopica*	+	0.5m	NC	

Site R01

Described by NW

Location Wellard

MGA Zone50 390725mE 6430290mN

Habitat Dampland

Soil Wet brown loam

Rock Type

Vegetation Low Open Forest of *Melaleuca rhaphiophylla* and *Baumea articulata.*

Veg Condition Good

Fire Age Moderate

Notes Aspect: N/A.
Bare ground: 60%.
Litter cover: 1% Logs; 2% Twigs; 5% Lvs.
Disturbance type: Cattle and weeds.

SPECIES LIST:

Name	Cover	Height	Specimen	Notes
Baumea articulata	20%	0.6m	R01.02	
Caesia micrantha	+	0.3m	R01.01	
Centella asiatica	+	0.2m	01.05	
Melaleuca rhaphiophylla	60%	4m	NC	

APPENDIX D
BUSH FOREVER CONDITION SCALE

APPENDIX D

BUSH FOREVER CONDITION SCALE

Condition Scale Code	Condition Scale
P	**Pristine (1)** Pristine or nearly so, no obvious signs of disturbance
E	**Excellent (2)** Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
VG	**Very Good (3)** Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
G	**Good (4)** Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
D	**Degraded (5)** Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
CD	**Completely Degraded (6)** The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Source: Government of Western Australia (2000). *Bush Forever Volume 2: Directory of Bush Forever Sites*. Department of Environmental Protection, Perth, Western Australia.

APPENDIX E
DATABASE SEARCH RESULTS

APPENDIX E

DATABASE SEARCH RESULTS

E1: Declared Rare and Priority Flora

FAMILY	TAXA	Conservation Status Code		Source	Life Cycle[1]	Flowering Time[1]	Habitat[1]
		STATE	FEDERAL				
Aponogetonaceae	*Aponogeton hexatepalus*	P4	-	DEC	Perennial	Jul-Oct	Pools (Aquatic)
Centrolepidaceae	*Centrolepis caespitosa*	P4	Endangered	EPBC Search	Perennial	Oct - Dec	Salt flats
Cyperaceae	*Cyathochaeta teretifolia*	P3	-	DEC	Perennial	Not Available	Swamps and creek edges
Cyperaceae	*Lepidosperma rostratum*	DRF	Endangered	EPBC Search	Perennial	Not Available	Peaty sand and clay
Ericaceae	*Andersonia gracilis*	DRF	Endangered	EPBC Search	Perennial	Sept - Nov	Winter-wet areas
Fabaceae	*Aotus cordifolia*	P3	-	DEC	Perennial	Aug-Jan	Swamps
Malvaceae	*Lasiopetalum pterocarpum*	DRF	Endangered	EPBC Search	Perennial	Sep- Dec	Sand over Limestone
Myrtaceae	*Darwinia foetida*	DRF	Crit End	EPBC Search	Perennial	Not known	Not known
Orchidaceae	*Caladenia huegelii*	DRF	Endangered	DEC / EPBC Search	Perennial	Sept-Oct	Sandy soils
Orchidaceae	*Diuris micrantha*	DRF	Vulnerable	DEC / EPBC Search	Perennial	Sept-Oct	Seasonally wet flats
Orchidaceae	*Drakaea elastica*	DRF	Endangered	EPBC Search	Perennial	Oct-Nov	Near seasonally wet flats
Proteaceae	*Grevillea curviloba* subsp. *incurva*	DRF	Endangered	EPBC Search	Perennial	Aug - Sept	Winter-wet health
Proteaceae	*Synaphea stenoloba*	DRF	Endangered	EPBC Search	Perennial	Aug - Oct	Winter-wet flats
Proteaceae	*Synaphea* sp. Fairbridge Farm (D.Papenfus 696)	DRF	Endangered	EPBC Search	Perennial	Oct	Near seasonally wet flats
Proteaceae	*Synaphea* sp. Serpentine (G.R. Brand 103)	P3	-	DEC	Perennial	Oct	Slumpland
Sapindaceae	*Dodonaea hackettiana*	P4	-	DEC	Perennial	Jul-Oct	Outcropping Limestone
Rutaceae	*Boronia juncea* subsp. *juncea*	P1	-	DEC	Perennial	Apr	Sand
Stylidiaceae	*Stylidium ireneae*	P4	-	DEC	Perennial	Sept-Oct	Saline clay flats
Stylidiaceae	*Stylidium longitubum*	P3	-	DEC	Annual	Oct-Dec	Seasonally wet flats

[1] Source: Western Australian Herbarium [WAH] (2010) *FloraBase - Information on the Western Australian Flora.* Department of Environment and Conservation, Perth. Online: http://florabase.calm.wa.gov.au [October 2010].

E2: Threatened and Priority Ecological Communities

Ecological Community	Description	Conservation Status		Source
		State	Federal	
SCP3a	*Corymbia calophylla - Kingia australis* woodlands on heavy soils of the Swan Coastal Plain	Endangered	Endangered	EBPC Search
SCP3c	*Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain	Critically Endangered	Endangered	EBPC Search
SCP19b	Woodlands over sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Critically Endangered	Endangered	DEC / EBPC Search
SCP26a	*Melaleuca huegelii - Melaleuca acerosa* (currently *M. systena*) shrublands on limestone ridges	Endangered	-	DEC
SCP09	Dense shrublands on clay flats	Vulnerable	-	DEC
SCP22	*Banksia ilicifolia* woodlands	Priority 2	-	DEC
SCP24	Northern Spearwood shrublands and woodlands	Priority 3	-	DEC
SCP21c	Low lying *Banksia attenuata* woodlands or shrublands	Priority 3	-	DEC

APPENDIX F
FLORA SPECIES LIST

APPENDIX F

FLORA SPECIES LIST

* denotes foreign introduced species

Abbreviations:

sp.: species (singular)
spp.: species (plural)
subsp.: subspecies
var.: variety
ms: manuscript name (unpublished)

FAMILY	TAXA
Anacardiaceae	**Schinus terebinthifolius*
Anthericaceae	*Caesia micrantha*
Apiaceae	*Centella asiatica*
Araceae	**Zantedeschia aethiopica*
Arecaceae	**Livistona australis*
Asclepiadaceae	**Gomphocarpus fruticosus*
Asteraceae	**Cirsium vulgare*
Asteraceae	**Sonchus oleraceus*
Cyperaceae	*Baumea articulata*
Lamiaceae	**Prunella vulgaris*
Lauraceae	*Cassytha racemosa*
Moraceae	**Ficus carica*
Myrtaceae	*Eucalyptus rudis* subsp. *rudis*
Myrtaceae	*Melaleuca lateritia*
Myrtaceae	*Melaleuca rhaphiophylla*
Poaceae	**Briza maxima*
Poaceae	**Cortaderia selloana*
Poaceae	**Holcus lanatus*
Poaceae	**Lolium perenne* x *rigidum*
Poaceae	**Paspalum dilatatum*
Polygonaceae	**Rumex crispus*
Rosaceae	**Rubus anglocandicans*
Typhaceae	**Typha orientalis*

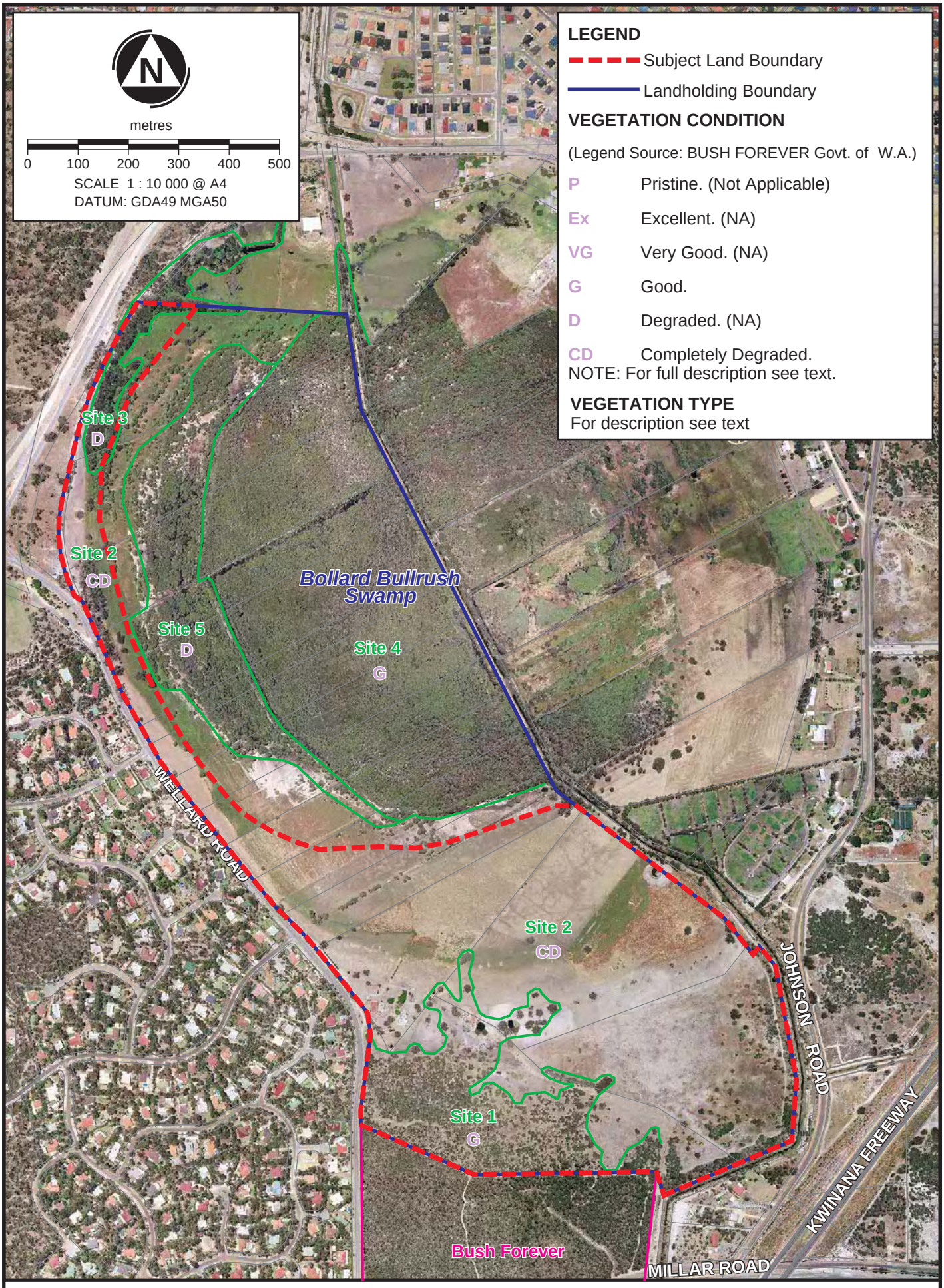
APPENDIX G
MATRIX OF TAXA BY SITE

APPENDIX G

MATRIX OF TAXA BY SITE

Species Name	Q01	Q02	Q03	R01
Baumea articulata	5%	1%	30%	20%
**Briza maxima*			+	
Caesia micrantha				+
Cassytha racemosa	+	+	+	
Centella asiatica	30%	60%	20%	+
**Cirsium vulgare*	+	+		
**Cortaderia selloana*	1%			
Eucalyptus rudis subsp. *rudis*	+	2%	20%	
**Ficus carica*	+			
**Gomphocarpus fruticosus*		+		
**Holcus lanatus*	10%	1%	+	
Livistona australis	+			
**Lolium perenne* x *rigidum*			+	
Melaleuca lateritia		+		
Melaleuca rhaphiophylla	40%	6%	5%	60%
**Paspalum dilatatum*	40%	2%		
**Prunella vulgaris*		+		
**Rubus anglocandicans*	nc			
**Rumex crispus*	1%	1%		
**Schinus terebinthifolius*	+			
**Sonchus oleraceus*			+	
**Typha orientalis*	3%			
**Zantedeschia aethiopica*	+	2%	+	

APPENDIX B
BOLLARD BULRUSH SWAMP WEST VEGETATION CONDITION MAPPING (ENV 2009)



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DevX - BOLLARD BULLRUSH SWAMP WEST
ENVIRONMENTAL ASSESSMENT TO SUPPORT
SPECIAL RESIDENTIAL & RESIDENTIAL SUBDIVISION

VEGETATION TYPE AND CONDITION

Environmental Geology: Geological Survey of Western Australia, 1:50 000 Environmental Series

FIGURE 5

env Australia

APPENDIX C
BOLLARD BULRUSH EAST FAUNA ASSESSMENT

BOLLARD BULRUSH EAST

FAUNA ASSESSMENT

BOLLARD BULRUSH EAST

FAUNA ASSESSMENT

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Content Review:	*Teresa Gepp*
Date:	*29 July 2011*

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STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) ("scope of services"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, ENV has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to ENV.

Environmental Conclusions

In accordance with the scope of services, ENV has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions. Also it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. ENV assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of ENV or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

ENV will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

EXECUTIVE SUMMARY

ENV.Australia Pty Ltd was commissioned by Greg Rowe and Associates, on behalf of the Wellard Landowners Group, in June 2010 to undertake a fauna and fauna habitat assessment for the Bollard Bulrush East survey area. The survey area is approximately 73 hectares in size.

The purpose of this assessment is to provide supporting documentation for proposed future residential development of the survey area. The objectives of the fauna assessment are to:

- Document the general fauna habitat types in the survey area as they relate to faunal assemblages.
- Compile a list of terrestrial vertebrate fauna previously recorded in the region, based on database searches.
- Identify terrestrial vertebrate fauna of conservation significance that potentially occur within the survey area, based on databases and past work in the surrounding area.
- Develop a map illustrating the fauna habitat types present.
- Provide technical advice on fauna issues likely to constrain the proposed development.

A Level One assessment was undertaken in the survey area, in consideration of the Environmental Protection Authority *Guidance Statement No. 56.*

One fauna habitat type was identified in the survey area; a *Melaleuca* Dampland. This fauna habitat type represents 32% of the survey area; the remaining 68% is largely made up of degraded land previously used for agriculture. Based on a site assessment and survey, the fauna habitat type is considered to be of low value and is unlikely to support a wide suite of fauna species and/or species of conservation significance. There is a lack of microhabitat diversity due to the presence of weed species which dominate the understorey and midstorey layers of the fauna habitat. There is also a lack of important habitat structures such as large trees with hollows, loose bark and fallen hollow logs (used by many fauna species as den and nest sites).

Two-hundred and eleven species of fauna have been previously recorded within the vicinity of the survey area, including six amphibians, 33 reptiles, 150 birds and 22 mammals. During the fauna survey twenty-nine terrestrial vertebrate fauna were recorded, comprising of one amphibian species, one reptile species, 18 bird species and two mammal species. Of these only the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) is a species of conservation significance and is listed on the Department of Environment and Conservation Priority list. Secondary evidence in the

form of species specific conical diggings was recorded in moderate density across the survey area.

Twenty-eight species of conservation significance have been previously recorded within the vicinity of the survey area. This includes three reptile species, 18 bird species and seven mammal species. Of these one was 'Recorded', two species were considered as 'Likely', three species 'Possible', 18 as 'Unlikely' to occur. Four were considered as 'Highly Unlikely' to occur within the survey area. This is based on the ecological requirements and known distribution of the species and the type and quality of fauna habitats within the survey area. Species considered as 'Likely' to occur are bird species namely the Cattle Egret and Eastern Great Egret.

Generally the site was degraded and cleared and did not provide much value to a wide suite of fauna species. Approximately 32% of the survey area contained fauna habitat and the remaining was in degraded condition and depauperate of faunal assemblages. In addition the survey area has been subject to past and present agriculture activities and this has largely reduced the sites value for fauna particularly species with conservation significance.

1 INTRODUCTION

ENV.Australia Pty Ltd ('ENV') was commissioned by Greg Rowe and Associates, on behalf of the Wellard Landowners Group in June 2010 to undertake a fauna and fauna habitat assessment for the Bollard Bulrush East site ('the survey area'). The survey area is approximately 73 hectares (ha) in size.

The purpose of this assessment is to provide supporting documentation for proposed future residential development of the survey area.

1.1 OBJECTIVES

The objectives of the fauna assessment are to:

- Document the general fauna habitat types in the survey area as they relate to faunal assemblages.
- Compile a list of terrestrial vertebrate fauna previously recorded in the region, based on database searches.
- Identify terrestrial vertebrate fauna of conservation significance that potentially occur within the survey area, based on databases and past work in the surrounding area.
- Develop a map illustrating the fauna habitat types present.
- Provide technical advice on fauna issues likely to constrain the proposed development.

1.2 LOCATION

The Bollard Bulrush East survey area is located approximately 35 kilometres (km) south of the Perth Central Business District, in the suburb of Wellard, in the Town of Kwinana. The survey area is bounded by housing and a school on its northern, eastern and southern sides and remnant vegetation on its western side (Figure 1).

1.3 CLIMATE

The climate of this region is warm Mediterranean, with an average maximum summer temperature of 28.3°C and an average minimum winter temperature of 10.9°C (Bureau of Meteorology (BoM) 2010). The region receives an average annual rainfall of 765.3 mm, with the majority of precipitation occurring in winter (BOM 2010) (Figure 2).

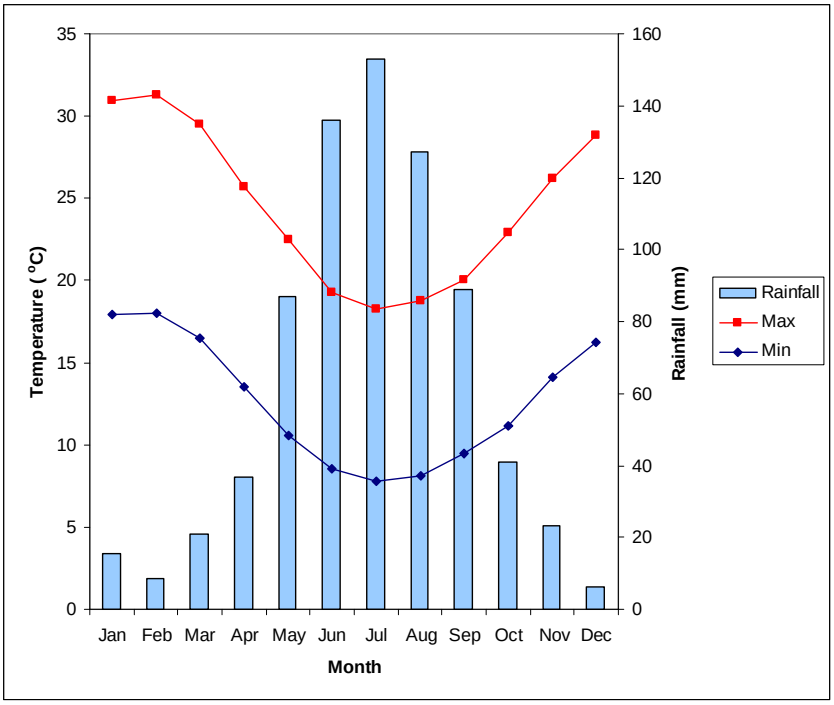

Figure 2: Average monthly rainfall and maximum and minimum temperatures at Medina Research Station (1983-2010) (BoM 2010)

1.4 REGIONAL SOILS, LANDFORMS AND VEGETATION

For a development proposal to be assessed in terms of the fauna and habitat values that may be impacted upon, an understanding of the vegetation communities at the survey area in question is required. In Western Australia, there are various reports that detail a region's botanical values.

A widely-used vegetation classification system that maps and describes vegetation communities in southwest Western Australia is *Vegetation of the Darling System* in the *Atlas of Natural Resources, Darling System, Western Australia* (Department of Conservation and Environment 1980). This document describes vegetation communities as vegetation complexes, and maps the distribution of each complex.

Vegetation complexes are defined as a combination of distinct site vegetation types usually associated with a particular geomorphic, climatic, and floristic and vegetation structural association. Vegetation complexes are based on the pattern of vegetation at a regional scale, as it reflects the underlying key determining factors of landforms, climate and soils.

The soils and landform unit, as well as the vegetation complex the survey area supports, are described below.

1.4.1 Soils and Landforms

The survey area occurs on the Swan Coastal Plain portion of the Darling System (Churchward and McArthur 1978). The Swan Coastal plain consists of aeolian and fluviatile deposits, specifically the survey area is on:

- Herdsman unit: Peaty swamps associated with Bassendean and Karrakatta units.

1.4.2 Beard Vegetation Mapping

The survey area is in the South West Botanical Province and the Darling Botanical District (Beard 1990). The vegetation of this region typically consists of forest with related woodlands and is divided into four subregions or botanic subdistricts.

The survey area is within the Swan Coastal Plain Subregion in the Drummond Botanical Subdistrict (Beard 1990). The Drummond Botanical Subdistrict consists mainly of the following vegetation communities:

- *Banksia* Low Woodland on leached sands and *Melaleuca* Swamps in poorly drained areas.
- Woodland of Tuart (*Eucalyptus gomphocephala*).
- Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) woodlands on the less leached soils (Beard 1990).

1.4.3 Vegetation Complex Mapping

Heddle *et al*., (1978) mapped the area as containing one Swan Coastal Plain vegetation complex which is related to the underlying soil profile:

- Herdsman Complex: Vegetation consists of sedgeland and fringing woodland of *Eucalyptus rudis* - *Melaleuca* species.

The Environmental Protection Authority's (EPA) document *Levels of Assessment for Proposals Affecting Natural Areas Within System 6 Region and Swan Coastal Plain Portion of the System 1 Region* (EPA 2006) gives an estimate of the percentage of each complex that remains compared to its pre-European settlement extent, so an estimate of the scarcity of each complex can be determined.

In Western Australia 34.6% of the Herdsman Complex is estimated to remain (EPA 2006). While within the Perth Metropolitan Area (PMA), 31% of the Herdsman Complex is estimated to remain (Government of Western Australia 2000).

The EPA recognises certain vegetation complexes that are not well represented in reserves as being significant. Vegetation complexes which have 10%-30% remaining may be considered regionally significant. Proposals that would impact on a vegetation

complex with 10% or less remaining are likely to be formally assessed by the EPA (EPA 2006).

1.5 PREVIOUS FAUNA STUDIES

There is only a limited amount of published or publicly available biological survey work undertaken within the vicinity of Wellard. The most recent of these are within 15 km of the survey area and include:

- Fauna Survey (Level 2) East Rockingham WWTP Site (Harewood 2009).
- Fauna Survey (Level 1) East Rockingham WWTP Site (Harewood 2008).
- Fauna Assessment of Bush Forever Site 355 (Bamford 2005).
- Fauna Assessment of a Portion of the Sepia Depression Ocean Outlet Landline, Lake Richmond (ENV 2005).

2 METHODOLOGY

2.1 BACKGROUND TO SURVEY METHODOLOGY

2.1.1 Protection of Fauna and Fauna Habitat

Fauna, habitat, and fauna ecological communities are protected formally and informally by various legislative and non-legislative measures, which are outlined below. Species listed under these Acts and non-legislative measures are considered 'conservation significant' in this assessment.

Legislative Protection

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Western Australian *Wildlife Conservation Act 1950* (WC Act).
- Western Australian *Environmental Protection Act 1986* (EP Act).

Non-Legislative Protection

- Department of Environment and Conservation (DEC) Priority lists.
- Informal recognition of fauna of interest.

A short description of these legislative and non-legislative measures is given below, and definitions of the species conservation codes and ecological community categories they use, are provided in Appendix A.

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act aims to protect matters of national environmental significance, which are detailed in Appendix A. Under the EPBC Act, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) lists protected species and Threatened Ecological Communities (TECs) by criteria set out in the act (Commonwealth of Australia 2007). Species are considered to be conservation significant if they are listed as Threatened (i.e. Vulnerable, Endangered etc.), or Migratory.

Migratory bird species listed under the EPBC Act are also listed under international migratory bird agreements relating to the protection of birds which migrate between Australia and other countries. These includes the: Japan-Australia Migratory Bird Agreement (JAMBA); China-Australia Migratory Bird Agreement (CAMBA); Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA); and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Some marine fauna or terrestrial fauna that use marine habitats are listed as Marine under the EPBC Act. These species are only considered conservation significant when a proposed development occurs in a Commonwealth marine area (i.e. any Commonwealth Waters or Commonwealth Marine Protected Area). Outside of such areas the EPBC Act does not consider these species to be matters of national environmental significance, so they are not protected under the Act. As such species only listed as Marine under the EPBC Act are not considered in this assessment.

Wildlife Conservation Act 1950

The DEC, lists taxa under the provisions of the WC Act as protected and are classified as Schedule 1 to Schedule 4 according to their need for protection (see Appendix A). The Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the WC Act.

Environmental Protection Act 1986

Significant habitat necessary for the maintenance of indigenous fauna to Western Australia as well as TECs is given special consideration in environmental impact assessment, and areas with TECs present have special status as Environmentally Sensitive Areas (ESAs) under the EP Act, and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

The protection of 'significant habitats' for fauna indigenous to Western Australia and TECs is a 'clearing principle' for assessing applications for permits to clear native vegetation. Where exemptions for a clearing permit under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* do not apply. There are substantial penalties for unlawfully damaging ESAs.

DEC Priority Lists

The DEC produces a list of Priority species that have not been assigned statutory protection under the WC Act. Priority Fauna are under consideration as 'Scheduled' fauna, but are in urgent need of further survey or require regular monitoring, and although not currently threatened may become so in the future. Appendix A provides definitions of Priority codes.

In addition, the DEC maintains a list of Priority Ecological Communities which identifies those communities that need further investigation before being nomination as a TEC.

Although DEC Priority species and communities have no formal legal protection, they are under consideration as 'Scheduled' taxa under the WC Act or as ESAs under the EP Act. Sensitivities to harm Priority species or communities can therefore be expected to be heightened.

Informal Recognition of Threatened Fauna

Certain populations or communities may be of local significance or interest because of their distribution and or abundance. For example, fauna may be locally significant because they represent a range extension (i.e. outside of known distribution) or are newly discovered taxa and therefore have the potential to be listed as Threatened in the future. In addition, many species are in decline as a result of threatening processes, and relict populations of such species maybe locally important.

2.1.2 EPA Requirements for Fauna Surveys

The survey was carried out in a manner consistent with the EPA requirements for environmental surveying and reporting of fauna surveys in Western Australia:

- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002).

- *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56* (EPA 2004).

According to the EPA *Guidance Statement No. 56* (EPA 2004), a baseline field fauna survey for environmental impact assessment should at the very least provide a comprehensive list of species within a given area. There are two levels of fauna survey as outlined by the EPA:

- ***Level One:*** desktop study to collate historical knowledge, in conjunction with a reconnaissance survey (site inspection).

- ***Level Two:*** trapping and opportunistic field survey to characterise the fauna present, combined with a Level One survey. Where the scale and nature of the proposed impact is moderate to high, a Level Two survey will be required in most areas of the state, and is typically required for resource development projects.

The methodology of the current survey, a Level One survey, has been developed in consideration of the EPA *Guidance Statement No. 56.* The relatively small size of the survey area and extensive level of faunal assemblage knowledge on the Swan Coastal Plain, a Level One survey is appropriate for the proposed development.

2.2 DESKTOP REVIEW

The purpose of the desktop review was to gather background information on the survey area and the fauna that it may support. This involved a search of the following sources:

- Western Australian Museum (WAM) and DEC combined biological database *NatureMap* (DEC 2010a) (an approximate 10 km buffer surrounding the survey area was searched).

- DEC Threatened and Priority Fauna Database (DEC 2010b) (area search was as above).
- SEWPAC *Protected Matters Search Tool* (SEWPAC 2010), also known as an EPBC search (an approximate 10 km buffer surrounding the survey area was searched).
- Birds Australia's Birdata (Birdata 2010) (area search was based on a one degree square which encompassed the survey area).
- Previous fauna surveys (e.g. previous ENV reports, other consultant's reports, DEC reports).

Collectively, these sources were used to compile a list of species that have been previously recorded in the vicinity of the survey area (Appendix B). This list will invariably include some species that do not occur in the survey area, because some fauna have a limited or patchy distribution, high level of habitat specificity, are locally extinct or were erroneously identified in previous surveys. Some records were excluded from this list, such as extinct species and clearly erroneous records.

2.3 FIELD SURVEY

The purpose of the field survey was to verify the accuracy of the desktop survey and to further delineate and characterise the fauna and faunal assemblages in the study area. The fauna field survey consisted of a fauna habitat assessment and opportunistic observations.

2.3.1 Fauna Habitat Assessment

During the field survey, broad fauna habitats were identified based on vegetation structure and landforms. These fauna habitats were then assessed for their potential to support species of conservation significance and the quality of habitat they provide to a wider suite of fauna. Habitats were rated as high, moderate or low on the basis of the complexity of microhabitats, including significant trees with hollows, loose bark, fallen hollow logs and leaf litter, and their representation in the region and survey area.

The locations of the fauna habitat assessment sites are included in Figure 3 and the information recorded presented in Appendix C.

2.3.2 Opportunistic Observations

Fauna was opportunistically observed and recorded during the field component of the field assessment. Field staff searched for and investigated scats, tracks, burrows and other traces of animals throughout the entire survey area. Where conservation significant species were located, the coordinates were recorded with a GPS.

2.4 TAXONOMY

If there were any taxonomic nomenclature issues for species identified in the desktop assessment (through subsequent name changes or taxonomic reviews) an effort was made to determine the currently accepted scientific name for each taxon. In cases where correct taxonomy of an old record cannot be determined, previous scientific names may be presented. Some taxa names may be followed by 'sp.', indicating that the species name was not provided in the data source or the taxonomy is in doubt. Where there are previously recorded taxa such as this that have the potential to be a conservation significant species, they will be discussed specifically in the results section.

Species were identified in the field using relevant field guides. Tyler *et al*. (2000) and Cogger (2000) were used to identify frogs. Wilson and Swan (2008), Storr *et al*. (1999, 2002) and Cogger (2000) were used to identify reptiles. Pizzey and Knight (2007), Simpson and Day (2004) and Geering *et al*. (2007) were used to identify birds. Menkhorst and Knight (2004), van Dyck and Strahan (2008) and Churchill (2008) were used to identify mammals, while Triggs (1996) was used to identify mammal scats, tracks and traces.

3 RESULTS

3.1 VARIABLES INFLUENCING THE FAUNA SURVEY

As per EPA *Guidance Statement No. 56* (EPA 2004), variables which may influence a survey need to be documented. These variables are detailed in Table 1.

Table 1: Variables Associated with the Fauna Assessment

Variable	Impact on Survey Outcomes
Experience levels/ Resources	The biologists that executed these surveys included practitioners that are regarded as suitably qualified in their respective fields. Field Reconnaissance: • Mr John Trainer – Zoologist. Data Interpretation / Report Writing: • Mr Matthew Love – Senior Zoologist. • Mr John Trainer – Zoologist.
Scope: sampling methods/ Intensity	A Level One survey was carried out, which included a desktop review and site reconnaissance. A site reconnaissance involved performing fauna habitat assessments and opportunistic recordings, therefore many species that occur in the survey area would not have been observed, particularly small ground-dwelling fauna that are typically captured by trapping techniques employed in a Level Two survey.
Sources of Information	At the bioregion level, the south west of Western Australia has been the subject of many targeted biological surveys, primarily for the resource and residential development sector. Site-specific data is limited, but this is not considered a limiting factor for this survey. Previous fauna surveys in the general vicinity are highlighted in Section 1.5.
Timing, weather, season.	The survey was undertaken in spring on the 29 September 2010. The area had received 455.4 millimetres (mm) of rain in the year to date (January to September) which is significantly below the long term average of 604.7 mm for the same period (1983 – 2007) (BOM 2010). This below average rainfall may reduce the number of flora species in the area and the number which can be identified (reduced fruit, seed and flowering) particularly for groundcover species e.g. grasses and herbs. This in turn reduces foraging and sheltering sites for ground dwelling fauna e.g. small mammals and reptiles.

Variable	Impact on Survey Outcomes
Disturbances	No disturbances affected the outcomes of the fauna survey.
Access problems	No access problems affected the outcome of the fauna survey.

3.2 HABITAT ASSESSMENT

3.2.1 Habitat Types

There was one fauna habitat type identified in the survey area - *Melaleuca* Dampland. This fauna habitat type is mapped in Figure 4, and with detailed results presented in Appendix C.

The survey area also contains areas that have been cleared (and so are degraded). These areas provide little to no value as habitat and are principally cleared areas as a consequence of historical agriculture activity.

Table 2: Major habitat types of the survey area

Habitat Type	Habitat Value	Approximate Area of Habitat Type (ha)
Melaleuca Dampland	Low	22.7 ha
Degraded	n/a	50.2 ha
Total		72.9 ha

***Melaleuca* Dampland**

The *Melaleuca* Dampland low woodland habitat forms a small portion of the survey area (32%) and is the only fauna habitat type present. The dominant vegetation in this fauna habitat type consists of Swamp Paperbark (*Melaleuca rhaphiophylla*), Flooded Gum (*Eucalyptus rudis* subsp. *Rudis*), **Paspalum dilatatum*, Yorkshire Fog (**Holcus lanatus*), *Centella asiatica*, Curled Dock (**Rumex crispus*) and Jointed Rush (*Baumea articulata*). The midstorey and understorey are heavily disturbed and dominated by weed species such as the Blackberry (**Rubus anglocandicans*) and Arum Lily (**Zantedeschia aethiopica*). The soils were generally low-lying, black sand and will often inundate during or after rain events. Frog species may become prevalent during these times when surface water is present. Fauna typically associated with this habitat include the Marbled Gecko (*Christinus marmoratus*), Western Swamp Skink (*Egernia luctuosa*), and Tiger Snake (*Notechis scutatus*). The *Melaleuca* Dampland was in Good - Degraded condition as per the Keighery condition scale which is used in Bush Forever assessment

(Government Western Australia 2000). The Wetland habitat type is considered to be of low value to fauna within the survey area.

3.3 FAUNA ASSEMBLAGE

Twenty-nine terrestrial vertebrate fauna were recorded during the survey, comprising one amphibian species, one reptile species, 25 bird species, and two mammal species (Appendix B). Two-hundred and eleven species of fauna have been previously recorded within the vicinity of the survey area, including six amphibians, 33 reptiles, 150 birds and 22 mammals. All fauna previously recorded in the vicinity of the survey area also listed in Appendix B.

3.3.1 Amphibians

One amphibian species recorded during the fauna assessment was Glauert's Froglet (*Crinia glauerti*) (Appendix B1).

Six species of amphibians have been previously recorded in the vicinity of the survey area (Appendix B1). Species likely to occur in the survey area include the common Motorbike Frog (*Litoria moorei*) and Moaning Frog (*Heleioporus eyrei*).

3.3.2 Reptiles

One species of reptile was recorded during the fauna assessment, Buchanan's Snake-eyed Skink (*Cryptoblepharus buchananii*) (Appendix B2).

Thirty-three species of reptiles have been previously recorded in the vicinity of the survey area (Appendix B2). Reptiles likely to occur in the survey area include the Southwestern Cool Skink (*Acritoscincus trilineatum*), the Two-toed Earless Skink (*Hemiergis quadrilineata*) and the Bobtail (*Tiliqua rugosa*).

3.3.3 Birds

Twenty-five species of bird were recorded in the survey area, including species like the Pacific Black Duck (*Anas superciliosa*), Whistling Kite (*Haliastur sphenurus*), Splendid Fairy-wren (*Malurus splendens*), Grey Fantail (*Rhipidura fuliginosa*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae*) and Australian Magpie (*Cracticus tibicen*) (Appendix B3).

One species of introduced bird was recorded during the fauna assessment, the Rainbow Lorikeet (**Trichoglossus haematodus moluccanus*).

One hundred and fifty species of birds have been previously recorded in the vicinity of the survey area (Appendix B3). Many of these species are unlikely to occur in the survey area, since these records are from a larger area encompassing a wide range of habitats and include migratory birds that only occur on a transitory basis. In addition many of

these birds are also associated with fresh water and marine systems and are included due to the close proximity of the survey area to the ocean.

3.3.4 Mammals

During the fauna assessment one mammal species of conservation significance, the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) was recorded in the survey area (Appendix B4).

The only introduced mammal recorded during the fauna assessment was the European Rabbit (**Oryctolagus cuniculus*).

Twenty-two species of mammal have previously been recorded in the vicinity of the survey area (Appendix B4). Many of these species are unlikely to occur in the survey area, since these records are from a large area encompassing a wide range of habitats that don't occur in the survey area.

3.4 CONSERVATION SIGNIFICANT FAUNA

A database search of the Bollard area resulted in 28 conservation significant fauna species being identified as potentially occurring in the area (Appendix D). This is comprised of three reptile species, 18 bird species and seven mammal species. Some of the conservation significant fauna previously recorded in the region will not occur in the survey area as they have a limited or patchy distribution, high level of habitat specificity, are locally extinct or were erroneously recorded in previous surveys.

One species, the Southern Brown Bandicoot was recorded in the survey area. This species is listed as Priority 5 on the DEC Priority Fauna List. Secondary evidence in the form of species specific conical diggings was recorded in moderate density across the survey area.

Two species were considered as 'Likely', three species as 'Possible', 18 as 'Unlikely' and four as 'Highly Unlikely' to occur within habitats of the survey area. This is based on the ecological requirements and known distribution of the species and the type and quality of fauna habitats within the survey area. The species considered as 'Likely' to occur are bird species namely the Cattle Egret and Eastern Great Egret.

4 DISCUSSION

4.1 FAUNAL ASSEMBLAGE

Twenty-nine terrestrial vertebrate fauna were recorded during the survey, comprising one amphibian species, one reptile species, 25 bird species, and two mammal species. As this was a Level One survey that included a reconnaissance survey to assess fauna habitat types, many of the potentially occurring species were not recorded. For example, many ground dwelling reptiles and mammals are mainly recorded or captured when trapping techniques are employed during a Level Two survey. This level of fauna species is expected given the poor condition of the survey area. In addition a clear lack of vegetation in the midstorey and understorey of the survey area restricts the number of micro-niches available, which further results in less diversity, particularly of ground-dwelling species.

The Swamp Paperbark and Flooded Gum could provide shelter and foraging opportunities for a number of different species including arboreal reptiles and mammals and a number of bird species. These species however would be commonly recorded urban species and none would have any conservation significance.

The conservation significant Southern Brown Bandicoot was recorded during the survey. The survey area would not support a large population of this species given the clear lack of native understorey species (which it requires) and the low-lying areas that would become inundated during rain events (van Dyck and Strahan 2008). The Southern Brown Bandicoot has been recorded in the vicinity of the survey area and has a long historical presence on the Swan Coastal Plain.

Historically twenty-eight fauna species of conservation significance have been recorded within the vicinity of the survey area. Three species were considered as 'Likely'; seven species were 'Possible'; 31 were considered as 'Unlikely'; and two were considered as 'Highly Unlikely' to occur within habitat of the survey area. This was based on the ecological requirements and known distribution of the species and the type and quality of fauna habitats present.

The species considered as 'Likely' to occur are bird species namely the Cattle Egret and Eastern Great Egret. These species and the Southern Brown Bandicoot that was recorded in the survey area will be discussed in more depth regarding any potential impacts.

4.2 SIGNIFICANCE OF FAUNA HABITAT

The *Melaleuca* Dampland within the survey area is degraded as a result of the lack of midstorey and understorey species and the presence of weeds; consequently it is of little value to conservation significant species (unlikely to support any additional species of conservation significance) or to common species. The understorey contains a large

array of weed species such as Blackberry and Arum Lilies which restricts the micro-niche diversity of the fauna habitat type.

The survey area is approximately 73 ha in size and is located between residential housing to the west and pastoral land to the east. The survey area is isolated from other similar habitats in the local vicinity. The fauna habitat in the survey area is highly fragmented with little habitat connectivity with surrounding area. This greatly reduces the value and functionality of the survey area to fauna, particularly those that require larger areas or home ranges. Ecological connectivity facilitates many life-history functions of fauna, particularly fauna of the area. The ability to utilise connected habitats is integral to the life histories of a broad spectrum of species, with connectivity between habitats being crucial to important functions such as breeding.

4.3 SIGNIFICANCE OF FAUNA SPECIES

The species recorded in the fauna assessment were common species often recorded in the general area, and have many historic records for the Swan Coastal Plain.

The species recorded in the survey area and the Egrets that were considered as 'Likely' to occur may not be impact by any potential development within the survey area. The Cattle Egret and Easter Great Egret are highly mobile and can easily move to other areas with similar habitat. The Southern Brown Bandicoot is ground-dwelling so their capacity to translocate to other areas outside of the survey area is not as easy as for more mobile species. However the habitat within the survey area is largely degraded as is not expected to support a significant population.

5 CONCLUSION

The fauna assessment undertaken by ENV determined that:

- One fauna habitat type was identified in the survey area; a *Melaleuca* Dampland. This fauna habitat type was considered to have low habitat value.
- Two-hundred and eleven species of fauna have been previously recorded within the vicinity of the survey area, including six amphibians, 33 reptiles, 150 birds and 22 mammals.
- During the fauna survey twenty-nine terrestrial vertebrate fauna were recorded, comprising of one amphibian species, one reptile species, 18 bird species, and two mammal species.
- One species is of conservation significance, the Southern Brown Bandicoot (Priority 5).
- Twenty-eight species of conservation significance have been previously recorded within the vicinity of the survey area. This was comprised of three reptile species, 18 bird species and seven mammal species.
- Three species were considered as 'Likely'; seven species were 'Possible'; 31 were considered as 'Unlikely'; and two were considered as 'Highly Unlikely' to occur within habitat of the survey area.

Generally the site was degraded and cleared and did not provide much value to a wide suite of fauna species. Approximately 32% of the survey area contained fauna habitat and the remaining was in degraded condition and depauperate of faunal assemblages. In addition the survey area has been subject to past and present agriculture activities and this has largely reduced the sites value for fauna particularly species with conservation significance.

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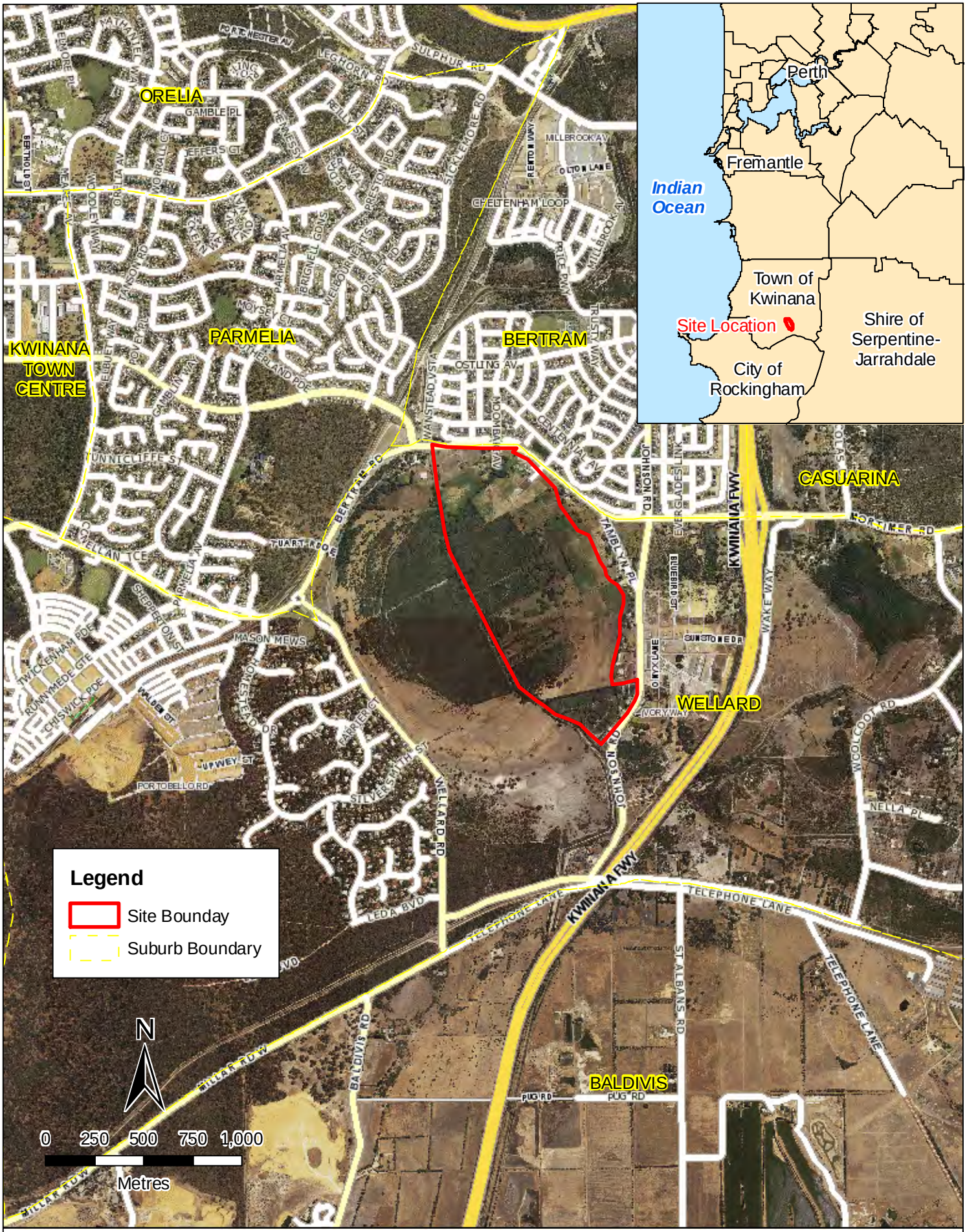
FIGURES



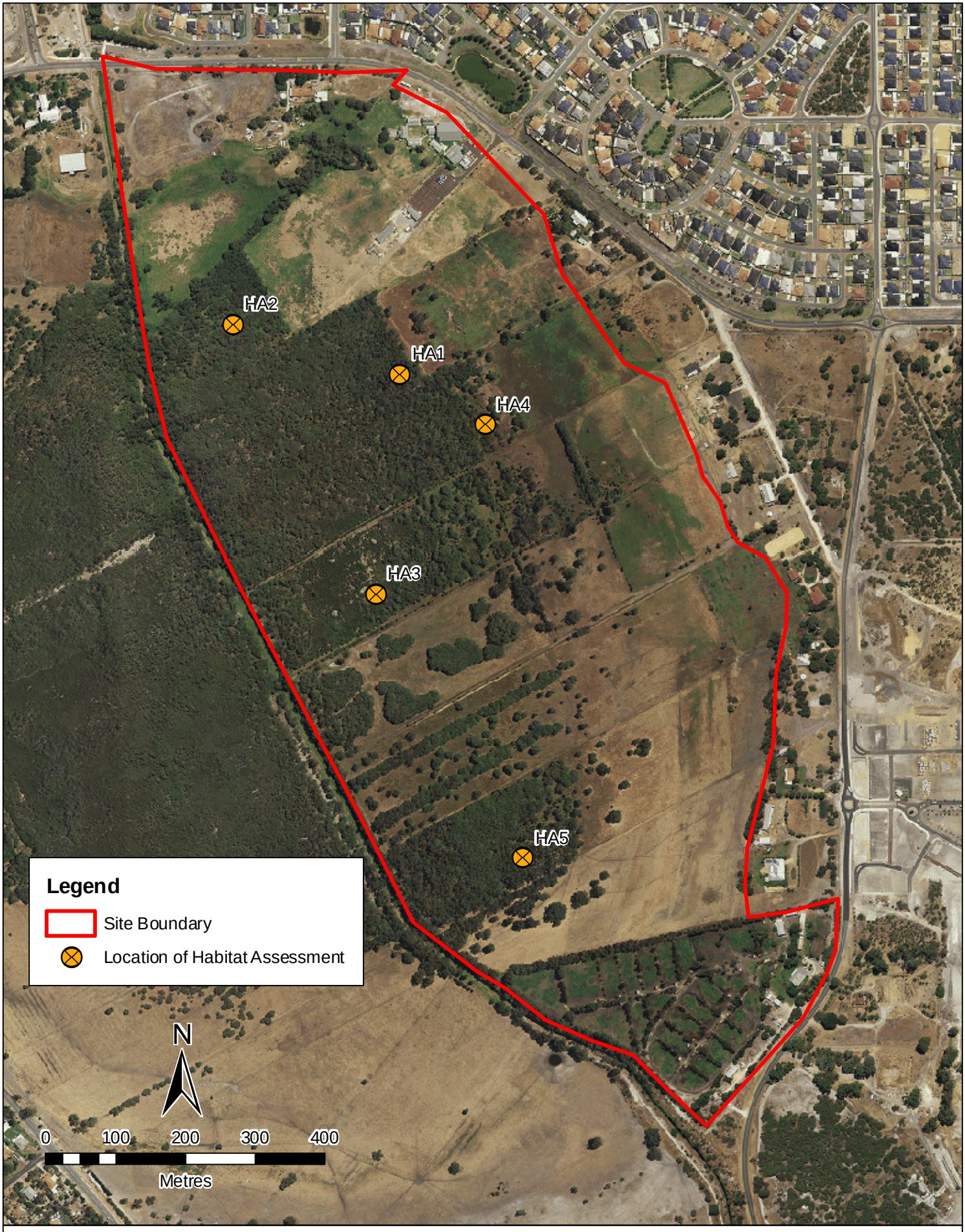
CLIENT		JOB NO.	
Wellard Landowners Group		10.127	
AUTHOR:	DRAWN	DATE	
M. Love	T. Ellis	16-11-2010	
SCALE	PROJECTION		
1:25,000 @ A4	GDA 94 MGA 50		

env Australia

Location Map

Bollard Bulrush East Fauna Assessment

FIGURE 1



CLIENT
Wellard Landowners Group

JOB NO.
10.127

AUTHOR:
M. Love

DRAWN
T. Ellis

DATE
16-11-2010

SCALE
1:7,000 @ A4

PROJECTION
GDA 94 MGA 50

Location of Fauna Habitat Assessments

Bollard Bulrush East
Fauna Assessment

FIGURE 3

CLIENT		JOB NO.	
Wellard Landowners Group		10.127	
AUTHOR:	DRAWN	DATE	
M. Love	T. Ellis	16-11-2010	
SCALE	PROJECTION		
1:7,000 @ A4	GDA 94 MGA 50		

Fauna Habitat Map

Bollard Bulrush East
Fauna Assessment

FIGURE 4

APPENDIX A

DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

BOLLARD BULRUSH EAST FAUNA ASSESSMENT

APPENDIX A

DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

A1: *Environment Protection and Biodiversity Conservation Act 1999* (*Cth*): Threatened Species and Threatened Ecological Communities Codes

The *EPBC Act* prescribes seven matters of national environmental significance:-

- World Heritage properties;
- National Heritage places;
- Wetlands of international importance;
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

Species in the categories ExW, CE, E, V and M (see below), and Threatened Ecological Communities in the CE and E categories are protected as matters of national environmental significance under the *EPBC Act*.

Category	Code	Category
Extinct	**Ex**	Taxa for which there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	**ExW**	Taxa known to survive only in cultivation, in captivity or as a naturalised population well outside its past range; or not recorded in its known and/or expected habitat at appropriate seasons anywhere in its past range despite exhaustive surveys over a timeframe appropriate to its life cycle and form.
Critically Endangered	**CE**	Taxa facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	**E**	Taxa not critically endangered and facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Vulnerable	**V**	Taxa not critically endangered or endangered and facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria**.**
Conservation Dependent	**CD**	Taxa which are the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within five years.

Category	Code	Category
Migratory	**Mi**	Taxa that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations, that are included in an international agreement approved by the Minister for the Environment, Heritage and the Arts and that have been placed on the national List of Migratory Species under the provisions of the EPBC Act. At present there are four such agreements: • the Bonn Convention • the China-Australia Migratory Bird Agreement (CAMBA) • the Japan-Australia Migratory Bird Agreement (JAMBA) • the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
Marine	**Ma**	Taxa protected in a Commonwealth Marine Protected Area by virtue of section 248 of the *EPBC Act*. These taxa include certain seals, crocodiles, turtles and birds, as well as various marine fish. Commonwealth marine areas are matters of national environmental significance under the *EPBC Act*. An action will require approval if the: • action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment, or • action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area[1] The Commonwealth marine area is any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not State or Northern Territory waters. The Commonwealth marine area stretches from 3 to 200 nautical miles (approximately 5-370 km) from the coast. Marine protected areas are marine areas which are recognised to have high conservation value.

A2: Western Australian Threatened Fauna Categories

Wildlife Conservation Act 1950 (WA)

Category	Code	Description
Schedule 1	S1	Rare or likely to become extinct.
Schedule 2	S2	Presumed extinct.
Schedule 3	S3	Birds subject to an agreement between the governments of Australia and Japan, the People's Republic of China & the Republic of Korea relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Other specially protected fauna.

A3: Department of Environment and Conservation Fauna Priority Codes

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring: not currently threatened or in need of special protection, but could become so. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring: not considered threatened, but the subject of a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

APPENDIX B

PREVIOUSLY RECORDED FAUNA IN THE REGION

APPENDIX B

B1: AMPHIBIAN SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = Listed in Naturemap, B = Listed by Birds Australia, C = Previous fauna surveys records (<15km), D = Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

AMPHIBIANS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Family HYLIDAE								
Litoria adelaidensis	Slender Tree Frog				x			
Litoria moorei	Motorbike Frog, Bell Frog				x			
Family MYOBATRACHIDAE								
Crinia glauerti	Glauert's Froglet				x			x
Crinia insignifera	Squelching Froglet				x			
Heleioporus eyrei	Moaning Frog				x			
Limnodynastes dorsalis	Bullfrog or Banjo Frog				x			

[X] fauna species recorded from the survey area.

APPENDIX B

B2: REPTILE SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = Listed in Naturemap, B = Listed by Birds Australia, C = Previous fauna surveys records (<15km), D = Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

REPTILES		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Family CHELUIDAE								
Chelodina oblonga	Oblong Turtle						x	
Family AGAMIDAE								
Ctenophorus adelaidensis	Western Heath Dragon				x		x	
Pogona minor	Bearded Dragon				x		x	
Family GEKKONIDAE								
Christinus marmoratus	Marbled Gecko				x		x	
Strophurus spinigerus spinigerus	Southwestern Spiny-tailed Gecko				x		x	
Family PYGOPODIDAE								
Aprasia repens	Sand-plain Worm-lizard						x	
Delma fraseri	Fraser's Delma				x		x	
Delma grayii	Side-barred Delma						x	
Lialis burtonis	Burrton's Legless Lizard				x		x	
Pletholax gracilis	Keeled Legless Lizard				x			
Pygopus lepidopodus	Common Scaly-foot				x			
Family SCINCIDAE								
Acritoscincus trilineatum	Southwestern Cool Skink				x		x	
Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink						x	x
Ctenotus australis					x		x	
Ctenotus fallens					x		x	
Ctenotus gemmula	Jewelled Ctentous			P3	x			
Hemiergis quadrilineata	Two-toed Earless Skink				x		x	
Lerista elegans					x		x	
Lerista lineata	Lined Skink			P3	x		x	
Menetia greyii	Common Dwarf Skink				x		x	
Morethia lineoocellata					x		x	
Morethia obscura	Woodland Flecked Skink				x		x	
Tiliqua occipitalis	Western Blue-tongue				x		x	
Tiliqua rugosa	Southwestern Bobtail				x		x	
Family VARANIDAE								
Varanus tristis	Black-headed Monitor				x		x	
Family TYPHLOPIDAE								
Ramphotyphlops australis	Southern Blind Snake				x		x	
Family ELAPIDAE								
Brachyurophis semifasciata	Southern Shovel-nosed Snake				x			
Neelaps bimaculatus	Black-naped Snake				x			
Neelaps calonotos	Black-striped Snake			P3	x			
Notechis scutatus	Tiger Snake				x			
Pseudonaja affinis	Dugite				x		x	
Pseudonaja nuchalis	Gwardar				x			
Simoselaps bertholdi	Jan's Banded Snake				x			

[X] fauna species recorded from the survey area.
[*] denotes introduced species.

APPENDIX B

B3: BIRD SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = Listed in Naturemap, B = Listed by Birds Australia, C = Previous fauna surveys records (<15km), D = Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Family PHASIANIDAE								
Coturnix pectoralis	Stubble Quail	Ma			x			
Family ANATIDAE								
Anas gracilis	Grey Teal				x	x		
Anas rhynchotis	Australasian Shoveler				x	x		
Anas superciliosa	Pacific Black Duck				x	x		x
Aythya australis	Hardhead				x	x		
Biziura lobata	Musk Duck	Ma			x	x		
Chenonetta jubata	Australian Wood Duck				x	x		x
Cygnus atratus	Black Swan				x	x		
Malacorhynchus membranaceus	Pink-eared Duck				x	x		
Oxyura australis	Blue-billed Duck				x	x		
Tadorna tadornoides	Australian Shelduck				x	x		
Family PODICIPEDIDAE								
Poliocephalus poliocephalus	Hoary-headed Grebe				x	x		
Podiceps cristatus	Great Crested Grebe				x	x		
Tachybaptus novaehollandiae	Australasian Grebe				x	x		
Family ANHINGIDAE								
Anhinga melanogaster	Darter				x	x		
Family PHALACROCORACIDAE								
Phalacrocorax carbo	Great Cormorant				x	x		
Phalacrocorax melanoleucos	Little Pied Cormorant				x	x		
Phalacrocorax sulcirostris	Little Black Cormorant				x	x		x
Phalacrocorax varius	Pied Cormorant				x	x		
Family PELECANIDAE								
Pelecanus conspicillatus	Australian Pelican	Ma			x	x		
Family ARDEIDAE								
Ardea garzetta	Little Egret	Ma			x	x		
Ardea ibis	Cattle Egret	Mi, Ma			x	x		
Ardea modesta	Eastern Great Egret	Mi, Ma			x	x		
Ardea novaehollandiae	White-faced Heron				x	x	x	
Ardea pacifica	White-necked Heron				x	x		
Ixobrychus minutus	Little Bittern			P4	x			
Nycticorax caledonicus	Rufous Night Heron	Ma			x	x		
Family THRESKIORNITHIDAE								
Platalea flavipes	Yellow-billed Spoonbill				x	x		
Platalea regia	Royal Spoonbill				x	x		
Threskiornis molucca	Australian White Ibis	Ma			x	x		x
Threskiornis spinicollis	Straw-necked Ibis	Ma			x	x		x
Family ACCIPITRIDAE								
Accipiter cirrocephalus	Collared Sparrowhawk				x	x	x	
Accipiter fasciatus	Brown Goshawk	Ma			x	x	x	
Aquila audax	Wedge-tailed Eagle				x	x		
Aquila morphnoides	Little Eagle				x	x	x	
Circus approximans	Swamp Harrier	Ma			x	x		
Elanus axillaris	Black-shouldered Kite				x	x	x	
Haliaeetus leucogaster	White-bellied Sea-Eagle	Mi, Ma			x	x		
Haliastur sphenurus	Whistling Kite	Ma			x	x	x	x
Lophoictinia isura	Square-tailed Kite				x			
Family FALCONIDAE								
Falco berigora	Brown Falcon				x	x		
Falco cenchroides	Australian Kestrel	Ma			x	x	x	

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Falco longipennis	Australian Hobby				x	x	x	
Falco peregrinus	Peregrine Falcon		S4		x	x	x	
Family RALLIDAE								
Fulica atra	Eurasian Coot				x	x		
Gallinula tenebrosa	Dusky Moorhen				x	x		
Gallirallus philippensis	Buff-banded Rail	Ma			x			
Porphyrio porphyrio	Purple Swamphen	Ma			x	x		x
Porzana pusilla	Baillon's Crake				x	x		
Porzana tabuensis	Spotless Crake	Ma			x	x		
Tribonyx ventralis	Black-tailed Native-hen				x			
Family TURNICIDAE								
Turnix varia	Painted Button-quail				x	x		
Family SCOLOPACIDAE								
Actitis hypoleucos	Common Sandpiper	Mi, Ma			x	x		
Calidris acuminata	Sharp-tailed Sandpiper	Mi, Ma			x	x		
Calidris ferruginea	Curlew Sandpiper	Mi, Ma			x	x		
Calidris ruficollis	Red-necked Stint	Mi, Ma			x	x		
Numenius madagascariensis	Eastern Curlew	Mi, Ma		P4	x			
Tringa glareola	Wood Sandpiper	Mi, Ma			x	x		
Tringa nebularia	Common Greenshank	Mi, Ma			x	x		
Family BURHINIDAE								
Burhinus grallarius	Bush Stone-curlew			P4	x			
Family RECURVIROSTRIDAE								
Cladorhynchus leucocephalus	Banded Stilt				x	x		
Himantopus himantopus	Black-winged Stilt	Ma			x	x		
Recurvirostra novaehollandiae	Red-necked Avocet	Ma			x	x		
Family CHARADRIIDAE								
Charadrius melanops	Black-fronted Dotterel				x	x		
Charadrius rubricollis	Hooded Plover	Ma		P4	x			
Charadrius ruficapillus	Red-capped Plover	Ma			x	x		
Vanellus tricolor	Banded Lapwing				x			
Family LARIDAE								
Larus novaehollandiae	Silver Gull	Ma			x	x		
Sterna caspia	Caspian Tern	Mi,Ma				x		
Family COLUMBIDAE								
**Columba livia*	Domestic Pigeon				x	x		
Ocyphaps lophotes	Crested Pigeon				x	x		
Phaps chalcoptera	Common Bronzewing				x	x	x	x
**Streptopelia chinensis*	Spotted Turtle Dove				x	x		
**Streptopelia senegalensis*	Laughing Turtle-Dove				x	x	x	
Family PSITTACIDAE								
Cacatua roseicapilla	Galah				x	x	x	x
Cacatua sanguinea	Little Corella				x	x		x
**Cacatua tenuirostris*	Eastern Long-billed Corella				x	x		
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	S1		x	x		
Calyptorhynchus baudinii	Baudin's Cockatoo	VU	S1					
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	S1		x	x	x	
Neophema elegans	Elegant Parrot				x	x		
Polytelis anthopeplus	Regent Parrot				x	x		
Platycercus zonarius	Australian Ringneck				x	x	x	x
Platycercus spurius	Red-capped Parrot				x	x	x	
Platycercus icterotis	Western Rosella				x	x		
**Trichoglossus haematodus*	Rainbow Lorikeet				x	x		x
Family CUCULIDAE								
Cacomantis flabelliformis	Fan-tailed Cuckoo	Ma			x	x		
Chrysococcyx basalis	Horsfield's Bronze Cuckoo	Ma			x	x	x	
Chrysococcyx lucidus	Shining Bronze Cuckoo	Ma			x	x		
Cuculus pallidus	Pallid Cuckoo	Ma			x	x		
Family STRIGIDAE								
Ninox novaeseelandiae	Boobook Owl	Ma			x	x		
Family TYTONIDAE								
Tyto javanica	Eastern Barn Owl				x		x	
Family PODARGIDAE								
Podargus strigoides	Tawny Frogmouth				x	x		

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Family APODIDAE								
Apus pacificus	Fork-tailed Swift	Mi, Ma			x	x		
Family HALCYONIDAE								
**Dacelo novaeguineae*	Laughing Kookaburra				x	x	x	
Todiramphus sanctus	Sacred Kingfisher	Ma			x	x		
Family MEROPIDAE								
Merops ornatus	Rainbow Bee-eater	Mi, Ma			x	x	x	
Family MALURIDAE								
Malurus elegans	Red-winged Fairy-wren				x			
Malurus splendens	Splendid Fairy-wren				x	x	x	x
Family PARDALOTIDAE								
Pardalotus punctatus	Spotted Pardalote				x	x		
Pardalotus striatus	Striated Pardalote				x	x	x	x
Family ACANTHIZIDAE								
Acanthiza apicalis	Broad-tailed Thornbill (Inland Thornbill)				x	x	x	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				x	x		
Acanthiza inornata	Western Thornbill				x	x	x	
Gerygone fusca	Western Gerygone				x	x	x	x
Sericornis frontalis	White-browed Scrubwren				x	x	x	
Smicrornis brevirostris	Weebill				x	x	x	
Family MELIPHAGIDAE								
Anthochaera carunculata	Red Wattlebird				x	x	x	x
Anthochaera lunulata	Western Little Wattlebird				x	x		
Acanthorhynchus superciliosus	Western Spinebill				x	x		
Lichmera indistincta	Brown Honeyeater				x	x	x	x
Lichenostomus ornatus	Yellow-plumed Honeyeater				x			
Lichenostomus virescens	Singing Honeyeater				x	x	x	
Manorina flavigula	Yellow-throated Miner				x			
Melithreptus chloropsis	Western White-naped Honeyeater				x	x		
Phylidonyris melanops	Tawny-crowned Honeyeater				x	x		
Phylidonyris nigra	White-cheeked Honeyeater				x	x		
Phylidonyris novaehollandiae	New Holland Honeyeater				x	x	x	
Family PETROICIDAE								
Eopsaltria georgiana	White-breasted Robin				x			
Melanodryas cucullata	Hooded Robin				x	x		
Petroica goodenovii	Red-capped Robin				x	x		
Petroica multicolor	Scarlet Robin				x	x	x	
Family NEOSITTIDAE								
Daphoenositta chrysoptera	Varied Sittella				x	x	x	
Family PACHYCEPHALIDAE								
Colluricincla harmonica	Grey Shrike-thrush				x	x	x	
Pachycephala pectoralis	Golden Whistler				x	x		
Pachycephala rufiventris	Rufous Whistler				x	x	x	
Family DICRURIDAE								
Grallina cyanoleuca	Magpie-lark	Ma			x	x	x	
Rhipidura fuliginosa	Grey Fantail				x	x	x	x
Rhipidura leucophrys	Willie Wagtail				x	x	x	x
Family CAMPEPHAGIDAE								
Coracina novaehollandiae	Black-faced Cuckoo-shrike	Ma			x	x	x	x
Lalage sueurii	White-winged Triller				x	x		
Family ARTAMIDAE								
Artamus cinereus	Black-faced Woodswallow				x	x		
Artamus cyanopterus	Dusky Woodswallow				x	x		
Family CRACTICIDAE								
Cracticus tibicen	Australian Magpie				x	x	x	x
Cracticus torquatus	Grey Butcherbird				x	x	x	x
Strepera versicolor	Grey Currawong				x	x		
Family CORVIDAE								
Corvus coronoides	Australian Raven				x	x	x	x
**Corvus splendens*	House Crow				x			
Family HIRUNDINIDAE								
Cheramoeca leucosternus	White-backed Swallow				x	x		
Hirundo ariel	Fairy Martin				x			
Hirundo neoxena	Welcome Swallow	Ma			x	x	x	x

BIRDS		Conservation Codes						
Scientific Name	**Common Name**	**EPBC**	**WC**	**DEC**	**A**	**B**	**C**	**D**
Hirundo nigricans	Tree Martin	Ma			x	x	x	
Family ZOSTEROPIDAE								
Zosterops lateralis	Silvereye	Ma			x	x	x	x
Family SYLVIIDAE								
Acrocephalus australis	Australian Reed-warbler	Ma			x	x		
Cincloramphus cruralis	Brown Songlark				x	x		
Megalurus gramineus	Little Grassbird				x	x		
Family DICAEIDAE								
Dicaeum hirundinaceum	Mistletoebird				x	x		
Family PASSERIDAE								
**Passer montanus*	Eurasian Tree Sparrow				x			
Family MOTACILLIDAE								
Anthus australis	Australian Pipit; Richard's Pipit				x	x	x	

[X] fauna species recorded from the survey area.
[*] denotes introduced species.

APPENDIX B

B4: MAMMAL SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = Listed in Naturemap, B = Listed by Birds Australia, C = Previous fauna surveys records (<15km), D = Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

MAMMALS		Conservation Codes						
Scientific Name	**Common Name**	**EPBC**	**WC**	**DEC**	**A**	**B**	**C**	**D**
Family DASYURIDAE								
Dasyurus geoffroii	Western Quoll, Chuditch	VU	S1		x			
Phascogale calura	Red-tailed Phascogale	EN	S1					
Phascogale tapoatafa ssp. (WAM M434)	Southern Brush-tailed Phascogale		S1		x			
Family PERAMELIDAE								
Isoodon obesulus fusciventer	Southern Brown Bandicoot, Quenda			P5	x		x	x
Family MACROPODIDAE								
Macropus fuliginosus	Western Grey Kangaroo						x	
Macropus irma	Western Brush Wallaby			P4	x			
Setonix brachyurus	Quokka	VU	S1					
Family PHALANGERIDAE								
Trichosurus vulpecula vulpecula	Common Brushtail Possum				x			
Family TARSIPEDIDAE								
Tarsipes rostratus	Honey Possum, Noolbenger				x			
Family VESPERTILIONIDAE								
Chalinolobus gouldii	Gould's Wattled Bat						x	
Nyctophilus timoriensis timoriensis	Greater Long-eared Bat						x	
Vespadelus regulus	Southern Forest Bat						x	
Family MOLOSSIDAE								
Austrononus australis	White-striped Freetail-bat						x	
Mormopterus planiceps	Southern Freetail-bat						x	
Family MURIDAE								
Hydromys chrysogaster	Water-rat			P4	x			
**Mus musculus*	House Mouse				x		x	
Rattus fuscipes	Western Bush Rat						x	
**Rattus rattus*	Black Rat				x		x	
Family LEPORIDAE								
**Oryctolagus cuniculus*	Rabbit						x	x
Family CANIDAE								
**Vulpes vulpes*	Red Fox						x	
Family FELIDAE								
**Felis catus*	Cat				x		x	
Family SUIDAE								
**Sus scrofa*	Pig				x			

[X] fauna species recorded from the survey area.
[*] denotes introduced species.

APPENDIX C

HABITAT ASSESSMENT DATA SHEETS

BOLLARD BULRUSH EAST FAUNA ASSESSMENT

APPENDIX C

HABITAT ASSESSMENT DATA SHEETS

Habitat Assessment - HA 1

Broad Fauna Habitat: *Melaleuca* Dampland

UTM Co-ordinates: Easting: 390760 Northing: 64340605

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.

Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: 20%	**Woody Debris:** 5%	**Bare Ground:** 25%		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	*Melaleuca rhaphiophylla*	30-70%	6-12 m
Midstory	*Typha* sp., Blackberry (**Rubus anglocandicans*), Common Fig (**Ficus carica*)	30-70%	< 2 m
Understory	**Paspalum dilatatum*, Curled Dock (**Rumex crispus*)	< 2%	< 0.3 m

Condition Rating: Very Good
Disturbance: Weeds, Fencelines
Fire Age Old

Other Relevant Information:

No Black Cockatoo foraging habitat, Numerous Quenda Diggings.

Habitat Assessment - HA 2

Broad Fauna Habitat: *Eucalyptus* Dampland

UTM Co-ordinates: Easting: 390520 Northing: 6430676

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.

Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: < 1%	**Woody Debris:** < 1%	**Bare Ground:** < 1%		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	*Melaleuca rhaphiophylla*	30-70%	6 m
Midstory	Common Fig (**Ficus carica*), Arum Lily (**Zantedeschia aethiopica*)	< 2%	< 1 m
Understory	**Paspalum dilatatum*, Curled Dock (**Rumex crispus*), *Centella asiatica*	70-100%	< 0.3 m

Condition Rating: Excellent
Disturbance: Weeds
Fire Age Old

Other Relevant Information:

No Black Cockatoo foraging habitat; Vegetation 100% very little bare ground and / or woody debris; small amounts of surface water damp low-lying areas; Quenda diggings.

Habitat Assessment - HA 3

Broad Fauna Habitat: *Eucalyptus* Dampland

UTM Co-ordinates : Easting: 390725 Northing: 6430290

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.

Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: 5%	**Woody Debris:** 5%	**Bare Ground:** 50%		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	nil		
Midstory	*Melaleuca rhaphiophylla*, Jointed Rush (*Baumea articulata*)	30-70%	< 2 m
Understory	**Paspalum dilatatum*, Curled Dock (**Rumex crispus*)	< 2%	< 0.3 m
Condition Rating:	Very Good		
Disturbance:	Weeds, cattle damage		
Fire Age	Old		

Other Relevant Information:

No Black Cockatoo foraging habitat; vegetation 40%.

Habitat Assessment - HA 4

Broad Fauna Habitat: *Eucalyptus* Dampland

UTM Co-ordinates: Easting: 390881 Northing: 6430533

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.

Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: < 1%	**Woody Debris:** < 1%	**Bare Ground:** 30%		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	*Melaleuca rhaphiophylla*	30-70%	6 m
Midstory	Jointed Rush (*Baumea articulata*), Arum Lily (**Zantedeschia aethiopica*)	10-30%	< 2 m
Understory	*Centella asiatica*	70-100%	< 0.1 m

Condition Rating: Very Good
Disturbance: Weeds
Fire Age Old

Other Relevant Information:

No Black Cockatoo foraging habitat, significant number of weeds; Quenda diggings, excessive damp areas; vegetation 70%.

Habitat Assessment - HA 5

Broad Fauna Habitat: *Eucalyptus* Dampland

UTM Co-ordinates: Easting: 390936 Northing: 6429912

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.

Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: 10%	**Woody Debris:** 5%	**Bare Ground: 5%**		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	*Melaleuca rhaphiophylla*, *Eucalyptus rudis*	30-70%	6-15 m
Midstory	Jointed Rush (*Baumea articulata*)	30-70%	< 1 m
Understory	*Centella asiatica*, **Paspalum dilatatum*, **Holcus lanatus*	30-70%	< 0.1 m

Condition Rating: Excellent
Disturbance: Weeds
Fire Age Old

Other Relevant Information:

No Black Cockatoo foraging habitat

APPENDIX D

CONSERVATION SIGNIFICANT FAUNA RECORDED WITHIN THE VICINITY OF THE SURVEY AREA

BOLLARD BULRUSH EAST FAUNA ASSESSMENT

APPENDIX D

CONSERVATION SIGNIFICANT FAUNA RECORDED WITHIN THE VICINITY OF THE SURVEY AREA

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
REPTILES				
Jewelled *Ctenotus* (*Ctenotus gemmula*)	P3	The Swan Coastal Plain population of the Jewelled *Ctenotus* occurs in coastal heaths and semi-arid woodlands. This species has a patchy distribution along the coastal plains and adjacent interior of the southwest (Wilson and Swan 2008). This species is particularly difficult to locate, and is infrequently collected in biological surveys.	The project area does not contain coastal heaths which is the preferred habitat type for this species. In addition very little is known of its current distribution on the Swan Coastal Plain.	Unlikely
Lined Skink (*Lerista lineata*)	P3	The Lined Skink occurs in sandy coastal heath and shrubland areas in isolated populations in the southwest and midwest coast of Western Australia and in disjunct and isolated populations (Wilson and Swan 2008). This burrowing species is found in loose soil or sand beneath logs and termite mounds, where it feeds on termites and other small insects (Cogger 2000).	The project area lacks coastal heath and shrublands that is the preferred habitat type for this species.	Unlikely
Black-striped Snake (*Neelaps calonotos*)	P3	The Black-striped Snake favours sandy soils of coastal and near coastal dunes and sandplains supporting heath and *Banksia* Eucalypt Woodlands (Nevill 2005, Bush *et al*. 2007). The Black-striped Snake is typically	The project area is not found in coastal to near coastal areas therefore lacks the costal heath vegetation type that is preferred by this species. This species of snake is also very cryptic and is infrequently	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		found in these sandplain habitats having a very limited distribution exclusive to the Swan Coastal Plain. This taxon is particularly difficult to locate, and is infrequently collected during biological surveys.	collected and or recorded during biological assessments.	
BIRDS				
Cattle Egret (*Ardea ibis*)	Mi	The Cattle Egret occurs in the wetter parts of Western Australia, in particular the Kimberley and the south-west. This species inhabits short grass, in particular damp pastures and wetlands, usually in the company of cattle and occasionally other livestock. In Western Australia it is an irregular visitor, occurring mostly in autumn, and is not thought to breed regularly in Western Australia (Johnstone and Storr 1998).	The project area does contain damp pastures and wetlands which are the preferred habitat for this species. In addition the project area does contain some areas that may be inundated or flooded during peak rain events	Likely
Eastern Great Egret (*Ardea modesta*)	Mi	The Eastern Great Egret occurs in the Kimberley, Pilbara, and on the west coast from the Murchison River south, throughout the south-west, and east to Cape Arid. This species is considered common to very common in the Kimberley, and scarce to moderately common elsewhere (Johnstone and Storr 1998). It inhabits mostly shallow fresh lakes, pools in rivers, lagoons, lignum swamps, clay pans and samphire flats, large dams and sewage ponds. It also inhabits shallow saltwater habitat such as mangrove creeks, tidal pools, samphire swamps and salt work ponds. It breeds colonially at wooded swamps and river pools, nesting in riparian	The project area does contain low-lying areas that may be inundated during peak rain events. The Eastern Great Egret may potentially forage in these areas.	Likely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		trees.		
Little Bittern (*Ixobrychus minutus*)	P4	The Little Bittern occurs north to Moora and south-east to Two Peoples Bay (Johnstone and Storr 1998). It is usually recorded on dense vegetation beds of freshwater pools, swamps and lagoons, well screened with trees. This species often shelters in dense beds of *Typha* sp., *Baumea* sp., and tall rushes in freshwater swamps around lakes and along rivers (Johnstone and Storr 1998).	The Little Bittern prefers well screened wetlands with rush and sedge species, but can also be found roosting in *Melaleuca* which are often found fringing the water bodies. However the quality of the fauna habitat type in the project area is not extensive and a true wetland does not exist for the project area. No roosting or foraging potential exists within habitats of the project area.	Unlikely
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	Mi	The White-bellied Sea Eagle is distributed along the coast, islands and estuaries of Western Australia but not the lower west and southwest or far east (Johnstone and Storr 1998). They feed on fish, sea snakes and nesting seabirds. Nests are usually placed on high ground such as rock pinnacles, rigid shrubs or in tall trees (Simpson and Day 2004).	This species predominantly inhabits coastal areas or wetlands (Pizzey and Knight 2007) but rarely inland. This species may fly over the project area but no suitable habitat exists in the project area.	Unlikely
Peregrine Falcon (*Falco peregrinus*)	S4	The Peregrine Falcon occurs mainly along coastal cliffs, rivers and ranges as well as wooded watercourses and lakes (Johnstone and Storr 1998). The Peregrine Falcon nests primarily on cliffs, granite outcrops and quarries, and feeds mostly on birds (Johnstone and Storr 1998).	The Peregrine Falcon may forage on an infrequent basis in the project area as part of a larger home range. There are no suitable nesting sites for this species.	Possible

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Common Sandpiper (*Actitis hypoleucos*)	Mi	This Migratory bird breeds from the British isles to Siberia and Japan. It migrates to Australian waters in August to May (Pizzey and Knight 2007). It is moderately common to uncommon around Perth and Mandurah. This species requires marine waters for habitat such as banks, rocks, and sandy beaches (Simpson and Day 2004).	The survey area lacks suitable habitat for this species as they are typically found in more marine environments.	Unlikely
Sharp-tailed Sandpiper (*Calidris acuminata*)	Mi	This Migratory bird breeds in Siberia and migrates to Australian waters in August to April (Pizzey and Knight 2007). It is common around Perth and Mandurah. This species is found widespread in coastal and interior wetlands (Simpson and Day 2004).	The project area does not contain the preferred habitat for this species.	Unlikely
Curlew Sandpiper (*Calidris ferruginea*)	Mi	This migratory bird breeds in Siberia and migrates to Australian waters in August to April (Pizzey and Knight 2007). It is abundant to common around Perth and Mandurah. This species is found in coastal and inland mudflats, sometimes saltworks (Simpson and Day 2004).	The survey area lacks suitable habitat for this species such as coastal inland mudflats and estuarine environments.	Unlikely
Red-necked Stint (*Calidris ruficollis*)	Mi	This migratory bird breeds in Siberia and Alaska and migrates to Australian waters in August to April (Pizzey and Knight 2007). It is abundant to common around Perth and Mandurah during this time. This species requires marine waters for habitat such as coastal and inland shores (Simpson and Day 2004).	This species prefers drying inland freshwater and salt lakes where exposed mud and sand provide foraging and roosting potential. These types of fauna habitats do not exist in the project area.	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Eastern Curlew (*Numenius madagascariensis*)	Mi, P4	The Eastern Curlew is a large non-breeding migratory shorebird, found commonly along the north coast of Western Australia, but rarely south of Shark Bay. It inhabits a range of coastal habitats, but primarily inter-tidal mudflats, particularly on exposed seagrass beds or mudflats feeding on burrowing crabs or shrimps (Geering *et al*. 2007).	The Survey area does not contain the intertidal mudflats which are the preferred habitat for this species	Unlikely
Wood Sandpiper (*Tringa glareola*)	Mi	The Wood Sandpiper is a summer non-breeding migratory shorebird that occurs along the coast and inland regions of Western Australia. It primarily inhabits freshwater wetlands and rarely inter-tidal mudflats (Geering *et al*. 2007).	No freshwater wetlands such as shallows swamps and drying lakes exist in the project area, suggesting this species is unlikely to occur.	Unlikely
Common Greenshank (*Tringa nebularia*)	Mi	This migratory bird breeds from Scotland to Siberia and migrates to Australian waters in September to April (Pizzey and Knight 2007). It is commonly found around Perth and Mandurah. This species prefers estuaries, inland lakes and open swamps (Simpson and Day 2004).	Shallow fresh waters (claypans, lagoons, open swamps, river pools and dams) do not exist within the survey area making this species unlikely to occur.	Unlikely
Caspian Tern (*Hydroprogne caspia*)	Mi	The Caspian Tern is distributed along the coast of Western Australia. It is scarce or uncommon north of Broome and uncommon to moderately common further south (Johnstone and Storr 1998). This species inhabits coastal areas as well as inland watercourses, saline and brackish lakes (Simpson and Day 2004).	The Caspian Tern is usually found foraging and sheltering in marine habitats such as beaches and estuaries and inlets. This species may fly over the survey area on an infrequent basis but will not use habitats of the survey area for any purpose.	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp. *naso*)	VU,S1	The Forest Red-tailed Black Cockatoo is distributed through the humid and sub-humid southwest of Western Australia from Gingin through the Darling Ranges to the southwest from approximately Bunbury to Albany (Johnstone and Storr 1998).	The vegetation of the project area does not contain any potential foraging resources for this species. The Flooded Gums on survey area (*Eucalyptus rudis*) are not a known feeding resource for black cockatoos and or breeding resource on the Swan Coastal Plain. The trees on survey area did not contain any hollows to be considered as potential nesting sites.	Unlikely
Baudin's Cockatoo (*Calyptorhynchus baudinii*)	VU,S1	Baudin's Cockatoo is distributed through the south-western humid and sub-humid zones, from the northern Darling Range and adjacent far east of the Swan Coastal Plain (south of the Swan River), south to Bunbury and across to Albany (Johnstone and Storr 1998). Baudin's Cockatoo rarely occurs near the coast north of Mandurah, and rarely occurs north of the Swan River (Johnstone and Kirkby 2008, Johnstone and Storr 1998).	The vegetation of the project area does not contain any potential foraging resources for this species. The Flooded Gums on survey area (*Eucalyptus rudis*) are not a known feeding resource for black cockatoos and or breeding resource on the Swan Coastal Plain. The trees on survey area did not contain any hollows to be considered as potential nesting sites.	Unlikely
Carnaby's Cockatoo (*Calyptorhynchus latirostris*)	EN,S1	Carnaby's Cockatoo is endemic to southwest Western Australia, and is distributed from the Murchison River to Esperance and inland to Coorow, Kellerberrin and Lake Cronin (Cale 2003). The species was once common, but the population has declined significantly in the last half century (Johnstone and Storr 1998).	The vegetation of the project area does not contain any potential foraging resources for this species. The Flooded Gums on survey area (*Eucalyptus rudis*) are not a known feeding resource for black cockatoos and or breeding resource on the Swan Coastal Plain. The trees on survey area did not contain any hollows to be considered as potential nesting sites.	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Fork-tailed Swift (*Apus pacificus*)	Mi	The Fork-tailed Swift is a summer migrant (October-April) to Australia, that has not been recorded breeding in Australia (Barrett *et al*. 2003). The Fork-tailed Swift is an aerial species, which forages high above the tree canopy and rarely lower so is independent of terrestrial habitats in Australia (Johnstone and Storr 1998). It usually occurs in flocks of up to 2000 and is often seen accompanying Tree Martins and Masked Woodswallows (Johnstone and Storr 1998).	As this species forages high in the airspace it is reasonably independent of the ground habitat. This species may fly over the survey area from time to time but only as a temporary migrant.	Possible
Rainbow Bee-eater (*Merops ornatus*)	Mi	The Rainbow Bee-eater is a common breeding migrant that occurs in Western Australia in the Kimberley, and Pilbara through to the southwest (Johnstone and Storr 1998). It generally breeds in summer in the greater southwest and occurs as a passage migrant or visitor in the northern part of its range throughout the rest of the year (Johnstone and Storr 1998, Barrett *et al.* 2003). It occurs in lightly wooded, often sandy country, preferring areas near water. The Rainbow Bee-eater feeds on airborne insects, and nests in burrows excavated in sandy ground or banks, often at the margins of roads and tracks (Johnstone and Storr 1998).	The Rainbow Bee-eater is a commonly recorded migrant that occurs in a variety of habitats. No suitable nesting sites were present in the project area.	Possible
MAMMALS				
Chuditch (*Dasyurus geoffroii*)	VU,S1	The Chuditch (Western Quoll) previously occurred over 70% of Australia, but now only occurs in the southwest of Western Australia.	The lack of suitable habitat suggests this species should not occur within the survey area. The Chuditch needs large logs as den	Highly Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		Being a relatively large predator, it occurs at low densities. Adult females inhabit a core area of 55-200 hectares around their den, while the corresponding figure for males is 400 hectares or more (van Dyck and Strahan 2008). The Chuditch is now only found in sclerophyll forest, woodland and mallee shrubland (van Dyck and Strahan 2008, Menkhorst and Knight 2004). It is highly mobile, and appears able to utilise bush remnants and corridors. Numbers have decreased because of habitat alteration, removal of suitable den logs and dens, and competition for food and predation by foxes and cats (van Dyck and Strahan 2008). The Chuditch has been locally extinct through-out the metropolitan area for some time.	sites which are not found in this area. The Chuditch has a large home range and there is no connectivity with surrounding bush land sufficient enough to support this species. It is highly unlikely to occur in the survey area as it is presumed locally extinct on the Swan Coastal Plain.	
Red-tailed Phascogale (*Phascogale calura*)	EN, S1	The Red-tailed Phascogale is found in isolated reserves from the Wheatbelt to the south coast, and prefers Wandoo and Sheoak woodlands. It has a preference for long unburnt habitat with continuous canopy and tree hollows. Numbers have decreased because of fragmentation and loss of habitat (Menkhorst and Knight 2004).	The project area resides far outside of this species current distribution (van Dyck and Strahan 2008) and no suitable nesting vegetation occurs in the project area for this species to be present.	Highly Unlikely
Southern Brush-tailed Phascogale, Wambenger (*Phascogale tapoatafa* ssp. [WAM M434))		The Wambenger is an undescribed subspecies of the Brush-tailed Phascogale (Phascogale tapoatafa) that occurs in south-west Western Australia (van Dyck and Strahan 2008, Peter Mawson pers. com. [DEC]). The Wambenger's distribution is believed to have been reduced	This species preferred habitat type does not occur within the project area. The Wambenger is typically found in the south-west in dry sclerophyll forests and not on the Swan Coastal Plain.	Highly Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		to approximately 50% of its former range. It is restricted to the extreme south-west, and its characteristic low population densities make it vulnerable to localised extinction (van Dyck and Strahan 2008). This subspecies has been observed in dry sclerophyll forests and open woodlands containing hollow-bearing trees but a sparse ground cover. Habitat destruction, in particular, the loss of hollow-bearing trees and predation by feral animals, are thought to be the major threats to surviving populations.		
Southern Brown Bandicoot, Quenda (*Isoodon obesulus* subsp. *fusciventer*)	P5	The Quenda (Southern Brown Bandicoot) occurs in forest, heath or coastal scrub and occurs along the coast of south-western WA from Moore River mouth to approximately Israelite Bay (Menkhorst and Knight 2004). They typically seek daytime refuge from predators in very thick ground-storey vegetation, often associated with swamps or damplands, and forage by night in more open areas, leaving distinctive conical feeding holes in the ground. The Quenda is threatened by clearing and fragmentation of its preferred habitat (van Dyck and Strahan 2008).	The Southern Brown Bandicoot produces conical diggings that are easily identifiable and are species specific. These diggings were recorded in the project area.	Recorded
Western Brush Wallaby (*Macropus irma*)	P4	The Western Brush Wallaby occurs in open forest or woodland, particularly where there is grassy understory and scrubby thickets present (Menkhorst and Knight 2004). It is found only in south-western Western	This species preferred habitat type does not occur within the project area. In addition, due to the level of development around the project area it is unlikely that the Western Brush Wallaby would occur.	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		Australia, where it appears to be in decline, probably as a result of an increase in the numbers of foxes.		
Quokka (*Setonix brachyurusis*)	VU,S1	The Quokka found in the southwest regions of Western Australia, from south of Perth in Jarrah, Marri and Karri Forest to Two People's Bay (Menkhorst and Knight 2004). It mostly occurs in densely vegetated swamps, tea tree thickets on sandy soils along creek lines and dense heath on slopes (van Dyck and Strahan 2008). Quokka numbers have declined because of predation by foxes and the clearing and burning of swamp habitats.	There is a lack of suitable habitat in the project area and the Quokka occurs in only small pockets on the mainland in forested areas of south-west. This species is considered locally extinct on the Swan Coastal Plain.	Highly Unlikely
Water-rat (*Hydromys chrysogaster*)	P4	The Water Rat occupies a wide variety of freshwater habitats, from sub-alpine streams and other inland waterways to lakes, drainage lines, swamps and farm dams (van Dyck and Strahan 2008). It favours areas close to water with thick vegetation cover. The species is widespread in south-western and northern WA, and is also found on various offshore islands.	The project area does not contain the vegetated waterways required for this species to become resident which is the preferred habitat for this species. The Damplands are low-lying inundated areas which are not true wetlands.	Unlikely

KEY:

En	**Listed as Endangered under the EBPC Act 1999.**
Vu	**Listed as Vulnerable under the EBPC Act 1999.**
Mi	**Listed as Migratory under the EBPC Act 1999.**

S	**Scheduled under the WC Act 1950.**
P	**Listed as Priority by the DEC.**
Recorded	**Recorded during the field survey or site reconnaissance.**
Likely	**Suitable habitat is present in the project area and the project area is in the species' known distribution.**
Possible	**Limited or no suitable habitat is present in project area but is nearby, the species has good dispersal abilities and is known from the general area.**
Unlikely	**No suitable habitat is present in project area but is nearby, the species has poor dispersal abilities, but is known from the general area; or suitable habitat is present, however the project area is outside of the species' known distribution.**
Highly Unlikely	**The species has poor dispersal abilities, no suitable habitat is present, and the species is uncommon; or the species is thought to be locally extinct.**

APPENDIX D
BORE SOIL LOGS

Client:
Logged By: D.P & E.S
Drilled By: Strataprobe Pty Ltd
Soil Bore No: MW2

Project:
Job No: 06.127
Date Logged: 20-Jul-06
Installation Method: Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
	Indication Level											
			0 - 0.5	CLAYEY/SAND - Dark brown Medium grained Moderately sorted - Dry								
	0.25											
	0.50											
			0.5 - 1.0	SAND - Grey Medium grained Poorly sorted - Dry								
	0.75											
1.0	1.00											
			1.0 - 1.5	SAND - Light brown/almost brown Medium grained Poorly sorted								
	1.25											
	1.50											
			1.5 - 2.0	SAND - Olive brown Medium grained Moderately sorted - Damp								
	1.75											
2.0	2.00											
			2.0 - 3.75	SAND - Olive brown Medium grained Moderately sorted - Wet								
	2.25											
	2.50											
	2.75											
3.0	3.00					GPS 50390461 E 6430946 N Total Depth of Well - 3.75m Depth to Water - 1.5m Screen: 3.75m - 0.75m Blank: 0.75m - 0m Gravel: 3.75m - 0.5m Bent: 0.5m - 0m						
	3.25											
	3.50											
	3.75											
4.0	4.00											
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: **Project:**
Logged By: D.P & E.S **Job No:** 06.127
Drilled By: Strataprobe Pty Ltd **Date Logged:** 20-Jul-06
Soil Bore No: MW2 **Installation Method:** Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
				Indication Level								
			0 - 0.5	CLAYEY/SAND - Brown Fine grained Moderately sorted - Dry								
	0.25											
	0.50											
	0.75		0.5 - 1.0	CLAY - Dark brown Fine grained Moderatley sorted - Damp								
1.0	1.00					Colour change to grey at 0.95m						
	1.25		1.0 - 1.5	CLAY - Grey/olive Fine grained Well sorted - Wet								
	1.50											
	1.75		1.5 - 2.0	GRAVELLY/CLAY - Orange/brown Medium grained Moderatley sorted - Wet		Colour change at 1.65m Gravelly rocks present						
2.0	2.00											
	2.25		2.0 - 2.5	CLAYEY/GRAVEL - Grey Fine grained Moderately sorted - Wet		Limestone between 2.0m - 2.5m Gravelly Colour change at 2.2m						
	2.50					Like sludge						
	2.75		2.5 - 3.0	CLAY - Grey Fine grained Moderately sorted - Saturated		2.7m - 3.0m dark green/blue/grey mottled shell fragments becoming more prominent with depth						
3.0	3.00											
	3.25					GPS 50390469 E 6430730 N						
	3.50					Total Depth of Well - 3.1m Depth To Water - 0.56m						
	3.75					Screen: 3.1m - 0.1m Blank: 0.1m - + 0.1m Gravel: 3.1m - 0.2m Bent: 0.2m - 0m						
4.0	4.00											
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: **Project:**
Logged By: D.P & E.S **Job No:** 06.127
Drilled By: Strataprobe Pty Ltd **Date Logged:** 20-Jul-06
Soil Bore No: MW3 **Installation Method:** Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
			Indication Level									
			0 - 0.5	SILTY/SAND - Brown Medium grained Moderately sorted - Dry								
	0.25											
						Colour change at 0.5m						
	0.50		0.5 - 1.0	SAND - Light grey Medium grained Well sorted - Damp		Quartz sand						
	0.75											
1.0	1.00		1.0 - 1.5	SAND - Grey Medium grained Well sorted - Damp								
	1.25					Colour change between 0.4m - 0.6m coffee coloured sand						
	1.50		1.5 - 2.0	CLAYEY/SAND - Grey (darker) Medium grained Well sorted - Wet								
	1.75											
2.0	2.00					Colour change from grey to dark brown						
	2.25		2.0 - 2.5	CLAYEY/SAND - Brown Medium grained Well sorted - Wet		at approximately 2.0m						
	2.50											
	2.75		2.5 - 3.0	CLAYEY/SAND - Brown/olive Medium grained Well sorted - Wet								
3.0	3.00											
	3.25					GPS 50391262 E 6430374 N						
	3.50					Total Depth of Well - 3.5m Depth to Water - 1.3m						
	3.75					Screen: 3.5m - 0.5m Blank: 0.5m - 0m Gravel: 3.5m - 0.5m Bent: 0.5m - 0m						
4.0	4.00											
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: **Project:**
Logged By: D.P & E.S **Job No:** 06.127
Drilled By: Strataprobe Pty Ltd **Date Logged:** 20-Jul-06
Soil Bore No: MW4 **Installation Method:** Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
	Indication Level											
			0 - 0.5	SANDY/CLAY - Brown black Fine grained Well sorted Damp		Organic matter present						
	0.25											
	0.50											
			0.5 - 1.0	SANDY/CLAY - Brown Fine grained Well sorted Damp								
	0.75											
1.0	1.00											
			1.0 - 1.5	SANDY/CLAY - Brown/orange Fine grained Well sorted Damp								
	1.25											
	1.50											
			1.5 - 2.0	CLAYEY/SAND - Grey Medium grained Well sorted - Wet								
	1.75											
2.0	2.00											
			2.0 - 2.5	SILTY/SAND - Light greeny grey Coarse grained Well sorted Wet								
	2.25											
	2.50											
			2.5 - 3.0	SILTY/GRAVEL - Grey Coarse grained Poorly sorted Wet								
	2.75											
3.0	3.00					Hit limestone at 3.0m						
			3.0 - 3.1	SILTY/GRAVEL/SAND - Grey Coarse grained Poorly sorted Wet		Coarse fragments of limestone throughout						
	3.25											
	3.50					GPS 5039096 E 6430240 N						
	3.75											
4.0	4.00					Total Depth of Well - 3.1m Depth to Water - 0.5m						
	4.25					Screen: 3.1m - 0.1m Blank: 0.1 - +0.2m Gravel: 3.1m - 0.2m Bent: 0.2m - 0						
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client:
Logged By: D.P & E.S
Drilled By: Strataprobe Pty Ltd
Soil Bore No: MW5

Project:
Job No: 06.127
Date Logged: 20-Jul-06
Installation Method: Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
				Indication Level								
			0 - 0.5	CLAY - Brown black Fine grained Well sorted Damp								
	0.25											
	0.50											
			0.5 - 1.0	CLAY - Brown Fine grained Well sorted Damp								
	0.75											
1.0	1.00											
			1.0 - 1.5	CLAY/LIMESTONE - Dark grey Fine grained Well sorted Damp		Hitting limestone at 1.2m						
	1.25											
	1.50											
			1.5 - 2.0	CLAY/LIMESTONE - Grey Fine grained Well sorted Wet								
	1.75											
2.0	2.00					Can not core more than 2.0m						
	2.25					GPS 50390681 E 6430064 N						
	2.50					Total Depth of Well - 3.43m Depth to Water - 0.1m						
	2.75					Screen: 3.43m - 0m Blank: 0m - +0.43m Gravel: 3.43m - 0.2m Bent: 0.2m - 0m						
3.0	3.00											
	3.25											
	3.50											
	3.75											
4.0	4.00											
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: **Project:**
Logged By: D.P & E.S **Job No:** 06.127
Drilled By: Strataprobe Pty Ltd **Date Logged:** 20-Jul-06
Soil Bore No: MW6 **Installation Method:** Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
				Indication Level								
			0 - 0.5	CLAYEY/SAND - Brown Fine grained Well sorted Damp								
	0.25											
	0.50											
			0.5 - 1.0	CLAY - Brown Fine grained Well sorted Damp								
	0.75											
1.0	1.00					Change to sand at approximately 1.0m						
			1.0 - 1.5	CLAYEY/SAND - Brown/olive Medium grained Well sorted Wet								
	1.25											
	1.50											
			1.5 - 2.0	CLAYEY/SAND - Grey Fine grained Well sorted Wet		Colour change to grey at 0.65m						
	1.75											
2.0	2.00											
			2.0 - 2.5	CLAYEY/SAND - Grey Fine grained Well sorted Saturated								
	2.25											
	2.50											
			2.5 - 3.0	SANDY/CLAY - Grey Medium grained Moderately sorted Wet								
	2.75											
3.0	3.00											
						GPS 50391120 E 6429960 N						
	3.25											
	3.50					Total Depth to Well - 3.36m Depth to Water - 1.1m						
	3.75											
4.0	4.00					Screen: 3.36m - 0.3m Blank: 0.3m - 0.1m Gravel: 3.36m - 0.5m Bent: 0.5m - 0m						
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

APPENDIX E
HISTORICAL AERIAL PHOTOGRAPHS

APPENDIX D
HISTORICAL AERIAL PHOTOGRAPHS

Photograph 27/11/1953

Photograph 11/03/1965

Photograph 06/09/1974

Photograph 07/06/1977

Photograph 30/08/1981

Photograph 19/06/1985

Photograph 06/02/1995

Photograph 24/02/2000

Photograph 26/01/2001

Photograph 26/01/2003

Photograph 12/12/2004

Photograph 16/03/2006

Photograph 06/07/2008

Photograph 02/11/2010

APPENDIX F
INTERIM WATER MONITORING SUMMARY (ENV 2010)

23 December 2010

Our Ref: 10.102-L001-KD

Greg Rowe and Associates
Level 3, 369 Newcastle Street
Northbridge WA 6003

ATTENTION: Darren Evans

Dear Darren

SUBJECT: WATER MONITORING SUMMARY AT BOLLARD BULLRUSH EAST

ENV Australia Pty Ltd (ENV) is pleased to provide Greg Rowe and Associates with the following summary of hydrological monitoring at the Bollard Bullrush East site.

There are seven groundwater monitoring bores located across Bollard Bullrush East site (see Attachment for bore locations). ENV has undertaken six occasions of groundwater level monitoring and two occasions of groundwater quality monitoring between July 2010 and December 2010.

Groundwater Levels

Groundwater on the site generally flows west towards the Peel Main Drain and the centre of Bollard Bullrush Swamp. Groundwater levels were closest to the surface at MW5-E and MW4-E located in the central areas of the swamp with a depth of 0.18 m to 0.3 m below ground level respectively. In August, water levels for all bores on site were closer to ground level, indicating an average groundwater level rise of 0.3 m across the site. In September, groundwater levels dropped their August readings. Groundwater level decline continued into October, with the exception of MW1-E which increased, with depth to groundwater levels varying from surface to 1 metre.

Groundwater levels did not fluctuate greatly over the monitoring period likely due to low rainfall over winter 2010.

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ENV•Australia ABN 72 091 839 520

Table 1: Bore details and groundwater levels (m AHD)

Sample ID	Ground Level (m AHD)	Top of Casing (mAHD)	Depth of Bore (m)	Depth to Water (m AHD)					
				1/07/2010	8/07/2010	5/08/2010	8/09/2010	28/10/2010	11/11/2010
MW1-E	6.87	8.60	4.35	6.29	6.277	6.440	6.418	6.222	6.204
MW2-E	4.41	5.35	5.80	3.55	3.568	4.057	4.199	3.902	3.776
MW3-E	6.38	6.81	3.73	Dry	Dry	Dry	Dry	Dry	Dry
MW4-E	4.08	4.44	3.59	3.78	3.754	3.983	4.135	3.884	3.784
MW5-E	3.87	4.37	3.42	3.69	3.678	3.910	3.958	3.954	3.918
MW6-E old	4.80	5.18	3.68	4.11	4.107	4.462	4.594	4.547	4.836
MW6-E new	4.89	5.49	4.30	4.07	4.037	4.344	4.605	4.223	4.176

Groundwater Quality – Physical Parameters and Nutrients

Water sampling results were compared against ANZECC Lowland River Guidelines (2000) and the Short and Long Term Targets outlined in the Swan Canning Clean-up Program Action Plan (SCCP).

Water sampling analysis indicates that groundwater is relatively neutral, with an average pH of 7.3. pH levels for the site are within the ANZECC Guidelines of 6.5 to 8.

Salinity onsite ranges from 3000 uS/cm (Brackish) to 530 uS/cm (Fresh). The higher salinities onsite are located to the south of the site at MW6-E new and MW6-E old. Progression to the north of the site to MW1-E records a reduction in salinity. Across the sampling period all bores on site recorded a variable reduction in salinity. The October sampling demonstrated that bores to the north (MW1-E and MW2-E) reduced by an average of 240 uS/cm, bores in the central Swamp region (MW4-E and MW5-E) reduced by an average of 835 uS/cm. To the south MW6-E New dropped dramatically by 900 uS/cm while MW6-E Old only dropped by 100 uS/cm. Salinity is consistent with the results shown in the Perth Groundwater Atlas.

Water quality data shows that Total Nitrogen ranges from 3.8 mg/L to 1.1 mg/L; with a site average of 2.0 mg/L. These results are above the ANZECC Guidelines of 1.2 mg/L and the long term SCCP Targets (1 mg/L).

Total Phosphorus ranges from of 1.3 mg/L to 0.07 mg/L; with a site average of 0.48 mg/L. All records are above the ANZECC Guidelines of 0.065 mg/L. All bores across the site recorded an average reduction of 0.38 mg/L between July and October, with the exception of MW1-E to the north which remained the same at a very high 1.3 mg/L.

The water quality results recorded to date show variability, further monitoring on this site will likely clarify the results.

Table 2: Water Quality – Physical Parameters and Nutrients

Date	Bore ID	pH	EC uS/cm	Total P mg/L	PO4 mg/L	Total N mg/L	NO2-N mg/L	NO3-N mg/L	NH3-N mg/L	TKN mg/L
8/07/2010	**MW1E**	7.3	810	1.30	0.250	3.8	0.039	0.720	0.02	3.0
28/10/2010	**MW1E**	7.6	530	1.30	0.300	1.3	0.092		0.02	1.2
8/07/2010	**MW2E**	7.6	1200	0.58	0.005	1.1	0.005	0.007	0.57	1.1
28/10/2010	**MW2E**	7.4	1000	0.12	0.005	1.3	0.008		0.64	1.2
8/07/2010	**MW4E**	7.8	1600	0.46	0.005	1.7	0.023	0.140	0.53	2.1
28/10/2010	**MW4E**	7.6	780	0.15	0.005	1.7	0.033		0.53	1.6
8/07/2010	**MW5E**	7.5	1800	0.38	0.005	1.3	0.036	0.068	0.37	1.6
28/10/2010	**MW5E**	7.1	950	0.12	0.008	1.3	0.031		0.19	1.3
8/07/2010	**MW6 (New)**	7.1	3000	0.88	0.005	2.3	1.500	1.500	1.10	10.0
28/10/2010	**MW6 (New)**	6.9	2100	0.03	0.005	2.7	0.360		0.36	2.4
8/07/2010	**MW6**	7.4	2200	0.38	0.005	2.3	0.220	4.000	0.28	7.8
28/10/2010	**MW6**	6.5	2100	0.07	0.005	3.3	0.180		0.56	3.1
Average		**7.3**	**1506**	**0.48**	**0.050**	**2.0**	**0.211**	**1.073**	**0.43**	**3.0**
Median		**7.4**	**1400.0**	**0.38**	**0.005**	**1.7**	**0.038**	**0.430**	**0.45**	**1.9**
	SCCP Long Term Target			0.1		1				
	SCCP Short Term Target			0.2		2				
	ANZECC Fresh Water	6.5 - 8		0.065		1.2				

Water Quality – Dissolved Metals

Samples were analysed for arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury.

Table 3: Water Quality (Dissolved Metals)

		Metals							
Date	Bore ID	Arsenic mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Mercury mg/L
8/07/2010	**MW1E**	0.001	0.0001	0.005	0.003	0.001	0.003	0.01	0.0001
28/10/2010	**MW1E**	0.010	0.0020	0.040	0.057	0.067	0.006	0.02	0.0003
8/07/2010	**MW2E**	0.001	0.0001	0.005	0.003	0.001	0.002	0.01	0.0001
28/10/2010	**MW2E**	0.020	0.0020	0.028	0.033	0.013	0.006	0.01	0.0001
8/07/2010	**MW4E**	0.001	0.0001	0.005	0.002	0.001	0.004	0.01	0.0001
28/10/2010	**MW4E**	0.100	0.0020	0.180	0.024	0.024	0.050	0.02	0.0004
8/07/2010	**MW5E**	0.002	0.0001	0.005	0.001	0.001	0.007	0.01	0.0001
28/10/2010	**MW5E**	0.010	0.0020	0.006	0.005	0.005	0.005	0.01	0.0001
8/07/2010	**MW6 (New)**	0.001	0.0001	0.005	0.002	0.001	0.003	0.01	0.0001
28/10/2010	**MW6 (New)**	0.070	0.0020	0.260	0.450	0.180	0.074	0.16	0.0001
8/07/2010	**MW6**	0.002	0.0001	0.005	0.004	0.001	0.005	0.01	0.0001
28/10/2010	**MW6**	0.050	0.0020	0.120	0.046	0.086	0.043	0.16	0.0003
Average		**0.022**	**0.0011**	**0.055**	**0.053**	**0.032**	**0.017**	**0.04**	**0.0002**
	ANZECC & ARMCANZ Guidelines (2000)*	0.024	0.0002	0.01	0.0014	0.0034	0.011	0.008	0.00006

On average only arsenic was recorded below ANZECC guidelines and cadmium, chromium, copper, lead, nickel, zinc and mercury were all above the guidelines. Variation between bores for certain metals was recorded, in particular arsenic, chromium and nickel which recorded concentrations both within the ANZECC guidelines and exceeding them.

Further monitoring for dissolved metals is recommended.

Summary

- Groundwater flow westerly towards Bollard Bulrush Swamp and the Peel Main Drain;
- Groundwater levels are falling sporadically;
- pH levels are neutral and within ANZECC Guidelines;
- Salinity across the site ranges from fresh to brackish;
- Total Phosphorus and Total Nitrogen exceed the ANZECC guidelines; and
- On average, dissolved metals were above ANZECC guidelines, only Arsenic was recorded below ANZECC guidelines.

Further monitoring of dissolved metals and water quality parameters is to be undertaken.

Should you have questions regarding the above please contact the undersigned on 9214 6100.

Yours sincerely
ENV Australia Pty Ltd

SUZANNE SMART
Senior Environmental Scientist

ATTACHMENT

Bollard Bullrush East Sampling Locations – Bore Locations

REFERENCES

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000, *Australian Water Quality Guidelines for Fresh and Marine Waters, National Water Quality Management Strategy*, Australian and New Zealand Environment and Conservation Council, Canberra.

CLIENT
Greg Rowe

JOB NO.
10.102

AUTHOR:
P. Arthur

DRAWN
S. Rho

DATE
02-07-2010

SCALE
1:10,000 @ A4

PROJECTION
GDA 94 MGA 50

Bollard Bullrush East Sampling Locations

Bollard Bullrush East Bore Locations

FIGURE
1

APPENDIX G
SITE ASSESSMENT, BOLLARD BULRUSH SWAMP (STRATEGEN 2012)

STRATEGEN
environmental consultants

Level 2, 322 Hay Subiaco WA 6008 PO Box 243 Subiaco WA 6904
Phone (08) 9380 3100 Fax (08) 9380 4606
Podium Level, Bunbury Tower, 61 Victoria Street Bunbury WA 6230 PO Box 287 Bunbury WA 6231
Phone 08 9792 4797 Fax 08 9792 4708

To Darren Evans Date 15 February 2012

Company Greg Rowe and Associates Reference No GRA11202.01

Fax/Email Inquiries Julia Morgan / Darren Walsh

Site assessment – Bollard Bulrush Swamp, Wellard

Numbers below each photographic plate correspond with photo point numbers in Figure 1.

Sketch 1 Field photo locations

Legend

Photo location & angle

STRATEGEN
info@strategen.com.au
www.strategen.com.au

Scale

0 80 160
metres

1:8,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 13/02/2012
Author: atomeo

Source: Imagery sourced from Nearmap, 08/01/2012.
Cadastre sourced from SLIP WMS service, courtesy of Landgate.
Note that positional errors may occur in some areas

Path: \\Gis-01\gis\Consult\2011\GRA\GRA11202\ArcMap_Documents\Working\GRA11202_SK001_Field_Photo_Locations.mxd

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Photograph 5

Photograph 6

Photograph 7

Photograph 8

Photograph 9

Photograph 10

Photograph 11

Photograph 12

Photograph 13

Photograph 14

Photograph 15

Photograph 16

Photograph 17

Photograph 18

Photograph 19

Photograph 20

Photograph 21

Photograph 22

Photograph 23

Photograph 24

Photograph 25

Photograph 26

Photograph 27

Photograph 28

APPENDIX H
BOLLARD BULRUSH SWAMP FLOOD MODELLING (GHD 2010)

Memorandum

10 December 2010

To	Darren Evans, Greg Rowe & Associates		
Copy to			
From	Helen Brookes	Tel	61 8 6222 8702
Subject	Wellard Urban Precincts East and West	Job no.	61/25042/01

Introduction

It is proposed to develop land immediately surrounding the Bollard Bullrush Swamp environmental protection policy lake boundary. The development proposes to amend the environmental protection policy boundary in the Eastern Precinct and extend development into the floodway. In order that development may occur areas of the floodway will have to be filled and so it is necessary to determine the up and downstream impacts of this effective reduction in the flood capacity of the swamp.

GHD have been engaged to undertake preliminary investigations into the impact of the proposed fill for the purposes of rezoning and structure planning.

It is noted that the Water Corporation may have made some revisions to the Peel Main Drain InfoWorks model since the completion of the Jandakot Drainage and Water Management Plan that are not available at this time and that future assessments may need to be done with an updated version of the model. However since this is a comparative assessment of the impact from a specific development proposal it is not likely that any changes to other sections of the model will make substantial difference to the results.

Both the Department of Water and Water Corporation have been consulted during this study to gain approval to use the Peel Main Drain InfoWorks model for this purpose and correspondence with them is attached.

Methodology

The dimensions of the Bollard Bullrush Swamp as modelled for the Jandakot Drainage and Water Management Plan were amended to reflect the proposed filling of the proposed development areas to the south and north east of the swamp as seen in Figure 1. Modelling assumed that the environmental protection policy boundary and buffer are successfully moved in the Eastern Precinct so that the full extent of development can go ahead. In the Western Precinct the environmental protection policy boundary and buffer are maintained.

In addition, because of the proposed change in land use within the development areas, the percentage of impermeable area (and hence generated runoff) was increased according the local structure plan shown in Figure 1. This will give a worst case indication of the likely impact, since it does not take into consideration that the development will provide additional compensation and promote additional infiltration through the use of water sensitive urban design and therefore is likely to retain or reduce predevelopment runoff characteristics.

A second scenario has also been modelled which incorporates detention capacity within the development to maintain the pre-development discharge peak flow rates into the Main Drain.

The modelling parameters used adapted from those established within the Jandakot DWMP and are presented in Tables 1 and 2 below.

Table 1 Land use impervious areas

Land use	Area (m^2)	Percent impervious	Impervious area (m^2)
School	77797	72%	56014
Grouped Dwellings	7682	28%	2151
Aged Persons	10020	35%	3507
Low Density	481644	28%	134860
Existing Residential	223430	28%	62560
Roads	381155	80%	304924
Medium Density	209403	28%	58633
POS	144472	0%	0
Drainage	935238	0%	0
Total	**2,470,841**		**622,649**

Table 2 Runoff surface characteristics

Runoff surface ID	Description	Surface type	Surface roughness (Manning's n)	Initial loss (mm)	Fixed runoff coefficient
61	URBAN (Perv') 2yr	Pervious	0.025	0	0.1
62	URBAN (Perv') 10yr	Pervious	0.025	0	0.15
63	URBAN (Perv') 100yr	Pervious	0.025	0	0.2
7	URBAN (IMP)	Impervious	0.015	15	1

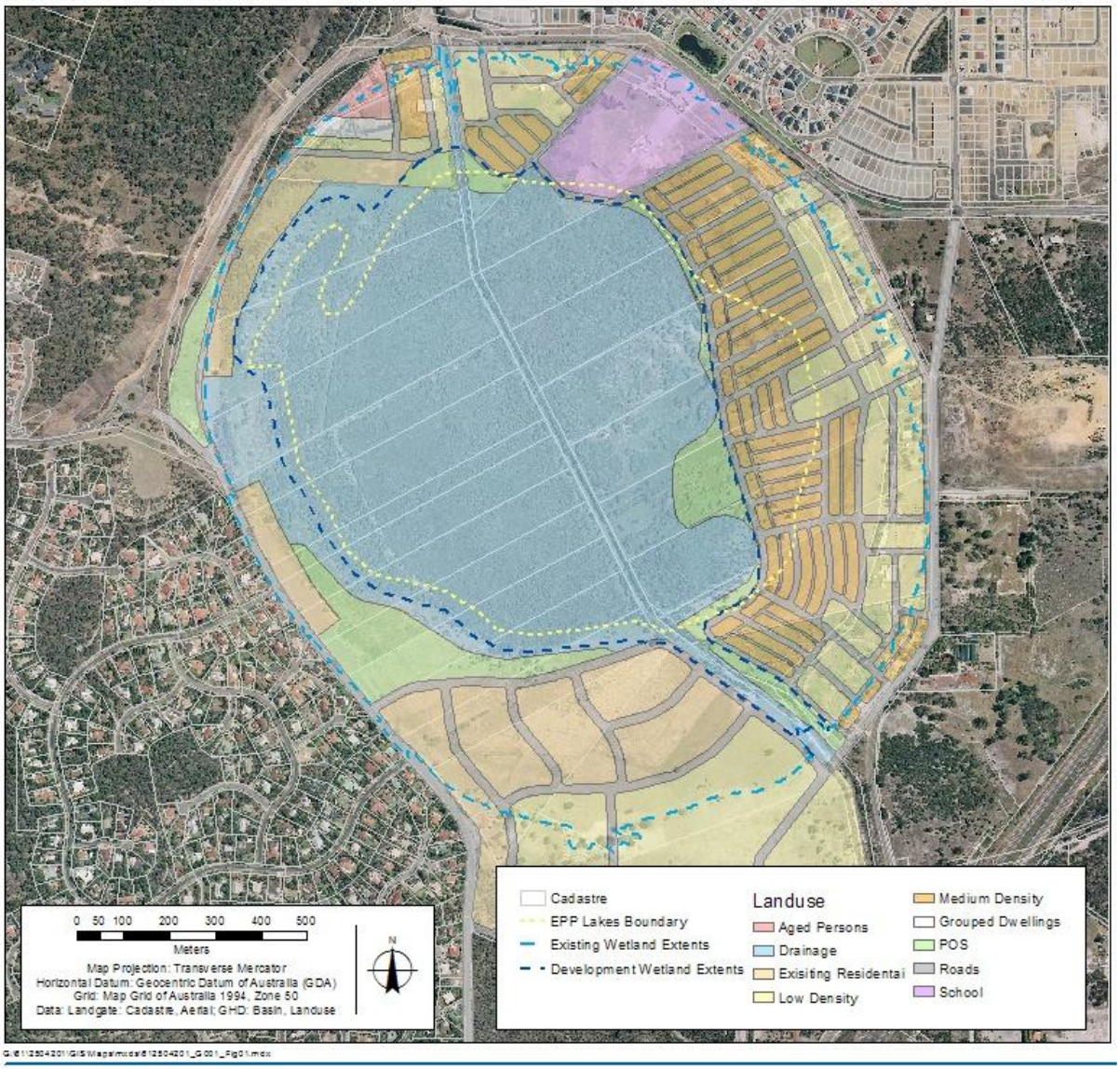

Figure 1 Exiting and Ultimate Wetland Extents with Proposed Landuse

Notes to figure 1:

1. Wetland extents indicated by the hatched lines are the areas available within the pre- and post-development models to accept overflow from the Peel Main Drain.
2. The land use type 'drainage' is used to define runoff parameters only and does not reflect the flooded area predicted by the model.

Results

Table 3 below presents top water levels and peak flow rates from modelling undertaken in support of the Jandakot Drainage and Water Management Plan at critical locations. Tables 4 and 5, also below, present a summary of the results of modelling for the two scenarios described above. Table 6 presents the discharge peak flow rates and required detention capacities within the development.

Table 3 Jandakot Drainage and Water Management Plan modelling results

Location	Top Water Level (mAHD)		Peak Flow (m^3/s)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Peel Main Drain at Bertram Road	7.90	8.20	3.25	3.82
Bollard Bullrush Swamp	4.82	5.61	3.38	4.00
Peel main Drain at Millar Road	4.70	5.59	4.38	5.06

Table 4 Modelling of full extent of proposed development without stormwater detention

Location	Top Water Level (mAHD)		Peak Flow (m^3/s)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Peel Main Drain at Bertram Rd	7.90 *(no change)*	8.20 *(no change)*	3.25 *(no change)*	3.82 *(no change)*
Bollard Bullrush Swamp	4.85 *(+ 30 mm)*	5.65 *(+ 40 mm)*	3.38 *(no change)*	4.00 *(no change)*
Peel main Drain at Millar Road	4.72 *(+20 mm)*	5.62 *(+ 30 mm)*	4.73 *(+ 350 L/s)*	5.77 *(+ 710 L/s)*

Table 5 Modelling of proposed development including provision of on-site detention

Location	Top Water Level (mAHD)		Peak Flow (m^3/s)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Peel Main Drain at Bertram Rd	7.90 *(no change)*	8.20 *(no change)*	3.25 *(no change)*	3.82 *(no change)*
Bollard Bullrush Swamp	4.82 *(no change)*	5.62 *(no change)*	3.38 *(no change)*	4.00 *(no change)*
Peel main Drain at Millar Road	4.70 *(no change)*	5.59 *(no change)*	4.39 *(+ 10 L/s)*	5.14 *(+ 80 L/s)*

Table 6 Discharge peak flows and required detention volumes for the proposed development

ARI storm event	Basin outflow (m^3/s)	Storage volume required (m^3)
10 Year	0.2	30,000
100 Year	0.35	39,000

Notes to table 6:

1. Detention volumes are provided as a guide only for the entire development. Detention areas have not been determined at this time since this will be dependent on the depth and landscaping configuration of the designed basin.

Conclusions

The modelling summarised above indicates that in scenario 1, which is the worst case scenario given no detention capacity within the development area, the top water level within the Bollard Bullrush Swamp changes by less than 100 mm for the 100 year ARI event and that levels both up and downstream also remain relatively unchanged.

The scenario 2 results indicated that by providing a total detention capacity of approximately 39,000 m^3 for a 100 year ARI event (30,000 m^3 for a 10 year ARI event) within the development area the change in top water level will be zero.

Suitable fill levels for development must be determined by detailed site investigations in conjunction with drainage and earthworks design for the site. This modelling indicates that a minimum habitable floor level of 6.12 m AHD will be required to ensure that 500 mm of clearance is provided from the 100 year ARI event flood level in Bollard Bullrush Swamp.

In scenario 1, peak flows within the Peel Main Drain upstream of and within the swamp also remain unchanged, however there is an increase of up to 710 L/s on the downstream peak flow rate in the Peel Main Drain for the 100 year ARI event. This increase in flow rate is related to the increased impervious area and it will be a requirement of development that sufficient detention capacity is provided within the drainage system and public open space areas to ensure that this does not occur.

In scenario 2 the increase in downstream peak flow rate is managed through the provision of 39,000 m^3 total detention capacity within the development area. This results in a downstream peak flow rate in the Peel Main Drain for the 100 year ARI event of 5,140 L/s which is within 80 L/s of the predevelopment downstream peak flow rate.

The indicated detention capacity of 39,000 m^3 for the 100 year ARI event which is required in order to maintain the peak discharge peak flow rates for the development will need to reviewed during the development of drainage designs. It is likely that the drainage design process will be able to reduce this detention capacity through water sensitive urban design practices, providing capacity for minor events throughout the development on lots and in road reserves as well as provision of flood detention areas within the normal public open space provision.

Recommendations:

1. Rezoning submissions should indicate that the change in top water level is predicted to be zero in the 10 and 100 year ARI events as a result of the proposed development.
2. Rezoning submissions should also indicate that there is less than 100 L/s predicted increase in peak downstream flow rates in the 10 and 100 year ARI events as a result of the proposed development, and that this is not likely to cause any downstream impacts.
3. The design of the proposed development should provide sufficient detention capacity within lots, road reserves and/or public open space to ensure that predevelopment peak discharge flow rates are not exceeded (indicatively 30,000 m^3 and 39,000 m^3 respectively for the 10 and 100 year ARI events).
4. The design of the proposed development should incorporate a minimum habitable floor level of 6.12 m AHD.

Helen Brookes

Manager, Waterways