


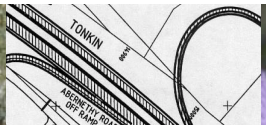


Abernethy Road – Tonkin Highway On-ramp




Public Environmental Review

Prepared for:

Main Roads Western Australia

Prepared by:

Biota Environmental Sciences Pty Ltd

April 2003

Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

Main Roads Western Australia proposes to construct an on-ramp from Abernethy Road to Tonkin Highway, Kewdale. In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (PER) has been prepared which describes the proposal and its likely effects on the environment. The PER is available for a public review period of four weeks from Monday 5th May 2003 closing on Monday 2nd June 2003.

Comments from government agencies and from the public will help the EPA to prepare an assessment report in which it will make recommendations to government.

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 EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in the EPA's report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with 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 PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- 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 PER;
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which sections you are considering; and
- 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;
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is Monday 2nd June 2003.

Submissions should ideally be emailed to: rachael.mercy@environ.wa.gov.au *(Please note: one complete submission should be emailed following thorough consideration of the document)* or addressed to:

Chairman
Environmental Protection Authority
PO Box K822
PERTH WA 6842
Attention: Rachael Mercy

Abernethy Road – Tonkin Highway On-ramp Public Environmental Review

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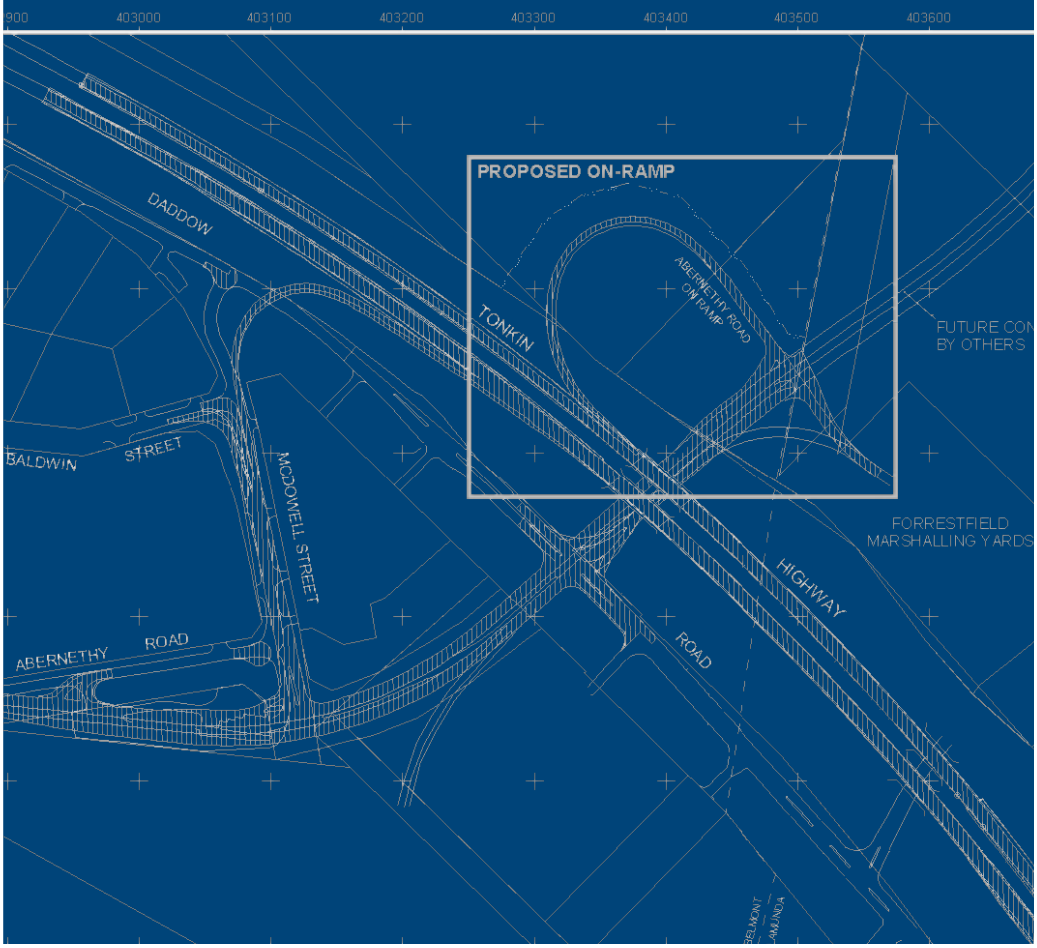

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Executive Summary

Main Roads Western Australia (Main Roads) is currently finalising project design, land acquisition and formal approvals for the proposal to construct an on-ramp at the Abernethy Road – Tonkin Highway interchange in Kewdale. The proposal will require the construction of the on-ramp itself, and the construction of a new stormwater retention basin within the loop created by the on-ramp as shown below (Figure 1).

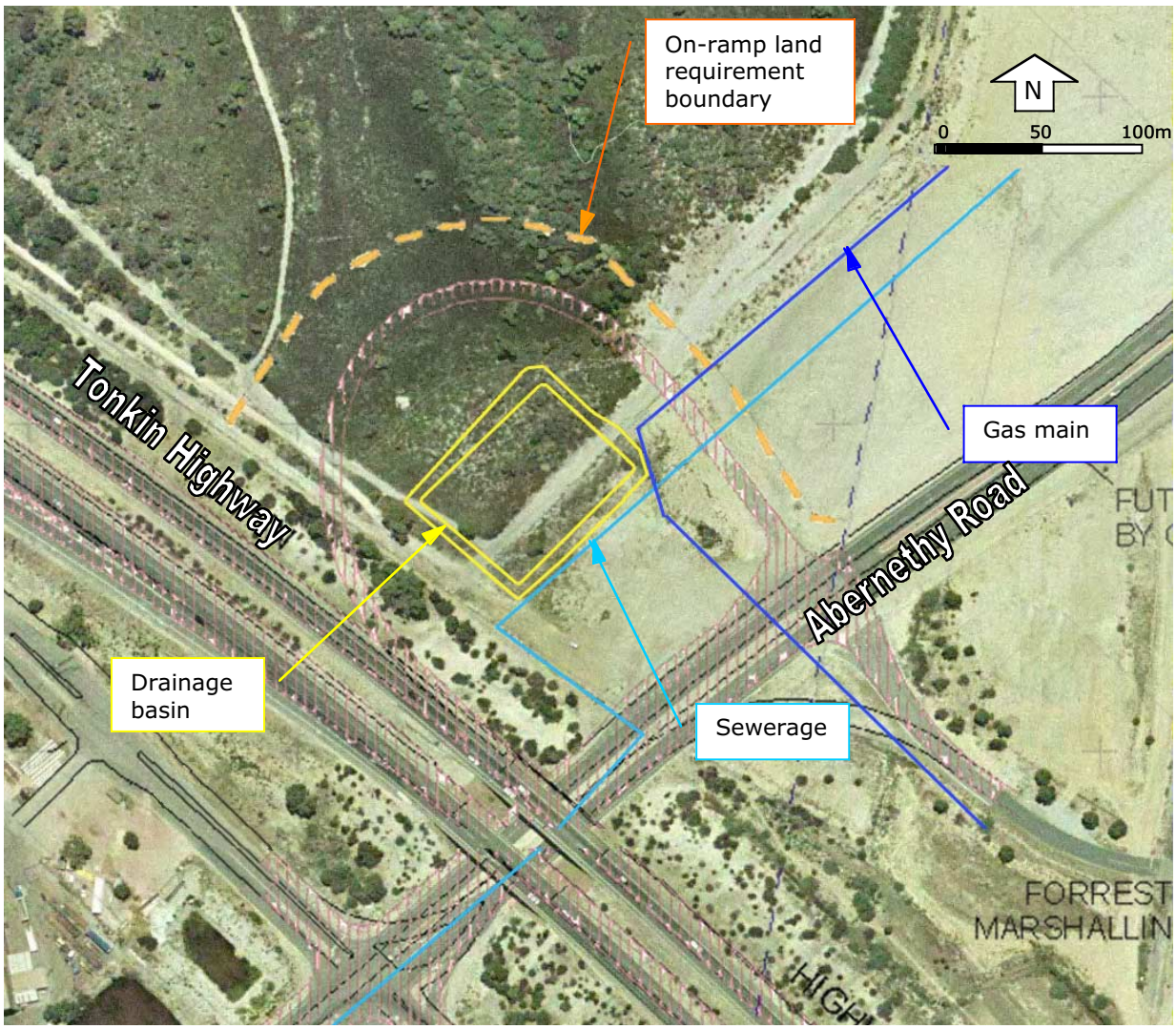


Figure 1: Aerial photograph of the project area showing land requirement for the proposed on-ramp, drainage basin design and the location of existing constraints.

The on-ramp will require 2.3 ha of land, 1.4 ha of which is currently part of Bush Forever Site 386 (Perth Airport and adjacent bushland). The potential impacts of the development on threatened flora, fauna, wetlands and vegetation communities within this latter area have formed the central issues for the formal assessment of this project. This Public Environmental Review (PER) provides a summary and update of previously completed studies on the subject land and evaluation of the environmental factors the Environmental Protection Authority (EPA) considered relevant to the proposal.

The Proposal and Other Options Considered

One of the main purposes for the on-ramp is to provide improved access from the Kewdale, Forrestfield and Wattle Grove industrial areas to the primary road network via Tonkin Highway. One of the principal demands for this within the Forrestfield industrial area is the CBH Metropolitan Grain Terminal, which attracts a large number of semi-trailer and road

train vehicles on a seasonal basis. It is therefore highly desirable from both safety and community amenity perspectives that Main Roads provides an on-ramp in this area.

Three other options were considered to provide the required access to the primary road network. Two were rejected on the basis of their increased land requirement from Perth Airport bushland compared to the on-ramp design as proposed. The remaining alternative, which was the best option from a purely environmental perspective, could not be pursued due to the inherent safety risks it would create for road users. The proposed design provides a balance of traffic safety considerations and provision of access to the primary network where it is most required, whilst minimising land requirement from Bush Forever Site 386.

Relevant Environmental Factors

The environmental factors the EPA considered relevant to the proposed on-ramp were:

- Flora and vegetation
- Threatened flora
- Threatened vegetation
- Fauna
- Threatened fauna
- Wetlands
- Aboriginal heritage

A summary of the existing environment with respect to these factors, the potential impacts of the proposal on them and proposed management measures, follows.

- **Flora, Vegetation and Threatened Vegetation**

The on-ramp project area has been surveyed for flora and vegetation on two occasions prior to the investigations for this PER. This was supplemented during the current assessment by the completion of additional systematic sampling sites and targeted searches for threatened flora.

These surveys have recorded a total of 173 flora species from the on-ramp project area. The flora comprised representatives from 118 genera and 46 families. The best-represented families were the Myrtaceae (myrtles), Papilionaceae (peas), Poaceae (grasses), Stylidiaceae (triggerplants) and Asteraceae (daisies). The best represented genera were *Stylidium* (triggerplants), *Melaleuca, Hibbertia* (guinea flowers), *Leucopogon* (beard heaths) and *Acacia* (wattles). Weeds comprised a small proportion of the flora of the project area with the vegetation in the area largely intact in this respect.

The vegetation of the project area belongs to the Southern River Complex, which is described as an "open woodland of *Corymbia calophylla – Eucalyptus marginata – Banksia* species with fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* along creek beds". At a finer scale of consideration, four vegetation types were recognised within the area of land required for the proposed on-ramp:

1. *Pericalymma ellipticum* var. *ellipticum* shrubland on sumplands;
2. *Melaleuca rhaphiophylla/M. preissiana* woodland over sedgelands;
3. *Banksia attenuata/B. menziesii* woodland over mixed low shrublands on low sandy rises; and
4. Cleared areas with scattered remnant vegetation over weeds.

The on-ramp area consists of a mosaic of these vegetation types, with intergrades, or ecotones, between each. The principal impact arising from the proposed on-ramp will be the requirement to remove approximately 1.4 ha of these significant vegetation types (in addition to the 0.9 ha of land that is already cleared). Evaluation of the clearing impacts indicates that a relatively small proportion of the local extent and actual area of each vegetation type will be cleared to accommodate the on-ramp. Over a third of the area to be removed is located within existing degraded areas. The most affected intact vegetation types, the *Pericalymma ellipticum* shrubland and the *Banksia* spp. woodland, will be

reduced by 0.6 ha each, leaving 7.3 ha and 8.2 ha respectively in the immediate project area. Clearing for the proposal would remove 0.2 ha of the other vegetation type in the land requirement area (*Melaleuca rhaphiophylla* woodland) leaving 2.1 ha intact in the balance of the project area.

Statistical analysis of the systematic floristic data indicated that the vegetation types present were referrable to three of the Gibson et al. (1994) floristic community types:

1: *Pericalymma ellipticum* var. *ellipticum* shrubland on sumplands;
2: *Melaleuca rhaphiophylla/M. preissiana* woodland over sedgeland; and
3: *Banksia menziesii* woodland over mixed low shrublands on low sandy rises.

All of these community types have a reservation status of 'Well Reserved' and none are recognised as Threatened Ecological Community types (TECs). However, whilst the vegetation communities present in the impact area may not be formally listed as TECs, they are still of high regional conservation significance. The airport area represents one of the few remaining areas of intact remnant vegetation on the transition zone between the Bassendean dunes and Pinjarra Plain. Given its size and relative intactness (Government of Western Australia 2000), it is probably the most significant remaining site in the Perth metropolitan area in this regard.

In recognition of the removal of 1.4 ha of this regionally significant vegetation, the proponent is in the process of advancing an offset package consisting of the provision and securing of a wetland/urban bushland area for long-term conservation that is not currently part of the conservation estate. Main Roads has investigated three options for offset opportunities prior to the current proposed offset, including rehabilitation of degraded vegetation within the airport area itself, acquisition of a nearby wetland and the regeneration of a disturbed area in the central part of the Dundas Road Bushland (Bush Forever Site 319). None of these previous approaches proved viable, and Main Roads is now advancing a package comprising the relinquishment of an area of land originally purchased by Main Roads for road utility purposes. Lot 109 Clifford Street is situated in Orange Grove and is 1.85 ha in size (0.45 ha greater than the impact area required for the proposed on-ramp). The bushland contains:

- Declared Rare Flora;
- a Conservation Category wetland;
- habitat for, and records of, threatened fauna;
- Bassendean Dunes and Pinjarra Plain landforms and soils; and
- was identified as regionally significant vegetation as part of Bush Forever (Site No. 53; Government of Western Australia 2000).

This lot is vested in the Commissioner for Main Roads, zoned for Rural under the MRS and situated to the south of the proposed on-ramp site on the Tonkin Highway reservation. Main Roads currently intends to relinquish this significant site and pursue a process to transfer ownership of the lot to a more suitable management agency for conservation purposes. To this end, an in-principle agreement has been reached with the Department of Conservation and Land Management in respect of securing and managing the land in question for long term conservation. Main Roads has provided a commitment to follow this process to completion or identify a similar offset package to the satisfaction of the relevant conservation agencies.

In addition to the immediate reduction in area of regionally significant vegetation, other project related potential impacts on vegetation largely relate to ongoing degradation of the intact vegetation that will remain within the adjacent bushland following the construction of the on-ramp. These include:

- introduction of dieback or other soil-borne pathogens;
- weed introduction;
- effects on phreatophytic flora;
- changes to hydrological regime;
- changes to fire regimes; and
- edge effects and increased public access.

An Environmental Management Programme (EMP) will be prepared to address these potential impacts, as the risks of initiating most of these arise largely during the construction period of the proposal. Environmental auditing will be completed both during and after construction to ensure that the management measures to address these risks are implemented.

- **Threatened Flora**

Three species of threatened flora are known to occur in the on-ramp project area. One Declared Rare Flora species *Macarthuria keigheryi* and one Priority 3 species *Platysace ramosissima* have been recorded in the project area, but are outside the land requirement boundary for the on-ramp and are not expected to be impacted. The locally occurring populations of *Macarthuria keigheryi* are of regional significance and several surveys have been completed of the impact area associated with the on-ramp in an attempt to locate additional individuals. These surveys have not recorded *M. keigheryi* from the *Banksia* spp. woodland within the land requirement area and, whilst this remains potential habitat for the species, there is appears to be no evidence that it occurs within the land to be directly affected by clearing for the on-ramp.

The Priority 4 species *Verticordia lindleyi* subsp. *lindleyi* was recorded from two individuals within the on-ramp land requirement area and would be directly affected by the proposed construction. The proponent has committed to undertake species-specific transplantation initiatives for this species to the satisfaction of the Department of Conservation and Land Management.

- **Fauna**

Other than avifauna surveys, no specific fauna surveys were conducted for this assessment. However systematic surveys of the airport bushland area have been conducted previously by the WA Museum and Tingay and Associates. The site is significant compared to other habitat remnants on the Swan Coastal Plain given its:

- high level of habitat intactness;
- variation in habitat types within the site;
- the size of other adjoining and adjacent habitat remnants within the larger area of Bush Forever Site 386 (Perth Airport bushland); and
- distance from residential developments.

Survey data indicate that five mammal species (including three exotics, noting that no bat surveys have been completed), 87 bird species and 30 reptile species occur in the entire Perth Airport bushland. Most of the fauna species known from the airport site occur elsewhere on the Swan Coastal Plain or further afield, but the site is of regional significance due to the diversity and relative intactness of the fauna community present. The fauna of the on-ramp project area is likely to be a subset of this assemblage, given the relatively small area under consideration, the reduced array of habitats and the proposed location for the on-ramp site on the edge of the bushland.

Of the bird species known from the project area, 11 appear on the listing of species considered as 'Significant bird species of the Swan Coastal Plain portion of the metropolitan area' in Bush Forever. The airport bushland site has regional conservation significance for avifauna, particularly for species that now have reduced habitat extents on the Swan Coastal Plain. A number of invertebrate taxa occur on the site that have the potential to be restricted in distribution.

The primary impact of the proposed on-ramp on invertebrate and vertebrate fauna species will be the direct removal of habitat, and the associated immediate mortality or subsequent displacement of individuals utilising this area. Clearing for the on-ramp will amount to 1.4 ha of intact habitat in total, primarily constituting sumpland wetland habitats and upland ecotones into *Banksia* woodlands. Construction activities could also have impacts on fauna due to increased vehicle movements, with noise and other disturbance factors, pedestrian intrusion into intact bushland and increased bushfire risk presenting ongoing, but probably low level

impact risks. Most of these issues should be reduced to an acceptable level by the environmental management measures to be contained in the EMP committed to by the proponent.

- **Threatened Fauna**

Two threatened fauna species are known to occur in the immediate vicinity of the proposed on-ramp; Carnaby's Cockatoo *Calyptorhynchus latirostris* (Schedule 1) and the Southern Brown Bandicoot *Isoodon obesulus fusciventer* (Conservation Dependent). These species are considered likely to continue to persist in the intact bushland adjacent to the site if the proposal is implemented. The former species appears to only periodically visit the area (primarily to forage on proteaceous shrubs), with its local occurrence inferred from characteristically damaged eucalypts. *I. o. fusciventer,* which currently utilises the denser vegetated habitats of the area, appears able to persist in urban bushland remnants of sufficient size with an intact understorey. It is therefore likely that its long term persistence in the 75.6 ha of conservation zoned land in south-west portion of the airport site would not differ significantly from its local persistence in the 77 ha present if this proposal was not implemented.

The general environmental management measures addressing fauna and habitat impacts in the EMP for the project will also assist in mitigating the impacts on these species of higher conservation significance.

- **Wetlands**

A substantial proportion of the project area contains wetland habitat. This wetland is principally a meandering sumpland unit that is seasonally inundated, with a small area of somewhat deeper linear sumpland and fringing water-gaining soils on upland margins. Vegetation in this area was dominated by *Pericalymma ellipticum* shrubland and *Melaleuca rhaphiophylla* woodland over open mixed sedges and rushes and was generally in very good to excellent condition with minimal weed invasion apparent. The wetland was evaluated as a Category 'C' (Conservation) wetland and also provides habitat for the Priority fauna species the Southern Brown Bandicoot *I. o. fusciventer* (Conservation Dependent).

The on-ramp project area contains approximately 10.2 ha of Category C (Conservation) wetland. The land requirement for the on-ramp will result in the removal of approximately 0.8 ha of this wetland habitat or approximately 8% of its occurrence in the project area. Similar wetland vegetation units are also represented throughout the remainder of the airport site, including in conservation purpose zoned land. Hydrological studies concluded that the proposed on-ramp is likely to have minimal impact on surface water hydrology or local groundwater regimes (Aquaterra 2003; Appendix 6 of this PER). Surface drainage is from the north towards the site, with the on-ramp situated in the bottom of the local catchment and the local wetlands upgradient of the on-ramp site (and therefore at minimal risk of road-related contaminant risks). The risk of road run-off contamination will be further addressed by run-off being directed into a central detention/infiltration basin for local recharge. Any pollutants will be retained in the basin or filtered by the sand below, with the drainage treatment also providing for spillage entrapment in the event of a road accident.

- **Aboriginal Heritage**

Several historical heritage assessments have addressed the Perth Airport bushland area. Relevant Aboriginal groups were re-consulted as part of the additional investigations completed for this PER. This yielded varying responses from the relevant groups and the findings of the study were submitted for consideration by the Aboriginal Cultural Materials Committee (ACMC) to determine if a site existed for the purposes of the *Aboriginal Heritage Act 1972*. The Department of Indigenous Affairs (DIA) has since advised that the impact area contains no sites for the purposes of the Act. Updated archaeological surveys of the area did not identify any archaeological sites within the land requirement boundary.

Given this, it is expected that there will be no significant impacts on Aboriginal heritage values as a result of the proposal proceeding. The proponent will still ensure that an

archaeologist is on-site during earthworks to monitor any potential finds that may be uncovered during excavation works.

Summary

The evaluation completed in this PER has identified the environmental factors of significance with the potential to be impacted by the construction of the proposed on-ramp. Some of these impacts appear unlikely to be significant, others can be managed by design approaches and construction work methods, whilst the remainder are more difficult to quantify or directly address. A summary of the impacts identified and their likelihood of occurring given the proposed environmental management is presented in Table 1.

Table 1: Summary of potential impacts, factors affected and risks with the management proposed for the Abernethy Road – Tonkin Hwy on-ramp project.

Impacts	Relevant Factors	Risk of Impacts Given Proposed Management Measures
Short Term (Construction)		
1. Vegetation clearing (Section 4.3.1, Section 2.3.4)	Flora, Vegetation, Fauna, Wetlands	Loss of relatively small area (1.4 ha) of regionally significant vegetation/wetland habitat will occur -> significant impact that has been reduced by planning and design as far as possible
2. Vehicle and plant movements beyond clearing area (Section 4.3.1)	Flora, Vegetation, Fauna, Wetlands	Induction and clearing controls procedures during construction in EMP and specifications -> low level of risk of impact
3. Pedestrian movements beyond clearing area (Section 4.3.1)	Flora, Vegetation, Fauna, Wetlands	Induction and clearing controls procedures during construction in EMP and specifications -> low level of risk of impact
4. Construction bushfires in adjacent bushland (Section 4.3.1)	Flora, Vegetation, Fauna, Wetlands	Bushfire risk control procedures during construction in EMP and specifications -> low level of risk of impact
Long Term (Operational Life)		
1. Weed introduction and spread into adjacent bushland (Section 4.3.2)	Flora, Vegetation	Hygiene during construction with follow-up monitoring and control -> low level but ongoing risk of introduction of exotics
2. Dieback introduction into adjacent bushland (Section 4.3.2)	Flora, Vegetation	Hygiene during construction -> low risk of dieback introduction
3. Surface hydrology changes (Section 4.6.2)	Flora, Vegetation, Fauna, Wetlands	Low probability of significant impact
4. Groundwater changes (Section 4.6.2)	Flora, Vegetation, Fauna, Wetlands	Low probability of significant impact
5. Increased fire frequency (Section 4.3.2)	Flora, Vegetation, Fauna, Wetlands	Ongoing risk, but probably insignificant increase in current risk levels given existing proximity of Tonkin Highway
6. Edge effects / bushland integrity reduction (Section 4.3.2; Section 4.7)	Flora, Vegetation, Fauna	Reduction of local conservation Zone (77ha) and Bush Forever Site 386 (629 ha) by 1.4 ha will occur -> some low level of reduction in long term ecological viability
7. Increase in local noise levels (Section 4.5.2)	Fauna	Potential impact on breeding success difficult to quantify, but considered unlikely given existing local noise levels
8. Road kill increases (Section 4.5.2)	Fauna	Low probability of significant impact
9. Contaminant spills (Section 4.6.2)	Flora, Vegetation, Fauna, Wetlands	Detention basins providing spillage entrapment -> low probability of significant impact

The over-arching impact to emerge from this assessment is related more to a reduction of 1.4 ha in regionally significant conservation area (Bush Forever site 386) rather than focussed on impacts to any particular species or specific feature of the site. Vegetation and fauna communities on the eastern Swan Coastal Plain have been subject to heavy clearing and habitat fragmentation through past land practices, such that there are few areas that now support substantial remnants. The Perth Airport bushland is one of these sites and any further reduction in its area is likely to have some level of effect on the long term viability of the communities and integrity of the ecosystem process present. It must be recognised however, that the on-ramp proposal is a relatively small disturbance area both in real terms (1.4 ha) and in its proportional representation of the Bush Forever site (0.2%).

In addition, the Perth Airport area has been well studied and subject to a lengthy integrated planning process. This masterplan aimed to identify the areas with the highest conservation values and set these aside from development. The 313 ha set aside included the on-ramp project area, but also recognised its future presence in its currently proposed location. The masterplan was then formally agreed on as the subject of a Memorandum of Understanding between the Perth Airports Corporation and the State Government. This agreement was recognised in Bush Forever and offers some certainty with regards to future land-use and development in the area. One aspect of this is that it is unlikely that the identified conservation areas within the site will be further eroded by any currently unforeseen developments, given the extensive planning and consultation process required to arrive at the masterplan. The on-ramp development was foreshadowed at its current site in the masterplan, but no other potential land clearing was noted for the conservation zones.

Based on this, the view could be taken that the balance of the remnant bushland in the airport area is somewhat more secure from future land development than urban remnants in other parts of the metropolitan region. A lack of integrated regional planning can often lead to unrelated projects independently clearing land in the same locality without any rationalisation of overall impacts. This should not be the case in the airport area given its history and planning structure, with the current expectation being one of no further reduction in the extent of the bushland conservation zones. Even with this being the case, the proponent recognises the regional significance of the environmental features that may be impacted and is preparing a package of environmental offsets, with the objective of achieving no net loss of environmental values within the locality.

The environmental management procedures committed to by Main Roads should ensure that the impact of the on-ramp is kept to the minimum possible, with ongoing degradation processes reduced in the adjacent Bush Forever site to the extent that this is possible in an urban bushland context.

Proponent Commitments

The proponent has developed a number of environmental management commitments derived from the potential impacts to the environmental factors relevant to this proposal. These are provided in summary form in the following table.

Proponent commitments for the proposed Abernethy Road – Tonkin Highway on-ramp.

No.	Topic	Objective	Action	Timing	Advice from †
1	Environmental offset	To provide an appropriate offset for the removal of regionally significant vegetation and wetland area.	Develop and implement a strategy to address the loss of conservation values through the rehabilitation of a degraded area, or acquisition or securing of another area of similar ecological value for conservation purposes.	Process commenced pre-construction, to be finalised during or within three months of the completion of construction.	DCLM, DEP, DPI, DOLA
2	Environmental Management Programme	To minimise the impacts of construction works on the adjacent vegetation and fauna habitat remaining within Bush Forever Site 386. To ensure no impacts on nearby populations of Threatened Flora occur.	To prepare and implement an Environmental Management Programme (EMP) for the construction of the Abernethy Road – Tonkin Highway on-ramp. Components of the plan will include: 1. vegetation clearing controls 2. topsoil and landscaping plan 3. dieback and weed hygiene 4. environmental inductions 5. fire risk management 6. environmental auditing 7. drainage management	Prepared and approved prior to construction. Implemented during construction. Audits completed during construction works and post-construction.	DEP
3	Drainage Management	To ensure that no road surface run-off directly enters the wetland. To ensure that there is provision for contaminant spillage entrapment. To ensure continued function in disposal of road run-off and infiltration /recharge to the local aquifer.	Construct the detention / infiltration basin as designed. Periodic monitoring of the infiltration basin post-construction to ensure continued function and maintain as required.	Design finalised pre-construction, implemented during construction and post-construction.	DEP, WRC
4	Priority Flora	To ensure that DCLM requirements are met regarding rehabilitation, transplanting or other management measures for threatened flora species.	Liaise with DCLM regarding management requirements for Priority flora in regards to transplanting of *Verticordia lindleyi* subsp. *lindleyi.*	Pre-construction, with any DCLM required management actions.	DCLM

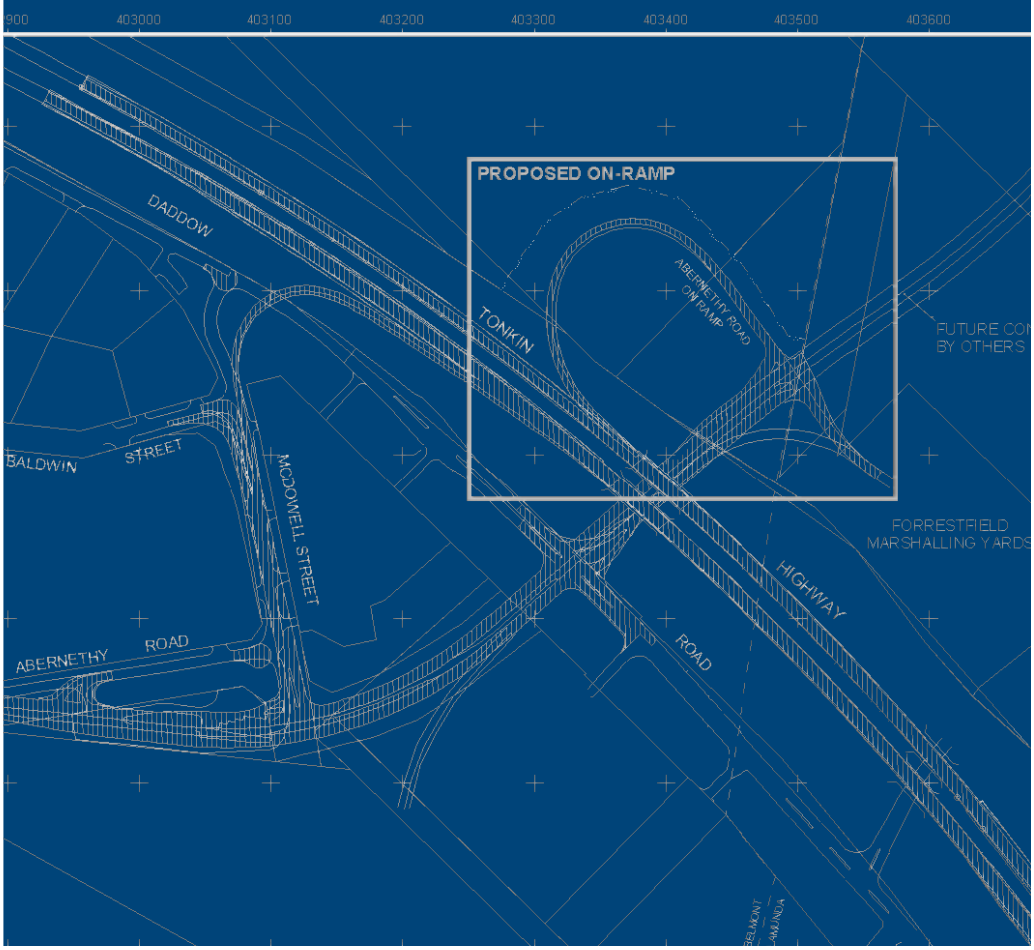
Proponent commitments for the proposed Abernethy Road – Tonkin Highway on-ramp.

No.	Topic	Objective	Action	Timing	Advice from †
5	Acid Sulfate Soils	To ensure that adjacent wetland areas are not impacted by any acid drainage that may arise from sediments exposed during construction.	Implement assessment and management procedures in accordance with the Draft DEP Guidance Statement on ASS	Testing carried out prior to commencement of earthworks, any management procedures that may be required to be implemented during construction in accordance with the Draft DEP Guidance Statement on ASS	DEP
6	Aboriginal Heritage	To ensure that no sites of significance to Aboriginal people are impacted.	Prepare an Aboriginal Heritage Management Plan, to specify archaeological monitoring during construction activities.	Plan prepared prior to the commencement of construction and implemented during construction, with any statutory processes followed as per the requirements of the *Aboriginal Heritage Act 1972*.	DIA

† Advisory agencies: DEP – Department of Environmental Protection, DCLM – Department of Conservation and Land Management, DPI = Department of Planning and Infrastructure, DOLA = Department of Land Adminstration, WRC = Water and Rivers Commission, DIA = Department of Indigenous Affairs.

Section 1.0

Introduction



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1.0 Introduction

1.1 Project Background

Main Roads Western Australia (Main Roads) is in the process of finalising project design, land acquisition and formal approvals for the proposal to construct an on-ramp at the Abernethy Road – Tonkin Highway interchange in Kewdale. The general scope of the proposed activities includes the construction of the on-ramp itself, and the construction of a new stormwater retention basin within the loop created by the on-ramp (see Figure 1.1).

The potential environmental impacts associated with the proposed on-ramp have been investigated to varying degrees in a number of previous studies (see Section 1.5). These have largely revolved around the status of the land proposed for the on-ramp and the remnant vegetation present thereon. The on-ramp will require 2.3 ha of land, 1.4 ha of which forms part of Bush Forever Site 386 (Perth Airport and adjacent bushland). The potential impacts of the development on Threatened Flora and vegetation communities have formed a focus for the formal consideration of this project. This Public Environmental Review (PER) provides a summary and update of the previously completed studies relating to these issues and a wider consideration of other environmental factors relevant to the proposal.

1.2 The Proponent

The proponent for this proposal is Main Roads Western Australia (Main Roads). For the purposes of this proposal, the contact details for the proponent are:

Main Roads Western Australia
Don Aitken Centre
Waterloo Crescent
East Perth WA 6001
Attention: Mr. Paul West

Note that submissions on this PER should be directed to the Environmental Protection Authority (EPA) Service Unit as outlined on the first page of this document and not sent directly to the proponent.

1.3 Statutory Requirements

The proposal to construct the Abernethy Road - Tonkin Highway on-ramp was referred to the EPA under Section 38 of the *Environmental Protection Act 1986*. The EPA determined that the proposal would be formally assessed at the level of PER, with a four week public comment period (Appendix 1). This PER primarily addresses the requirements of the *Environmental Protection Act 1986*, but also addresses the requirements of other acts that have bearing on the issues involved. The main acts of relevance include:

- *Wildlife Conservation Act 1950-1979;*
- *Soil and Land Conservation Act 1945;*
- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999);*
- *Agriculture and Related Resources Protection Act 1976; (and)*
- *Aboriginal Heritage Act 1972.*

The requirements of these acts and their applicability to the issues at hand are discussed individually in the relevant sections of this PER.

1.4 Relevant Environmental Factors

The environmental factors relevant to this proposal were identified in the EPA scoping document for the proposal (Main Roads 2002; Appendix 2), as reproduced below in Table 1.1.

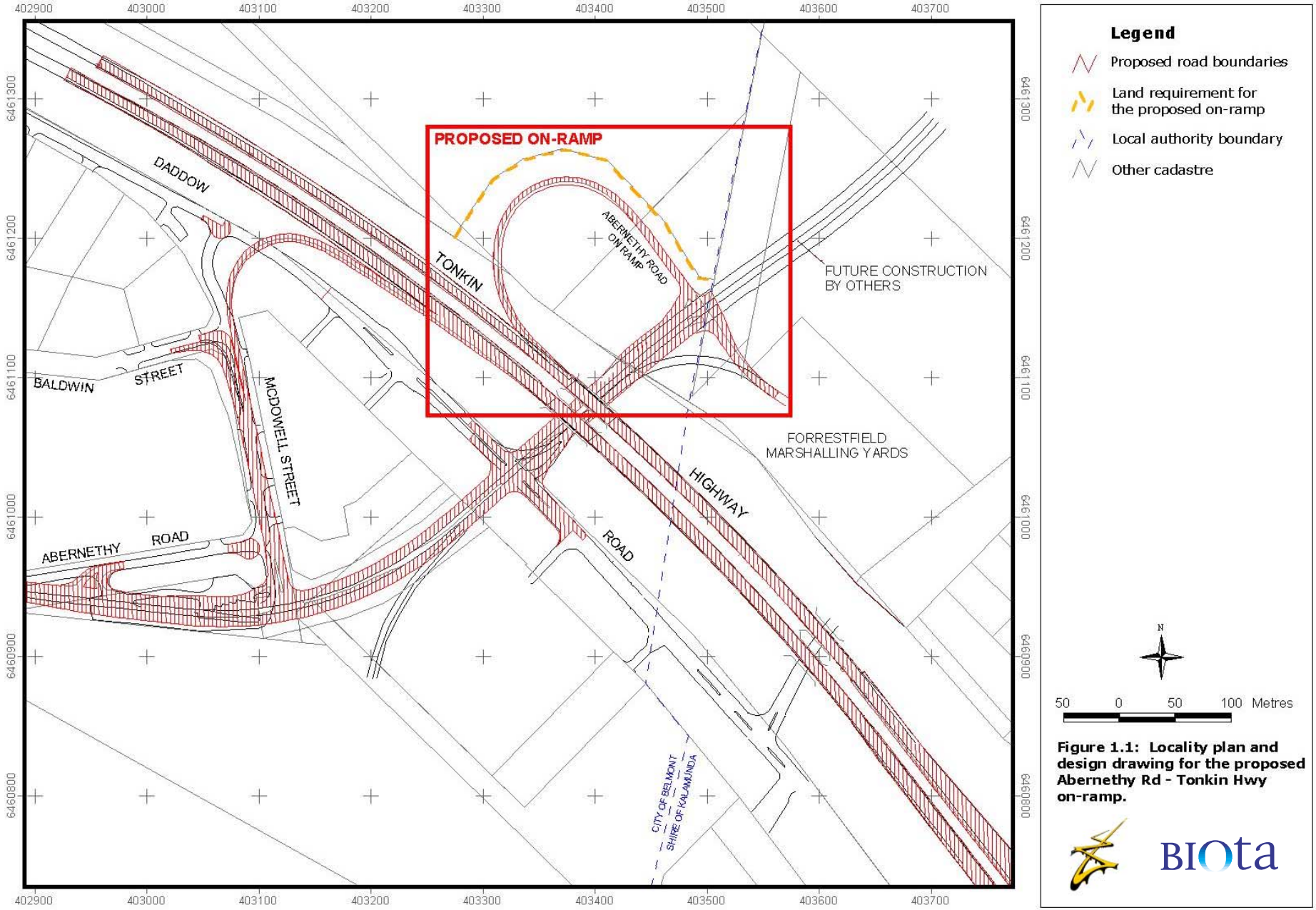


Figure 1.1: Locality plan and design drawing for the proposed Abernethy Rd - Tonkin Hwy on-ramp.

Table 1.1: Environmental Factors relevant to the proposal (source: Main Roads 2002; Appendix 2).

Environmental Factors	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management
Biophysical					
Fauna	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	Minimise disturbance to fauna that occur within or adjacent to the study area.	Clearance of 1.43 ha of habitat	Undertake a field survey to determine if there are any Significant Bird Species of the Swan Coastal Plain Portion of the Perth Metropolitan Region.	Clearing will be undertaken in a progressive manner to ensure that corridors are available to the more mobile fauna. Rehabilitate an adjacent disturbed area to create suitable habitat for the fauna of the area.
Threatened Fauna	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	No mortalities to the Southern Brown Bandicoot. Provide appropriate habitat by rehabilitating an adjacent area.	Clearance of 1.43 ha of Southern Brown Bandicoot habitat.	None	The impact to the bandicoot is not expected to be significant as the area to be cleared is less than an individual's home range. Clearing will be undertaken in a progressive manner to ensure that corridors are available to the more mobile fauna.
Flora and Vegetation	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	To ensure that the overall objectives of the construction of the on-ramp is compatible with maintaining and, where possible, enhancing the biological integrity of the surrounding environment and minimising vegetation loss and degradation.	Clearance of 1.43 ha of vegetation.	Assess the adjacent disturbed area to determine the likely vegetation types it supports.	Peg and fence clearance boundaries. Rehabilitate an adjacent disturbed area using the topsoil and seeds from the project area. Offsets/mitigation potential. Seed will be collected prior to clearing. Mulched vegetation from the project area will be used to assist rehabilitation.
Threatened Flora	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	Not to have a negative impact upon the survival of the endangered DRF *Macarthuria keigheryi*.	One DRF is known to occur within the vicinity of the project area. Three targeted surveys have not identified the species within the 1.43 ha to be impacted upon.	Undertake another DRF survey and determine if the species is likely to be impacted upon by the project.	If within the immediate vicinity of the project area, peg off known sites to ensure individual plants are properly protected.

Table 1.1 (cont): Environmental Factors relevant to the proposal (source: Main Roads, 2002; Appendix 2).

Environmental Factors	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management
Threatened Vegetation	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	Not to have a negative impact upon the survival of the endangered TEC Shrublands and woodlands of the Eastern Swan Coastal Plain.	Approximately 0.6 ha of 'Shrublands and woodlands of the Eastern Swan Coastal' Plain will be cleared within the project area. 8.2 ha will still remain in an adjacent area.	Assess the adjacent disturbed area to determine the likely vegetation types it is likely support.	Rehabilitate an adjacent disturbed area using the topsoil and seeds from the project area. Offsets/mitigation potential. Seed will be collected prior to clearing. Mulched vegetation from the project area will be used to assist rehabilitation. The main focuses of the landscaping plan will be to promote the growth of this association in rehabilitated areas.
Wetlands	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	Minimise the impacts to the hydrology of the airport site.	Clear 0.8 ha of Conservation Category Wetland. Some ongoing indirect effects may occur on the wetland habitat remaining in the area adjacent to the on-ramp.	Assess the adjacent disturbed area to determine whether the area has a wetland category status. Undertake a hydrological study to determine the likely hydrological impacts in and around the project area.	Investigate whether the adjacent disturbed area is a wetland. If possible, a rehabilitation plan will be developed to improve the quality of the wetland. Offsets/mitigation potential. Undertake construction of the on-ramp during drier months. Drainage system to be designed so as to avoid direct runoff or stormwater discharge entering adjacent wetland areas. A sump will be located within the on-ramp.
Social					
Aboriginal Heritage	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	To ensure that there is no unauthorised disturbance to Aboriginal heritage sites associated with the construction of the on-ramp.	None at this stage.	An Ethnographic survey is currently being undertaken. Outcome of consultation has not yet been determined.	Aboriginal community may be used to assist with the collection of seed and rehabilitation.

These environmental factors provided the framework for the structure and scope of this PER, within the general guidance provided by the EPA Guidelines for Preparing a Public Environmental Review / Environmental Review and Management Programme (see Appendix 2). The relevant environmental factors are addressed in the various sections of this PER, including an account of historical work completed on each factor (Section 1.5), and the scope and outcomes of the additional investigations identified in Table 1.1. Preliminary environmental management approaches to address the objective for each factor were then reviewed and refined in light of this additional work where appropriate (Sections 4.0 and 5.0).

1.5 Previous Studies

The proposal to construct an on-ramp to Tonkin Highway in this area has been under active development by Main Roads for more than four years. Work completed prior to the preparation of the current report includes:

- Final design report (CMPS&F 1999);
- Transport planning and option evaluation studies (Egis 2002);
- Fauna and flora assessment survey (Ecologia 1998);
- Spring rare flora and vegetation survey (Ecologia 1999);
- Preliminary ethnographic investigations (O'Connor 1998);
- Preliminary archaeological investigations (Harris 1998);
- Draft Environmental Assessment and Management Plan (EAMP) (Egis 1999); and
- Preliminary Environmental Impact Assessment (Biota 2002).

The findings of these reports have been drawn on and summarised where relevant in the preparation of this PER.

1.6 Definition of Spatial Scale Terms

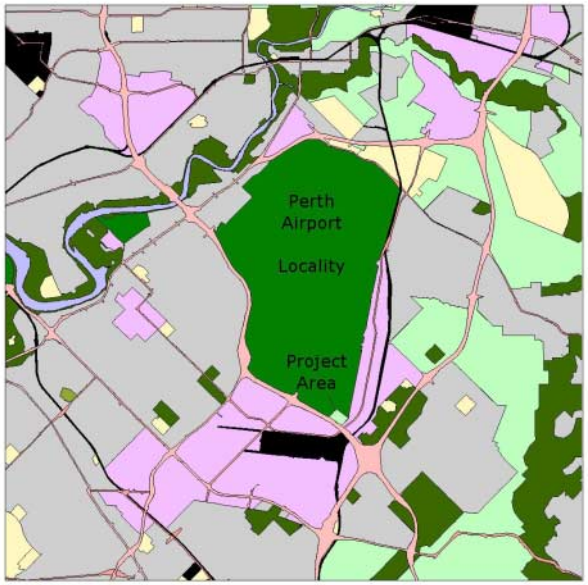
In the interests of clarifying what spatial scale is being discussed in this document, the following terms have been used to equate to specific geographic scales (see Figure 1.2):

- **Region (regional)** – Used as equivalent to the Swan Coastal Plain (SCP) bioregion (Thackway and Cresswell 1995);
- **Locality (local)** – Taken as equating to the Perth Airport bushland (Bush Forever Site 386; Government of Western Australia 2000);
- **Project area** – This area has been used as the subset of Bush Forever site 386 that is in the immediate area of the proposed on-ramp. This area is the scale presented in most figures shown in the PER and is the area within which vegetation was mapped to evaluate the loss and remaining representation of vegetation types/habitats in the immediate area of the proposed on-ramp (see Figure 3.1); and
- **Land requirement** – the smallest scale of reference for this PER, this term equates to the Main Roads area of land identified to accommodate the proposed on-ramp. This 1.4 ha area is the area of vegetated land that will be directly impacted through clearing as a result of the proposal proceeding.

These terms have been used consistently throughout this PER to identify various spatial scales of consideration and are also consistent with the terms used for the assessment of conservation significance presented in Section 4.2.

Regional

Project area



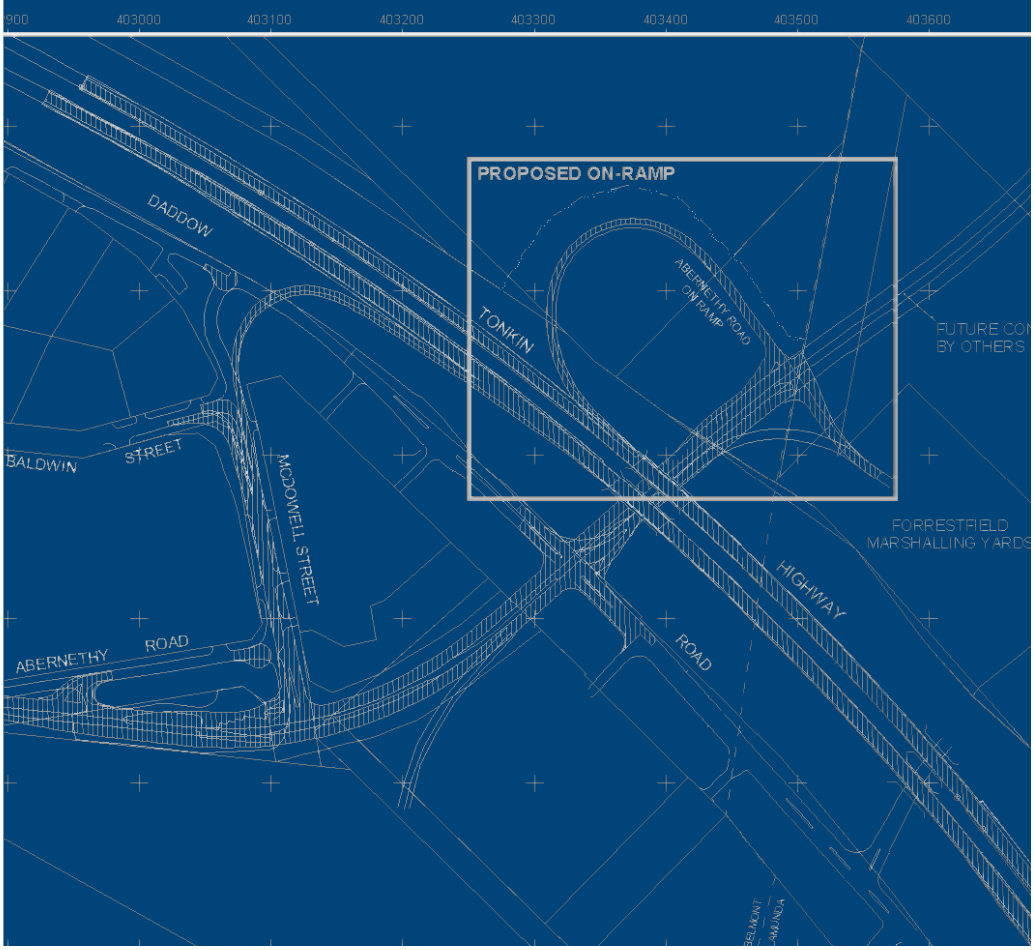
Local

Land requirement

Figure 1.2: Spatial scales used in reference to this PER (in descending order of magnitude; relevant scale shown in green).

Section 2.0

The Proposal



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2.0 The Proposal

2.1 Description of the Proposal

The proposed Abernethy Road – Tonkin Highway on-ramp will require the addition of approximately 2.3 ha of land to the existing Tonkin Highway reservation. This area will comprise 0.9 ha which is already cleared and 1.4 ha of remnant native vegetation that is currently part of the Perth Airport bushland (see Figure 2.1; Section 2.2). The proposal will involve vegetation clearing, preliminary site earthworks, the construction of the on-ramp itself and the implementation of drainage treatments and controls. Design drawings are shown in Figure 1.1, with the land requirement, existing constraints and construction boundaries overlain on aerial photography of the site in Figure 2.1.

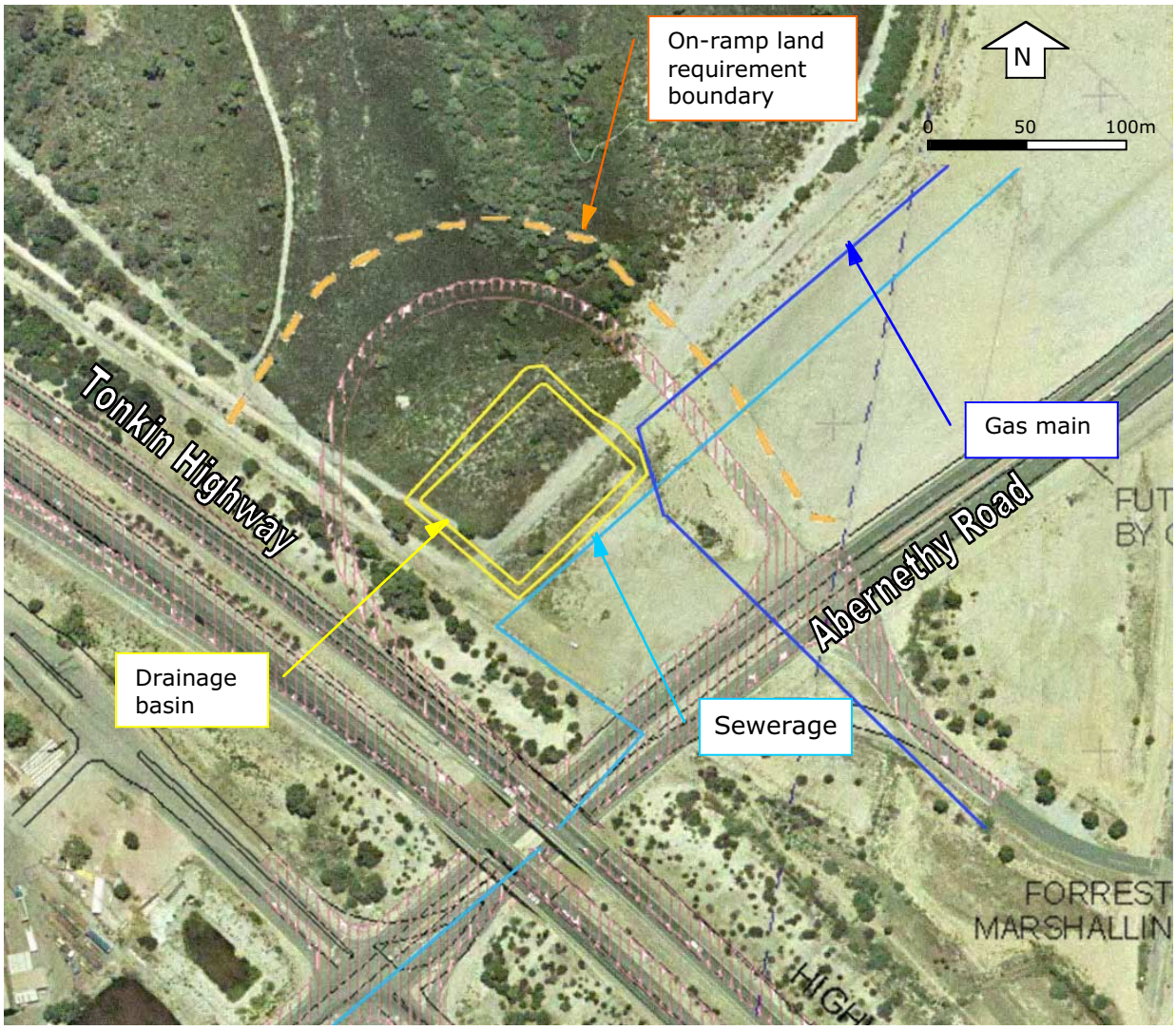


Figure 2.1: Aerial photography of the proposed site for the on-ramp showing land requirement, drainage basin and existing constraints.

The acquisition/rehabilitation of additional land to add to another area of regionally significant bushland will also form an integral part of the proposal (see Section 5.2). This area will be set aside for conservation purposes, with the proponent also developing urban bushland management measures. A summary of the key characteristics of the proposal is provided in Table 2.1.

Table 2.1: Key characteristics of the proposal.

Element	Description
Construction duration	4 months
Operation life of proposal	Ongoing (30 years plus)
Area of disturbance	2.3 ha (1.4 ha vegetated, 0.9 ha already cleared)
Components	• On-ramp to Tonkin Highway • Drainage treatments and detention basin
Traffic volume	~5,700 vehicle movements per day by 2021
Environmental offsets	Acquisition of bushland area for conservation purposes

2.2 Land Status

Tonkin Highway is reserved in the Metropolitan Region Scheme (MRS) as a 'Primary Regional Road', with Abernethy Road identified as an 'Other Regional Road' (Egis 2002). According to the Department of Land Administration (DOLA), the land proposed to accommodate the construction of the on-ramp is situated within Pt Lot 389 (1.4 ha) and Swan Loc 13626 (0.9 ha). Swan Loc 13626 is a cleared parcel of land, currently zoned 'Industrial' under the MRS (see Figure 2.2). The remainder of the land required for the on-ramp is within Pt Lot 389, located inside the Perth Airport site. It is the environmental values of this latter parcel of land that is the main focus of this assessment. Pt Lot 389 currently forms part of the Perth Airport site and is therefore zoned for 'Public Purposes' (CG – Commonwealth Government) under the MRS (Figure 2.2). Main Roads is currently in the process of acquiring the required land (and has been for a considerable period). The acquisition of the airport land is part of a complex land swap involving several organisations including Main Roads, Westralian Airport Corporation, DOLA, Swan and Kalamunda Councils. The Australian Government Solicitor is currently developing an inter-government Deed of Agreement to put the land swap into effect legally and it is hoped that this will be finalised and signed within the next two months.

The Department of Planning and Infrastructure (DPI) has confirmed that the land will be rezoned to 'Primary Regional Road' (consistent with its proposed use) once the acquisition process has been finalised. The Western Australian Planning Commission (WAPC) has declared a 'planning control area' over the land in the interim, preventing other development until the land can be rezoned and incorporated into the Tonkin Highway reservation.

2.3 Evaluation of Options

2.3.1 Requirement for the On-ramp

One of the main purposes for the on-ramp is to provide improved access from the Kewdale, Forrestfield and Wattle Grove industrial areas to the primary road network via Tonkin Highway. One of the principal demands for this within the Forrestfield industrial area is the CBH Metropolitan Grain Terminal, which attracts a large number of semi-trailer and road train vehicles on a seasonal basis. It is therefore highly desirable from both safety and community amenity perspectives that Main Roads provides an on-ramp in this area. The specific traffic requirements for ramp connections between Abernethy Road and Tonkin Highway (Egis 2002) include the provision of:

- improved freight access to the industrial development in the Forrestfield Marshalling yards (particularly the CBH Metropolitan Grain Terminal);
- truck access to the inter-modal facilities on the Kewdale railway land; and
- improved heavy freight access to the existing Kewdale / Welshpool industrial areas.

2.3.2 Options Considered as Alternatives to the Proposed On-ramp

The proposed location for the on-ramp is largely determined by proximity to existing and planned highway interchanges and the necessity to allow safe distances for heavy freight traffic to integrate into existing traffic flows on Tonkin Highway. Traffic modelling and operational analysis is discussed further in Egis (2002).

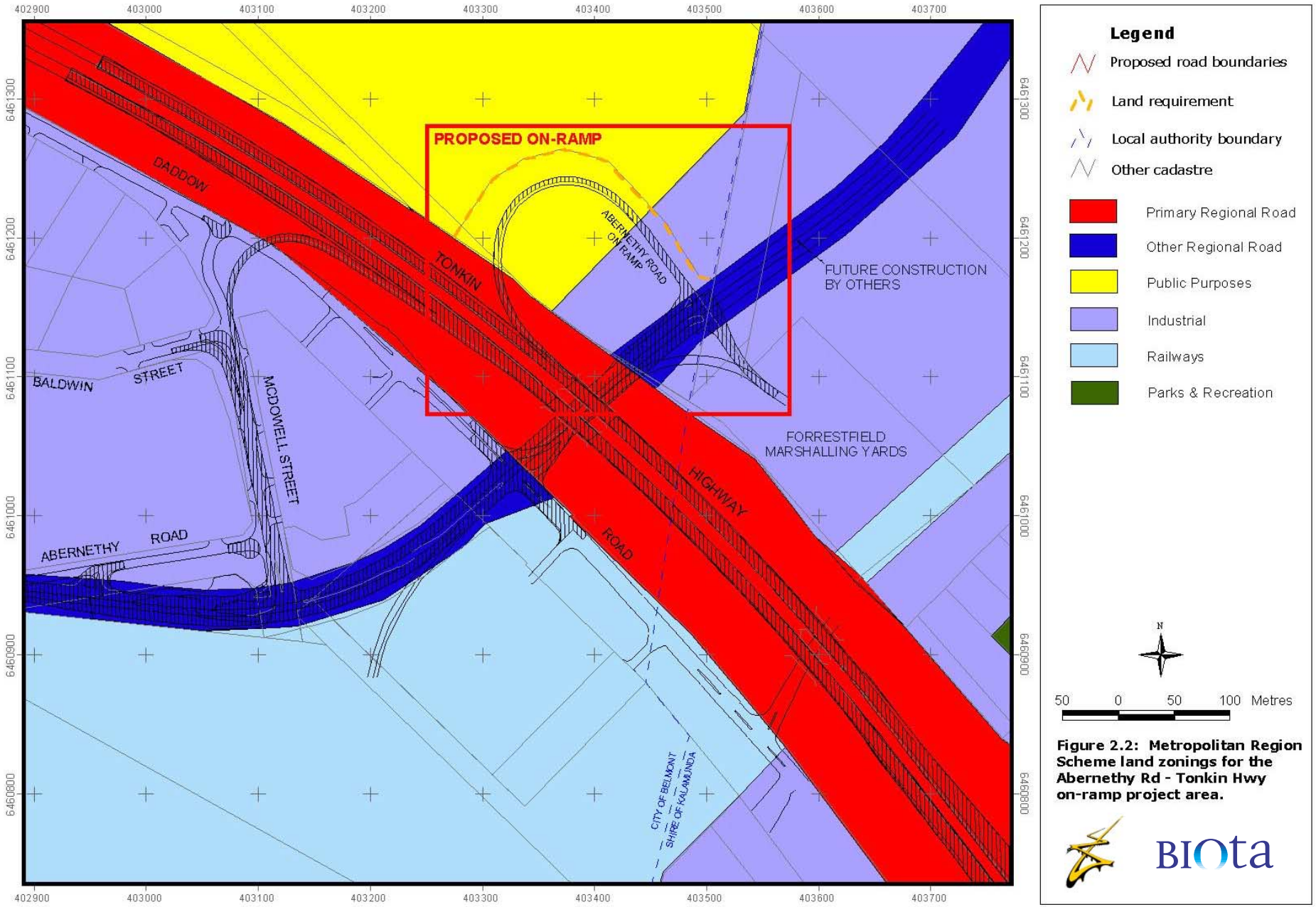


Figure 2.2: Metropolitan Region Scheme land zonings for the Abernethy Rd - Tonkin Hwy on-ramp project area.

Three alternative interchange arrangements at Abernethy Road were examined to provide better access and avoid the need for additional land requirement. These were all rejected in favour of the currently proposed design. A summary of the evaluation of these options follows.

Option 1 - Abernethy Road ramps to the north

An option was considered that included additional ramps at Abernethy Road to provide access to and from Tonkin Highway north as shown in Figure 2.3.

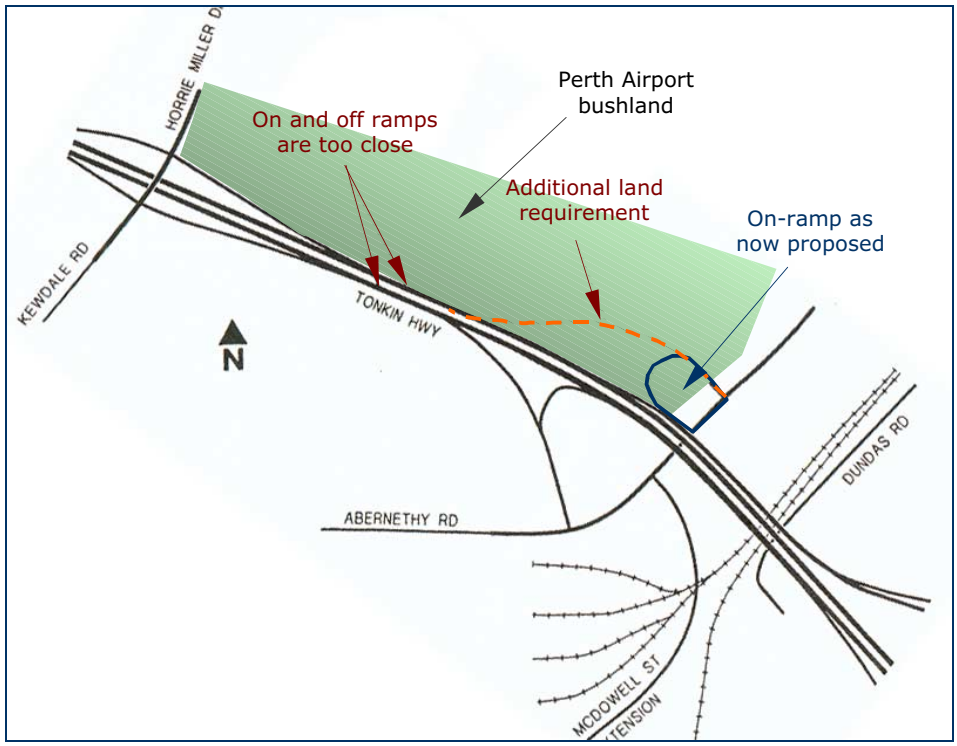


Figure 2.3: Option 1 - Abernethy Road ramps to the north (modified from Egis 2002; not to scale, boundaries and locations approximate).

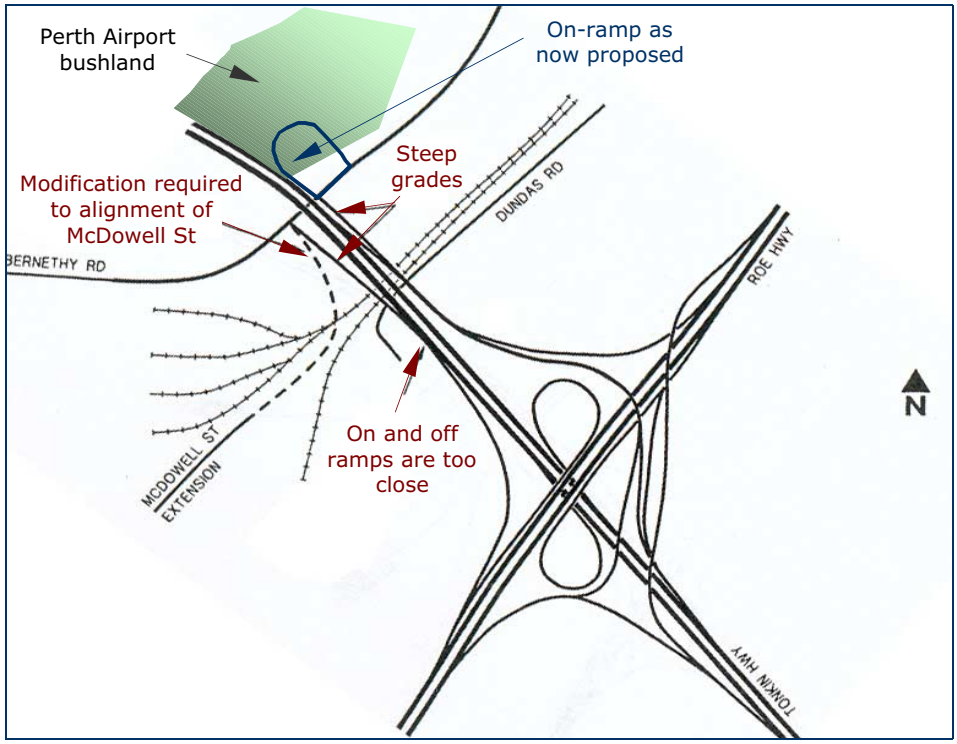


Figure 2.4: Option 2 – Half-diamond ramps to the south (modified from Egis 2002; not to scale, boundaries and locations approximate).

Option 1 was rejected primarily because of the substantial additional land requirement and associated environmental impact that it would have had on the Perth Airport bushland (see Figure 2.3; Egis 2002). With this option the ramps would also be too close to the future interchange at Kewdale Road and Horrie Miller Drive, with access to the primary road network to the north available via this interchange with minimal additional travel distance.

Option 2 – Half-diamond ramps to the south

The option of half-diamond ramps to the south was investigated with a view to avoiding any land requirement within the Perth Airport land (see Figure 2.4). Unfortunately this option did not prove feasible as it would provide only a short distance between Abernethy Road and the bridge over the existing railway. This would result in a very steep on-ramp, with the steep upward grade preventing larger vehicles from accelerating up to highway speed. This would then result in a dangerous speed differential where entering traffic from the ramp merges with existing traffic on Tonkin Highway (Egis 2002). The off-ramp under this scenario would also have a steep downward grade that could be dangerous for heavy vehicles exiting Tonkin Highway and having to stop at Abernethy Road.

In addition, the off-ramp would be too close to the on-ramp from Roe Highway west for safe traffic filtering, and would also not allow for the extension of McDowell Street to Abernethy Road on its proposed alignment (Egis 2002; Figure 2.4).

Option 3 – Extended on-ramp

The option of constructing an extended on-ramp was investigated as this would have enabled the ultimate interchange layout at Tonkin and Roe Highways to be retained, avoiding the need for additional land on the western side of Tonkin Highway (Figure 2.5).

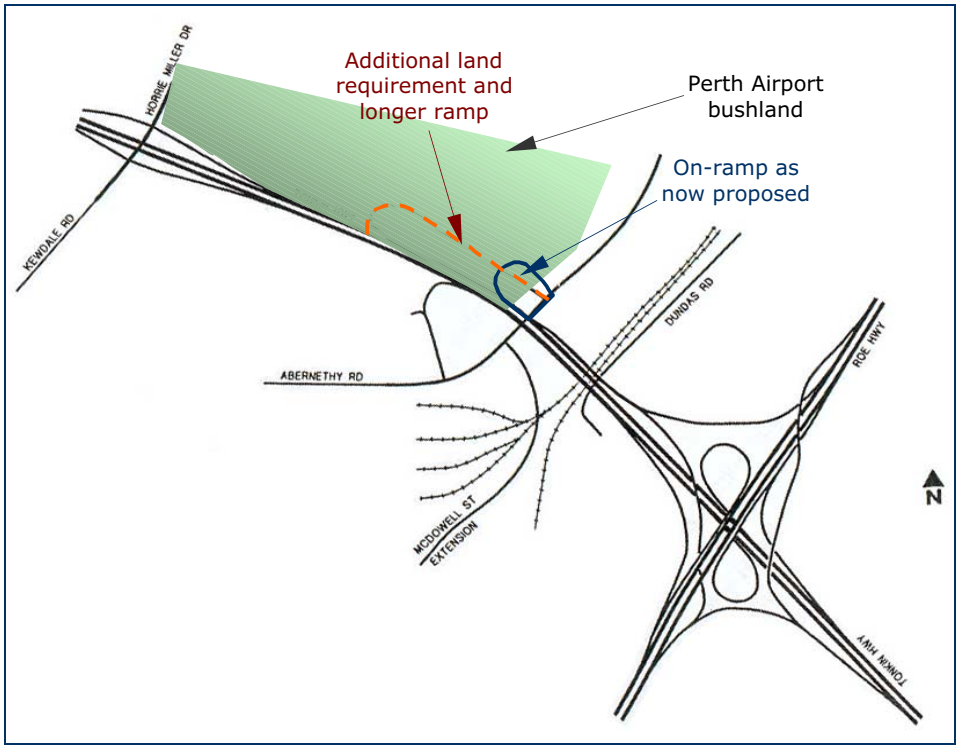


Figure 2.5: Option 3 – Extended on-ramp (modified from Egis 2002; not to scale, boundaries and locations approximate).

This option was rejected, primarily because of the increased land requirement to the north and associated impact on the Perth Airport bushland (see Figure 2.5). The ramp length for this scenario would also need to be longer, therefore providing little benefit over using the future on-ramp at Kewdale Road / Horrie Miller Drive (Egis 2002).

A summary of the key features of the interchange alternatives considered, relative to the arrangement as now proposed, is provided in Table 2.2.

Table 2.2: Summary of the key features of the alternative interchange arrangements considered relative to the proposed on-ramp.

Option	Land requirement from Perth Airport site	Traffic safety considerations
1 (Abernethy Rd ramps to the north)	Substantially greater	Too close to Kewdale Rd / Horrie Miller Dr interchange
2 (Half-diamond ramps to the south)	None	Steep grades on ramps creating dangerous speed differentials Too close to on-ramp from Roe Hwy west
3 (Extended on-ramp)	Greater	Acceptable

Options 1 and 3 were rejected on the basis of their increased land requirement from Perth Airport bushland compared to the on-ramp design as proposed. Option 2, which was the best option from a purely environmental perspective, could not be pursued due to the inherent safety risks it would create for road users.

The preferred option has provided a balance of traffic safety considerations and provision of access to the primary network where it is most required, whilst minimising land requirement from Bush Forever Site 386. Main Roads final design for the on-ramp under the preferred option has moved the on-ramp as close to the existing Abernethy Road alignment as design and traffic safety constraints would allow. This has resulted in the minimum possible vegetation clearing for this option, with 40% of the additional land required to build the on-ramp comprising existing cleared areas (0.9 ha; Section 2.1; Section 5.1).

2.3.4 Construction Method and Detailed Design Options Considered

Given that the option evaluation arrived at a relatively fixed location for the proposed on-ramp, detailed design and construction method options were also investigated. This primarily related to the construction format and work method for the on-ramp and the size and location of the drainage basin.

The on-ramp will be constructed as a solid earthworks structure, with steep angle of repose stabilised batters or retaining. The option of constructing the on-ramp as a so-called 'raised deck' was considered but would have entailed building a curved bridge and, based on typical unit costs for bridges in the Perth metropolitan area, would have increased the cost of the ramp by approximately five million dollars. This additional expense could not be justified on environmental grounds, given that the raised deck would not have resulted in any real reduction in the disturbance footprint as there would still be a requirement for the same level of construction access and movement of construction traffic in order to install footings.

The size and location of the drainage basin was also reviewed by Main Roads' design engineers with a view to minimising its footprint and moving it as far to the south-east as possible. The size of the basin was determined primarily by the extent of the road surface catchment that would deliver drainage to the basin based on a criterion of accepting a 1 in 100 year storm event. The shape and location of the basin was dictated primarily by the requirement to accommodate this storage capacity within the existing constraints of a high pressure gas pipeline and a wastewater treatment infrastructure already present on the site (see Figure 2.1). Reducing the size of this basin or following other approaches such as swale type drains would not have provided for containment of larger storm run-offs, and would have led to potential flooding of the adjacent sewer pumping station and caused erosion and scour. Other drainage treatments would also have reduced the basin's functionality as a contaminant spillage entrapment device.

2.4 High Wide Load Corridor (HWL) Project

As part of Government's support of the heavy engineering industry in Western Australia, Cabinet has agreed to the allocation of substantial funding for the provision of a High Wide Load (HWL) Corridor capable of accommodating loads up to 8 m high x 8 m wide and 24 m long. The proposed Abernethy Road on-ramp is recommended to form part of this corridor, which in turn forms part of a broader recommendation to service the metropolitan area between Kewdale and the Great Northern and Great Eastern Highways. The HWL project is being advanced by an inter-agency working group that has identified that the proposed Abernethy Road on-ramp connections would provide substantial benefit by relocating Heavy Haulage traffic away from suburban areas such as Forrestfield.

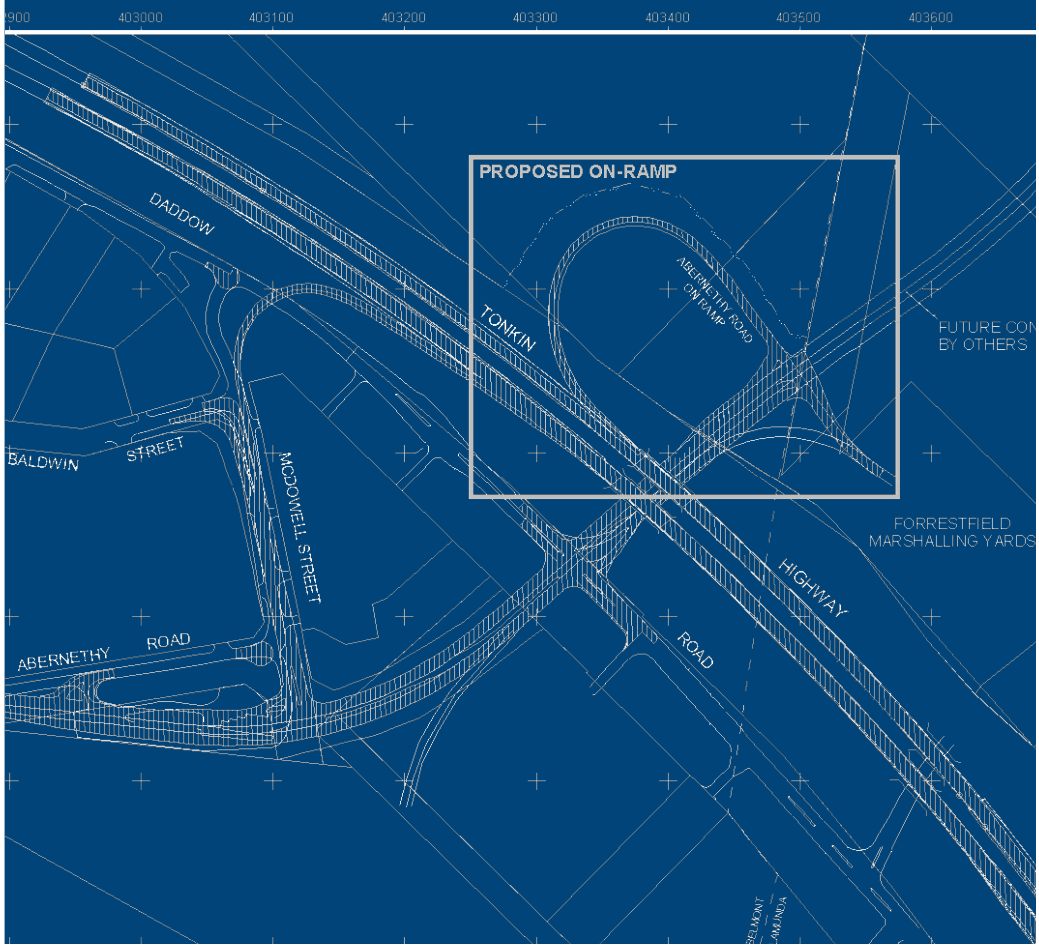
Works that will be undertaken as part of the implementation of the HWL project include bridge strengthening, traffic light relocation, minor pavement widening and adjustments to medians. Implementation of these works as part of the HWL initiative would not result in any increase in the land requirement or ecological impacts associated with the proposed Abernethy Road - Tonkin Highway on-ramp.

2.5 Project Timing

At present, the future timing for project implementation is largely dependent on finalisation of land acquisition processes and the completion of the formal environmental approval process of which this PER forms a part. Subject to these issues being resolved, it is Main Roads' intention to commence construction works in the area early in the 2003-2004 financial year. Construction of the on-ramp is expected to be complete within four months of the commencement of works on the site.

Section 3.0

Existing Environment



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3.0 Existing Environment

3.1 Geomorphology and Soils

At a regional scale, the project area is situated in the eastern half of the Swan Coastal Plain bioregion (Thackway and Cresswell, 1995). The landform in the project area primarily consists of a flat sandplain overlying clays and swamp deposits in some areas. Soils largely consist of Bassendean sands (fine to medium grained quartz of aeolian origin) and pebbly silts overlying Guildford Formation (pale brown, silty to sandy clay of fluvial origin) (Egis 1999, Aquaterra 2003). A small area associated with the wetland formation in the project area comprises dark grey and black peaty clay with variable sand content. This area consists of thin swamp deposits of low permeability overlying Guildford Formation.

3.2 Flora and Vegetation

3.2.1 Methodology

- **Previous Surveys**

Two detailed flora and vegetation surveys have previously been carried out in the proposed on-ramp project area:

- Fauna and Flora Assessment Survey (Ecologia 1998); and
- Spring Rare Flora and Vegetation Survey (Ecologia 1999).

A targeted rare flora survey and confirmation of vegetation mapping boundaries was also completed as part of a preliminary environmental assessment of the current proposal (Biota 2002). The area in question has therefore been the subject of three flora and vegetation surveys prior to the additional investigations completed as part of this PER. The data arising from these earlier surveys were consolidated into the current assessment. A cumulative species list for the project area was compiled using these reports and the results of the current survey (Appendices 3 and 4).

Several other general surveys of the Perth airport reserve have also been completed previously, providing useful context for the project area (Table 3.1).

Table 3.1: Previous surveys carried out within the Perth Airport bushland.

Survey	Type of Survey	Reference
Flora and Vegetation Survey of the Perth Airport	Detailed flora and vegetation	Tingay and Associates 1994a
Systems 6 assessment update	Partial flora and vegetation	Keighery 1995
Systems 6 assessment update	Partial flora and vegetation	DEP 1996
Systems 6 assessment update	Partial flora and vegetation	DEP 1998
Systems 6 assessment update	Partial flora and vegetation	DEP 1999
Flora and Vegetation Survey of the Perth Airport	Detailed flora and vegetation	Mattiske in prep.

- **Surveys completed as part of this PER**

Vegetation in the project area was surveyed during November 2002, within six detailed flora quadrats with a precisely measured area of 10 m x 10 m (see Figure 3.1 on pg. 41 of this PER).

The following parameters were recorded for each quadrat:

- Unique site code (of the form 'AR01') (note that site code AR04 was not used);
- vegetation type (a broad description based on dominant species and strata);
- landform, substrate and general soil type;
- location (recorded using a hand-held Global Positioning System (GPS) to an accuracy within 5 m in WGS84 datum);
- disturbance (evidence of vehicle tracks, fires etc);
- flora species present within the main strata (trees, shrubs, sedges and herbs) and their estimated cover (to the nearest percent if possible, otherwise a range was used); and
- vegetation condition (utilising the scale shown in Table 3.2).

Table 3.2: Vegetation Condition Scale (Trudgen 1988).

E = Excellent Pristine or nearly so; no obvious signs of damage caused by the activities of European man.
VG = Very Good Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds such as **Ursinia anthemoides* or **Briza* spp., or occasional vehicle tracks.
G = Good More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones such as **Ehrharta* spp.
P = Poor Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man, such as grazing, partial clearing (chaining) or very frequent fires. Weeds as above.
VP = Very Poor Severely impacted by grazing, fire, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.
D = Completely Degraded Areas that are completely or almost completely without native species in the structure of their vegetation; ie. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

Flora species were identified in the field where identities were certain, or specimens were collected for later identification using the resources of the Western Australian Herbarium. Any other flora species not recorded from the quadrat sampling were also collected as part of traverses and opportunistic collections (including specific searches for Threatened Flora species known to occur in the project area). Flora taxonomy used in this report is based on the most recent version of Max (the WA Herbarium flora nomenclature database).

Vegetation variation within the project area was classified and mapped in the field on the basis of floristic composition, vegetation structural components (principally the dominant species in each stratum) and substrate type. In order to provide regional context, the resultant vegetation types were compared against the floristic community types of (Gibson et al. 1994). This publication is an overall assessment of floristic communities present on the southern Swan Coastal Plain. Systematic quadrat data from the project area were entered into a PATN analysis against the Swan Coastal Plain survey dataset (Gibson et al. 1994) and other floristic data from the Swan Coastal Plain (by M.E. Trudgen and E.A. Griffin; Appendix 1) in an attempt to assign the vegetation types present to floristic community types.

3.2.2 Flora

A total of 173 flora species is known from the on-ramp project area (Ecologia 1998, Ecologia 1999, Biota 2002, this study; Appendix 3). The flora comprised representatives from 118 genera and 46 families. The best-represented families were the Myrtaceae (myrtles), Papilionaceae (peas), Poaceae (grasses), Stylidiaceae (triggerplants) and Asteraceae (daisies) (see Table 3.3). The best-represented genera were *Stylidium* (triggerplants), *Melaleuca*, *Hibbertia, Leucopogon* and *Acacia* (Table 3.3).

Table 3.3: Best represented families and genera amongst the flora of the project area.

Family	Number of taxa
Myrtaceae	20
Papilionaceae	14
Poaceae	11
Stylidiaceae	10
Asteraceae	10
Genus	**Number of taxa**
Stylidium	9
Melaleuca	5
Hibbertia	5
Acacia	4
Leucopogon	4

3.2.3 Threatened Flora

- **Legislative Framework**

In Western Australia, all native flora species are protected under the *Wildlife Conservation Act 1950-1979,* making it an offence to remove or harm native flora species without approval. In addition to this basic level of statutory protection, a number of plant species are assigned an additional level of conservation significance based on the fact that there is a limited number of known populations, some of which may be under threat (see Table 3.4). Species of the highest conservation significance are designated Declared Rare Flora (DRF), either extant or presumed extinct. Species that appear to be rare or threatened, but for which there is insufficient information to properly evaluate their conservation significance, are assigned to one of four Priority flora categories.

Table 3.4: Categories of conservation significance for flora species (Atkins 2001).

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.
Declared Rare Flora - Presumed Extinct. 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.
Priority 1 - Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations which are under threat.
Priority 2 - 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 threat.
Priority 3 - Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under threat.
Priority 4 - Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Note that of the above classifications, only 'Declared Rare Flora' has statutory standing. The Priority Flora classifications are employed by the Department of Conservation and Land Management (DCLM) to manage and classify their database of species considered potentially rare or at risk, but these categories have no legislative status. Proposals that appear likely to affect DRF require formal written approval from the Minister for the Environment under Section 23(f) of the *Wildlife Conservation Act 1950-1979*.

Rare or threatened flora species may also be protected at the Federal level under the *EPBC Act 1999*. Flora species listed under this legislation are assigned to one of six categories (Table 3.5).

Table 3.5: Categories of Threatened Species under the *EPBC Act 1999*.

EXTINCT: A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
EXTINCT IN THE WILD: A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) 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: A native species is eligible to be included in the critically endangered category at a particular time if, at that 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.
ENDANGERED: A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
VULNERABLE: A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CONSERVATION DEPENDENT: A native species is eligible to be included in the conservation dependent category 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.

A total of 658 threatened taxa is currently listed nationally under the *EPBC Act 1999*. In the case of Western Australia, the list of Federally protected flora comprises the State listed DRF species.

- **Threatened Flora from the Project Area**

Three species of threatened flora are known to occur in the proposed on-ramp project area. One DRF species *Macarthuria keigheryi* and one Priority 3 species *Platysace ramosissima* have been recorded in the project area, but outside the land requirement boundary for the on-ramp. The Priority 4 species *Verticordia lindleyi* subsp. *lindleyi* was recorded from two individuals within the on-ramp land requirement area and would be directly affected by the proposed construction.

More detailed accounts of these threatened flora species, their status and the records from the project area follow.

***Macarthuria keigheryi* - DRF (State), Endangered (Federal)**

This threatened flora species differs from the two local common species of *Macarthuria* in that it has hairy stems (see Plate 3.1). It is a low, rush-like herbaceous perennial, with clustered cream flowers in September to March. It has a substantial underground vegetative stock (Plate 3.2), which provides the species with resilience to grazing and drought. A seed stock may also be present in the soil, with seeds dispersed by ants (Brown et al. 1998).

Atkins (2001) lists this species as occurring at Mullering Brook and Cooljarloo (Badgingarra), Kewdale and Forrestfield. There are ten specimens of this species in the WA Herbarium, representing five closely situated populations in Kewdale, Forrestfield, East Cannington and Kenwick. There is also an outlying population near Badgingarra. None of these populations appear to be protected within a reserve.

Plate 3.1: Clustered flowers and hairy stems of *Macarthuria keigheryi*.

Plate 3.2: Habit of *Macarthuria keigheryi* – a low sprawling sub-shrub with a suckering habit (the main woody stem is underground and numerous shoots arise from this).

Based on herbarium specimen notes, the known populations typically have very few individuals (either being genuinely scarce, or difficult to detect and therefore potentially underestimated). Other records of *M. keigheryi* indicate that populations can be relatively common in a very small area. It is possible that the species is opportunistic in nature, responding to soil disturbance, seasonal factors or fire. These factors could contribute to its local abundance and persistence where recorded.

Four targeted surveys have now been completed to assess the occurrence of this species within the on-ramp project area (see Table 3.6).

Table 3.6: Targeted surveys for the DRF species *Macarthuria keigheryi* in the proposed Abernethy Road on-ramp project area.

Survey	Survey Timing	Number of Records	Location
Ecologia (1998)	Oct 1998	1	~ 120 m NNW of on-ramp land requirement area
Ecologia (1999)	Nov 1999	9	~ 120 m NNW of on-ramp land requirement area
Biota (2002)	Jan 2002	2	~ 400 m N of on-ramp land requirement area
Biota (this study)	Nov 2002	1 (repeat record)	~ 120 m NNW of on-ramp land requirement area

Nine individuals of this species were initially located during surveys by Ecologia (1998; 1999) in *Banksia* woodland approximately 120 m to the north-north-west of the edge of the on-ramp land requirement boundary. The population was reassessed during a survey in January 2002 (Biota 2002) during which the original plants could not be located and were presumed dormant. Two additional plants were, however, recorded at this time approximately 400 m to the north of the proposed on-ramp land requirement boundary. An additional survey was carried out in late November 2002 during the preparation of this PER, which located a single individual from the stand of *Banksia* woodland where the species was first recorded in 1998.

Even with this repeated and locally intensive survey effort, *M. keigheryi* has not been recorded from within the area to be cleared to accommodate the proposed on-ramp. This is despite the presence of its apparent preferred habitat (low lying *Banksia* woodland - Vegetation Type 2; Section 3.2.4). *M. keigheryi* is, however, a cryptic species, which makes definitive assessment of its distribution and abundance difficult. It appears to be grazed to the ground by rabbits (Beverley Koch, pers. comm.) and is not overly distinctive from other commonly distributed herb layer species. It is therefore possible that the species is underestimated, both within the project area and in other areas on the Swan Coastal Plain. However, based on the available survey data, no known individuals of *M. keigheryi* would be removed as a result of the clearing required to construct the proposed on-ramp.

***Platysace ramosissima* - Priority 3 Flora**

This species is a perennial herb growing to 30 cm in height, with umbels of cream-white flowers in October to November (see Plate 3.3). It grows in sandy soil (Paczkowska and Chapman 2000).

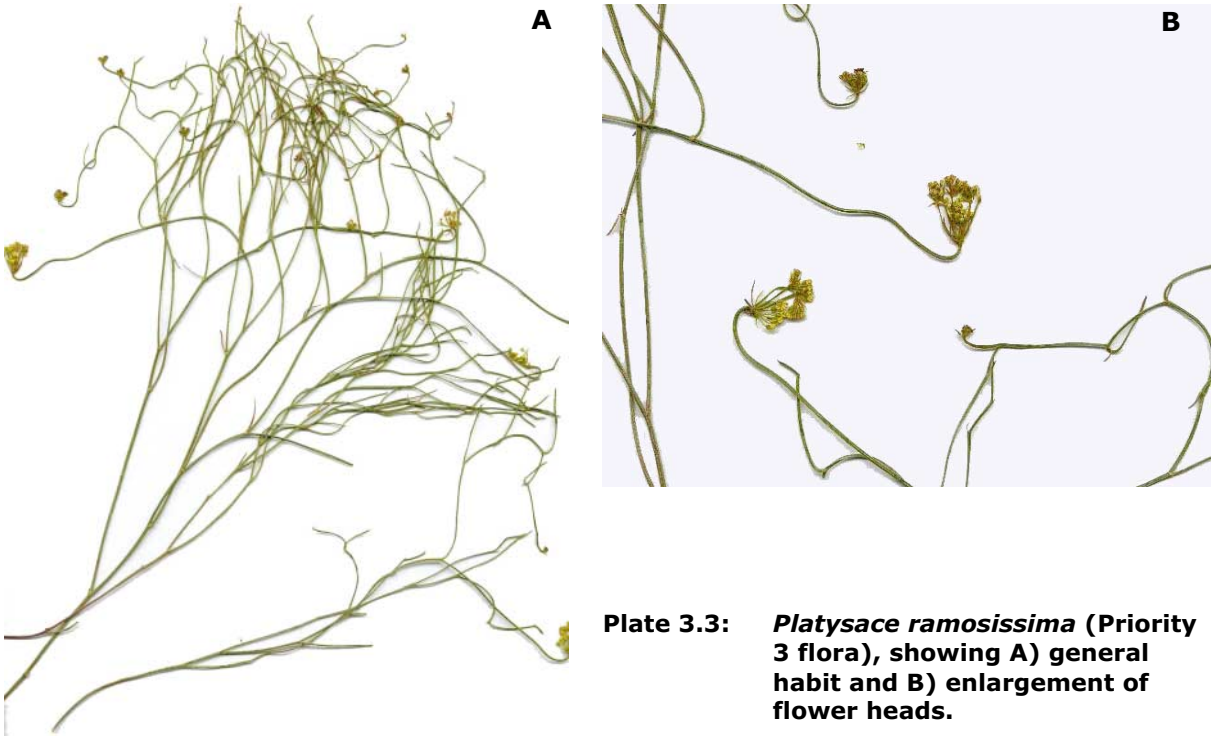


Plate 3.3: ***Platysace ramosissima*** **(Priority 3 flora), showing A) general habit and B) enlargement of flower heads.**

Atkins (2001) lists this species as occurring at Yalgorup, Boonanarring, Gingin and Lancelin. Only two specimens are included in the WA Herbarium's collection (from Bindoon and Gingin), however this probably represents a curatorial issue rather than poor collection, as much of the material from this genus appears to be on loan. During the current assessment, this species was recorded from approximately 80 m north of the northern on-ramp land requirement boundary. A single individual was present and this would not be disturbed by the construction of the proposed on-ramp.

***Verticordia lindleyi* subsp. *lindleyi* - Priority 4 Flora**

This species is a low, erect shrub to 75 cm, with pink, terminal (at end of branches) flowers (see Plate 3.4). It grows in sandy clay or sand in winter wet depressions (Paczkowska and Chapman 2000).

Atkins (2001) lists this species as occurring at Gillingarra to Forrestdale, Cannington, Guildford, Muchea, Gingin, Murray River and Moore River. There are 45 specimens of this species in the WA Herbarium collection, with the majority of these from the eastern side of the Swan Coastal Plain in the Perth metropolitan area. This includes the records of this species by Tingay and Associates (1994a) from other sites within the Perth Airport bushland. Some outlying populations also occur near Gingin, Moore River National Park and Mandurah. Over half of the specimens were collected before 1990 and the status of the populations that they represent has not been reviewed since this time. This species was collected from the Moore River National Park in 1995, which indicates that it is currently represented within at least one reserve.

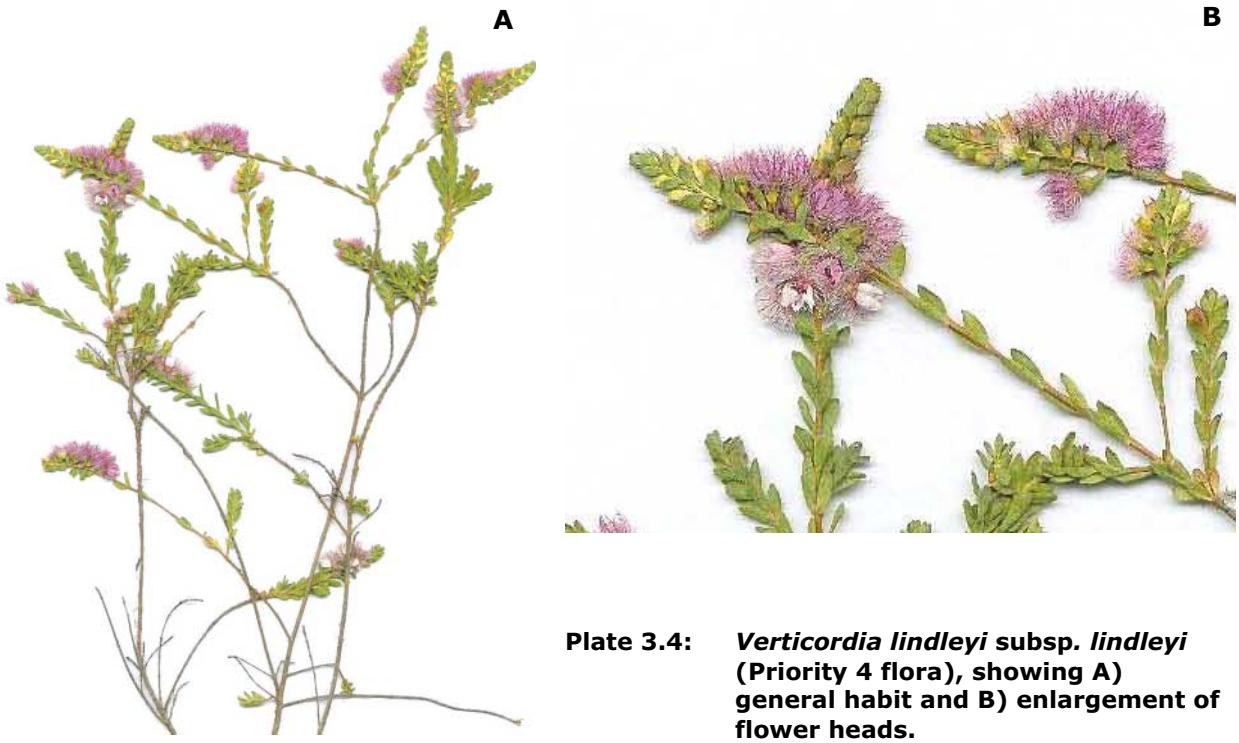


Plate 3.4: ***Verticordia lindleyi* subsp. *lindleyi* (Priority 4 flora), showing A) general habit and B) enlargement of flower heads.**

A single individual of *V. lindleyi* subsp. *lindleyi* was recorded during the current assessment just outside of Site 5 (see Figure 3.1). Ecologia (1998) also recorded *V. lindleyi* within the *Pericalymma ellipticum* var. *ellipticum* shrubland unit, but did not identify this record to the subspecies level. Given the proximity of the recent record, it is likely that this also represented *V. lindleyi* subsp. *lindleyi.* Both individuals are within the on-ramp direct impact area and would be removed as a result of the clearing required for the proposal.

In addition to the above species, one DRF (*Conospermum undulatum*) and four Priority flora species (*Haemodorum loratum*, *Myriophyllum echinatum*, *Schoenus benthamii* and *Stylidium longitubum* (all P3)) have previously been recorded from the Perth Airport bushland (Tingay and Associates 1994a, Government of Western Australia 2000). None of these species have been recorded from the land required for of the proposed on-ramp. Given that the area is relatively small, and has now been surveyed by botanists on four occasions (including two spring surveys; Section 3.2.1), it appears unlikely that any of these other threatened flora species occur in the area of vegetation to be cleared.

3.2.4 Vegetation

- **Vegetation Complex Level**

The broadest level of vegetation unit normally considered on the Swan Coastal Plain is the vegetation complex level. Vegetation complexes are groupings of vegetation types, developed on units characterised by particular soil types, geomorphology and climate (Heddle et al. 1980, Government of Western Australia 2000). According to mapping in Bush Forever (Government of Western Australia 2000; Volume 1), the vegetation of the project area belongs to the Southern River Complex. This complex is described as an "open woodland of *Corymbia calophylla – Eucalyptus marginata – Banksia* species with fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* along creek beds" (Government of Western Australia, 2000). Based on site specific data however, the vegetation of the project area also appears to contain elements more closely resembling 'Bassendean Complex – Central and South', which also occurs within the Perth Airport site (Government of Western Australia 2000). This latter complex is described as ranging from "woodlands of jarrah-sheoak-banksia on sand dunes, to a low woodland of *Melaleuca* spp. and sedgelands on low lying depressions and swamps. It includes the transition area of jarrah and pricklybark [*Eucalyptus todtiana*] in the vicinity of Perth [the area of the on-ramp proposal]…*Banksia attenuata*, *B. grandis* and *B. menziesii* are common on the upper slopes…*Melaleuca preissiana* are common on the low-lying moister soils, where marri replaces jarrah in dominance" (Heddle et al. 1980). For the purposes of this assessment, however, the vegetation of the project area has been considered as belonging to the Southern River Complex (Government of Western Australia 2000).

- **Vegetation Type Level**

The vegetation of the project area includes a number of discrete vegetation types (a finer scale of vegetation mapping recognising floristic composition, structure and soil types), typically on Bassendean (eastern) sands. Vegetation present includes low rises supporting *Banksia* woodland and shrublands, with intermittent inundated depressions supporting myrtaceous shrublands, and *Melaleuca* woodlands over shrublands and sedgelands. Detailed vegetation type descriptions and species inventories of the project area were completed in Ecologia (1998). Vegetation mapping was subsequently revised and updated in Biota (2002) and as part of the current assessment (see Figure 3.1).

Four vegetation types occur within the proposed on-ramp land requirement area:

1. *Pericalymma ellipticum* var. *ellipticum* shrubland on sumplands;
2. *Melaleuca rhaphiophylla/M. preissiana* woodland over sedgelands;
3. *Banksia attenuata/B. menziesii* woodland over mixed low shrublands on low sandy rises; and
4. Cleared areas with scattered remnant vegetation over weeds.

Two other vegetation types were recorded from the immediate project area, but do not occur within the land required to accommodate the on-ramp:

5. *Adenanthos cygnorum* shrubland; and
6. Open *Xanthorrhoea preissii* over *Hypocalymma angustifolium* low shrubland.

The on-ramp project area consists of a mosaic of these vegetation types, with intergrades, or ecotones, between each. The clearest ecotone areas are those between vegetation type 3 (*Banksia attenuata/B. menziesii* woodlands) and types 1 (*Pericalymma ellipticum* var. *ellipticum* shrubland) and 5 (*Adenanthos cygnorum* shrubland). Given the lack of definitive boundaries and the subtle shift between the vegetation types, these ecotones were not generally mapped as separate units (Figure 3.1). Their appearance in the field may therefore initially appear somewhat disparate to vegetation maps and descriptions.

A more detailed account of the vegetation types present, and their relationship to the Gibson et al. (1994) floristic community types (Section 3.2.5), follows.

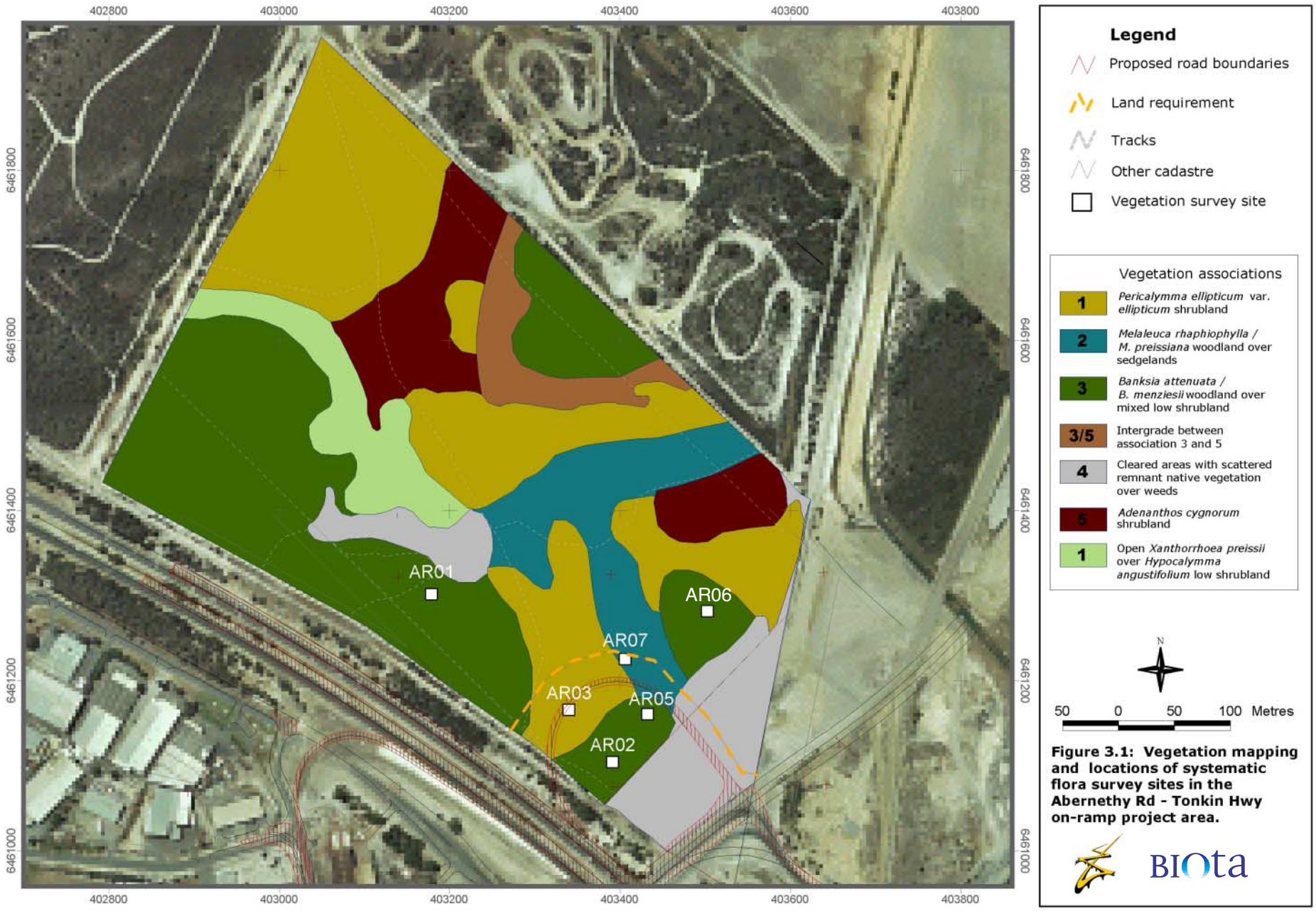


Figure 3.1: Vegetation mapping and locations of systematic flora survey sites in the Abernethy Rd - Tonkin Hwy on-ramp project area.

1: *Pericalymma ellipticum* var. *ellipticum* shrubland on sumplands (Site AR03)

This vegetation type occurs in the seasonally wet parts of the project area (see Figure 3.1). It consisted of a medium to tall, dense heath of *Pericalymma ellipticum* var. *ellipticum* over open low rushes *Hypolaena exsulca* (see Plate 3.5). *Melaleuca preissiana* was present as a sparse emergent. Sparse mixed shrubs included *Verticordia densiflora* var*. densiflora, Daviesia physodes, Euchilopsis linearis, Lechenaultia expansa, Hypocalymma angustifolia, Melaleuca seriata, Stirlingia latifolia* and *Calothamnus lateralis*. Sparse herbaceous perennials included the monocots *Xanthorrhoea preissii, Conostylis juncea, Dasypogon bromeliifolius, Phlebocarya ciliata* and *Patersonia occidentalis* and the dodder *Cassytha racemosa*. Sparse perennial rushes and sedges included *Lyginia imberbis, Desmocladus flexuosus, Schoenus efoliatus* and *Meeboldina scariosa*. The few herbs present at the time of the most recent survey (see Section 3.2.1), included sparse *Stylidium dichotomum, S. calcaratum, S. brunonianum* and *Thysanotus multiflorus*.

Twenty-nine species were recorded within the single 2002 flora site in this vegetation type. An additional four species have been recorded from other sites in this vegetation type during previous flora surveys of the project area (*Caladenia longicauda, Eutaxia virgata, Melaleuca preissiana* and *Hibbertia stellaris*), bringing the known flora for this type in the area to 33 species. This vegetation was in Excellent condition (Table 3.2) with only scattered occurrences of the weeds **Aira cupaniana* and **Gladiolus caryophyllaceus.* This vegetation type accounted for almost half (0.6ha; 43%) of the vegetated portion of the on-ramp land requirement area (Figure 3.1).

2: *Melaleuca rhaphiophylla*/*M. preissiana* woodland over sedgeland (Site AR07)

This vegetation type was present in approximately 15% (0.2 ha) of the north-east corner of the on-ramp land requirement area (Figure 3.1) and consisted of moderately dense low trees of *Melaleuca rhaphiophylla* and *M. preissiana,* over moderately dense rushes *Meeboldina scariosa* and sparse sedges *Lepidosperma longitudinale* (Plate 3.6). Other sparse low trees included *Banksia littoralis*. Sparse medium shrubs included *Eutaxia virgata, Calothamnus lateralis, Melaleuca lateritia, Astartea fascicularis* and *Pericalymma ellipticum* var*. ellipticum.* Scattered annual herbs recorded were *Drosera nitidula* subsp*. nitidula, Gratiola pubescens, Helichrysum macranthum, Microtis media* subsp*. ?media, Senecio quadridentatus, Siloxerus filifolius, Villarsia ?albiflora* and *Thysanotus multiflorus.*

Twenty-one species were recorded within the single detailed flora site in this vegetation type. Survey sites in this vegetation type during previous flora surveys of the project area have recorded three additional species (*Meeboldina cana*, *Melaleuca viminea* and *Trachymene pilosa*), bringing the flora of this vegetation type in the area to 24 species. This vegetation was in Excellent condition with only scattered occurrences of the weeds **Briza minor, *Hypochaeris glabra and *Sonchus oleraceus.*

Plate 3.5: *Pericalymma ellipticum* shrubland (Vegetation type 1)

Plate 3.6: *Melaleuca rhaphiophylla* woodland (Vegetation type 2).

3: *Banksia menziesii* woodland over mixed low shrublands on low sandy rises
(Sites AR01, AR02, AR04 and AR05)

This vegetation type accounted for 43% of the on-ramp land requirement area (0.6 ha), however this included large areas of intergrade between this type and vegetation type 1 (*Pericalymma ellipticum* var. *ellipticum* shrubland). The most notable differences in the intergrade areas compared to the typical *Banksia* woodland were that the tree strata gradually thinned out, species dominance changed and occasional floristic elements of the *Pericalymma* shrubland became evident as the ground became lower and wetter (see Plates 3.7 and 3.8). *Banksia menziesii* was present as open trees on low sandy rises, gradually decreasing in frequency towards the sumpland unit. Many seedlings and young plants were present, indicating that the *Banksia* woodland may be in the process of encroaching into the sumplands. This may be due to a long term drying out of the area due to climate or hydrological changes (see also Section 3.4). *Banksia attenuata* was less common and was only recorded at Site 1 outside of the land requirement area (see Figure 3.1).

The understorey comprised a moderately dense, low shrubland. Dominant medium shrubs (0.5 m – 1.5 m) included *Acacia pulchella* var. *goadbyi*, *Jacksonia densiflora / floribunda* complex*, Eremaea pauciflora* var*. pauciflora, Hibbertia hypericoides, Melaleuca seriata* and *Stirlingia latifolia*. Low dominant shrubs (to 0.5 m) included *Gompholobium tomentosum, Leucopogon conostephioides, Bossiaea eriocarpa, Acacia huegelii* and *Scholtzia involucrata*.

Herbaceous perennial monocots (grass-like species) were a distinctive feature of the vegetation, partly due to its proximity to wetter areas. These typically included *Xanthorrhoea preissii, Dasypogon bromeliifolius, Patersonia occidentalis, Conostylis aurea, C. juncea, Phlebocarya ciliata* and *Laxmannia ramosa* subsp*. ramosa.* Typical sparse annual and weakly perennial herbs included *Stylidium repens, S. calcaratum, Dampiera linearis, Siloxerus humifusus, Burchardia umbellata, Trachymene pilosa* and *Podotheca angustifolia* and the weeds **Hypochaeris glabra, *Ursinia anthemoides, *Gladiolus caryophyllaceus* and **Sonchus oleraceus*. Sparse grasses included *Amphipogon turbinatus, Austrostipa compressa* and the weeds **Ehrharta calycina, *Briza maxima* and **B. minor. Desmocladus flexuosus, Lyginia barbata* and *L. imberbis* were common rushes present at sparse to open densities, with *D. flexuosus* often forming dense, low colonies.

Plate 3.7: Open *Banksia* woodland with patches of mixed shrublands at the southern extremity of the study area (Vegetation type 3).

Plate 3.8: *Banksia* woodland (Vegetation type 3) approaching intergrade area immediately north west of the on-ramp area.

Declining rainfall and human influences have led to a drop in the water table in the Perth area generally over recent decades. The effect that this has on *Banksia* woodlands is twofold:

1. *Banksia* woodland may be slowly encroaching into areas that had vegetation typical of wetlands (*Pericalymma* shrublands in this case). Young *Banksia menziesii* can be seen colonizing the low shrubland in the area proposed for the on-ramp; and
2. it causes spot deaths in mature trees that are reliant on groundwater.

Occasional *Banksia* trees observed on site appeared to have died recently and this may be attributable to water stress (although fire and dieback may also have been factors). This vegetation type also often intergraded with type 5 (*Adenanthos cygnorum* shrublands), with many species common to both types. Within this type there were occasional large emergent trees of Marri *Corymbia calophylla* and Jarrah *Eucalyptus marginata*, with low trees including *Allocasuarina fraseriana* and *Eucalyptus todtiana*.

4: Cleared or Degraded with remnant vegetation over weeds

This vegetation unit occurred as several small areas of cleared bushland to the north-east, north-west and south-east of the proposed on-ramp (in addition to the 0.9 ha of cleared land within the on-ramp land requirement area itself) (see Figure 3.1). These areas had little or no native flora and had been colonized by a range of introduced grass species.

Contextual survey work in the project area mapped two additional vegetation types that were not represented within the on-ramp land requirement area (see Figure 3.1):

5: *Adenanthos cygnorum* Shrubland

This vegetation type consisted of an open, medium to tall shrubland of Common Woollybush *Adenanthos cygnorum* var. *cygnorum* over a mixed low shrubland (Plate 3.9). It was often adjacent to, and intergraded with, vegetation type 3 (*Banksia attenuata / Banksia menziesii* woodland over mixed low shrublands).

6: Open *Xanthorrhoea preissii* over *Hypocalymma angustifolium* Low Shrubland

This vegetation type consisted of an open cover of Grasstrees *Xanthorrhoea preissii* over dense low shrubland of *Hypocalymma angustifolium* (see Plate 3.10). Other species typically present included *Dasypogon bromeliifolius,* with occasional sparse emergent species including *Banksia menziesii,* Marri *Corymbia calophylla* and *Eucalyptus todtiana.*

Plate 3.9: *Adenanthos cygnorum* shrubland (Vegetation type 5)

Plate 3.10: Open *Xanthorrhoea preissii* over *Hypocalymma angustifolium* low shrubland (Vegetation type 6)

3.2.5 Swan Coastal Plain Floristic Community Types

- **Conservation Status and Legislative Framework**

Gibson et al. (1994) carried out an overall assessment of floristic communities present on the southern Swan Coastal Plain, including assigning the communities identified to categories based on reservation status and conservation status (see Table 3.7). The floristic communities of highest conservation status were subsequently designated Threatened Ecological Community (TEC) types by English and Blyth (1997) utilising a more detailed set of criteria based on IUCN conservation categories (Table 3.8).

Table 3.7: Reservation Status of Vegetation Communities (Gibson et al. 1994)

Reservation Status	Criteria
Well Reserved	Known from two or more A class National Parks or Nature Reserves.
Poorly Reserved	Known from a single A class National Park or Nature Reserve.
Unreserved	Not known to occur in any A class National Park or Nature Reserve.
Conservation Status	**Criteria**
Presumed Destroyed	A community that is totally destroyed or so extensively modified that it is unlikely to re-establish ecosystem processes in the foreseeable future
Critical	A community with most or all of its known occurrences facing severe modification or destruction in the immediate future.
Endangered	A community in danger of severe modification or destruction throughout its range, if causal factors continue operating.
Susceptible	A community of concern because there is evidence that it can be modified or destroyed by human activities, or would be vulnerable to new threatening process.
Low Risk	A community that does not qualify for one of the above categories.
Insufficiently known	A community for which there is inadequate data to assign to one of the above categories.

Table 3.8: Threatened Ecological Community Categories (English and Blyth 1997).

Category	Criteria
Category 1: Presumed Totally Destroyed	An ecological community which has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.
Category 2: Critically Endangered	An ecological community which has been adequately surveyed and found to have been subject to a major contraction in area and/or which was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.
Category 3: Endangered	An ecological community which has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Category 4: Vulnerable	An ecological community which has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community which is still widespread but threatening processes continue or begin operating throughout its range.
Category 5: Data Deficient	An ecological community for which there is inadequate data to assign it to one of the above categories and/or which is not yet evaluated with respect to status of threat.
Category 6: Lower Risk	A community which has been adequately surveyed and evaluated and available information suggests that it does not qualify for one of the above categories.

Vegetation types identified as TECs now also receive statutory protection through listing under the *EPBC Act 1999*. TECs are assigned to one of three categories under this act (Table 3.9) and actions that significantly impact listed communities must be referred to the Federal Minister for the Environment via Environment Australia (see Section 5.2).

Table 3.9: Conservation Category Descriptions for Threatened Ecological Communities under the *EPBC Act 1999*.

Category	Description
Critically Endangered	If at that time it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	If at that time it is not critically endangered and is facing a high risk of extinction in the wild in the near future.
Vulnerable	If at that time it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

Based on the output from the PATN analysis of the flora quadrat data (Appendix 4), the three intact vegetation types occurring inside the on-ramp land requirement area were assigned to Gibson et al. (1994) floristic community types (see Appendix 1).

1: *Pericalymma ellipticum* var. *ellipticum* shrubland on sumplands (Site AR03)

This vegetation type was considered a form of floristic community type 4: '*Melaleuca preissiana* wetlands', of Gibson et al. (1994), which is listed as 'Well Reserved' and 'Low Risk' (Table 3.7). It is not listed as a TEC under the *EPBC Act 1999* (English and Blyth 1997) (Tables 3.8 and 3.9).

2: *Melaleuca rhaphiophylla/M. preissiana* woodland over sedgeland (Site AR07)

Site AR07 appeared to be intermediate between floristic community types 11 and 12 (Wet forests and woodlands' and '*Melaleuca teretifolia* / *Astartea* aff. *fascicularis* shrublands'), both of which are 'Well reserved' and 'Low risk' (Gibson et al. 1994; Appendix 1; Table 3.7). Neither community type is listed as a TEC under the *EPBC Act 1999* (English and Blyth 1997) (Tables 3.8 and 3.9).

3: *Banksia menziesii* woodland over mixed low shrublands on low sandy rises (Sites AR01, AR02, AR05 and AR06)

This vegetation type was referrable to floristic community type 21c: 'Low lying *Banksia attenuata* woodlands or shrublands', which is listed by Gibson et al (1994) as 'Well reserved' and 'Susceptible' (see Table 3.7; Appendix 1). It is not listed as a TEC under the *EPBC Act 1999* (English and Blyth 1997) (Tables 3.8 and 3.9).

In summary, the analysis of the systematic floristic data indicates three Gibson et al. (1994) floristic community types are represented in the land required for the on-ramp, none of which are currently listed as TECs (Table 3.8 and 3.9; Appendix 1).

3.2.6 Weeds and Soil Pathogens

- **Weeds**

Weeds within Western Australia are managed under the provisions of the *Agriculture and Related Resources Protection Act 1976*. This act is administered by Agriculture WA, which assigns declared weed species to various categories dependent on the nature of the plant and its perceived threat potential. There is also provision under the act for weed species to be classified as 'Pest Plants', with local management requirements specific to certain localities. This is approached principally from an agricultural rather than ecological perspective, but in practice these two objectives are often jointly met. In general terms, all introduced flora present within or near bushland can be considered environmental weeds. The level of serious environmental weeds is a good indicator of condition and long-term viability of bushland.

The flora of the undisturbed portions of the project area appears to be relatively intact with respect to weed species, with exotics accounting for 23 of the 173 (13%) flora species known from the project area (see Table 3.10; Appendix 3). This represents a low proportion of weed species in an urban bushland context on the eastern Swan Coastal Plain, with the worst weed invasion areas generally limited to the disturbed margins of the site.

Table 3.10: Exotic flora recorded from the proposed on-ramp project area.

Weed Species	Common Name	Status	Distribution/Abundance
**Aira caryophyllea*	Silvery Hairgrass	†P3	Single record in Banksia WL[1]
**Aira cupaniana*	Silvery Hairgrass	†P3	Occasional in Banksia WL[1]
**Anagallis arvensis*	Pimpernel	†P3	Occasional in Banksia WL[1]
**Briza maxima*	Blowfly Grass	†P2	Scattered in Banksia WL[1]
**Briza minor*	Shivery Grass	†P2	Scattered in Banksia WL[1]
**Dischisma arenarium*	-	†P3	Single record on firebreak
**Echium plantagineum*	Paterson's Curse	†P3,*P1	Single record on firebreak
**Ehrharta calycina*	Perennial Veldt Grass	†P1	Scattered in Banksia WL[1]
**Eragrostis curvula*	African Lovegrass	†P1	Single record on firebreak
**Euphorbia peplus*	Petty Spurge	†P3	Single record on firebreak
**Gamochaeta falcata*	-	NA	Single record on firebreak
**Gladiolus caryophyllaceus*	Wild Gladiolus	†P1	Scattered in Banksia WL[1]
**Hypochaeris glabra*	Smooth Catsear	†P3	Scattered in Banksia WL[1]
**Isolepis marginata*	Coarse club rush	NA	Single record in wetland
**Lagurus ovatus*	Hare's Tail Grass	†P2	Single record in Banksia WL[1]
**Leptospermum laevigatum*	Eastern States Teatree	†P1	Scattered on firebreaks
**Pelargonium capitatum*	Rose Pelargonium	†P1	Single record in Banksia WL[1]
**Pentaschistis airoides*	False Hairgrass	NA	Single record in Banksia WL[1]
**Romulea rosea*	Guildford Grass	†P1	Single record in Banksia WL[1]
**Silene gallica*	French Catchfly	†P3	Single record in Banksia WL[1]
**Solanum nigrum*	Black Berry Nightshade	†P2	Single record in wetland
**Sonchus oleraceus*	Common Sow's Ear	†P3	Occasional in Banksia WL[1]
**Ursinia anthemoides*	Ursinia	†P3	Occasional in Banksia WL[1]

† = Environmental Weed (Scheltema and Harris 1995); * = Declared Plants (P1: Major weed, P1: Spread of seed prohibited, P2: Nuisance weed, P3: Minor weed), [1] WL = Woodland

The vegetation within sumpland areas was predominantly weed free. *Banksia* woodland had low densities of commonly naturalized species such as Blowfly Grass **Briza maxima,* Ursinia **Ursinia anthemoides* and Smooth Catsear **Hypochaeris glabra* with scattered infestations of Perennial Veldt Grass **Ehrharta calycina*.

Most weed species were recorded from firebreaks, disturbed areas and the margins of bushland. The most serious environmental weeds recorded were the woody weed Eastern States Tea Tree **Leptospermum laevigatum*, African Lovegrass **Eragrostis curvula,* Rose Pelargonium **Pelargonium capitatum,* Guildford Grass **Romulea rosea*, Wild Gladiolus **Gladiolus caryophyllaceus* and Perennial Veldt Grass **Ehrharta calycina*. Only Perennial Veldt Grass and Wild Gladiolus were widespread within bushland, with the remaining species restricted to firebreaks or recorded once within bushland.

One exotic species recorded from the site is listed as a Declared Plant under the *Agriculture and Related Resources Protection Act 1976*:

Paterson's Curse *_Echium plantagineum_

This Declared Plant species is listed as category P1 for Western Australia (movement prohibited). It is an annual or biennial herb (Paczkowska and Chapman 2000) with a basal rosette of leaves and tall, purple flower inflorescences. This species is very widespread in the southwest of Western Australia (Hussey et al. 1997). Paterson's Curse was recorded as scattered individuals on the southern firebreak adjacent to the project area (see Figure 3.1). Management measures will be put in place as part of the project EMP to address the occurrence of this species to ensure it is not spread during construction (see Section 4.3).

- **Dieback**

A review of key dieback indicator species present in the project area was conducted during the botanical assessments of the area. The vegetation present showed little or no evidence of the effects of the fungal pathogen *Phytophthora*. The *Banksia* species and members of the family Papilionaceae generally appeared to be in good to excellent condition with no evidence of crown die-off or other decline. Some mature *Banksia* trees were dead but this appeared to be attributable to historical fire events or site hydrological changes (see Section 3.2.4). Young seedlings of the same *Banksia* species were in good condition immediately beside these dead trees. Jarrah *Eucalyptus marginata* was also present at low frequency within the general area of the proposed on-ramp, and all individuals appearing to be in good condition with no evidence of foliage die-off. Given the available indicators, and the generally excellent condition of the vegetation, works in the area will be managed on the basis of the site being classified as 'Dieback Free' (see Section 4.3).

3.3 Fauna

3.3.1 Methodology and Approach

Given the amount of previous work in the locality, and that the extent of fauna habitat clearing associated with the proposal was limited to 1.4 ha, the Department of Environmental Protection (DEP) advised that a site-specific vertebrate trapping programme was not required for this assessment. Instead, the assessment of fauna values in the area has been based on:

- description and assessment of fauna habitat units present in the project area;
- opportunistic records (sightings, scats, tracks, hand-captures, remains, etc); and
- extrapolation from previous systematic surveys conducted in the Perth Airport bushland (primarily How et al. (1996) and Tingay and Associates (1994b)).

This approach was used to prepare a list of species that are known to be present or potentially occur in the project area. This was reviewed and refined based on capture records held by the Western Australian Museum (via the Faunabase web site).

In addition to the above, avifauna utilisation was systematically surveyed, with transects of fixed duration completed through the project area on 12 occasions from November 2002 to January 2003. This field work was supplemented by records from the Storr and Johnstone bird record database (R. Johnstone, Western Australian Museum) and summary data in How et al. (1996) (Appendix 5). The primary aim was to assess the use of habitats in the project area by birds identified in Bush Forever as 'Significant Bird Species of the Swan Coastal Plain portion of the Perth Metropolitan Region' (Government of Western Australia 2000, Volume 2).

3.3.2 Vertebrate Fauna

- **Fauna Habitats**

Fauna habitat description for the project area has been based on consideration of the vegetation types present (Section 3.2.4; Figure 3.1), structural complexity, surface hydrology and substrates. The habitat types derived from this approach were matched to habitat units presented in How et al. (1996) to facilitate extrapolation of the likely fauna assemblage for the project area (Table 3.11).

Table 3.11: Fauna habitats of the project area, their local extent and relationship to the habitat units of How et al. (1996) (Area=extent of habitat in project area; see Section 1.6).

Habitat type	Area (ha)	How et al. (1996) Unit
Dense tall *Pericalymma* shrubland on seasonally water-logged sands over heavy soils.	7.9	5. *Pericalymma ellipticum* heath.
Low, closed *Melaleuca* woodland – shrubland over sedges and shrubs on seasonal swamps.	2.3	7. *Melaleuca / Banksia littoralis* swamp.
Open – moderately dense low *Banksia* woodland over low shrubland on low rises of Bassendean sands	8.8	1. *Banksia* low woodland.
Open *Adenanthos* shrubland over low shrubs on Bassendean sands.	2.4	6. *Adenanthos* tall shrubland.
Open *Xanthorrhoea / Hypocalymma* shrubland.	1.5	Not specifically surveyed.
Degraded open areas.	0.9	Not specifically surveyed.

- **Faunal Assemblage of the Project Area**

Although partially disturbed on its margins, the project area is likely to support a relatively rich fauna assemblage compared to other habitat remnants on the Swan Coastal Plain given its:

- high level of vegetation intactness (see Section 3.2.4);
- variation in habitat types within the site;
- the size of other adjoining and adjacent habitat remnants within the larger area of Bush Forever Site 386 (Perth Airport bushland) (629 ha); and
- distance from residential developments.

Ecologia (1998) listed 12 mammal species, up to 223 species of avifauna and up to 47 species of herpetofauna as potentially occurring in the project area. The assessment carried out in How et al. (1996) of fauna occurrence is probably a more accurate indication of the fauna assemblage, being based on long-term field survey data. This study listed five mammal species (including three exotics), 87 bird species and 30 reptile species for the entire Perth Airport bushland. The fauna of the current project area is likely to be a subset of this assemblage, given the relatively small area under consideration, the reduced array of habitats (four of the eight habitats assessed in How et al. (1996)) and the proposed location for the on-ramp at the edge of the bushland. One site of Tingay and Associates (1994b) was situated in the on-ramp project area (site D), as were two of the survey sites of How et al. (1996) (sites 7 and 8). Species records from these sites have been collated in the following sections as the best account of the fauna of the proposed on-ramp area. This has been supplemented by other records for habitat units surveyed elsewhere but occurring in the project area (i.e. the *Pericalymma* and *Adenanthos* shrublands) and with avifauna and other opportunistic records collected during the site visits for this PER (see Section 3.3.1; Appendix 5).

- **Herpetofauna**

Based on the combined data of How et al. (1996) and Tingay and Associates (1994b), 19 species of herpetofauna are known from the project area (comprising five frog and 14 reptile species; Table 3.12). This tally increases to 22 species when the survey records from the other two habitats represented at the site are included (see Table 3.10). The available data indicate a relatively diverse herpetofauna assemblage for the area, considering that of the 31 species known in total from the entire airport site, two thirds are represented in the project area. Representative plates of a selection of the herpetofauna known from the site are provided in Plates 3.11 to 3.18.

Of the species known from the project area, the Crowned Snake *Elapognathus coronatus* (Plate 3.18) is of note, being at its northern limit in the Perth area and having not been recorded from other urban bushland remnants in the metropolitan region (How et al. 1996).

Table 3.12: Herpetofauna known from habitats within the proposed on-ramp project area (Habitats: MW=*Melaleuca* Woodland, BW=*Banksia* Woodland, PS=*Pericalymma* Shrubland, AS=*Adenanthos* Shrubland. ✓ = recorded from the project area, + =recorded elsewhere at the airport in habitats present in the project area).

Species	Common Name	MW	BW	PS	AS
Amphibians					
Heleioporus eyrei	Moaning Frog	✓	✓	+	+
Limnodynastes dorsalis	Western Banjo Frog			+	+
Pseudophryne guentheri	Guenther's Toadlet	✓		+	+
Crinia insignifera	Squelching Froglet	✓	✓	+	+
Litoria adelaidensis	Slender Tree Frog	✓			
Litoria moorei	Pobblebonk	3			
Reptiles					
Delma grayii	Gray's Legless Lizard		✓	+	
Lialis burtonis	Burton's Legless Lizard	✓	✓	+	+
Pletholax gracilis gracilis	Keeled Legless Lizard		✓	+	
Pogona minor minor	Western Bearded Dragon	✓	✓	+	+
Acritoscincus trilineatum	Southwestern Cool Skink	✓	✓	+	+
Cryptoblepharus plagiocephalus	Fence Skink	✓			+
Ctenotus australis	Western Limestone Ctenotus		✓		+
Ctenotus fallens	West Coast Ctenotus	✓	✓	+	+
Hemiergis quadrilineata	Two-toed Earless Skink		✓	+	+
Lerista elegans	West Coast Four-toed Lerista		✓	+	+
Menetia greyii	Common Dwarf Skink	✓	✓	+	+
Tiliqua rugosa rugosa	Bobtail	✓	✓		
Varanus gouldii	Gould's Monitor				+
Ramphotyphlops australis	Southern Blind Snake			+	
Elapognathus coronatus	Crowned Snake		✓		+
Pseudonaja affinis affinis	Dugite		✓	+	+
	Total:	11	15	15	16

- **Avifauna**

Previous survey work has recorded 25 bird species from sites in the project area, with an additional 18 species likely for the area when records from the other two habitats represented at the site from elsewhere in the airport are included (Tingay and Associates 1994b, How et al. 1996, Appendix 5). This total of 43 species for the project area was further increased during the systematic avifauna survey work carried out for this PER (Section 3.3.1) to 45 species, with the addition of the White-browed Scrubwren *Sericornis frontalis maculatus* and the Inland Thornbill *Acanthiza apicalis* (Table 3.13; Appendix 5). Historical records from the Storr-Johnstone database then add an additional 42 bird species to this tally, bringing the total avifauna for the project area to 87 species. The project area is therefore considered to have a diverse and regionally significant avifauna (How et al. 1996, Government of Western Australia 2000), including several species that are now uncommon on the Swan Coastal Plain.

Of the bird species known from the project area, 11 appear on the listing of species considered as 'Significant bird species of the Swan Coastal Plain portion of the metropolitan area' in Bush Forever (Government of Western Australia 2000; see Table 3.13; Appendix 5). These species are assigned to one of four categories; 1 (Threatened Fauna under the *Wildlife Conservation Act 1950-1979*), 2 (listed migratory species), 3 (habitat specialists with a reduced distribution on the Swan Coastal Plain) and 4 (wide-ranging species with reduced populations on the Swan Coastal Plain). Five of the significant bird species known from the site were category 3, with the remaining 6 listed as category 4 (Table 3.13).

Plate 3.11: ***Heleioporus eyrei***

Plate 3.12: ***Pseudophryne guentheri***

Plate 3.13: ***Crinia insignifera***

Plate 3.14: ***Litoria adelaidensis***

Plate 3.15: ***Cryptoblepharus plagiocephalus***

Plate 3.16: ***Delma grayii***

Plate 3.17: ***Pseudonaja affinis affinis***
(Photography for all plates by Greg Harold).

Plate 3.18: ***Elapognathus coronatus***

Table 3.13: Significant bird species of the Swan Coastal Plain known from habitats within the proposed on-ramp project area (Bush Forever category shown in brackets; Habitats: MW=*Melaleuca* Woodland, BW=*Banksia* Woodland, PS=*Pericalymma* Shrubland, AS=*Adenanthos* Shrubland. Numbers = individual records from 2002 surveys as part of this PER; ✓ = previously recorded from the project area, + =recorded elsewhere at the airport in habitats present in the project area).

Species	Common Name	MW	BW	PS	AS
Accipitridae (Eagles, Hawks)					
Accipiter c. cirrocephalus (4)	Collared Sparrowhawk			+	
Accipiter f. fasciatus (4)	Brown Goshawk			+	+
Aquila m. morphnoides (4)	Little Eagle	✓	✓	+	+
Maluridae (Wrens)					
Malurus s. splendens (3)	Splendid Fairy-wren	7		+	
Acanthizidae (Thornbills)					
Acanthiza apicalis (3)	Inland Thornbill	3			
Acanthiza chrysorrhoa (3)	Yellow-rumped Thornbill	✓	2	+	
Sericornis frontalis maculatus (3)	White-browed Scrubwren	3			
Meliphagidae (Honeyeaters)					
Phylidonyris nigra gouldii (4)	White-cheeked Honeyeater		✓	+	+
Phylidonyris melanops (4)	Tawny-crowned Honeyeater			+	+
Neosittidae (Sitellas)					
Daphoenositta chrysoptera pileata (3)	Varied Sitella		✓	+	
Artamidae (Woodswallows)					
Artamus cinereus (4)	Black-faced Woodswallow			+	+

Two of the birds known from the project area are migratory species that fall under the jurisdiction of the *EPBC Act 1999* (Section 5.2). The Rainbow Bee-eater *Merops ornatus* was recorded during surveys for this PER (including a breeding pair) and the Great Egret *Ardea alba* is known from database records from the immediate vicinity (Appendix 5). Carnaby's Cockatoo *Calyptorhynchus latirostris* was also recorded from the site and is a listed endangered species at both State and Federal levels (see Section 3.3.4). This latter species is known from database records from the Perth Airport terminal area (Appendix 5), and its use of the project area was inferred from characteristically damaged trees (R. Johnstone, pers. comm.).

- **Mammals**

Trapping work conducted on the Perth Airport site by Tingay and Associates (1994b) and How et al. (1996) recorded just a single confirmed native mammal species; the Quenda or Southern Brown Bandicoot *Isoodon obesulus fusciventer*. This species was recorded from all areas surveyed within the airport area and appears to have an extensive and viable population in the area (How et al. 1996). The habitats of the project area are still utilised by *I. obesulus*, with diggings being recorded from the *Pericalymma* shrubland during site surveys for this PER. Two skulls were also collected from the margin of the *Banksia* woodland and *Melaleuca* woodland units. *I. obesulus* is currently listed as a Priority fauna species (Conservation Dependent) by DCLM (see Section 3.3.4). An additional species, the Brushtail Possum *Trichosurus vulpecula vulpecula* was added to the list during site surveys for this PER based on tracks on a firebreak.

There are also anecdotal reports of the Echidna *Tachyglossus aculeatus* from the northern part of the airport bushland (Tingay and Associates 1994b, How et al. 1996), but there are no records or evidence of this species from the area proposed for the on-ramp. The remainder of the mammal fauna in the area is likely to comprise exotics including the Fox *Vulpes vulpes*, Black Rat *Rattus rattus*, House Mouse *Mus musculus* and Rabbit *Oryctolagus cuniculus*.

3.3.3 Invertebrate Fauna

Many recent publications have highlighted taxonomic groups of invertebrates with naturally small distributions (less than 10, 000 km^2) (general; Harvey 2002, freshwater snails; Ponder and Colgan 2002, land snails; Clark and Richardson 2002). These taxa are variously described as narrow range endemics or short-range endemics (see Harvey 2002) and are in part characterised by poor dispersal capabilities, confinement to disjunct habitats and low fecundity (Harvey 2002, Ponder and Colgan 2002). Given the importance of short-range endemism to the conservation of biodiversity, the assessment of such invertebrate taxa is a potentially important component of impact assessment. Examples of taxonomic groups that show high levels of short-range endemism in this respect include millipedes, mygalomorph spiders and freshwater and terrestrial molluscs.

The invertebrate fauna of the Perth Airport bushland was surveyed by How et al. (1996), including two sites in the current project area. These sites were the same locations as those drawn upon for the vertebrate fauna assessment (Section 3.3.2) and the data from How et al. (1996) has been extrapolated in a similar fashion in this section. This study generated a very large amount of material and only a selection of target taxa were chosen for detailed identification at the time of publication, many of which had potential to contain short range endemics as outlined above. A summary account of the occurrence of these invertebrate groups in the on-ramp project area is presented in Table 3.14.

Table 3.14: Invertebrate fauna of the proposed on-ramp project area (Numbers = number of taxa recorded from each habitat; Habitats: MW=*Melaleuca* Woodland, BW=*Banksia* Woodland, PS=*Pericalymma* Shrubland, AS=*Adenanthos* Shrubland; How et al. 1996).

Invertebrate Groups	Habitat				Taxa of Interest, Other Comments
	MW	BW	PS	AS	
Arachnida					
Araneae (Spiders) - Mygalomorphae	1	3	2	2	Mostly single individuals representing each species, except *Chenistonia tepperi* (n=26 from all habitats in the project area). All taxa known from elsewhere on the Swan Coastal Plain.
Araneae (Spiders) - Araneomorphae	34	20	33	34	Most taxa known to be widespread. Specimens of *Laestrygones* (an undescribed species recorded at this site only) and *Australutica* sp. 1 (known only from this site and Bold Park).
Opilionida (Harvestmen)	4	4	4	4	Most taxa known to be widespread. *Nunciella* sp. only known from this site and Jandakot Airport.
Pseudoscorpionida (Pseudoscorpions)	1	2	1	1	Two species; *Austrochthonius* sp. and *Beirolpium bornemisszai,* both known to be widespread.
Scorpionida (Scorpions)	-	2	1	2	Two species; *Lychas marmoreus* and *Urodacus novaehollandiae,* both known to be widespread.
Chilopoda (Centipedes)	3	6	4	4	All taxa known to be widespread.
Diplopoda (Millipedes)	1	2	2	2	Two species; a member of the family Julidae (which is probably introduced) and *Antichiropus variabilis* (which appears to be a short range endemic restricted to the Bassendean Dune /Ridge Hill Shelf systems, south-east of the Swan River).

The Insecta were not thoroughly analysed at the time How et al. (1996) was published, with only two groups having been properly assessed (the cockroaches (Blatttodea) and the parasitic baeine wasps (Scelionidae: Baeini)). Sixteen species of Baeine wasp were collected from the project area, but none of these showed any notable geographic restrictions (How et al. 1996). Twenty-four species of cockroach were recorded from the project area, none of which were restricted to the airport site.

None of the taxa discussed in Table 3.14 (i.e. those known to occur in the project area) are currently listed as Threatened Fauna under the *Wildlife Conservation Act 1950-1979* (see Section 3.3.4). It is also possible that land snail taxa occur in the project area that have restricted distributions, but the status of this group is relatively poorly studied on the Swan Coastal Plain (S. Slack-Smith, WA Museum, pers. comm. 2003, although see Hill et al. (1983) for distributions of *Bothriembryon kendricki* and *B. bulla*). Several other invertebrate taxa that are of conservation significance may occur on the eastern Swan Coastal Plain and these are discussed in Section 3.3.4.

3.3.4 Threatened Fauna

In Western Australia, all native fauna species are protected under the *Wildlife Conservation Act 1950-1979*. Fauna species that are considered rare, threatened with extinction or have high conservation value are specially protected under the act. In addition, some species of fauna are covered under the 1991 ANZECC convention, while certain birds are listed under the Japan & Australia Migratory Bird Agreement (JAMBA) and the China & Australia Migratory Bird Agreement (CAMBA). The *Wildlife Conservation (Specially Protected Fauna) Notice 2001* recognises four distinct Schedules of rare and endangered fauna taxa (see Table 3.15).

Table 3.15: Schedules for threatened fauna species under the *Wildlife Conservation Act 1979*.

Schedule 1 taxa are fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection;
Schedule 2 taxa are fauna which are presumed to be extinct and are declared to be fauna in need of special protection;
Schedule 3 taxa are birds which are subject to an agreement between the governments of Australia, China and Japan relating to the protection of migratory birds and birds in danger of extinction which are declared to be fauna in need of special protection; and
Schedule 4 taxa are fauna that are in need of special protection, otherwise than for the reasons mentioned in paragraphs (1), (2) and (3).

In addition to the above, DCLM also classify fauna of less immediate conservation concern under four Priority codes (Table 3.16).

Table 3.16: Priority categories for fauna species used by DCLM.

Priority One: Taxa with few, poorly known populations on threatened lands Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Two: Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Three: Taxa with several, poorly known populations, some on conservation lands Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey & evaluation of conservation status before consideration can be given to declaration as threatened fauna
Priority Four: Taxa in need of monitoring Taxa which are considered to have been adequately surveyed or for which sufficient knowledge is available and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. Taxa which are declining significantly but are not yet threatened.

Based on DCLM database records, several species of threatened fauna may potentially occur in the locality (see Appendix 1). These include four schedule species and four priority species.

- **Schedule 1 (Fauna that is Rare or likely to become Extinct)**

Carnaby's Cockatoo *Calyptorhynchus latirostris*
Evidence of this species was recorded from the project area during site visits as part of the current assessment (Section 3.3.2). It is likely to be an occasional visitor to the project area, but would not be reliant on the area to be cleared as a primary breeding or foraging site.

Chuditch *Dasyurus geoffroii*
This large dasyurid species is relatively uncommon on the Swan Coastal Plain but there are recent records from the Wattle Grove area. The species is highly mobile, occupying a large home range and apparently utilising remnant habitat corridors. It may be a periodic visitor to the project area, but the land requirement for the on-ramp is likely to represent only a small proportion of the home range of a single individual (up to 15 km^2 for males and 3-4 km^2 for females (Sorena and Soderquist 1995)).

Native Bee *Leioproctus simplicior*
This species of native bee is known only from specimens collected at Armadale and Forrestdale Lake. The species appears associated with *Goodenia filiformis, Lobelia tenuior, Angianthus preissianus* and *Velleia* sp., none of which were recorded from the project area. It is therefore considered unlikely that this species would be reliant on the habitats of the proposed on-ramp site.

- **Schedule 4 (Fauna which is Otherwise Specially Protected)**

Peregrine Falcon *Falco peregrinus*
This species is widely distributed but nowhere is it common within its range. It is likely to be an occasional visitor to the project area.

- **Priority Taxa**

Southern Brown Bandicoot (Quenda) *Isoodon obesulus fusciventer* (P4)
The Southern Brown Bandicoot *Isoodon obesulus fusciventer* is known to utilise the project area. Evidence of the current presence of this species was recorded during the site surveys from its characteristic diggings in the *Pericalymma ellipticum* var. *ellipticum* shrubland habitat (see Figure 3.1). Given that:

- the on-ramp will remove 1.4 ha of habitat and the typical home range of an *I. obesulus* individual is in the order of 1.2 ha (Broughton and Dickman 1991)) to 2.2 ha (Halpern Glick Maunsell 1998); and
- How et al. (1996) considered the Perth Airport bushland population of this species to be 'extensive and abundant',

impacts on the local population are not likely to be substantial.

Western False Pipistrelle *Falsistrellus mackenziei* (P4)
This species of bat occurs in banksia woodland and jarrah forest where it roosts in small colonies in tree hollows and forages in spaces between trees. It has previously been recorded in the northern jarrah forests as well as on the Swan Coastal Plain. It possibly occurs in the airport area and may occasionally utilise the on-ramp site during foraging. Given the lack of taller woodland, it is unlikely to be reliant on the area to be removed by the on-ramp for roost sites.

Bush Stonecurlew *Burhinus grallarius* (P4)
This ground-nesting bird species is well camouflaged and prefers to 'freeze' rather than fly when disturbed. It has been recorded from open wooded areas in the Perth region in recent years. It possibly occurs in the project area, but there are no records of this species on the Storr-Johnstone database for the airport site (R. Johnstone, pers. comm.).

In addition to the above, DCLM was consulted as to whether it was considering the wetland habitats of the project area for potential translocation efforts for the Schedule 1 Western Swamp Tortoise *Pseudemydura umbrina*. The Department has confirmed that the area in question is not required for translocation efforts for this endangered species (see Appendix 1).

3.4 Wetlands and Hydrology

3.4.1 Methodology and Approach

The assessment of the wetlands of the project area comprised three components:

- a study of the hydrology and hydrogeology of the wetland and the area's groundwater regime was completed by Aquaterra (2002) (reproduced in Appendix 6);
- documentation of the biota of the wetland habitats (see Sections 3.2 and 3.3); and
- completion of an EPA Bulletin 686 wetland classification and mapping exercise consistent with standard Water and Rivers Commission (WRC) approach (EPA 1993).

3.4.2 Hydrological Regime

- **Groundwater**

The Bassendean sands form the main aquifer of relevance to groundwater in the project area (Aquaterra 2003; Appendix 6). This aquifer is underlain by the Guildford clays which form an impermeable layer at depths of between 4 – 6 m below surface (HydroSolutions 2001). Water levels measured in the three closest airport monitoring bores to the study area vary seasonally in the range of 1.8 – 3.5 m below surface, with annual fluctuation generally less than 1 m (Aquaterra 2003; Figure 3.2). The study area is slightly lower in elevation than the airports bores, so groundwater levels are probably somewhat shallower in relative terms.

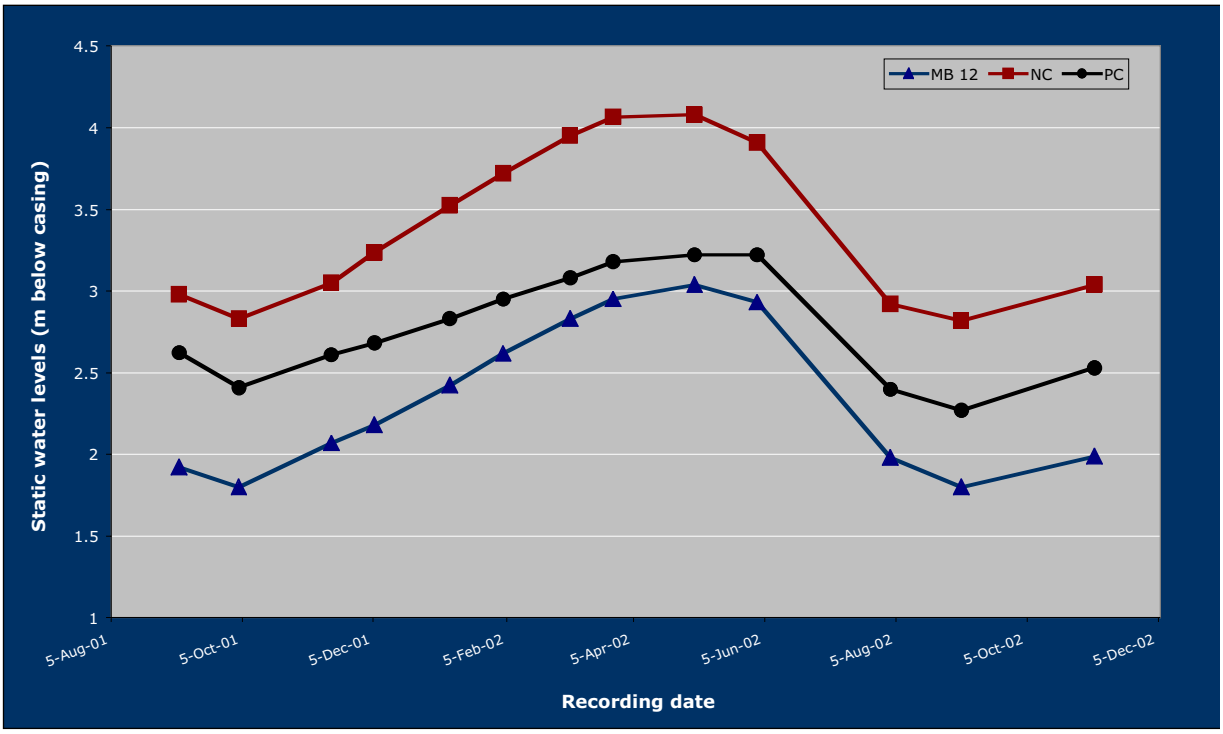


Figure 3.2: Seasonal groundwater level fluctuations in three closest airport monitoring bores adjacent to the project area (see Figure 3.3 for bore locations; Aquaterra 2003, original source: HydroSolutions 2001).

The larger scale assessments of the area (WRC 1997, Davidson 1995) do not show adequate detail to accurately delineate groundwater flow directions, showing a general groundwater flow from east to west. However, more detailed assessments undertaken on the Perth Airport property (HydroSolutions 2001) indicate a northeasterly – southwesterly flow direction at the site (Figure 3.3).

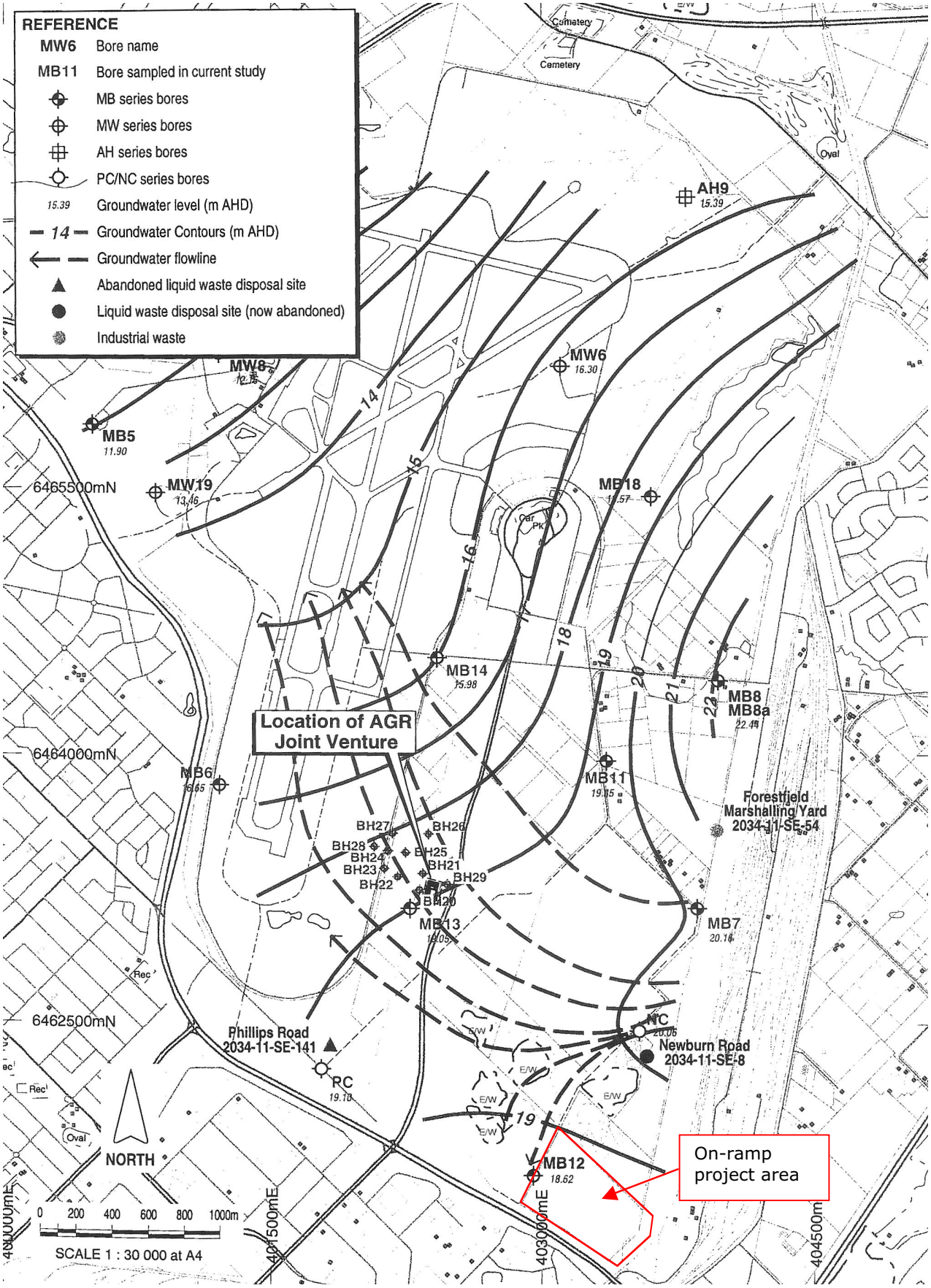


Figure 3.3: Groundwater contours in the vicinity of the project area, showing locations of monitoring bores (Aquaterra 2003 (Appendix 6), original source: HydroSolutions 2001).

- **Surface Hydrology**

The surface water catchment of the on-ramp land requirement area is bounded by the Tonkin Highway embankment to the west and Abernethy Road to the south. This local catchment consists predominantly of a wetland within the Perth Airport bushland site. These areas are probably depression storages as they do not appear to have an overland flow outlet (Aquaterra 2003). The catchment geomorphology is typically highly permeable sandy soil with a generally flat topography, separated by numerous localised and small-scale mounds and depression storages. There is no evidence of open drains or swales in the catchment to convey surface water runoff (Aquaterra 2003). Runoff is likely to comprise sheet flow from the mounds to the depressions, although some infiltration on the mounds will also occur. As there does not appear to be an overland flow outlet for the storages, the storage depressions are likely to store rainfall prior to it infiltrating to deeper groundwater (Aquaterra 2003).

- **Hydrological Function of the Wetland Area**

The closest bore to the project area (MB12) has a water table with maximum levels of just under 2 m below surface (Aquaterra 2003). This monitoring bore is slightly elevated compared to the on-ramp area and water levels in the project area are probably closer to the surface. During the site inspection, water levels in the base of the wetland depression were deeper than 0.5 m below surface (estimated to be between 0.5 - 1.0 m below surface). Surface water found in the wetlands on the site is not therefore surface expressions of groundwater, but will be related to surface water run-off during and after rainfall events (Aquaterra 2003). The shallow groundwater levels will however allow capillary rise of water levels to the surface, with the majority of the wetland vegetation being reliant on groundwater during the summer periods.

3.4.3 Wetland Description and Evaluation

- **General Description**

A substantial proportion of the project area contains wetland habitat (Figure 3.4). This wetland is principally a meandering sumpland unit that is seasonally inundated, with fringing water-gaining soils on upland margins. Previous WRC mapping classified part of the wetland area as Category 'C' (Conservation) and part as Category 'R' (Resource Enhancement) (Government of Western Australia 2000; Appendix 1). However, field inspection and discussions with officers from the Commission indicated that this broad-scale mapping was not accurate and the wetland area within the on-ramp land requirement should probably be reclassified to Category 'C' (Conservation) (Biota 2002).

Vegetation in this area was dominated by two main vegetation units (see Section 3.2). These were vegetation type 1: *Pericalymma ellipticum* Shrubland and type 2: *Melaleuca rhaphiophylla* Woodland over open mixed sedges and rushes. The vegetation supported by these wetland areas was generally in Very Good to Excellent condition (Table 3.2) with minimal weed invasion apparent (Section 3.2). The extent of these vegetation types generally defined the margin of the core wetland habitat at this site, with some ecotonal units grading on to higher ground (see Section 3.2.4). The wetland also provides habitat for the Southern Brown Bandicoot *Isoodon obesulus fusciventer* (Priority 4), which often occurs in association with wetland habitat with intact understorey (see Section 3.4).

- **Bulletin 686 Evaluation**

As noted above, the majority of the wetland area to be affected by the proposed on-ramp was previously mapped by the WRC as Category 'R' (Resource Enhancement). As this did not seem consistent with the intact state of the wetland, the area was re-evaluated against EPA Bulletin 686 ('A Guide to Wetland Management on the Swan Coastal Plain') (EPA 1993). This Bulletin is used to assess the various natural and human use attributes of wetlands on the Swan Coastal Plain, with the aim of assigning the wetland to one of five management categories (see Table 3.17). These categories are used by the WRC as a guide to conservation significance, management initiatives and acceptable use of wetland areas.

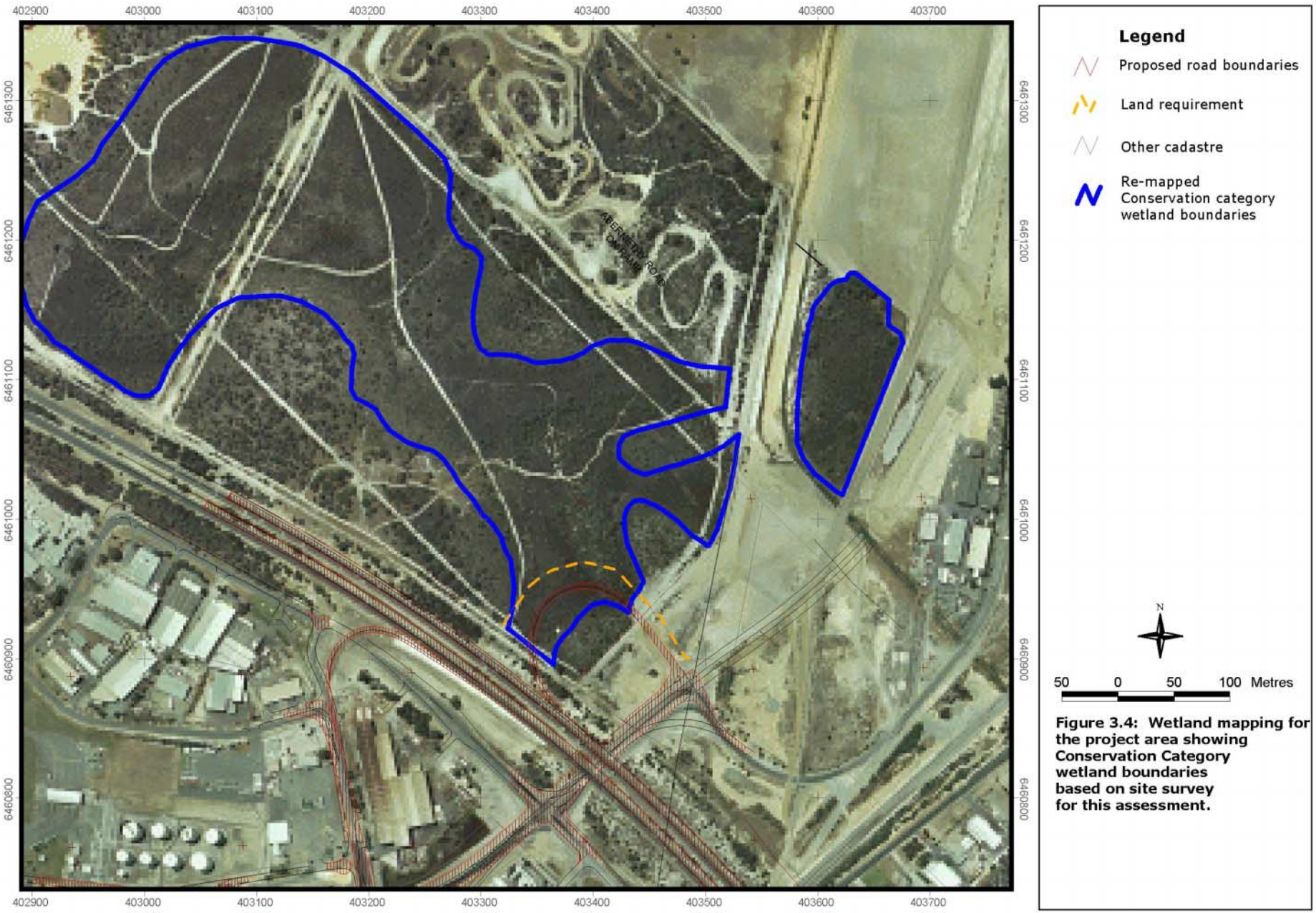


Figure 3.4: Wetland mapping for the project area showing Conservation Category wetland boundaries based on site survey for this assessment.

Table 3.17: Management categories for Swan Coastal Plain wetlands (EPA 1993).

High conservation (H) wetlands possess a high degree of naturalness and there is a high level of interest in using the wetland for various human purposes.
Conservation (C) wetlands possess a high degree of naturalness.
Conservation and recreation (O) wetlands have been modified (they have a moderate degree of naturalness) but are considered to play important roles in their urban and/or rural settings.
Resource enhancement (R) wetlands have been modified and do not have clearly recognised human-uses in their urban or rural settings (they have moderate degrees of naturalness and human interest).
Multiple use (M) wetlands are significant degraded, possessing few natural attributes and limited human-use interest.

The sumpland unit in the project area was re-mapped and re-evaluated in accordance with the requirements of Bulletin 686 and the results submitted to WRC (see Appendix 1). The outcome of this re-evaluation was for the entire sumpland unit shown in blue on Figure 3.4 to be evaluated as 'Conservation'. The Commission has advised that it accepts that the re-evaluation and mapping shown in Figure 3.4 reflects the revised boundaries and management category. The impacts of the proposal on this Conservation category wetland, and management approaches, are outlined in Section 4.5 of this PER.

3.5 Land Use, Social and Heritage Issues

3.5.1 Reserves and Land Status

Declared Conservation Reserves in Western Australia are vested in the Conservation Commission and managed by DCLM under the requirements of the *Conservation and Land Management Act 1984* (as amended). In addition to these reserves, a series of sites of high conservation value within the Perth Metropolitan region were identified as recommendations for conservation areas as part of the System 6 (Darling) study (Department of Conservation and Environment 1983). The System 6 areas within the Perth metropolitan region were then subsequently reviewed and updated as part of the development of Perth's Draft Bushplan (Government of Western Australia 1999). This project re-assessed the status of all System 6 sites and other areas of remnant bush within the Perth metropolitan area. In most respects this updated and superseded the recommendations of the original System 6 study. Perth's Draft Bushplan has recently been finalised as Bush Forever (Government of Western Australia 2000).

The land required for the proposed on-ramp forms part of Bush Forever Site 386 (Perth Airport and adjacent bushland) (see Figure 3.5). Site 386 covers 629.5 ha and is regionally significant as a major vegetation and fauna habitat remnant on the Swan Coastal Plain. Surveys have documented 295 native flora taxa (including 15 threatened taxa) and 127 fauna species from the site. The site also contains occurrences of four TECs and is one of the three most significant urban bushland remnants on the coastal plain for vertebrate fauna (How et al. 1996). The airport bushland also appears on the register of the National Estate, with the boundaries of the Australian Heritage Commission (AHC) site effectively corresponding to the Bush Forever site. The proponent has already undertaken liaison with the AHC (and the Bush Forever office) in respect of the land transfer from the National Estate, who have advised that this is acceptable subject to the completion of the EPA assessment of which this PER forms part (see Appendix 1).

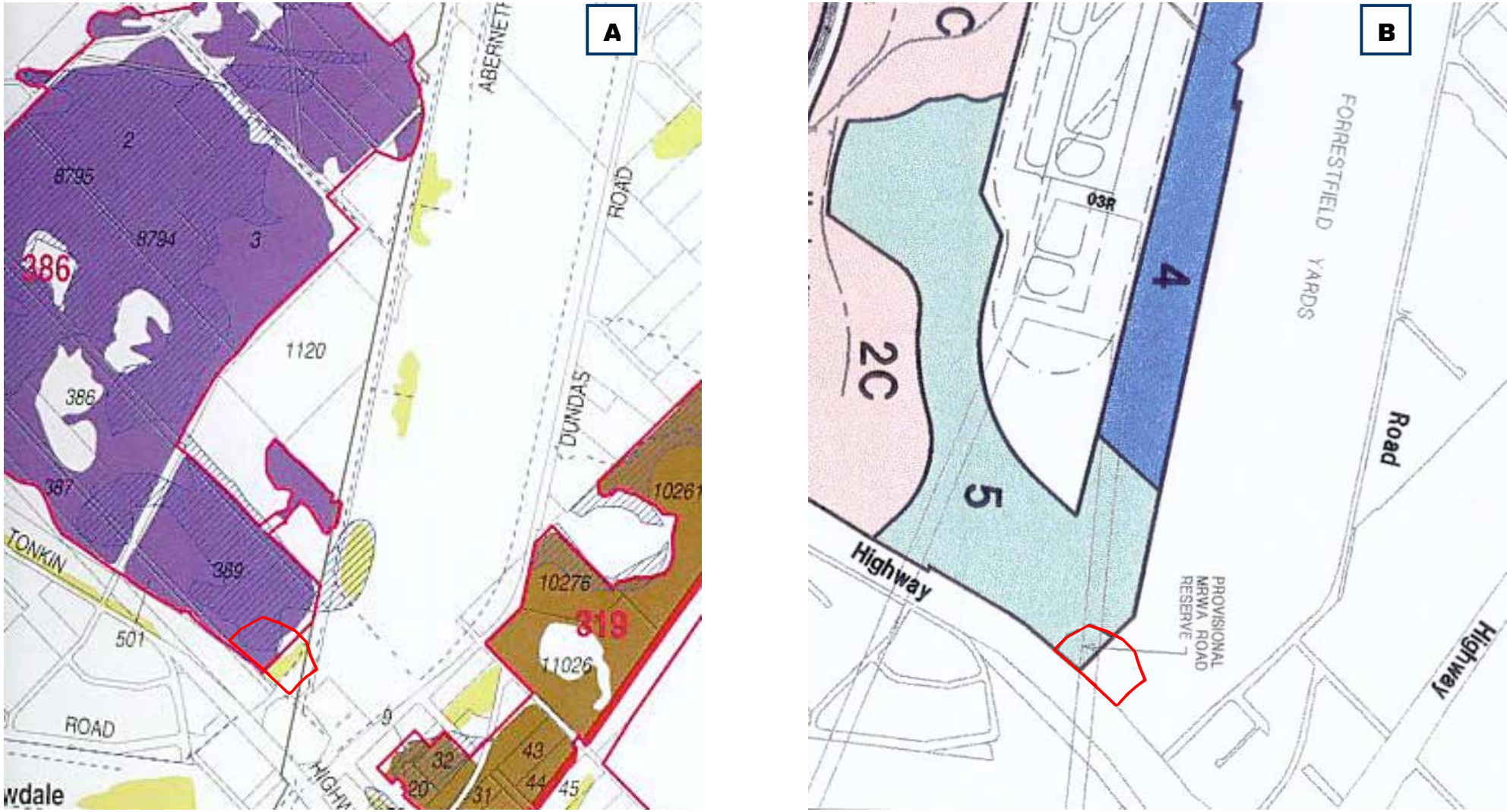


Figure 3.5: A) Bush Forever site 386 boundaries in the vicinity of the proposed on-ramp (approximate location shown in red) (Government of Western Australia 2000) and B) Perth Airport Masterplan management precincts showing conservation areas in the project area (Precinct 5) (Bechtel and Sinclair Knight Merz 1999).

The Perth Airport bushland was also subject to a formal master planning process that, amongst other land uses, allocated 313 ha of the highest conservation significance vegetation to be set aside for conservation purposes (Bechtel and Sinclair Knight Merz 1999). One of these conservation zones (Zone 5; 77 ha in size) was identified in the masterplan in the south-eastern portion of the airport land, including the current project area (see Figure 3.5). Note, however that the master plan also recognised the future presence of the proposed Abernethy Road on-ramp within this zone and made provision for the necessary land requirement (see Figure 3.5; Bechtel and Sinclair Knight Merz 1999). Bush Forever in turn took account of the master plan, identifying that a Memorandum of Understanding (MOU) has been signed with the Government of Western Australia endorsing the plan. Bush Forever identified that excluded areas were proposed for development (Appendix 3 of Government of Western Australia (2000)).

3.5.2 Social Setting

The setting in which the proposed on-ramp is to be situated is an area of remnant bushland on the boundary of a highly modified urban environment. The locality is generally dominated by major arterial roads (Tonkin Highway and Abernethy Road) and associated industrial land uses. The project area has few sensitive receivers in terms of visual amenity and is not situated in any particular viewsheds of notable recreational or cultural significance. The construction of the additional on-ramp appears unlikely to create any significant increase in the visual impacts already associated with the existing highway and interchange.

The site proposed for the construction of the on-ramp is adjacent to the existing Tonkin Highway, is close to Perth Airport and is situated in an area generally set aside for commercial and industrial uses. As such, noise levels are already considerable at the site, primarily due to the existing high traffic volumes on the highway. The construction of the on-ramp may result in some level of increase in the existing noise levels in the project area, but there appear to be no sensitive receivers in the immediate locality as defined under the *Environmental Protection Noise Regulations 1997*.

3.5.3 Aboriginal Heritage Values

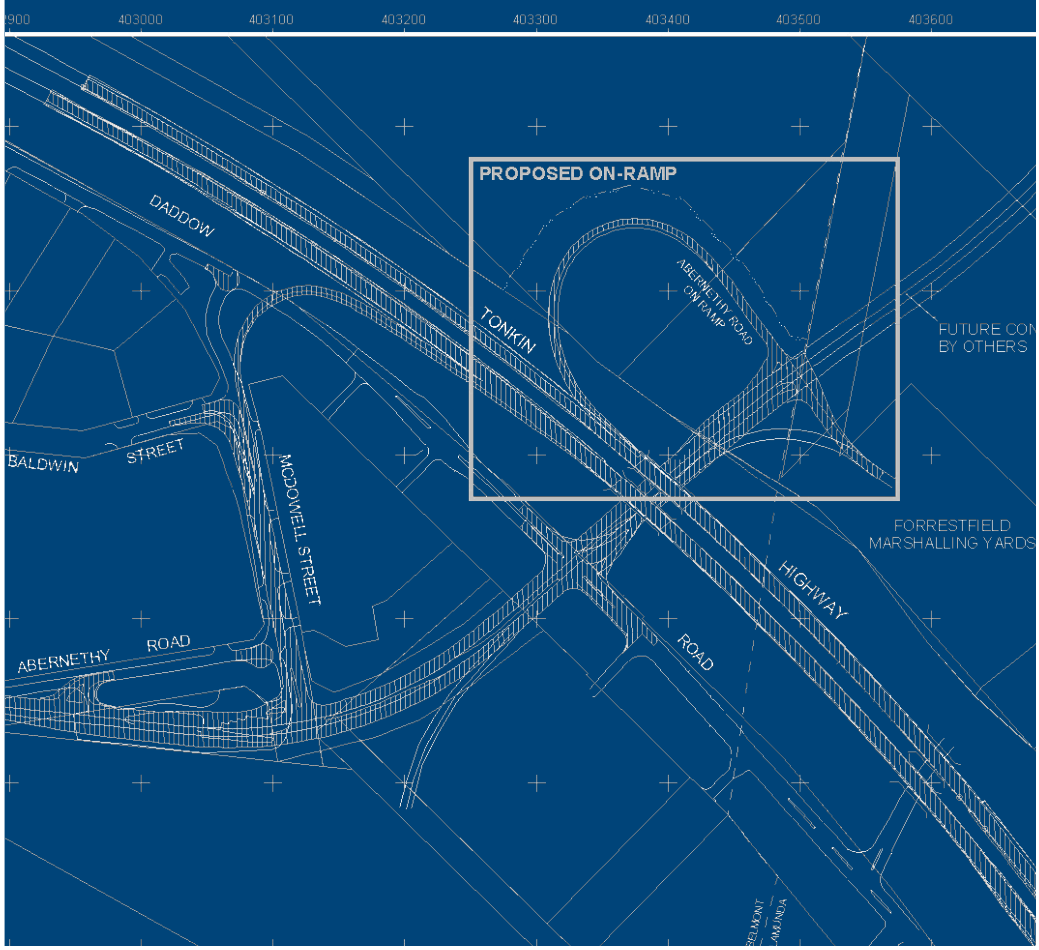
Previous investigations of the ethnographic and archaeological significance of the project area were undertaken by O'Connor (1998) and Quartermaine Consultants (1998) respectively. Both studies indicated that there were no sites of significance to aboriginal people within the required land, although an archaeological site had previously been adjacent to the project area (it has subsequently been excavated and destroyed). The proponent recognised, however, that the O'Connor (1998) study was a desktop investigation only of the potential for the area to contain ethnographic sites. Consultation with relevant aboriginal groups for this study was based on earlier studies that overlapped the current project area, conducted from 1982 through to 1997.

In order to ensure that Aboriginal heritage values were properly addressed, relevant Aboriginal groups were re-consulted as part of the additional investigations completed by Goode and Irvine (2002). This study involved consultation with the six relevant Aboriginal groups, which yielded varying responses on the significance of the proposed on-ramp area. Goode and Irvine (2002) recommended that these responses be submitted to the Aboriginal Cultural Materials Committee (ACMC) (pursuant to the requirements of the *Aboriginal Heritage Act 1972*) to confirm whether any site exists for the purposes of the act. The Department of Indigenous Affairs (DIA) subsequently advised that the ACMC determined that the impact area contained no sites for the purposes of the Act.

Updated archaeological surveys of the area (Quartermaine Consultants 2002) did not identify any archaeological sites within the land requirement boundary. However, Main Roads will still ensure that an archaeologist is on-site during earthworks as per the recommendations of Goode and Irvine (2002) (see Section 4.6.2).

Section 4.0

Impacts and Management



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4.0 Potential Impacts and Environmental Management

4.1 Approach and Impact Assessment Framework

Environmental impacts can be broadly divided into two categories for the purposes of impact assessment:

1) Short Term Impacts

These are impacts that occur over a short space of time such as clearing of vegetation, construction equipment movement, or noise and emissions from machinery. These types of impacts are often direct in nature and are typically associated with the construction phases of most developments. In an urban bushland context such as for the current proposal, vegetation clearing is usually the main impact of this type. Note that some impacts that are short term in nature can also represent the initiation of, or contribute to, other long term process of environmental change (e.g vegetation clearing leading to a reduction in remnant bushland area).

2) Long Term Impacts

Longer term impacts usually arise either from processes initiated by a short term impact or indirect effects associated with the ongoing presence of a new development. This may be in terms of the continuing presence of infrastructure or the ongoing changes to ecosystem process that may continue after the perceived completion of a project (such as mine closure). In the case of the current proposal, factors that fall into this category include processes such as weed invasion, changes to fire regimes, reduction in remnant bushland area and alteration to surface hydrology.

Dependent on their extent, both types of impact can typically be mitigated to varying degrees by proper implementation of environmental management procedures, both during construction and operation.

The significance of an impact can be assessed in part by evaluating its nature, intensity and duration (i.e. short or long term). The assessment of a potential impact also then needs to consider the nature of the environmental factor impacted, particularly its local and regional conservation significance and any specific sensitivity to the disturbance factor. The outcomes of this assessment then provide a measure of the risk of impacts occurring and their relative level of significance. This in turn may lead to the modification of the proposal to reduce or eliminate the identified impact and/or the development of management measures to mitigate it.

An account of the features of conservation significance from the project area follows (Section 4.2), along with an evaluation of potential impacts following the above principles, and planned management approaches (Section 4.3).

4.2 Conservation Significance

The conservation significance of the environmental features of the project area have been evaluated on several spatial scales. In descending order of geographical scale, these are:

- National (features of national conservation significance within Australia);
- State (features of conservation significance at the Western Australia level);
- Regional (significant at the Swan Coastal Plain scale of consideration); and
- Local (the 629.5 ha of Bush Forever Site 386 – Perth Airport bushland).

Each feature has then been assigned a relative conservation significance (significant, moderate significance, high significance) within each spatial context. A summary account of the aspects of the project area of conservation significance is provided in Table 4.1. More detail on each of these is supplied in Sections 3.1, 3.2 and 3.3.

Table 4.1: Environmental features of the Abernethy Road – Tonkin Hwy on-ramp project area and their relative conservation significance (note that factors significant at National / State level are by default also significant at regional and local scales of consideration).

Feature and scale of consideration	Conservation Significance	Comments
National / State		
Macarthuria keigheryi	Endangered (National), Declared Rare Flora (State); High at the State level.	Not recorded from the land requirement area, although potential habitat present. Occurs in the area to the immediate north.
Carnaby's Cockatoo *Calyptorhynchus latirostris*	Vulnerable (National), Schedule 1 Fauna (State); High at the State level.	Occasional visitor to the project area, one inferred record from the site and other reports from the adjacent bushland.
Regional		
Bush Forever Site 386 – regionally significant area of native vegetation	High at the regional level.	Values as outlined in this table, plus other regionally significant wetlands.
Intact fauna habitat forming part of a large urban remnant; supports a diverse avifauna and herpetofauna	High at the regional level.	Land requirement forms part of one of the top three urban bush remnants in Perth for avifauna values (Bush Forever Site 386).
Conservation (C) category wetland	High at the regional level.	C category wetland occupies the majority of the project area, a small portion of the wetland's local extent would be affected by the on-ramp.
Verticordia lindleyi subsp. *lindleyi*	Priority Flora (P4); Moderate at the regional level.	Two individuals recorded from the on-ramp impact area.
Isoodon obesulus fusciventer	Priority fauna (Conservation Dependent); Moderate at the regional level.	Occurs in the project area, utilises habitats within the land required for the on-ramp.
Platysace ramosissima	Priority Flora (P3); Moderate at the regional level.	Not recorded from the land requirement area, occurs in the area to the north.
11 species of 'Significant birds of the Swan Coastal Plain portion of the Perth metropolitan area'	Moderate at the regional level.	Important site for bird species with reduced habitat extents on the coastal plain.
Records of Crowned Snake *Elapognathus coronatus*	Regionally significant.	Most northerly record, probable range limit and unusual in Perth metropolitan area.
Some invertebrate taxa that appear to have restricted distributions; *Antichiropus variabilis* (a millipede), *Laestrygones* sp. and *Australutica* sp. 1 (spiders) and *Nunciella* sp. (an opilione)	Regionally significant.	Only recorded from habitats represented in the project area, likely to be restricted in range on the Swan Coastal Plain.
Local		
Gibson et al. (1994) floristic community types 4, 23c and 11/12	Locally significant.	Well represented in balance of Site 386 and elsewhere in the region.
Large eucalypts	Locally significant.	Potential habitat trees for possums and hollow-nesting bird species.

Potential impacts on these features of conservation significance are discussed in the following sections.

4.3 Vegetation and Flora Impacts and Management

4.3.1 Potential Short Term Impacts

The principal impact arising from the proposed on-ramp will be the requirement to remove approximately 1.4 ha of remnant vegetation (plus 0.9 ha of land that is already cleared). The area of impact is shown on Figure 3.1, including the wider extent of the affected vegetation types in the project area. ArcView GIS 3.2a was used to analyse the total area of impact on each vegetation type arising from the proposed on-ramp and the percentage that this represented of the mapped extent of the project area (Figure 3.1; Table 4.2).

Table 4.2: Current approximate local occurrence of vegetation types in the project area, estimated areas post-construction and percentage impact (on the project area scale) arising from the proposed on-ramp.

Code	Vegetation Type	Current Area (ha)	Area to be removed (ha)	% of extent in project area to be cleared
1	*Pericalymma ellipticum* var. *elllipticum* shrubland	7.9	0.6	8%
2	*Melaleuca rhaphiophylla* woodland	2.3	0.2	8%
3	*Banksia attenuata/Banksia menziesii* Woodland over species rich shrubland	8.8	0.6	7%
4	Cleared/degraded remnant vegetation over weeds	2.4	0.9	37%
5	*Adenanthos cygnorum* Shrubland	2.4	-	-
6	Open *Xanthorrhoea preissii* over *Hypocalymma angustifolium* Low Shrubland	1.5	-	-

Based on the figures in Table 4.2, a relatively small proportion of the local extent and actual area of each vegetation type will be cleared to accommodate the on-ramp. Over a third of the area to be removed is located within existing degraded areas (vegetation type 4; 0.9 ha). The most affected intact vegetation types, the *Pericalymma ellipticum* var. *ellipticum* shrubland and the *Banksia* spp. woodland, will be reduced by 0.6 ha each, leaving 7.3 ha and 8.2 ha respectively in the immediate project area (see Table 4.2; Figure 3.1). Clearing for the proposal would remove 0.2 ha of the other vegetation type in the land requirement area (*Melaleuca rhaphiophylla* woodland) leaving 2.1 ha intact in the immediate project area (Figure 3.1).

Considering the wider local extent of the Bush Forever Site 386, the broader vegetation types to be cleared are well represented (Tingay and Associates 1994a, Bechtel and Sinclair Knight Merz 1999, Government of Western Australia, 2000). According to these assessments, *Pericalymma* shrublands and *Banksia* woodlands are amongst the most widespread in the airport site. The areas of these vegetation types considered to be in the best condition and most intact will be set aside as long term conservation areas as part of the Perth Airport masterplan (see Figure 3.5; Bechtel and Sinclair Knight Merz 1999). This includes all of the native vegetation in the project area outside of the on-ramp land requirement (mapped in Figure 3.1). Remnant vegetation that would remain intact immediately adjacent to the completed on-ramp may, however, still be subject to ongoing degradation processes as discussed in Section 4.3.2.

In a regional context, the vegetation types to be impacted are referrable to Gibson et al. (1994) floristic community types 4 (*Melaleuca preissiana* wetlands), an intermediate between types 11 and 12 (Wet forests and woodlands and *Melaleuca teretifolia* / *Astartea* aff. *fascicularis* shrublands), and type 21c (Low lying *Banksia attenuata* woodlands or shrublands). All of these community types have a reservation status of 'Well reserved' (meaning that they are represented in at least two National Parks or 'A' Class Reserves;

Table 3.6) and conservation status categories of 'Low risk' or 'Susceptible' (the lowest conservation significance categories in Table 3.7 for communities where sufficient data is available).

At the broadest level of consideration, the proposal would result in the clearing of 1.4 ha of Southern River Complex vegetation. Historical clearing has reduced this vegetation complex from its original extent of 31,148 ha on the Swan Coastal Plain portion of the metropolitan region to 5,370 ha (Government of Western Australia 2000). Under the implementation of Bush Forever, 3,147 ha would be protected in land zonings of various conservation and other reserve status (59% of that currently remaining; 10% of the original estimated extent).

Other construction phase impacts relate to the risk of unintentional clearing or disturbance beyond the proposed area. The potential for a bushfire to arise from construction related activities also exists. These issues should be manageable by appropriate construction procedures (see Section 4.3.3).

4.3.2 Longer Term Potential Impacts

In addition to the short term impact of direct clearing, the vegetation remaining inside Site 386 adjacent to the construction area may be affected by the continuing presence and use of the new on-ramp. Potential impacts of this type include ongoing gradual degradation caused by:

- **Introduction of dieback or other soil-borne pathogens**. This risk is associated with pre-construction and construction phases of the proposal, where soil on earthmoving equipment could potentially introduce dieback to the area. The use of fill and other required materials not sourced from dieback-free areas also presents a risk in this respect. Once introduced into the area, dieback could potentially affect sensitive species in the intact vegetation remaining adjacent to the on-ramp subsequent to its completion.
- **Weed introduction**. Similar to dieback, weeds could be introduced during earthworks and subsequently become established inside the adjacent Bush Forever site. In addition to this, there would remain an ongoing risk of new weed species being introduced from wind-borne seed off vehicles using the on-ramp (particularly heavy vehicles carrying agricultural products or livestock).
- **Effects on phreatophytic flora.** If hydrological regimes are significantly changed in the area, this could have a long term effect on flora utilising groundwater (phreatophytes) or requiring water-gaining soils. The results of the site-specific hydrological study (Aquaterra 2003) indicate that this is unlikely to occur as groundwater and surface hydrology conditions should not be altered in the adjacent wetland as a result of the proposal (see Section 4.4.1).
- **Changes to fire regimes**. This principally relates to the potential for fire frequency to be increased subsequent to the on-ramp becoming operational. This relates to drivers discarding cigarettes or other vehicle related ignition events.
- **Edge effects/changes to management boundary**. This primarily relates to the reduction in overall area of Bush Forever site 386 and the resultant effect on the long-term integrity of remaining vegetation communities. The area to be removed for the on-ramp is, however, relatively minor in extent (1.4 ha of the 629 ha Bush Forever site) and the impact on long term viability will probably not significantly alter any long-term outcomes (this issue is discussed further in Section 4.5.1).
- **Increased public access**. The construction of the on-ramp could conceivably lead to increased public ingress (and associated impacts) to the adjacent Bush Forever site. However, given that there is existing vehicle and pedestrian access to the area in the immediate vicinity, it seems unlikely that this would worsen any existing management issues of this type.

Of these potential long term impacts, the risks of weed or dieback introduction and spread into adjacent bushland are probably the most significant and readily addressed. Implementation of sound environmental management measures during construction will control the majority of this risk, with follow-up action in respect of ongoing potential impacts (see Section 4.3.3).

4.3.3 Environmental Management Response

To address the impacts identified in Sections 4.3.1 and 4.3.2, Main Roads will develop and implement the following environmental management measures:

- **Clearing controls.** This will comprise definition of clearing limits on all design drawings and specifications, surveying in these limits in the field and erecting bunting or other clear boundary markers on-site. Vegetation clearing will constitute a hold point requiring written authorisation from the Site Superintendent prior to proceeding.
- **Construction site induction and constraints.** All personnel working on the site will be required to complete an environmental induction. This will highlight the significance of the bushland in the area, including outlining the need for weed hygiene, no access or clearing beyond the site limits and other relevant matters.
- **Topsoil and landscaping plan.** As per normal Main Roads practice, a landscaping specification will be prepared to make best use of recovered topsoil and mulched vegetation. This is likely to entail the local use of these in landscaping works in the completed on-ramp site. The completed site will be landscaped using locally occurring native species, including the use of topsoil and mulch from the site on the on-ramp batter slopes. Landscaping of the detention basin will utilise locally occurring native species giving consideration to maximising the value of this feature to waterbirds.
- **Weed and dieback hygiene.** All plant and equipment brought on to the site will be required to be free of vegetation and soil to ensure the risks of weed or dieback introduction are minimised. This will include the creation of formalised washdown points and inspection of all plant on site. All fill and other materials brought in for the project will be from weed and dieback free sources. The dieback hygiene procedures will be developed and implemented to the satisfaction of DCLM.
- **Fire risk management.** The risks of construction related fires will be minimised by measures such as controlled procedures for any welding and grinding activities, inspection of the exhausts of any clearing equipment and the use of spark suppressors on any generating equipment on site. A fire emergency response plan will be prepared to the satisfaction of the local authority.
- **Fencing.** The contractual specification will include the erection of 2 m high cyclone mesh fence around the land required for the on-ramp, providing a hard management boundary between the area and the adjacent Bush Forever site.
- **Drainage management strategy.** The approach to drainage management is largely identified in the design of the on-ramp as proposed (Section 2.0). This will centre on the use of a detention/infiltration basin to capture all road run-off. Regular inspection and maintenance of this basin will also be carried out after construction is complete.
- **Weed monitoring and control.** As a follow-up to the construction weed hygiene, Main Roads will liaise with the Federal Airports Authority with respect to ongoing periodic monitoring and control of weeds in the adjacent Bush Forever.

These measures will all be embodied in an Environmental Management Programme (EMP) and written up as contractual specifications with construction and post-construction environmental auditing (see Section 5.0).

4.4 Threatened Flora Impacts and Management

4.4.1 Potential Impacts

Three species of threatened flora have been recorded from the project area (Section 3.2.3). The potential short and long term impacts on these species are discussed individually below.

- ***Macarthuria keigheryi* (DRF)**

All of the currently known locations at which *Macarthuria keigheryi* (DRF) has been recorded in the project area are outside of the land required to construct the proposed on-ramp (see Table 3.6). This includes the original population location (Ecologia 1999) and that of the new individuals recorded as part of the current assessment. Given this, there would appear to be no direct impact on this species from the required clearing activities. The habitat type from which all records of this species have been made (*Banksia* woodland over low shrubland) is also relatively widespread in the local area, and would remain so following construction of the proposed on-ramp (see Table 4.2).

The close proximity of the population mapped in the Ecologia (1999) study could result in a potential risk of inadvertent direct disturbance to individuals during construction (see Section 4.4.2).

- ***Platysace ramosissima* (P3)**

Only one individual of this species was recorded, some 80 m to the north of the proposed land requirement boundary (see Section 3.3.2). Based on the available data, the proposal would have no impact on this Priority Flora species.

- ***Verticordia lindleyi* subsp. *lindleyi* (P4)**

This species is known from two individuals within the impact area of the proposed on-ramp and from several other sites within the Perth airport bushland (Section 3.2.3). Given that only one or two individuals are involved, the impact at the species level of consideration is likely to be minor. Management measures targeted at this species may still be able to ameliorate even this low level impact (see Section 4.4.2).

In summary, the above assessment indicates that it is unlikely that implementation of the proposal would result in a change in conservation status in any of these Threatened Flora taxa. Local impacts on threatened flora species will be addressed through construction management practices (Section 4.4.2).

4.4.2 Environmental Management Response

To address the impacts identified in Section 4.4.1, Main Roads will develop and implement the following environmental management measures:

- Clearing controls (as outlined in Section 4.3.3);
- Fire risk management (as outlined in Section 4.3.3); and
- **Transplantation programme for *Verticordia lindleyi* subsp. *lindleyi*.** Given that only one or two individuals of this Priority 4 species occur in the impact area, the proponent will develop a transplantation programme for these individuals to the satisfaction of DCLM and Kings Park Botanical Gardens. Locally, the species occurs on the low sandy rises supporting banksia woodlands; a habitat type well represented in the bushland areas adjacent to the on-ramp land requirement. Use of this target habitat will be discussed with DCLM and the WA Airports Corporation, along with procedures to maximise the chances of success (excavation of a substantial area of intact soil around each individual, follow-up irrigation and other measures).

These measures will all be embodied in an EMP and written up as contractual specifications with construction and post-construction environmental auditing (see Section 5.0).

4.5 Fauna Impacts and Management

4.5.1 Potential Short Term Impacts

The primary impact of the proposed on-ramp on invertebrate and vertebrate fauna species will be the direct removal of habitat, and the associated immediate mortality or subsequent displacement of individuals utilising this area. Clearing for the on-ramp will

amount to 1.4 ha of intact habitat in total, primarily constituting sumpland wetland habitats and upland ecotones into *Banksia* woodlands (see Table 4.2).

With regards to threatened fauna species, the only species that is currently confirmed to utilise habitats within the land requirement area is the Southern Brown Bandicoot *Isoodon obesulus fusciventer* (P4: Conservation Dependent). As with other local fauna, the principal impact on this species is likely to be habitat removal, with some resultant loss in individuals due either to direct mortality or to displacement effects arising from individual movement into adjoining habitat areas. The species is listed as a Priority 4 fauna species and DCLM will be consulted regarding any specific management requirements.

Construction activities could also have impacts on fauna due to increased vehicle movements, noise and other disturbance factors, pedestrian intrusion into intact bushland and increased bushfire risk. Most of these issues should be reduced to a management level by the proposed environmental management approach (Section 4.5.3).

4.5.2 Longer Term Potential Impacts

In addition to the short-term direct loss and displacement of native fauna, there may be an ongoing effect on local fauna communities due to reduction in overall contiguous habitat area. The affected sumpland and woodland habitat types have been subject to substantial historical clearing on the eastern portion of the Swan Coastal Plain (see Section 3.3.1) and any further reduction in extent at this site is likely to have some level of effect on the long term viability of the vertebrate fauna dependent on it. Both habitat types will, however, remain locally represented in adjoining area following the construction of the on-ramp, with 9.4 ha of core wetland habitats and 8.2 ha of banksia woodlands to remain in the same contiguous block of vegetation. In the wider context, these areas will remain as part of the 77 ha of high priority conservation land within Precinct 5 of the Perth Airport masterplan area (Bechtel and Sinclair Knight Merz 1999).

Increased noise levels associated with the operation of the new on-ramp could have an effect on fauna in the adjacent bushland areas. The existing environment already experiences substantial noise levels due to the proximity of Tonkin Highway. The on-ramp is likely to increase this somewhat in the immediate area, particularly given that a proportion of the traffic will be heavy vehicles accelerating from low speeds up the ramp. It is unlikely that this would result in a substantial change in the composition of local fauna communities, as any species truly sensitive to high noise levels will be absent from the area already. Any increase in local noise levels could have some effect on local fauna populations persisting in the area, via factors such as decreased reproductive success in species that rely on the detection of vocalisations for mating success (most of the local avifauna and frog fauna). Given the existing high noise levels it is considered unlikely that any such effect would be increased by the proposed on-ramp.

Increases in road-kill frequency is another potential impact typically associated with new road developments. Whilst it is possible there may be some increased risks for local fauna, the additional impact of the ramp over the existing Tonkin Highway and Abernethy Road is likely to be minor considering:

- the elevated nature of the on-ramp compared to ground level in the adjacent bushland;
- that Main Roads will fence the on-ramp site with 2 m high cyclone mesh fencing; and
- that the on-ramp will not subdivide any areas of fauna habitat and associated fauna populations, meaning the risk of ongoing attempted fauna movement across the new road barrier is reduced (this also indicates that other management treatments such as fauna underpasses do not appear warranted for this proposal).

In respect of threatened fauna species, it is likely that the two known species, Carnaby's Cockatoo *Calyptorhynchus latirostris* (Schedule 1) and the Southern Brown Bandicoot *Isoodon obesulus fusciventer* (Conservation Dependent), will persist in the intact bushland adjacent to the site. The former species appears to only periodically visit the area to utilise

proteaceous heaths and larger eucalypts (the local occurrence of which will be unaffected by the on-ramp). *I. obesulus* appears able to persist (at least over the medium term) in urban bushland remnants of sufficient size and with an intact understorey (Ecologia 1991, Tingay and Associates 1994b, How et al. 1996, Halpern Glick Maunsell, 1998, Government of Western Australia 2000). The species is also widespread and abundant in the wider aiport bushland, and the on-ramp land requirement is about the size to the home range of (Section 3.3.4). It is therefore likely that its long term persistence in the 75.6 ha of Zone 5 (Conservation) (and the total of 313 ha of conservation zoned land on the airport site) would not differ markedly from its local persistence if this proposal was not implemented.

4.5.3 Environmental Management Response

To address the impacts identified in Sections 4.5.1 and 4.5.2, Main Roads will develop and implement the following environmental management measures:

- Clearing controls (as outlined in Section 4.3.3);
- Construction site induction and constraints (as outlined in Section 4.3.3, with the addition of the prohibition of pets, traps and firearms on the construction site);
- Fire risk management (as outlined in Section 4.3.3);
- Fencing (as outlined in Section 4.3.3);
- Topsoil and landscaping plan (as outlined in Section 4.3.3); and
- Drainage management strategy (as outlined in Section 4.3.3). The creation of a drainage detention basin in this location may also increase local habitat resources for native water bird species. A brief survey of four other road drainage basins in the locality yielded records of over 400 water birds, representing 19 water bird species (including seven duck species). Landscaping of the basin with locally occurring wetland flora species will enhance the value of the drainage treatment in this respect (see Section 4.3.3).

These measures will all be embodied in an EMP and written up as contractual specifications with construction and post-construction environmental auditing (see Section 5.0).

4.6 Wetland Impacts

4.6.1 Potential Short Term Impacts

The proposed on-ramp project area supports approximately 10.2 ha of wetland dependent vegetation, representing a category C (Conservation) wetland (Section 3.3.3). The land requirement for the on-ramp will result in the removal of approximately 0.8 ha of this wetland habitat or approximately 8% of its occurrence in the project area (see Figure 3.1 and Table 3.2). Detailed mapping of the Bush Forever site was not carried out during field studies for this PER, but Tingay and Associates (1994a) mapped wetland vegetation units at a similar (somewhat coarser) level of resolution and the account of Bush Forever site 386 indicates representation of similar wetland vegetation throughout the remainder of the Bush Forever site (Government of Western Australia 2001).

This direct reduction in area of a category C wetland is the main impact on wetlands that is likely to arise from the proposal. The other long term impacts are either minor in nature or manageable (see Section 4.6.2). As there is no further scope to amend the on-ramp design to reduce the impact of the project on the wetland (Section 2.3), a mitigation and environmental offset approach will be adopted by the proponent, consistent with the Draft WRC hierarchy (see Section 5.3; Appendix 2).

Given that the area contains wetland peat deposits, it is possible that Acid Sulfate Soils (ASS) could be generated if dewatering or excavation of these sediments occurred, exposing them to air. The construction of the on-ramp will actually involve filling and raising of levels during earthworks. As there will also be no dewatering, it is considered unlikely that there is any risk of significant ASS generation (Aquaterra 2003). Nevertheless, Main Roads will carry out

an assessment and develop any management measures that may be required in accordance with the Draft DEWCP and EPA Guidance on ASS (DEWCP 2002).

4.6.2 Long Term Potential Impacts

It was recognised in the scoping document (Appendix 2) and earlier studies (Biota 2002) that the construction of the on-ramp is likely to have some minor and localised effects on surface hydrology in the areas immediately adjacent to the on-ramp. This could result in potential reductions in surface water inputs to local wetland habitats. The extent to which this would affect wetland dependent vegetation and the hydrological function of the wetland was examined as part of Aquaterra (2002) (Appendix 6). This study concluded that the proposed on-ramp will have minimal impact on surface water hydrology or the hydrological function of a small scale spring flow to the south of Abernethy Road (Aquaterra 2003). Surface drainage is from the north towards the site, with the on-ramp situated in the very bottom corner of the local catchment (Aquaterra 2003). The majority of the wetland area is upgradient of the planned on-ramp and should therefore not experience any significant change in surface water inputs (Aquaterra 2003). The road pavement runoff will discharge into the retention basin to be constructed in the centre of the ramp loop (Figure 1.1). The ramp embankment may still affect small scale local flows, with the potential for a small amount of surface water to pond adjacent to the embankment before infiltrating into the highly permeable sands below (Aquaterra 2003). This ponding is likely to be localised, small-scale, episodic and brief in duration (see Appendix 6). It is therefore considered unlikely to result in any alteration to the hydrological regime of the 9.4 ha of wetland area that will remain adjacent to the on-ramp.

The on-ramp will take up an area of 1.4 ha, of a total recharge area feeding the on-ramp area of 75 ha (2% of the local groundwater catchment; Aquaterra 2003). The presence of the on-ramp is therefore not expected to have any effect on local recharge to the aquifer, as rainfall will still be recharged to the local aquifer via infiltration through the drainage basin (Aquaterra 2003).

It is also possible that run-off from the proposed on-ramp could introduce soluble contaminants, litter and water-borne weed propagules into the wetland area that will remain adjacent to the required land. This aspect will be addressed and should be adequately managed by the proposed drainage design for the facility, with road run-off to be directed into a central detention/infiltration basin for local recharge (see Figure 1.1; Section 4.6.3). As the retention basin outlet is predominantly by infiltration, the pollutants will be retained in the basin or filtered by the sand below (Aquaterra 2003). The groundwater flow direction is away from the wetland (which is to the north of the ramp), so any pollutants that pass through the sand filter at the base of the basin and into the groundwater will not affect the upgradient wetlands. The detention basin also provides for short-term spillage entrapment in the event of a significant contaminant event on the on-ramp or adjacent Tonkin Highway (see Section 4.6.3).

Note however, that the potential for the introduction of air-borne weed propagules from agricultural freight transport utilising the on-ramp would remain an ongoing risk (see Section 4.3.2).

4.6.3 Environmental Management Response

The majority of the impacts that can be reduced by environmental management are addressed through the drainage design of the proposed facility, primarily the infiltration basin.

In addition to this design aspect, Main Roads will develop and implement the following environmental management measures:

- **Acid Sulfate Soils (ASS) generation potential assessment.** Any further appropriate management would then be developed in accordance with the Draft DEWCP and EPA Guidance on ASS;
- Clearing controls (as outlined in Section 4.3.3);
- Construction site induction and constraints (as outlined in Section 4.3.3);
- Fire risk management (as outlined in Section 4.3.3);
- Topsoil and landscaping plan (as outlined in Section 4.3.3);
- Weed monitoring and control (as outlined in Section 4.3.3); and
- Drainage management strategy (as outlined in Section 4.3.3).

These measures will all be embodied in an EMP and written up as contractual specifications with construction and post-construction environmental auditing (see Section 5.0).

4.7 Bush Forever Site

The direct impact of this proposal on Bush Forever Site 386 is primarily one of reduction in total area and reduction in boundary – area ratio. The on-ramp proposal would result in the removal of 1.4 ha of intact remnant vegetation from the 629 ha site. This represents a small percentage of the Bush Forever site in real area terms (0.2% of its total area), but the values affected are perhaps more significant than a simple numerical percentage expresses. Site 386 is of regional significance for conservation of vegetation, flora, fauna and wetland systems and represents one of the largest intact remnants on the eastern side of the Swan Coastal Plain portion of the Perth metropolitan region (see Section 3.0 and 4.2). The ability of even these largest vegetation remnants to retain their biodiversity values over the long term is questionable and any reduction in total area can only serve to reduce long term viability. Given this, even a small reduction in area such as that proposed here warrants careful evaluation. In recognition of this, the proponent has already examined alternative options and revised design as far as possible to reduce the land requirement on the site (see Section 2.3). The reduction in area in regionally significant vegetation will also be offset by the securing or ecological enhancement of another area of currently unprotected land containing a regionally significant vegetation remnant in the same locality (see Section 5.3).

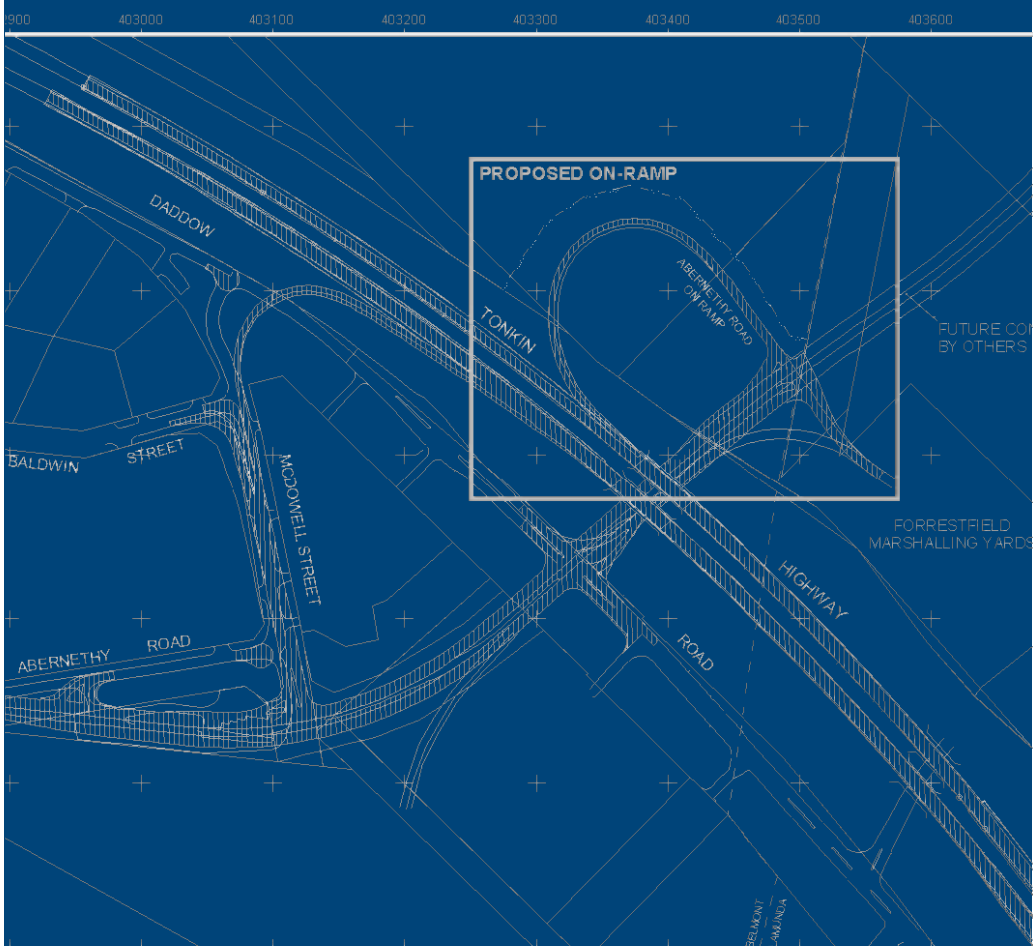
Potential impacts on the specific natural values that make the site of regional significance have been discussed in Sections 4.1 to 4.7 of this PER, including management measures to address these.

4.8 Social and Heritage Impacts

At present it is anticipated that there will be no significant impacts on Aboriginal heritage values as a result of the proposal proceeding. Main Roads is in the process of confirming that no sites of significance existing within the land requirement area (see Section 3.5.3). In the event that the ACMC determines a site is present, then Main Roads will abide by the requirements of the *Aboriginal Heritage Act 1972* in regards to obtaining a Section 18 clearance, including implementation of any conditions attached to such an approval (see Section 5.0).

Section 5.0

Summary and Commitments



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5.0 Summary and Proponent Commitments

5.1 Consolidation of Impact Assessment and Management Approaches

The evaluation completed in Section 4.0 of this PER has identified the environmental factors of significance that may be impacted by the construction of the proposed on-ramp. Some of the identified impacts appear unlikely to be significant, others can be managed by design approaches and construction work methods, whilst others are more difficult to quantify and directly address. A summary of the impacts identified and their likelihood of occurring given the proposed environmental management is presented in Table 5.1.

Table 5.1: Summary of potential impacts, factors affected and risks given the management proposed for the Abernethy Road – Tonkin Hwy on-ramp project.

Impacts	Relevant Factors	Risk of Impacts Given Proposed Management Measures
Short Term (Construction)		
1. Vegetation clearing (Section 4.3.1, Section 2.3.4)	Flora, Vegetation, Fauna, Wetlands	Loss of relatively small area (1.4 ha) of regionally significant vegetation/wetland habitat will occur -> significant impact that has been reduced by planning and design as far as possible
2. Vehicle and plant movements beyond clearing area (Section 4.3.1)	Flora, Vegetation, Fauna, Wetlands	Induction and clearing controls procedures during construction in EMP and specifications -> low level of risk of impact
3. Pedestrian movements beyond clearing area (Section 4.3.1)	Flora, Vegetation, Fauna, Wetlands	Induction and clearing controls procedures during construction in EMP and specifications -> low level of risk of impact
4. Construction bushfires in adjacent bushland (Section 4.3.1)	Flora, Vegetation, Fauna, Wetlands	Bushfire risk control procedures during construction in EMP and specifications -> low level of risk of impact
Long Term (Operational Life)		
1. Weed introduction and spread into adjacent bushland (Section 4.3.2)	Flora, Vegetation	Hygiene during construction with follow-up monitoring and control -> low level but ongoing risk of introduction of exotics
2. Dieback introduction into adjacent bushland (Section 4.3.2)	Flora, Vegetation	Hygiene during construction -> low risk of dieback introduction
3. Surface hydrology changes (Section 4.6.2)	Flora, Vegetation, Fauna, Wetlands	Low probability of significant impact
4. Groundwater changes (Section 4.6.2)	Flora, Vegetation, Fauna, Wetlands	Low probability of significant impact
5. Increased fire frequency (Section 4.3.2)	Flora, Vegetation, Fauna, Wetlands	Ongoing risk, but probably insignificant increase in current risk levels given existing proximity of Tonkin Highway
6. Edge effects / bushland integrity reduction (Section 4.3.2; Section 4.7)	Flora, Vegetation, Fauna	Reduction of local conservation Zone (77ha) and Bush Forever Site 386 (629 ha) by 1.4 ha will occur -> some low level of reduction in long term ecological viability
7. Increase in local noise levels (Section 4.5.2)	Fauna	Potential impact on breeding success difficult to quantify, but considered unlikely given existing local noise levels
8. Road kill increases (Section 4.5.2)	Fauna	Low probability of significant impact
9. Contaminant spills (Section 4.6.2)	Flora, Vegetation, Fauna, Wetlands	Detention basins providing spillage entrapment -> low probability of significant impact

The over-arching impact to emerge from this assessment is more related to reduction in regionally significant conservation area rather than focussed on any particular species or specific feature of the site. Vegetation and fauna communities on the eastern Swan Coastal Plain have been subject to heavy clearing through past land practices, such that there are few areas that now support substantial remnants. The Perth airport bushland is one of these sites and any further reduction in its area is likely to have some level of effect on the long term viability of the communities and integrity of the ecosystem process present. It must be recognised however that the on-ramp proposal is a relatively small disturbance area both in real terms and in its proportional representation of the Bush Forever site.

In addition, the Perth airport area has been relatively well studied (Dixon 1983, Tingay and Associates 1994a and b, How et al ,1996, Biota 2002) and subject to a lengthy integrated planning process (Bechtel and Sinclair Knight Merz 1999). This masterplan aimed to identify the areas with the highest conservation values and set these aside from development. The 313 ha set aside included the on-ramp project area, but also recognised its future presence in its currently proposed location (see Figure 3.5). The masterplan was then formally agreed on as the subject of a Memorandum of Understanding between the Perth Airports Corporation and the State Government. This agreement was recognised in Bush Forever (Government of Western Australia 2000) and offers some certainty with regards to future land-use and development in the area. One aspect of this is that it is unlikely that the identified conservation areas within the site will be further eroded by any unforeseen developments, given the extensive planning and consultation process required to arrive at the masterplan. The on-ramp development was foreshadowed at its current site in the masterplan, but no other potential land clearing was noted for the conservation zones (Bechtel and Sinclair Knight Merz 1999).

Based on this, the view could be taken that the balance of the remnant bushland in the project area is somewhat more secure from future land development than urban remnants in other parts of the metropolitan region. A lack of integrated regional planning can often lead to unrelated projects independently clearing land in the same locality without any rationalisation of overall impacts. This should not be the case in the airport area given its history and planning structure, with the current expectation being for no further reduction in the extent of the bushland conservation zones.

Despite the above, the proponent recognises the regional significance of the features impacted and is preparing a package of environmental offsets, with the objective of achieving no net loss of environmental values within the local area (see Section 5.3).

Table 5.2 presents a summary of the relevant environmental factors for this PER in accordance with the generic EPA guidelines for preparing a formal environmental review and the EPA approved scoping document specific to this project (see Appendix 2).

Table 5.2: Summary table of relevant environmental factors, potential impacts, planned management and predicted outcomes for the proposed Abernethy Road – Tonkin Highway on-ramp.

Environmental Factors	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Biophysical					
Fauna	Maintain the abundance, species diversity and geographic distribution of terrestrial fauna	Diverse array of vertebrate and invertebrate species occur in the area on the regional scale. Important habitat remnant for birds of the Swan Coastal Plain and for some reptiles and invertebrates with restricted distributions	Clearing of 1.4 ha of intact habitat, comprising three smaller scale habitat units. Some loss in viability of local fauna populations through direct impacts / displacement. Ongoing low level of impact, similar to existing highway.	Clearing Controls Environmental Inductions Bushfire risk management Topsoil and Landscaping Drainage basin development Environmental offsets (acquisition of other habitat remnant in locality).	Loss of 1.4 ha of intact habitat from the Perth airport bushland site, to be offset by improvements in area of other regionally significant bush in the locality (no net loss objective).
Threatened Fauna	Protect Specially Protected (Threatened) Fauna, consistent with the requirements of the *Wildlife Conservation Act 1950-1979*.	No Schedule Fauna reliant on the impact area (low level of utilisation by Carnaby's Cockatoo (Schedule 1)). Quenda (Conservation Dependent) present in wetland habitats in the impact area.	Clearing of 1.4 ha of intact habitat, most of which would be utilised by the Quenda (which has a large and viable population in the remainder of the bushland). No direct impact on habitats used locally by Carnaby's Cockatoo.	Clearing Controls Environmental Inductions Bushfire risk management Topsoil and Landscaping Environmental offsets (acquisition of other habitat remnant in locality).	No significant impacts on any Threatened fauna expected as a result of the proposal. No change in conservation status of any threatened fauna species as a result of the proposal.
Flora and Vegetation	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities	Floristically diverse and intact vegetation remnant. Low level of weed invasion. Vegetation types present relatively well represented in the local area and on Swan Coastal Plain (no TECs).	Clearing of 1.4 ha of intact and good condition vegetation, risks of weed / dieback introduction, bushfires, disturbance outside of clearing limits.	Clearing Controls Environmental Inductions Bushfire risk management Topsoil and Landscaping Weed / dieback hygiene Environmental offsets (acquisition of other habitat remnant in locality).	Loss of 1.4 ha of intact habitat from the Perth airport bushland site. Vegetation types to be removed are represented in other areas both locally and regionally; no significant reduction in regional conservation values for vegetation types at the floristic community level

Environmental Factors	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Threatened Flora	Protect Declared Rare and Priority Flora, consistent with the requirements of the *Wildlife Conservation Act 1950-1979*. Protect other flora species of conservation significance.	No DRF in the impact area (populations present to the north). Two individuals of one priority flora species (*Verticordia lindleyi* subsp. *lindleyi*) present in impact area.	No direct impact on DRF species (small risk of disturbance outside of clearing limits). Two individuals of *Verticordia lindleyi* subsp. *lindleyi* would be removed.	Clearing Controls Environmental Inductions Transplantation of two individuals of *Verticordia lindleyi* subsp. *lindleyi* to adjacent habitat.	No significant impacts on any DRF species expected as a result of the proposal. No change in conservation status of any threatened flora species as a result of the proposal.
Wetlands	Maintain the integrity, functions and environmental values of wetlands. Ensure that Environmental Protection Policy (EPP) lakes are protected and their key ecological functions are maintained.	Conservation category wetland present in the impact area and extending into adjacent bushland. No EPP wetlands present.	No impacts on EPP wetlands. Loss of 0.8 ha of a Conservation category wetland with a local extent of 10.2 ha (~8% loss). No significant indirect impacts anticipated on remaining 9.4 ha of the wetland.	Drainage design to be implemented including detention / infiltration basin. Basin to be monitored and maintained during operational life.	No reduction in EPP wetlands as a result of the proposal. Identification of a suitable site for wetland offset as per Draft WRC hierarchy guidelines.
Social					
Aboriginal Heritage	Ensure the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*. Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Advice pending on confirmation of lack of sites in the impact area.	None anticipated.	Archaeologist to monitor excavation for items of significance.	No sites of Aboriginal heritage significance will be disturbed by the proposal

5.2 Requirements of the Federal *Environment Protection and Biodiversity Conservation Act 1999*

Under the *EPBC Act 1999*, an 'action' consists of 'a project, development, undertaking, activity or series of activities'. Actions are required to be referred under the Act if they take place on Commonwealth land (or are an action by the Commonwealth), or are likely to significantly impact a matter of National Environmental Significance (NES). Part of the land required for the Tonkin Highway on-ramp project is currently Commonwealth land, but will not be by the time the action (construction of the on-ramp) occurs (see Section 2.2).

There are currently six NES factors identified in the *EPBC Act 1999*. These are:

- World Heritage properties;
- Ramsar wetlands of international significance;
- listed threatened species and ecological communities;
- listed migratory species;
- Commonwealth marine area; and
- nuclear actions (including uranium mining).

Four of these factors; Ramsar wetlands, World Heritage properties, Commonwealth waters, and nuclear actions are clearly not relevant to the proposed Abernethy Road - Tonkin Highway on-ramp. The only possible factors of relevance relate to threatened species and ecological communities and impacts on listed migratory species.

With respect to threatened species and communities, the surveys and analysis completed as part of this PER indicate that there are no TECs in the impact area of the proposed on-ramp (see Section 3.2.5). There are also no federally listed threatened flora species in the impact area for the project (Section 3.2.3). The only federally listed species known from the area is Carnaby's Cockatoo *Calyptorhynchus latirostris*, which was recorded from secondary evidence on trees adjacent to the land requirement area (Section 3.3.4). In order for the action of constructing the on-ramp to fall within the assessment scope of the *EPBC Act 1999*, it would need to have 'a significant impact on an important population' of this species. Given the apparent low level of abundance, and that the 1.4 ha of remnant vegetation is unlikely to be an important breeding or foraging resource for the species, this NES factor does not appear to be relevant to the proposed on-ramp.

Two migratory bird species have been recorded from the project area (Rainbow Bee-eater *Merops ornatus* and the Great Egret *Ardea alba*; Section 3.3.1). The referral and assessment criteria for migratory species is similar to that for endangered species, requiring the action to significantly impact an important population to fall under the Act's assessment requirements. Again, the site appears to have a typical or low level of utilisation by these species compared to other bushland remnants in the Perth area, and these would not be likely to comprise 'important populations' for the purposes of the Act.

Given the data collected as part of this PER, and outcomes of the above assessment, it appears that no *EPBC Act 1999* referral is necessary for the planned on-ramp.

5.3 Project Environmental Offset

In recognition of the removal of 1.4 ha of regionally significant vegetation, the proponent is in the process of advancing an offset package consisting of the provision and securing of a wetland/urban bushland area for long-term conservation that is not currently part of the conservation estate. Main Roads has already invested considerable effort in pursuing and assessing options for offset opportunities prior to the currently proposed offset. These included:

1. The rehabilitation of degraded vegetation within the Perth Airport bushland

This was Main Roads' initial option for the project offset as identified in the Scoping Document for the proposal (Appendix 2). Unfortunately, advice from the Westralia Airports Corporation indicated that it would not approve any management actions by a State government agency on the Federal land under its control (see Appendix 1).

2. Acquisition of a nearby wetland

A wetland area currently owned by Westrail was next identified as a potential offset for the project. The wetland was located in Belmont, but field inspections indicated that it was degraded, substantially modified and infested with weed species (a Multiple Use enhancement category wetland). It would therefore not have constituted a suitable offset for the values to be removed from Airport site by the proposal.

3. Rehabilitation of a disturbed area in the central part of the Dundas Road Bushland (Bush Forever Site 319)

The option involved the rehabilitation of an area central to Bush Forever Site 319. The land in question is owned by, and under the management of, the Water Corporation. Preliminary discussions were undertaken with Water Corporation which indicated it would consider the possibility of the Main Roads carrying out the proposed works, but that it may be considering the site for an environmental offset itself.

- **Provision of Bush Forever Site 53 for conservation purposes**

After considering the previous three previous options, Main Roads is now advancing a package comprising the relinquishment of a section of land (Lot 109 Clifford Street) that was originally purchased in 1983 by Main Roads for road utility purposes. Lot 109 Clifford Street is situated in Orange Grove and is 1.85 ha in size (0.45 ha greater than the impact area required for the proposed on-ramp). When considered against the draft WRC wetland mitigation criteria (Appendix 2), and the nature of the values being impacted by the proposal, the proposed offset meets the criteria well in most respects, as it:

- has a Conservation Category wetland on land currently set aside for road utility purposes;
- is within the same general locality (further south along Tonkin Highway);
- contains populations of Declared Rare Flora (*Conospermum undulatum*);
- has habitat for, and records of, threatened fauna;
- contains Bassendean Dunes and Pinjarra Plain landforms and soils; and
- was identified as regionally significant vegetation as part of Bush Forever (Site No. 53; Government of Western Australia 2000).

This lot is currently vested in the Commissioner for Main Roads and zoned for Rural use under the MRS (as at Dec 2002) and is situated south of the proposed on-ramp site on the Tonkin Highway reservation. Main Roads currently intends to relinquish this significant site and pursue a process to transfer ownership of the lot to a more suitable management agency for conservation purposes. To this end, an in-principle agreement has been reached with the Department of Conservation and Land Management in respect of securing and managing the land in question for long term conservation. Main Roads has provided a commitment to follow this process to completion or identify a similar offset package to the satisfaction of the relevant conservation agencies (see Section 5.4).

5.4 Proponent Commitments

Main Roads has developed a series of proponent commitments for the construction of the proposed Abernethy Road – Tonkin Highway on-ramp. These have been based on consideration of the issues relevant to the project and the receiving environment, potential impacts identified and environmental management approaches. The proponent commitments for this project are set out in Table 5.3. Note that the term 'commitment' as used in this table includes the entire row of the table and its six separate parts as follows:

- a commitment number;
- a commitment topic;
- the objective of the commitment;
- the "action" to be undertaken by the proponent;
- the timing requirements of the commitment; and
- the body/agency to provide technical advice to the DEP.

These commitments will be implemented by Main Roads as part of the Ministerial Approval to proceed with the Abernethy Road – Tonkin Highway on-ramp as described in this PER.

Table 5.3: Proponent commitments for the proposed Abernethy Road – Tonkin Highway on-ramp.

No.	Topic	Objective	Action	Timing	Advice from †
1	Environmental offset	To provide an appropriate offset for the removal of regionally significant vegetation and wetland area.	Develop and implement a strategy to address the loss of conservation values through the rehabilitation of a degraded area, or acquisition or securing of another area of similar ecological value for conservation purposes.	Process commenced pre-construction, to be finalised during or within three months of the completion of construction.	DCLM, DEP, DPI, DOLA
2	Environmental Management Programme	To minimise the impacts of construction works on the adjacent vegetation and fauna habitat remaining within Bush Forever Site 386. To ensure no impacts on nearby populations of Threatened Flora occur.	To prepare and implement an Environmental Management Programme (EMP) for the construction of the Abernethy Road – Tonkin Highway on-ramp. Components of the plan will include: 1. vegetation clearing controls 2. topsoil and landscaping plan 3. dieback and weed hygiene 4. environmental inductions 5. fire risk management 6. environmental auditing 7. drainage management	Prepared and approved prior to construction. Implemented during construction. Audits completed during construction works and post-construction.	DEP
3	Drainage Management	To ensure that no road surface run-off directly enters the wetland. To ensure that there is provision for contaminant spillage entrapment. To ensure continued function in disposal of road run-off and infiltration /recharge to the local aquifer.	Construct the detention / infiltration basin as designed. Periodic monitoring of the infiltration basin post-construction to ensure continued function and maintain as required.	Design finalised pre-construction, implemented during construction and post-construction.	DEP, WRC
4	Priority Flora	To ensure that DCLM requirements are met regarding rehabilitation, transplanting or other management measures for threatened flora species.	Liaise with DCLM regarding management requirements for Priority flora in regards to transplanting of *Verticordia lindleyi* subsp. *lindleyi.*	Pre-construction, with any DCLM required management actions.	DCLM

Table 5.3: Proponent commitments for the proposed Abernethy Road – Tonkin Highway on-ramp.

No.	Topic	Objective	Action	Timing	Advice from †
5	Acid Sulfate Soils	To ensure that adjacent wetland areas are not impacted by any acid drainage that may arise from sediments exposed during construction.	Implement assessment and management procedures in accordance with the Draft DEP Guidance Statement on ASS	Testing carried out prior to commencement of earthworks, any management procedures that may be required to be implemented during construction in accordance with the Draft DEP Guidance Statement on ASS	DEP
6	Aboriginal Heritage	To ensure that no sites of significance to Aboriginal people are impacted.	Prepare an Aboriginal Heritage Management Plan, to specify archaeological monitoring during construction activities.	Plan prepared prior to the commencement of construction and implemented during construction, with any statutory processes followed as per the requirements of the *Aboriginal Heritage Act 1972*.	DIA

† Advisory agencies: DEP – Department of Environmental Protection, DCLM – Department of Conservation and Land Management, DPI = Department of Planning and Infrastructure, DOLA = Department of Land Adminstration, WRC = Water and Rivers Commission, DIA = Department of Indigenous Affairs.

6.0 Acknowledgments

The assistance of Malcolm Trudgen and Ted Griffin in running PATN analysis of floristic data and assigning floristic community types is acknowledged.

Ric How and Ron Johnstone of the Western Australian Museum assisted by providing historical vertebrate fauna survey data from the airport site and database records for bird utilisation of the project area, respectively.

All herpetofauna photographs in this PER were taken by Greg Harold.

The wetland hydrological study was completed by Jeff Jolly of Aquaterra Consulting Pty Ltd.

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Relevant Correspondence

Appendix 1

BIOta

Malcolm Trudgen

Consultant Botanist

Mr Garth Humphreys
Biota Environmental Sciences
2/186 Scarborough Beach Road
Mt Hawthorn Western Australia 6016

10 Hehir St
Belmont
W.A. 6104
22 January 2003

Dear Garth,

Analysis of your Tonkin Highway data

After correcting for name changes from those used by Gibson *et al* (1994), we have run two analyses of your data (ARO and ECOL sites) *. The first is the production of a dendrogram using the FUSE and DEND modules of PATN. The second is a "nearest neighbours" analysis using the NNB module of PATN, rather than referring a new site to a group, the latter analysis shows the sites in the existing database which are most similar to the new sites. The new site can then be inferred to belong in or close to the same floristic community site as the nearest site.

After considering the results from the two analyses and the descriptions provided by Gibson *et al* (1994) of their floristic community types, we have made a best fit conclusion for each of the sites. You should bear in mind that adding even a small number of extra sites to the analysis can significantly change the dendrogram produced using FUSE and DEND.

The various AR (see Table 1, below) sites are referrable to either Floristic Community Type 23a, Floristic Community Type 4 or are intermediate between Floristic Community Types 11 and 12. The sites referrable to FCT 23a appear to be to a degree intermediate between FCT 23a and FCT 21c which each (from the maps in Gibson *et al* 1994) appear to occur in the vicinity of the area your data is from. The FCT 21c sites to which they tend to relate are ones from the northern end of Floristic Community Type 21c's range. Floristic Community Types 11 and 12 are related, both being communities in which *Astartea* aff. *fascicularis* is common or dominant. This vegetation can be very variable in the species present. It is therefore, not sound to define the site AR07 as either FCT 11 or 12.

Table 1: Summary of results of the two analyses and conclusions as to the best fit for the new data.

Site	FCT: from Nearest Neighbour Analysis using module NNB	FCT: from Classification using modules FUSE & DEND	FCT: conclusion
AR01	23a	21c	23a
AR02	23a	21c	23a
AR03	4	4	4
AR05	23a	21c	23a
AR06	23a	21c	23a
AR07	?11/12	11/12/13	?11/12
ECOL03	?13/4	4	?4
ECOL04	?17/13	17/13	?
ECOL08	?28	21c	?21c

The results for the "ECOL" sites was less satisfactory, these sites seem to have smaller species lists and possibly were recorded at a poor time of the year. This is likely to have affected the results somewhat.

* **Note that the location of AR0 series sites is shown in Figure 3.1 of this PER (ECOL sites were not utilised in the PER assessment given their evaluation as less satisfactory)**

Table 2: Results from the nearest neighbour analysis using NNB module.
The upper part of the table (left hand column in red) shows the new sites (left hand column) then the closest site (which can be also in the new data), then the floristic community type if the closest site is from the Gibson et al dataset. The sequence is then repeated for the second closest site etc. The lower part of the table shows the nearest neighbours of some of the sites closest to the new sites.

site	s1	fct1	si1	s2	fct2	si2	s3	fct3	si3	s4	fct4	si4	s5	fct5	si5
AR01	ECOL08		0.42	BULL-3	**23a**	0.4462	AR05		0.4528	KOON-1	20a	0.52	WIRR-1	23a	0.5294
AR02	AR05		0.4	AR01		0.5577	AR06		0.5641	WIRR-1	**23a**	0.5833	WARB-1	23a	0.5929
AR03	AR02		0.6667	FL-1	**4**	0.6757	AR05		0.6757	MODO-1	4	0.6774	MODO-6	4	0.6786
AR05	AR06		0.4	AR02		0.4	AR01		0.4528	WARB-1	**23a**	0.4783	YULE-1	23a	0.4902
AR06	AR05		0.4	YULE-1	**23a**	0.4444	YULE-2	23a	0.5385	NINE-2	21a	0.5455	WIRR-2	23a	0.5619
AR07	AUSTB-3	11	0.6596	RIVD-1	12	0.6667	ECOL03		0.6774	PAGA-3	5	0.68	hymus02	11	0.7273
ECOL03	AR07		0.6774	BANK -1A	13	0.7391	AR03		0.7436	MODO-6	4	0.7949	PAGA-3	5	0.8049
ECOL04	PAGA-5	17	0.6842	WATER -2	13	0.7333	RIVD-1	12	0.7647	AR07		0.7778	cool 01	17	0.8
ECOL08	AR01		0.42	YAN-3	28	0.5909	YAN-20	23b	0.6038	card7	21a	0.6098	M53	20a	0.6154
xxxxxxx	xxxxxxxxx	xxxx	xxxxxx	xxxxxxxx	xxx	xxxxxxx	xxxxxxx	xxxx	xxxxxxx	xxxxxxx	xxx	xxxxxxx	xxxxxxx	xxxx	xxxxxx
AUSTB-3	hymus02	11	0.6471	hymus05	11	0.6491	ELLEN-3	8	0.6533	AR07		0.6596	TWIN-11	11	0.68
BANK-1A	CAPEL-4	13	0.6667	KOOLJ-1	4	0.6875	FL-10	12	0.7241	RUAB-3	13	0.7333	welr 01	9	0.7368
BULL-3	hurst03	23a	0.3869	WHITE-1	23a	0.3906	WIRR-1	23a	0.411	ELDO-1	23b	0.4355	MODO-4	23a	0.4394
FL-1	MODO-1	4	0.55	rowe02	4	0.5625	TWIN-7	21c	0.5909	GUTHR-1	4	0.596	BULL-5	5	0.6
PAGA-5	cool 11	17	0.4286	ELLIS-1	17	0.5	LESCH-6	17	0.5714	MTB-5	17	0.5789	cool 01	17	0.6
WARB-1	WIRR-1	23a	0.2966	WIRR-2	23a	0.3571	WARB-3	23a	0.3944	ELDO-1	23b	0.4472	RAAF-1	23b	0.45
WIRR-1	WARB-1	23a	0.2966	WIRR-2	23a	0.3469	WARB-3	23a	0.3826	hurst03	23a	0.3846	BULL-3	23a	0.411
YAN-3	NEER-2	28	0.4433	NEER-3	28	0.4624	YAN-25	28	0.4706	DEPOT-1	28	0.5217	WARI-2	28	0.5229
YULE-1	YULE-2	23a	0.2389	hurst03	23a	0.3984	WHITE-1	23a	0.4035	WARB-3	23a	0.4419	AR06		0.4444

Table 3: Extracts from the classification (dendrogram) produced by the DEND module of PATN.
A row of crosses (xxxx) across the table indicates a break in the dendrogram.

<table>
<tr><th></th><th>gp30a</th><th>data</th></tr>
<tr><td></td><td></td><td>01/21/03 20:21:31.36 dend Biota Forrestfield sites Jan 2003</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>0.2050 0.3667 0.5283 0.6900 0.8517 1.0133 1.1750</td></tr>
<tr><td></td><td></td><td>| | | | | | |</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>AMBR-3</td><td>4</td><td>______________________________ |</td></tr>
<tr><td>CAPEL-3</td><td>4</td><td>_____________________________|________ |</td></tr>
<tr><td>PAYNE-1</td><td>4</td><td>_____________________________________|______ |</td></tr>
<tr><td>C58-1</td><td>4</td><td>_______________________ | |</td></tr>
<tr><td>MODO-1</td><td>4</td><td>_________________ | | |</td></tr>
<tr><td>MODO-6</td><td>4</td><td>________________|_____|___ | |</td></tr>
<tr><td>FL-9</td><td>4</td><td>_________________________|____ | |</td></tr>
<tr><td>GUTHR-1</td><td>4</td><td>_____________________________|__ | |</td></tr>
<tr><td>LYONS-1</td><td>4</td><td>_______________________________|___ | |</td></tr>
<tr><td>FL-1</td><td>4</td><td>________________________________ | | |</td></tr>
<tr><td>low14a</td><td>4</td><td>__________________________ | | | |</td></tr>
<tr><td>rowe02</td><td>4</td><td>_________________________|_____|__|________|_______ |</td></tr>
<tr><td>AR03</td><td></td><td>____ | |</td></tr>
<tr><td>ECOL03</td><td></td><td>____|_______ | |</td></tr>
<tr><td>KOOLJ-1</td><td>4</td><td>_____________________________ | | |</td></tr>
<tr><td>MELA-1</td><td>4</td><td>____________________________|________________ | | |</td></tr>
<tr><td>PLINE-4</td><td>4</td><td>___________________________________ | | | |</td></tr>
<tr><td>WHITE-2</td><td>4</td><td>__________________________________|_________|__|__|_____|______</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

AR07		
AUSTB-3	11	
RIVD-1	12	
FL-10	12	
TWIN-11	11	
hymus05	11	
hymus06	11	
CAPEL-6	12	
CAPEL-8	12	
CAPEL-9	12	
BANK-1A	13	
CAPEL-4	13	
RUAB-3	13	
C58-2	13	
WATER-1	13	
BULL-12	11	
hymus01	11	
hymus02	11	
MODO-3	11	
C71-1	11	
HARRY-6	11	
CARAB-3	11	
rowe01	11	
low10b	11	
MILT-5	14	
YAN-21	14	
		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
cool 01	17	
LESCH-6	17	
cool 11	17	
PAGA-5	17	
cool 04	17	
ELLIS-1	17	
MTB-5	17	
McLART-1	13	
PAGA-2	13	
MILT-2	13	
Possum5	17	
ECOL04		
WATER-2	13	
cool 09	19	
PB-1	19	
PB-6	19	
ELLIS-2	18	
ELLIS-3	18	
		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
AR01		
ECOL08		
AR02		
AR05		
AR06		
DEJONG-c	21c	
FL-5	21c	

FL-6	21c				
hymus03	21c				
hymus04	21c				
TWIN-7	21c				
TWIN-8	21c				
YULE-3	21c				
BANK-2	23a				
hurst03	23a				
MODO-4	23a				
low13b	23a				
BULL-3	23a				
WHITE-1	23a				
YULE-1	23a				
YULE-2	23a				
WARB-1	23a				
WIRR-1	23a				
WIRR-2	23a				
WARB-3	23a				
BANK-3	23a				
MODO-5	23a				
HARRY-4	23a				
WAND-1	23a				
hurst01	23a				
hurst02	23a				
hurst04	23a				
ELDO-1	23b				
MILT-7	23b				
RAAF-1	23b				
MELA-3	23b				
MILT-8	23b				
PLINE-2	23b				
MILT-3	23b				
PLINE-1	23b				
MELA-2	23b				
MELA-6	23b				
MELA-8	23b				
MELA-7	23b				
MELA-9	23b				
SINT-1	23b				
MPK01	23b				
MPK03	23b				
MUCK-1	23b				
RAAF-2	23b				
RAAF-3	23b				
YAN-19	23b				
YAN-20	23b				

By e-mail.

Malcolm Trudgen

Department for Planning and Infrastructure
Government of Western Australia

Environmental Planning
Bush Forever

469 Wellington Street, Perth, Western Australia 6000
Tel: (08) 9264 7777 Fax: (08) 9264 7566 www.dpi.wa.gov.au

Fax

TO:	Paul West - MRWA	FAX No:	9311 8383
FROM:	Emma Bamforth Bush Forever Office	TEL No:	9264 7772
DATE:	11 January 2002	PAGES (Including this one):	1

MESSAGE: Proposed Abernethy Road - Tonkin Hwy On-ramp. BF Site No 386

Paul,
Thank you for providing an opportunity for the Bush Forever Office to comment on the Abernethy Road – Tonkin Highway on ramp proposal so early on in the environmental assessment process. As discussed during the site inspection and onsite meeting held on Tuesday 8th January 2002, the Bush Forever Office considers the following to be the key issues for this proposal:

- the potential for declared rare or priority flora species to be adversely affected by the proposed development;
- the potential for any threatened ecological community to be adversely affected by the proposal;
- the boundary of the conservation category wetland (as from the site inspection it was clear that the area mapped by the WRC as a Resource Enhanced wetland was not correct) and the direct and indirect impacts on the wetland;
- the potential impacts on the Bush Forever Site No 386 - Perth Airport and Adjacent Bushland; and
- the management measures, such as an offset package for the Bush Forever Site and conservation category wetland, that will be considered.

It would also be useful for the environmental assessment document to provide justification for the proposed onramp alignment and a discussion on the alternative alignments that have been considered.

I trust this information satisfies your recent inquiry however should you require any additional information or clarification, please do not hesitate to call me on 9264 7772. I look forward to hearing from you soon.

Regards

Emma Bamforth

Emma Bamforth
Senior Environmental Planner

AUSTRALIAN HERITAGE COMMISSION

File no: 5/12/4/5
Contact officer: Annabel Wheeler ph (02) 6274 2145

10 November 1999

Karen Wilkinson
Department of Transport and Regional Services
GPO Box 594
CANBERRA CITY ACT 2601

Dear Karen

Proposed acquisition of land for Tonkin Highway ramp, Perth Airport

Thank you for referring to the Commission the proposal by Main Roads Western Australia to acquire Commonwealth land at Perth Airport to allow construction of an on-ramp from Abernethy Road to Tonkin Highway. As you are aware, this land is part of Forrestfield Bushland, a place now listed in the Register of the National Estate.

In its earlier advice of 13 November 1998 on this matter, the Commission advised that construction of the intersection could affect national estate values if the area contained vegetation of conservation significance and urged that botanical surveys be conducted in consultation with the Department of Environmental Protection (DEP). It is pleasing that Main Roads WA acted on this recommendation and that a further vegetation survey was carried out in spring 1998 at the request of DEP. This supplementary survey identified within the study area one endangered and one vulnerable vegetation type (*Banksia attenuata* woodland over species-dense shrubland and forests/woodlands of deep seasonal wetlands) and one Declared Rare Flora species (*Macarthuria keigheryi*). The Commission is satisfied that construction of the on-ramp is unlikely to have a significant adverse effect on these plants and communities providing that recommendations made by Ecologia Environmental Consultants to minimize clearing and soil disturbance, retain the rare plant population and prevent weed invasion are fully implemented.

Although there are no Aboriginal values listed in the area to be directly affected by the proposal, there are significant values in the surrounding

A STATUTORY BODY WITHIN ENVIRONMENT AUSTRALIA
GPO BOX 787 CANBERRA ACT 2601 AUSTRALIA PHONE (02) 6274 1111 FAX (02) 6274 2095

region. An important scarred tree, located within the Hartfield Recreation Reserve to the south of the proposal, is included in the Register of the National Estate. It is therefore highly likely that Aboriginal people may have interests in the region and that other Aboriginal places of significance may exist. The proponent is therefore advised to consult with the Aboriginal Affairs Department and all Aboriginal people with rights and interests in the area. It may also be advisable to liaise with the National Native Title Tribunal.

The Commission suggests that transfer of land from the Commonwealth and subsequent construction works should be conditional on Main Roads WA

- consulting about Aboriginal values of the area;
- complying with all of the recommendations made in the Spring Rare Flora and Vegetation Survey January 1999 (Section 4.0, Environmental Impacts and Management);
- receiving environmental clearance from the DEP.

Yours sincerely

Greg Plummer
Acting Director
Natural Environment Section

Facsimile Message
In reply please fax to: (08) 9311 8383

3 December 2001

MAIN ROADS
Western Australia

Metropolitan Region
2 Adams Drive
Welshpool WA 6106

ABN: 50 860 676 021

To:	**Dr. Andrew Burbidge CALM Senior Research Scientist**	From:	Paul West Metropolitan Roads
Fax N°:	9306 1066	Telephone:	9311 8347
N° of Pages:	2 (Including this page)	E-mail:	paul.west@mrwa.wa.gov.au
Your Ref:		Our Ref:	3-170771-8D (calm3/12/01)
Subject:	**WESTERN SWAMP TORTOISE RELOCATION SITE**		

Andrew,

As discussed, Main Roads Western Australia (MRWA) is proposing to construct the Abernethy Road – Tonkin Highway on-ramp. To construct this ramp, 1.4 ha of land from the Perth Airport will be required.

During the planning process for this project, it was identified that there was potential for the Western Swamp Tortoise to be relocated back into the Perth Airport site. To ensure that MRWA does not impact upon any potential translocation sites for this tortoise, please confirm in writing that there are no plans to relocated the Western Swamp Tortoise within the vicinity of the Abernethy Road – Tonkin Highway interchange, see following figure.

If you have any further queries, please do not hesitate to contact me on the above numbers or via e-mail (paul.west@mrwa.wa.gov.au). I look forward to receiving your response.

Regards

Paul West
ENVIRONMENTAL OFFICER

Subject: FW: Western Swamp Tortoise relocation site
Date: Tuesday, 5 March 2002 8:58 AM
From: WEST Paul (EO) <paul.west@mrwa.wa.gov.au>
To: "Garth Humphreys (E-mail)" <garth@biota.net.au>

-----Original Message-----
From: Burbidge, Andrew [mailto:andrewb@calm.wa.gov.au]
Sent: Thursday, February 28 2002 10:40 AM
To: paul.west@mrwa.wa.gov.au
Subject: Western Swamp Tortoise relocation site

Paul
I refer to your fax of 3 December, 2001. My apologies for the delayed response.
As I mentioned on the telephone, the preferred translocation site for the Western Swamp Tortoise within Perth Airport land managed by Westralia Airports Corporation is at the northern end of the airport. We have no interest in the land at the southern end of the airport adjacent to Tonkin Highway for this project.
Andrew

Dr Andrew A Burbidge
Deputy Director, Biodiversity Conservation
Department of Conservation and Land Management
PO Box 51, Wanneroo, WA 6946
Phone +61 8 9405 5103, fax +61 8 9306 1066
www.naturebase.net

WESTRALIA AIRPORTS CORPORATION
PERTH INTERNATIONAL AIRPORT.

10 February 2003

Our Ref ESM/0008

Mr Paul West
Environmental Officer
Main Roads Western Australia
PO Box 6202
East Perth WA 6892

Dear Paul

RE : PERTH AIRPORT – TONKIN HIGHWAY ON-RAMP

I refer to your letter dated 12 December 2003 seeking Westralia Airports Corporation's advice on possible use of airport land to be used to "offset" land that Main Roads WA propose to clear as part of your planned construction of an on-ramp from Abernethy Road to Tonkin Highway. I apologise for the delay in responding however there are a number of property matters under negotiation that have impacted on WAC's position on this matter.

I must advise that we are not in a position to agree to the use of airport land for this purpose due to these ongoing negotiations. Once again, I apologise for the delay in responding to you.

Yours sincerely

Peter Lees
Property Development Leasing Manager

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EPA Scoping Document, Generic PER Guidelines, and Draft WRC Wetland Mitigation Criteria

Appendix 2

BIOta

MAIN ROADS
Western Australia

Issue Date 14/6/02

ENVIRONMENTAL SCOPING DOCUMENT FOR A FORMALLY ASSESSED PROJECT

CONTENTS

1. PURPOSE OF DOCUMENT

The purpose of this document is to assist the EPA/DEP in scoping the necessary work required to ensure that all possible significant issues are properly considered during the Public Environmental Review (PER) period.

2. IDENTIFICATION OF PROPONENT

The proponent for the construction of the proposed Abernethy Road – Tonkin Highway on-ramp is Main Roads Western Australia (MRWA).

3. SUMMARY DESCRIPTION OF PROJECT

MRWA is now close to acquiring the land needed to construct the proposed Abernethy Road – Tonkin Highway on-ramp, Perth Airport, see Figure 1. One of the main purposes for this on-ramp is to provide improved access from the Kewdale, Forrestfield and Wattle Grove industrial areas to the primary road network.

In particular, the Forrestfield industrial area contains the CBH Metropolitan Grain Terminal, which attracts a large number of semi trailer and road train vehicles, on a seasonal basis. It is highly desirable from a safety and amenity perspective that MRWA provides an on-ramp. To construct the ramp, 1.4 ha of land from the Perth Airport will be required.

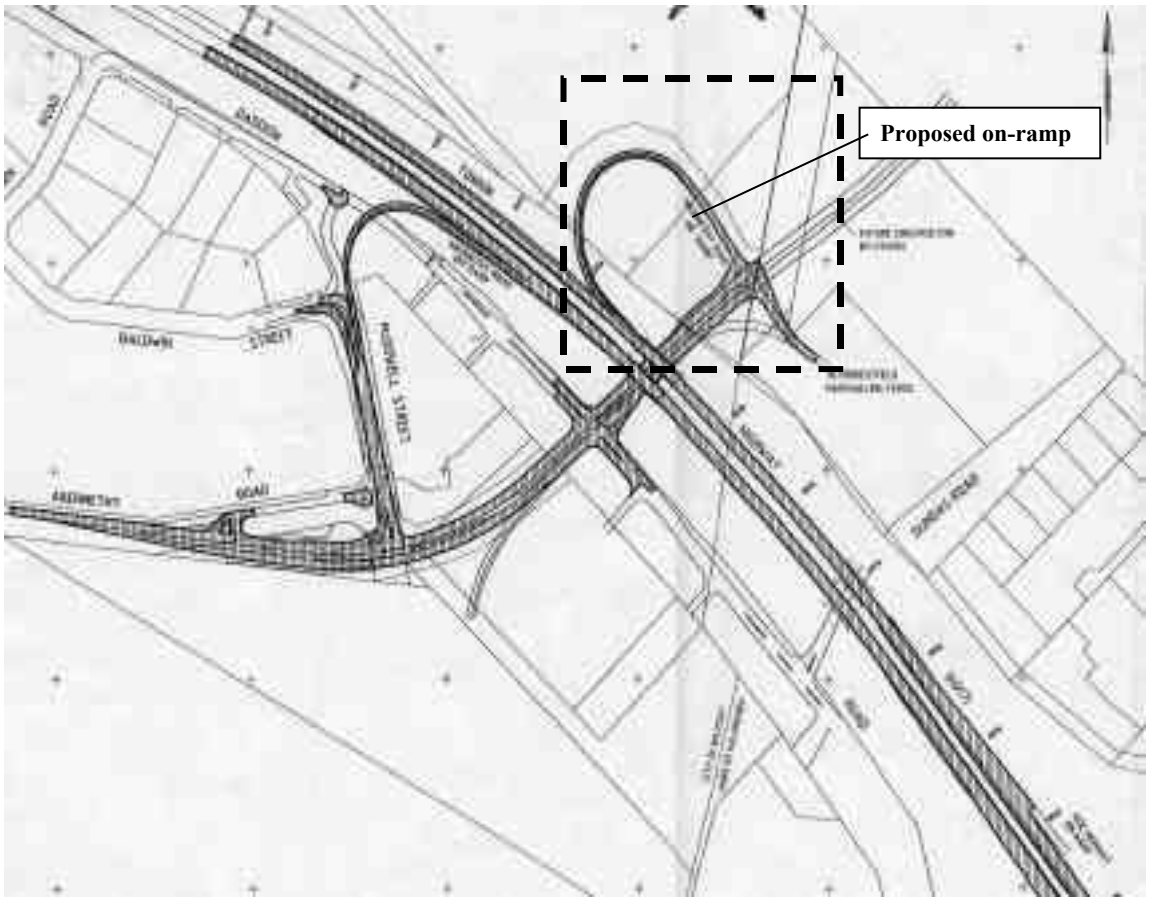

Figure 1. Locality Map for the Abernethy Road – Tonkin Highway On-ramp.

4. ALTERNATIVE OPTIONS CONSIDERED

As discussed in Miller and Associates (2000), "Alternative interchange arrangements at Abernethy Road were examined to provide better access and avoid the need for additional land". These alternative arrangements included:

- Abernethy Road ramps to the north;
- half diamond ramps to the south; and
- an extended on-ramp.

5. BASIS FOR JUSTIFYING PROPOSAL AND SELECTING PREFERRED OPTION

The proposed location for the on-ramp is largely determined by proximity to the nearby Tonkin/Roe interchange and the necessity to allow safe distances for heavy freight traffic to integrate into existing traffic flows on Tonkin Highway. Traffic modelling and evaluation of options is discussed in Millar and Associates (2000).

Alternative interchange arrangements at Abernethy Road were examined to provide better access and avoid the need for additional land. These were all rejected in favour of the current design.

The most environmentally favourable option of half diamond ramps to the south (on-ramp on southern side of Abernethy road, as opposed to northern side) is not considered a feasible option as there is only a short distance between Abernethy Road and the bridge over the railway which would make the ramps very steep. The on-ramp's steep upward grade would prevent larger vehicles from accelerating up to highway speed resulting in a dangerous speed differential where the ramp merges.

6. REGIONAL SETTING OF PROPOSAL

According to the Department of Land Administration, the on-ramp is located within Pt Lot 389 (1.4 ha) and Swan Loc 13626 (0.9 ha). Swan Loc 13626 is a cleared parcel of land, however Pt Lot 389 is located within the Perth Airport site. It is the latter parcel of land for which we are primarily concerned.

At a regional scale, the project area is situated in the eastern half of the Swan Coastal Plain bioregion. The landform in the project area primarily consists of a flat sandplain overlying clays and swamp deposits in some areas. Soils largely consist of Bassendean sands (fine to medium grained quartz of eolian origin) and pebbly silts overlying Guildford Formation (Egis, 1999). A small area associated with the wetland formation in the project area comprises dark grey and black peaty clay with variable sand content. This area consists of thin swamp deposits of low permeability overlying Guildford Formation.

The area required within the Perth Airport site makes up part of Bush Forever Site 386 (Perth Airport and Adjacent Bushland). Up to 1.4 ha of the 629.5 ha of Bush Forever Site 386 will need to be cleared to allow the on-ramp to be constructed. The wider extent of this Bush Forever site contains numerous Threatened Flora populations and the potential impacts of the development on Threatened Flora and vegetation communities has formed a focus for the formal consideration of this project.

7. SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS, THEIR SIGNIFICANCE AND POSSIBLE MANAGEMENT RESPONSES

7.1 Environmental Issues (Biota, 2002)

A substantial proportion of the project area contains wetland habitat. This wetland is principally a meandering dampland unit that is seasonally inundated, with fringing water-gaining soils on upland margins. Current Water and Rivers Commission (WRC) mapping classified part of the wetland area as Category 'C' (Conservation) and part as Category 'R' (Resource Enhancement). However, field inspection and discussions with officers from the Commission indicated that this mapping is no longer accurate and the majority of the currently intact wetland should actually be reclassified to Category 'C' (Conservation).

The mapped portion of the broader area supports approximately 10.2 ha of wetland dependent vegetation. The land requirement for the on-ramp will result in the removal of approximately 0.8 ha of this wetland habitat or approximately 8% of its local occurrence. Detailed mapping of the wider area was not carried out, but the full extent of Bush Forever site 386 contains additional representation of similar wetland vegetation (Government of Western Australia, 2000).

A *Banksia attenuata/Banksia menziesii* Woodland over species rich shrubland community is located on low sandy rises throughout the study area. The understorey is a diverse, dense low shrub, herb and sedgeland. This vegetation type has been listed as a Threatened Ecological Community (TEC) (Shrublands and Woodlands of the Eastern Swan Coastal Plain). Two other occurrences of this TEC have been documented in the northern Swan Coastal Plain; in Stratton and Helena Valley between eight and 13 km north east of the study area. In addition to this status, this vegetation type appears to be the preferred habitat for the Declared Rare Flora (DRF) species *Macarthuria keigheryi,* which is also a protected species under the *Environment Protection and Biodiversity Conservation Act* 1999.

The principal impact arising from the proposed on-ramp will be the requirement to remove approximately 1.4 ha of vegetation. ArcView GIS was used to analyse the total area of impact on each vegetation type of the land requirement for the on-ramp and the percentage that this represented of the local mapped extent (see Table 1).

Table 1: Current approximate local occurrence of vegetation associations, estimated areas post-construction and percentage impact arising from the proposed on-ramp.

Code	Vegetation Associations	Current area (ha)	Area to be removed (ha)	% cleared
1	Cleared/degraded remnant vegetation over weeds	0.9	-	-
2	*Banksia attenuata/Banksia menziesii* Woodland over species rich shrubland	8.8	0.6	7%
2a	*Adenanthos cygnorum* Shrubland	2.4	-	-
3	*Pericalymma ellipticum* Shrubland	7.9	0.6	8%
4	*Melaleuca rhaphiophylla* Woodland	2.3	0.2	8%
5	Open *Xanthorrhoea preissii* over *Hypocalymma angustifolium* Low Shrubland	1.5	-	-

All of the currently known locations at which *Macarthuria keigheryi* has been recorded are outside of the land requirement to construct the proposed on-ramp. This includes the original population location and that of the new individuals recorded as part of the Biota (2002) assessment. Given this, there would appear to be no direct impact from the

required clearing activities on this DRF species based on current knowledge. The habitat type from which all records of this species have been made (Association 2) is also relatively widespread in the local area, and would remain so following construction of the proposed on-ramp (see Table 1).

The ecology of this species is, however, not well understood and it is possible that changes to local hydrological regimes could potentially have an adverse effect on locally occurring individuals adjacent to the on-ramp. The close proximity of the population mapped in the Ecologia (1999) study also indicates a potential risk for inadvertent direct disturbance to individuals during construction.

8. PROPOSED STUDIES AND INVESTIGATIONS

8.1 Vegetation and Flora

In addition to Biota's (2002) recent vegetation mapping, a flora survey will be undertaken so that a full species list can be prepared for the project area. Special attention will be made to the occurrence and distribution of any Declared Rare or Priority Flora, TECs or significant flora on the site.

A weed and dieback survey will be undertaken to identify weed infestations and dieback classifications within and adjacent to the project area.

8.2 Fauna

An avifauna survey will be undertaken to determine whether "Significant Bird Species of the Swan Coastal Plain Portion of the Perth Metropolitan Region" occur within the project area and whether they will be impacted upon by the project.

Investigations will also be undertaken to assess the direct or indirect impact the project may have on the movement of fauna in the greater area.

8.3 Wetlands

A comprehensive hydrological investigation will be undertaken to determine what direct and indirect impacts the construction of the on-ramp will have on the wetland and hydrology of the area.

8.4 Aboriginal heritage

An ethnographic survey is currently being undertaken to determine whether there are any known sites of significance within the project area. This has involved consultation with the appropriate Land Council, Aboriginal Elders and the Department of Indigenous Affairs.

9. ENVIRONMENTAL FACTORS RELEVANT TO THIS PROPOSAL

Please refer to Appendix A.

Informal discussions have been undertaken with representatives from the Westralian Airports Corporation (WAC) in regard to identifying degraded areas that occur within WAC's proposed conservation area. One such area is shown in Figure 2. Further investigations into the suitability of this area as an offset will be undertaken in the near future. For offset purposes, the area shown in Figure 1 appears to be an ideal area to rehabilitate as:

- it is located within WAC's proposed conservation area;
- it is heavily degraded;
- it is likely to support similar vegetation to that found within the project area;
- it is likely to be classified as a wetland;
- it is within Bush Forever Site 386; and
- it is within close proximity to the project area.

If required, MRWA will liase with WAC to determine if there is opportunity to rehabilitate degraded land within the WAC lease area.

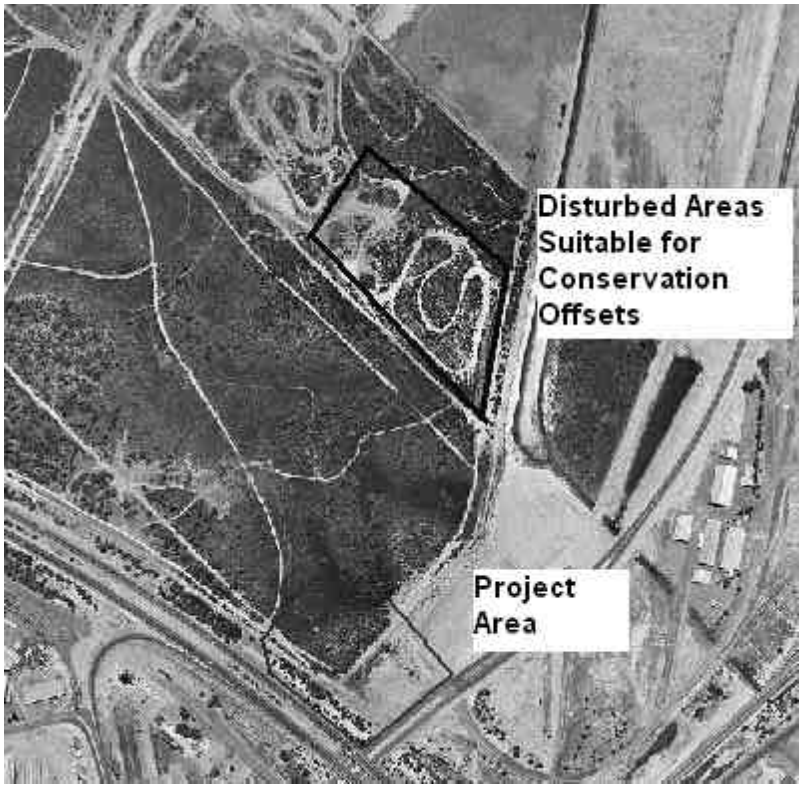

Figure 2 Location of Possible Offset Areas Suitable for Conservation Purposes

10. APPLICABLE LEGISLATION

Applicable legislation relevant to the construction of the on-ramp include the:

- *Environmental Protection and Biodiversity Conservation Act* 1999*;*
- *Environmental Protection Act* 1986*;*
- *Soil and Land Conservation Act* 1945*;*
- *Wildlife Conservation Act* 1950*;*
- *Metropolitan Region Town Planning Scheme Act* 1959*;* and
- *Aboriginal Heritage Act* 1980*.*

11. COMMUNITY AND OTHER STAKEHOLDER CONSULTATION PROGRAMME

To date, consultation has taken place with representatives from the:

- Bush Forever Office;
- Department of Environmental Protection;
- Water and Rivers Commission;
- Department of Conservation and Land Management;
- Westralian Airports Corporation;
- Airport Environment Protection and Building Controls Office;
- Australian Heritage Commission;
- Department of Transport and Regional Services;
- Environment Australia; and
- Department of Indigenous Affairs.

In addition to written correspondence, MRWA has also undertaken on-site meetings with representatives from most of these organisations.

MRWA has also undertaken consultation with all relevant Aboriginal groups to determine if there are any sites of significance within the project area. Groups (and dates they were consulted) that have been consulted include;

- Swan Valley Nyungah Community Aboriginal Corporation (25 July 2002);
- Ballaruck Group (31 July 2002);
- Metropolitan Environmental Group (1 August 2002);
- Ballardong Group (2 August 2002); and
- Yallagonga Group (2 August 2002).

Brad Goode, Consulting Anthropologist, is currently completing the report for this consultation.

12. PROJECT AND ASSESSMENT SCHEDULE

The proposal to construct an on-ramp to Tonkin Highway in this area has been under active development by MRWA for more than four years. Work completed prior to the submission of this report includes:

- Transport planning and option evaluation studies (Millar and Associates, 2000);
- Environmental Assessment (Biota, 2002)
- Final design report (CMPS & F, 1998);

- Fauna and flora assessment surveys (Ecologia, 1998);
- Spring rare flora and vegetation survey (Ecologia, 1999);
- Preliminary ethnographic investigations (O'Connor, 1998);
- Preliminary archaeological investigations (Harris, 1998); and
- Draft Environmental Assessment and Management Plan (EAMP) (Egis, 1999).

At present, the future timing for project implementation is largely dependent on land acquisition processes and environmental approvals processes, both State and Commonwealth. Subject to these issues being resolved, it is MRWA's intention to commence construction works in the area within the 02/03 financial year. Construction of the on-ramp would be expected to be completed within four months from the commencement of works on the site.

Where necessary, all surveys mentioned in Section 8 will be undertaken during the most appropriate season, which will be determined in consultation with the relevant government agency.

MRWA anticipates undertaking all of the required environmental investigations and submitting the draft document within three months of the scoping document being released.

13. PEER REVIEW

As the project area is relatively small, most of the impacts associated with the construction of the on-ramp will be quite localised. As the main issues of this project do not appear to be too specialised, the need for additional peer review does not appear warranted. The use of expert consultants followed by the document being reviewed by the relevant government agencies would appear to adequately ensure that the information provided is correct.

14. STUDY TEAM

The project will be managed by Mr Paul West (Bach of Science, Post. Grad EIA) (Environmental Officer Metropolitan Region). The preparation of the PER will be undertaken by a suitably qualified consultant. This will be determined once the procedures relating to engaging a consultant have been followed. The tender document will be released to various consultants once MRWA has received the scoping brief from the DEP.

15. REFERENCES

Biota Environmental Sciences (2002). Environmental Assessment; Abernethy Road – Tonkin Highway On-ramp, Forrestfield. Unpublished report prepared for MRWA.

CMPS and F (1999). Tonkin Hwy: Roe Hwy and Abernethy Rd Interchanges. Final Design Report prepared for Main Roads WA, Perth.

Ecologia Environmental Consultants (1998). Tonkin Hwy: Roe Hwy and Abernethy Rd Interchanges. Fauna and Flora Assessment. Unpublished report for Main Roads Western Australia.

Ecologia Environmental Consultants (1999). Tonkin Hwy and Abernethy Rd Interchange. Spring Flora and Vegetation Survey. Unpublished report for Main Roads Western Australia.

Egis Consulting (1999). Environmental Assessment And Management Plan For Tonkin Highway Abernethy Road Interchange [On Ramp]. Unpublished draft report prepared for Main Roads WA, Perth.

Government of Western Australia (2000). *Bush Forever – Volumes 1, 2 and 3*. Department of Environmental Protection, Perth.

Harris, J. (1998). Report on an archaeological investigation of a proposed roadwork programme, Tonkin Highway - Roe Highway - Abernethy Road. Unpublished report prepared for Egis Consulting and Main Roads WA, Perth

Millar and Associates (2000). Tonkin Hwy, Abernethy Rd and Roe Hwy Interchange. Planning report prepared for Egis Consulting and Main Roads WA, Perth.

O'Connor, R. (1998). Report on a preliminary ethnographic investigation of aboriginal sites Tonkin Highway / Roe Highway / Abernethy Road Interchange. Unpublished report prepared for Egis Consulting and Main Roads WA, Perth

Appendix A -Environmental Factors

Environmental Factors	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management
Biophysical					
Fauna	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	Minimise disturbance to fauna that occur within or adjacent to the study area.	Clearance of 1.43 ha of habitat	Undertake a field survey to determine if there are any Significant Bird Species of the Swan Coastal Plain Portion of the Perth Metropolitan Region.	Clearing will be undertaken in a progressive manner to ensure that corridors are available to the more mobile fauna. Rehabilitate an adjacent disturbed area to create suitable habitat for the fauna of the area.
Threatened Fauna	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	No mortalities to the Southern Brown Bandicoot. Provide appropriate habitat by rehabilitating an adjacent area.	Clearance of 1.43 ha of Southern Brown Bandicoot habitat.	None	The impact to the bandicoot is not expected to be significant as the area to be cleared is less than an individual's home range. Clearing will be undertaken in a progressive manner to ensure that corridors are available to the more mobile fauna.
Flora and Vegetation	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	To ensure that the overall objectives of the construction of the on-ramp is compatible with maintaining and, where possible, enhancing the biological integrity of the surrounding environment and minimising vegetation loss and degradation.	Clearance of 1.43 ha of vegetation.	Assess the adjacent disturbed area to determine the likely vegetation associations it is likely support.	Peg and fence clearance boundaries. Rehabilitate an adjacent disturbed area using the topsoil and seeds from the project area. Offsets/mitigation potential. Seed will be collected prior to clearing. Mulched vegetation from the project area will be used to assist rehabilitation.
Threatened Flora	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	Not to have a negative impact upon the survival of the endangered DRF *Macarthuria keigheryi*.	One DRF is known to occur within the vicinity of the project area. Three targeted surveys have not identified the species within the 1.43 ha to be impacted upon.	Undertake another DRF survey and determine if the species is likely to be impacted upon by the project.	If within the immediate vicinity of the project area, peg off known sites to ensure individual plants are properly protected.

Environmental Factors	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management
Threatened Vegetation	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	Not to have a negative impact upon the survival of the endangered TEC Shrublands and woodlands of the Eastern Swan Coastal Plain.	Approximately 0.6 ha of Shrublands and woodlands of the Eastern Swan Coastal Plain will be cleared within the project area. 8.2 ha will still remain in an adjacent area.	Assess the adjacent disturbed area to determine the likely vegetation associations it is likely support.	Rehabilitate an adjacent disturbed area using the topsoil and seeds from the project area. Offsets/mitigation potential. Seed will be collected prior to clearing. Mulched vegetation from the project area will be used to assist rehabilitation. The main focuses of the landscaping plan will be to promote the growth of this association within the rehabilitated area.
Wetlands	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	Minimise the impacts to the hydrology of the airport site.	Clear 0.8 ha of Conservation Category Wetland. Some ongoing indirect effects may occur on the wetland habitat remaining in the area adjacent to the on-ramp.	Assess the adjacent disturbed area to determine whether the area has a wetland category status. Undertake a hydrological study to determine the likely hydrological impacts in and around the project area.	Investigate whether the adjacent disturbed area is a wetland. If possible, a rehabilitation plan will be developed to improve the quality of the wetland. Offsets/mitigation potential. Undertake construction of the on-ramp during drier months. Drainage system to be designed so as to avoid direct runoff or stormwater discharge entering adjacent wetland areas. A sump will be located within the on-ramp.
Social					
Aboriginal Heritage	The section of the on-ramp that is located within Pt Lot 389 (1.43 ha)	To ensure that there is no unauthorised disturbance to Aboriginal heritage sites associated with the construction of the on-ramp.	None at this stage.	An Ethnographic survey is currently being undertaken. Outcome of consultation has not yet been determined.	Aboriginal community may be used to assist with the collection of seed and rehabilitation.

PER/ ERMP GUIDELINES

Environmental Protection Authority

Guidelines for Preparing a Public Environmental Review/ Environmental Review and Management Programme

Contents

These generic guidelines are provided to assist the preparation of the proponent's environmental review document.

Project specific information related to the proposal, environmental factors, impacts, management, consultation and proposed investigations are required to be outlined in the Environmental Scoping document prepared by the proponent (refer to www.epa.wa.gov.au/). The Environmental Scoping document, along with these generic guidelines, comprises the EPA agreed project guidelines.

The environmental review document must address all elements of the agreed Environmental Scoping document and these guidelines prior to approval being given to commence the public review. Where relevant the environmental review document must also address any requirements of the Commonwealth under the *Environment Protection and Biodiversity Conservation Act 1999* (refer to Environment Australia's website at www.erin.gov.au). The Commonwealth may, through bilateral agreements, delegate to the State the responsibility for conducting assessments consistent with the provisions of the agreement.The Environmental Protection Authority (EPA) expects the proponent to fully consult with interested members of the public and relevant stakeholders, and to take due care in ensuring any other relevant environmental factors, which may be of interest to the public and stakeholders, are addressed. The environmental review should document the results of all consultation undertaken.

Guidelines for preparing a Public Environmental Review/ Environmental Review and Management Programme

1. Overview

All environmental reviews have the objective of protecting the environment. Environmental impact assessment is deliberately a public process in order to obtain broad ranging advice. The review requires the proponent to:

- describe the proposal;
- describe the receiving environment;
- outline the potential impacts of the proposal on factors of the environment;
- identify the proposed management strategies to ensure those environmental factors are appropriately protected; and
- demonstrate that the proposal should be judged by the EPA to be environmentally acceptable.

Throughout the assessment process it is the objective of the Environmental Protection Authority (EPA) to help the proponent to design the proposal to improve the protection to the environment. The EPA Service Unit administers the environmental impact assessment process on behalf of the EPA Board.

The primary purpose of the environmental review is to provide information to the EPA on the proposal within the local and regional framework, with the aim of emphasising how the proposal may impact the relevant environmental factors and how those impacts may be mitigated and managed so as to be environmentally acceptable.

How the proponent will outline the environmental setting of the proposal, address environmental issues/factors and their management, and undertake consultation during the preparation of the environmental review are required to be described in the Environmental Scoping document.

To assist proponents, the EPA is preparing a series of Position Statements and associated Guidance for the Assessment of Environmental Factors which provides an indication of the EPA's views on matters of environmental importance and expectations about how to address specific factors. Proponents should ensure that they are aware of and utilise the information in these documents.

The language used in the body of the environmental review should be kept simple and concise, considering the audience includes non-technical people, and any extensive, technical detail should either be referenced or appended to the environmental review. The environmental review will form the legal basis of the Minister for the Environment and Heritage's approval of the proposal and therefore the environmental review should include a description of all the main and ancillary components of the proposal.

Information used to reach conclusions should be properly referenced, including personal communications. Such information should not be misleading or presented in a way that could be construed to mislead readers. Assessments of the significance of an impact should be soundly based rather than unsubstantiated opinion, and each assessment should lead to a discussion of the management of the environmental factor.

2. Objectives of the environmental review

The objectives of the environmental review are to:

- place this proposal in the context of the local and regional environment;
- adequately describe all components of the proposal, so that the Minister for the Environment and Heritage can consider approval of a well-defined project;
- provide the basis of the proponent's environmental management program, which shows that the environmental impacts resulting from the proposal, including cumulative impact, are minimised and can be acceptably managed;
- communicate clearly with stakeholders (including the public and government agencies), so that the EPA can obtain informed comment to assist in providing advice to government; and
- provide a document which clearly sets out the reasons why the proposal should be judged by the EPA and the Minister for the Environment and Heritage to be environmentally acceptable.

3. Preparation of the environmental review document

Proponents are encouraged to maintain close contact with the EPA Service Unit project officer during the preparation of the environmental review. The environmental review should be provided to the EPA Service Unit project officer as a draft for comment. At this stage the document should have all figures produced in the final format and colours.

The proponent and EPA Service Unit project officer/Manager should agree on the time to be taken to review the draft, taking into account the level of consultation during the environmental review preparation, EPA Service Unit project officer's availability, the need for external review and any peer review arranged by the proponent. Revision of the document may be requested to ensure that it addresses all topics and issues in these guidelines, can be read by the educated layperson, contains no significant error of science and meets the required format.

Where the proposal is subject to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the environmental review should also address requirements under that Act. These can be obtained from www.erin.gov.au.

When the EPA is satisfied with the standard of the environmental review document it will provide a written sign-off to the proponent, giving approval to advertise the document for public review. The review document should not be advertised for release before written approval is received.

Following approval to release the review for public comment, the final environmental review document should also be provided to the EPA Service Unit project officer as an electronic copy, in PC Microsoft Word 2000 format, and any scanned figures. Where possible, these figures should be legible and meaningful in a printed black and white format.

The EPA encourages proponents to prepare and publish the environment review and appendices in electronic format (CD and/or on the internet), although there remains the requirement for printed copies of the document. This should be discussed with the EPA Service Unit project officer early in the preparation of the environmental review document.

4. Contents of the environmental review document

The environmental review document should include an executive summary, introduction and at least the following:

4.1 The proposal

General requirements

The environmental review document should provide a comprehensive description of the proposal including its location (address and certificate of title details where relevant). Specific matters requiring attention are:

- the identification of the proponent and proposal location;
- justification and objectives for the proposed development;
- the legal framework, including existing zoning and environmental approvals, and decision making authorities and involved agencies; and
- alternatives considered, including location options.

Brief description of the proposal which is the subject of these guidelines

A description of the proposal and location, in sufficient detail to enable readers to clearly understand the nature and scale of the proposal, and to support later discussion of impacts. This should include an outline of the various components of the proposal (including how this proposal relates to other operations or proposals)

The proposal and its location should be indicated on attached plans.

Key characteristics of the proposal

The Minister's statement will bind the proponent to implementing the proposal in accordance with any technical specifications and key characteristics[1] in the environmental review document. It is important therefore, that the level of technical detail in the environmental review, while sufficient for environmental assessment, does not bind the proponent in areas where the project is likely to change in ways that have no environmental significance.

Include a description of the key components of the proposal, including the nature and extent of works proposed. This information must be summarised in the form of a table, an example of which follows:

Table 1: Key characteristics (example only)

Element	Description
Life of project (mine production)	< 5 yrs (continual operation)
Size of ore body	682 000 tonnes (upper limit)
Depth of mine pit	less than 30m
Water table depth	50m below ground surface
Area of disturbance (including access)	100 hectares
Mine operation	Daylight hours only, Monday to Friday
List of major components • pit • waste dump • infrastructure (water supply, roads, etc)	refer 'Plans, specifications, charts' section immediately below for details of map requirements
Ore mining rate • maximum	 • 200 000 tonnes per year
Solid waste materials • maximum	 • 800 000 tonnes per year
Water supply • source • maximum hourly requirement • maximum annual requirement	 • XYZ borefield, ABC aquifer • 180 cubic metres • 1 000 000 cubic metres
Fuel storage capacity and quantity used	50 000 litres; 300 000 litres per year

Plans, specifications, charts

Provide adequately dimensioned plans showing clearly the location and elements of the proposal which are significant from the point of view of environmental protection. Locate and show dimensions (for progressive stages of development, if relevant) of all relevant components of the proposal.

Only those elements of plans, specifications and charts that are significant from the point of view of environmental protection are of relevance here.

Always include:

- a map showing the proposal in the local context - an overlay of the proposal on a base map of the main environmental constraints;

[1] Changes to the key characteristics of the proposal following final approval would require assessment of the change and can be treated as non-substantial and approved by the Minister, if the environmental impacts are not significant. If the change is significant, it would require assessment under section 38 or section 46. Changes to other aspects of the proposal are generally inconsequential and can be implemented without further assessment. It is prudent to consult with the Department of Environmental Protection about changes to the proposal.

- a map showing the proposal in the regional context; and, if appropriate,
- a process chart / mass balance diagram showing inputs, outputs and waste streams.

The plan/s should include contours, north arrow, scale bar, legend, grid coordinates, the source of the data, and a title. The dates of any aerial photos should be shown.

Other logistics

- timing and staging of project; and
- ownership and liability for other aspects related to the proposal, such as waste during transport, disposal operations and long-term disposal (where appropriate to the proposal).

4.2 The environment

Provide a description of the existing environment in a local and regional context, with an emphasis on those aspects that may affect or be affected by the proposal, including:

- key ecosystem processes;
- biodiversity;
- existing site condition; and
- other environmental issues that may be constraints or fatal flaws to the proposal.

4.3 Environmental factors

The environmental review should focus on the key or more significant environmental issues and the environmental factors associated with these issues. The EPA has often combined several factors which have clear relationships into environmental issues or broadly interpreted a single factor to encompass a range of related impacts. These may be significant in a local, regional or cumulative context. Where this occurs, it is important that the factors are still identified.

The identification of key issues and relevant environmental factors for the proposal must be incorporated into the proponent's Environmental Scoping document and agreed by the EPA.

The EPA has prepared a Guide to Preparing an Environmental Scoping Document and a Guide to EIA Environmental Factors and Objectives to assist proponents of proposals being formally assessed. These guides are available at www.epa.wa.gov.au .

These environmental factors should be addressed within the environmental review document for the public to consider and make comment to the EPA. The EPA is required to address relevant environmental factors in its report to the Minister for the Environment and Heritage.

Reference to relevant Position Statements and demonstration of compliance with associated Guidance for the Assessment of Environmental Factors should be included in the discussion about environmental issues/ factors.

The EPA expects the proponent to fully consult with interested members of the public and take due care in ensuring all other relevant environmental factors, which may be of interest to the public, are addressed.

Additional environmental factors may be identified during the preparation of the environmental review. These should be addressed in the PER/ERMP. On-going consultation with the EPA and other relevant agencies is recommended. The EPA Service Unit can advise on the recommended EPA objective for any new environmental factors raised. Minor matters which can be readily managed as part of normal operations for the existing operations or similar projects may be briefly described.

The EPA will expect to see a discussion of the extent to which best practice will be applied to the proposal and also an explanation of how the principles of sustainability have been incorporated, where appropriate.

Discussion under each environmental issue/factor should include:

- a description of where this factor fits into the broader environmental / ecological context (only if relevant - may not be applicable to all factors);
- a clear definition of the area of assessment for this factor;

- the EPA objective for this factor;
- a description of what is being affected - why this factor is relevant to the proposal and how is it significant;
- a description of how this factor is being affected by the proposal - the predicted extent of impact;
- a straightforward description or explanation of any relevant standards / regulations / policy;
- environmental evaluation - does the proposal apply best practice and does it meet the EPA's objective as defined above;
- if not, what environmental management is proposed to ensure the EPA's objective is met; and
- predicted outcome.

The proponent should provide a summary table of the above information for all environmental factors, under the three categories of biophysical, pollution management and social surroundings as shown in Table 2:

Table 2: Environmental factors and management (example only)

Environ-mental Factor	EPA Objective	Existing environment	Potential impact	Environmental management	Predicted outcome
BIOPHYSICAL					
vegetation	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	Reserve 34587 contains 45 ha of community type 20b and 34 ha of community type 3b	Proposal avoids all areas of community types 20b and 3b	Surrounding area will be fully rehabilitated following construction	Community types 20b and 3b will remain untouched Area surrounding will be revegetated with seed stock of 20b and 3b community types
POLLUTION MANAGEMENT					
Dust	To ensure that emissions do not adversely affect the environment or health, welfare and amenity of people and nearby land uses by meeting statutory requirements and acceptable standards	Light industrial area - three other dust producing industries in close vicinity Nearest residential area is 800 metres	Proposal may generate dust on two days of each working week.	Dust Control Plan will be implemented	Dust can be managed to meet EPA's objective

SOCIAL SURROUNDINGS					
Visual amenity	To ensure that aesthetic values are considered and that measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable.	Area already built-up	This proposal will contribute negligibly to the overall visual amenity of the area	Main building will be in 'forest colours' and screening trees will be planted on road	Proposal will blend well with existing visual amenity and the EPA's objective can be met

4.4. Environmental management

The EPA expects the proponent to have in place an environmental management system (EMS) appropriate to the scale and impacts of the proposal, including provisions for performance review and a commitment to continuous improvement.

The system may be integrated with quality and health and safety systems and should include the following elements:

- environmental policy and commitment;
- planning of environmental requirements;
- implementation of environmental requirements;
- measurement and evaluation of environmental performance; and
- review and improvement of environmental outcomes.

A brief description of the environmental management system should be included in the environmental review documentation. If appropriate, the documentation can be incorporated into a formal environmental management system (such as AS/NZS ISO 14001). Public accountability should be incorporated into the approach on environmental management.

The environmental management program (EMP) is the key document of an environmental management system. The EMP should provide plans to manage the relevant environmental factors, define the performance objectives, describe the resources to be used, outline the operational procedures and outline the monitoring and reporting procedures which would demonstrate the achievement of the objectives.

4.5. Environmental management commitments

The final stage of the Environmental Impact Assessment (EIA) process is reached when the Minister for the Environment and Heritage issues the Ministerial Statement for the project, which is a set of legally enforceable conditions and procedures for the implementation of the project. One of the standard procedural conditions is a requirement for the proponent to implement the key commitments which have been made during the EIA process and which the EPA and the proponent wish to become legally enforceable.

A list of the proponent's key commitments will be attached to the Minister's statement, however, it is not compulsory for the proponent to make any legally enforceable commitments. The EPA will recommend conditions to address environmental matters that the implementation of the proposal should be subject to. The EPA expects proponents to implement all the commitments, which are finalised during the EPA's consideration of the proposal, as part of their commitment to good environmental management.

Commitments that are to be made legally enforceable should not be made lightly and should focus on the important, on-going, high-risk issues that will need a higher level of environmental management in terms of achieving a satisfactory outcome. They would be key components within the proponent's environmental management system and would be subject to both internal (company) and external (regulator) audit processes to ensure both compliance as well as outcome.

Smaller-scale, generalised, overly-specific and/or non-controversial management actions, objectives and policies that the proponent intends to undertake in implementing the proposal (eg. return 150 mm of topsoil, avoid coral reefs, minimise clearing of vegetation) do not need to be included in the list of legally enforceable commitments.

Ideally, management actions, etc, should be separated from the commitments in the public review document and they would not become specifically legally binding as would the commitments. However, the proponent would still be expected to implement these management actions as part of responsible environmental management as this is what the EPA will base its recommendations of acceptability upon.

It is important to ensure the commitments are auditable and, therefore, proponents are advised to follow a tabular format as explained below.

4.5.1. Commitment components

The commitments need to be framed in a format so that they have clarity and enforceability and, therefore, can be readily implemented by the proponent and audited efficiently by the Department of Environmental Protection (DEP). The required standard format for all commitments comprises a number of components as follows:

The proponent will, for a specific topic (environmental issue), undertake an action (**what, how, where)** to meet an environmental objective (**why**) to a time frame (**when)**, and on advice from a relevant advisory agency (**from whom**, eg. government agencies such as Department of CALM, Department of Mineral and Petroleum Resources, Shire Council). With regard to 'advice from whom', this need only be included if the expertise and/or statutory responsibilities of the third party is relevant to implementing the commitment.

It is important for the consolidated list of commitments to be numbered correctly for easy reference in the implementation and auditing stages of the project. These should therefore be sequentially numbered 1, 2, 3, ... without use of subgroups such as 1.1, 1.2 or 2(i) or 2(a), 2(b).

Writing the commitment in paragraph form can result in a confusing or clumsy sentence structure that may be difficult to interpret for future auditing purposes. Hence, a paragraph format is not acceptable and a tabular format is required.

4.5.2. Tabular format

It is recommended that the table column headings be titled: 'commitment number', 'topic', 'actions', 'objectives', 'timing' and 'advice from'. The example in paragraph format above can be written in tabular form as per example 1 below. Note that the tabular format also overcomes the sometimes long-winded sentence structure where there are multiple specific actions for the plan to address. Also, it is desirable to create a separate commitment for the preparation and implementation parts of the commitment. Finally, the tabular format provides an immediate audit framework for use both by the proponent and the DEP, which enables efficient administration of environmental approvals. An example of the three most common formats is given below and Example 4 shows how to rewrite a management strategy into a commitment.

Example 1. Prepare and Implement format

This is the most common format and will apply most of the time where there is an on going need to address the issue.

No.	Topic	Actions	Objectives	Timing	Advice from*
1.	Dust management	Prepare a Dust Control Plan for the foreshore construction site which addresses: 1) prevention of dust generation; 2) prevention of dust emissions off-site; and 3) monitoring and compensatory measures to address accidental emissions off-site.	1) Maintain the amenity of nearby residents. 2) Dust levels at nearest critical premise are within EPA dust control criteria (EPA, 1996).	Design phase (prior to the start of construct-ion)	Shire of Widgie
2.	Dust management	Implement the approved Dust Control Plan referred to in commitment 1.	Achieve the objectives of Commitment 1.	During construction	Shire of Widgie

* this may be left blank if no advisory local or state government agency is relevant; note that the DEP or the EPA or the Minister for the Environment and Heritage are never noted in this column. They are the regulators and the commitments are to their requirements, not advice.

Example 2. Once-off Action format

This format is for actions that have a clear completion time.

No.	Topic	Action	Objectives	Timing	Advice from
3.	Fauna protection	Undertake a trapping programme, approved by CALM, for capturing and relocating the Southern Brown Bandicoots from the area to be cleared.	Relocate the Southern Brown bandicoots to an area and in a manner where the population will be protected	Design (prior to the start of ground disturbance)	CALM

Example 3. Prepare, Implement and Upgrade format

This format is for circumstances when there is a clear need to modify a plan based on a study that is yet to be completed.

No.	Topic	Action	Objectives	Timing	Advice from
4.	Waste Rock Dump	Prepare a Waste Rock Dump Management Plan that: 1) ensures natural drainage is reinstated; 2) identifies rehabilitation options and techniques; 3) achieves a visual quality objective of level 3; 4) etc.	Construct a waste rock dump that: 1) blends with local landscape; 2) is stable in the long-term; and 3) will not produce leachate that would pollute the nearby wetlands.	Prior to the start of construction of the mine	Dept. Minerals and Energy

5.	Waste Rock Dump	Implement the WRDM Plan referred to in commitments 4 and 6.	As for commitment 4.	During construction and operations	DME
6.	Waste Rock Dump	Modify the WRDM Plan referred to in commitment 4 after the Acid Mine Drainage study referred to in commitment 9 is completed and the study findings approved by the EPA.	Ensure that drainage, including subsurface leachate, does not exceed water quality criteria (NHMRC, 1999).	During operations	DME

Example 4. How to rewrite a management action, etc, into a commitment

No.	Topic	Action	Objectives	Timing	Advice from
1.	Waste material	Remove waste material which cannot be accommodated on-site due to potential changes in final design levels to an acceptable landfill. **this is a management action and is rewritten below**	To prevent contaminated material removed from the western part of the site being relocated inconsistent with the final plans for the development.	During remedial works	Shire of Widgie
1.	Excess waste material	Prepare a Waste Material Plan for any excess contaminated material that: 1) identifies the quantity and location of the material; 2) specifies the methods of removal and transport of the material; and 3) identifies the landfill site for disposal and the monitoring methods for the landfill disposal operation.	Ensure that contaminated material that cannot be contained on-site is disposed of at an acceptable landfill site.	During the remedial stage (prior to the validation stage)	Shire of Widgie
2.	Excess waste material	Implement the approved Waste Material Plan referred to in commitment 1.	Achieve the objectives of commitment 1.	After plan is approved by the DEP (during remedial stage)	Shire of Widgie

5. Public consultation

A description of the public participation and consultation activities undertaken by the proponent in preparing the environmental review should be provided. It should describe the activities undertaken, the dates, the groups/individuals involved and the objectives of the activities. Cross-reference should be made with the description of environmental management of the factors which should clearly indicate how community concerns have been addressed. Those concerns which are dealt with outside the EPA process can be noted and referenced.

6. Conclusion

The environmental review document should indicate the proponent's view of the environmental costs and benefits of the proposal. This should be a synthesis of the preceding relevant information and aim of showing how the proposal would achieve an overall net environmental benefit.

When presenting this synthesis, the proponent should note that the proponent's own commercial arrangements and aspects such as employment opportunities, including economic benefits that might accrue as a result of these, are not matters that the EPA can consider in its assessment.

Where relevant, the implications of the adoption in the proposal design and operation of best practicable measures to minimise environmental impacts should be mentioned.

Proponents are also requested to outline the basis upon which they believe the EPA should conclude that the proposal is environmentally acceptable.

7. Availability of the environmental review

The EPA expects the proponent to provide copies of the PER/ERMP for distribution free of charge to the EPA, EPA Service Unit and relevant government agencies, local government authorities, libraries and other organisations.

As mentioned previously, the EPA encourages copies of the environmental review documentation to be distributed through electronic means (CD or internet), but a number of printed copies will also be required. The specific number of copies required, the type of copy, and the means of distribution, should be agreed with the EPA Service Unit project officer/Manager during the early stages of preparation of the environmental review document.

Example

Supplied to EPA/ EPA Service Unit:	Library/Information Centre	9
	EPA members	6
	Officers of EPA Service Unit	3
Distributed by the proponent to:		
Government departments	Department of Environmental Protection/ Water and Rivers Commission	3
	Department of Mineral and Petroleum Resources	2
	Department of Conservation and Land Management	2
	Department of Indigenous Affairs	1
	Office of Major Projects	1
Local government authorities	Shire of Roebourne	2
Libraries	J S Battye Library	3
	The Environment Centre	2
	Shire of Roebourne Library	2
Others	Conservation Council of WA	1
	Nickol Bay Nats	1
	Dampier Pistol Club	1
	Nickol Bay Speedway	1

Available for public viewing

- Department of Environmental Protection Library, Perth;
- Department of Environmental Protection Library, Karratha;
- Shire of Roebourne Library;
- J S Battye Library, Perth; and
- your website

Water and Rivers Commission: Criteria for Wetland Mitigation

The aim of a mitigation strategy will be to replace the attributes and functions lost as best as possible. The most appropriate way to do this is to match the impacted wetland with one of the same or better condition which is the same type, same suite, has similar vegetation species and occurs in the local area. However it is understood that achieving all of these is difficult. It is also highly desirable to mitigate with a wetland which otherwise would have experienced adverse impacts. It is not appropriate to replace it with a wetland which already has an appropriate level of protection or which is functioning healthily in its current setting, with that situation is unlikely to change.

Conservation Category Wetlands: Must be replaced by acquisition or appropriate covenanting of:

- a threatened conservation category wetland,
- a resource enhancement wetland the proponent has restored.

The replacement wetland must meet a number of criteria which are outlined below. It is understood that not all criteria will be able to be fulfilled but the best fit of the maximum number and priority criteria should be achieved. One approach would be to construct a matrix of a number of possible wetlands against the criteria.

Resource Enhancement Wetlands: The replacement is more flexible and negotiable. The aim here is for innovative approaches. For example it may be acceptable to purchase vegetation that creates a corridor or larger buffers between other protected conservation category wetlands. It may also be acceptable to purchase a smaller area of threatened conservation category wetland or rehabilitated resource enhancement wetland.

Multiple Use Wetlands : These are not required to be mitigated for. Impacts upon multiple use wetlands should be managed so that they do not adversely effect nearby conservation category or resource enhancement wetlands. Appropriate water sensitive urban design and catchment principles should be applied.

In the above discussion creation of wetlands has not been discussed. This may also be an appropriate mitigation measure. However it is not preferred when there are opportunities to enhance and protect resource enhancement wetlands. The justification for this position is that created wetlands often do not adequately replace the attributes and functions lost from natural wetlands. If creation becomes appropriate, the best approach is to use a multiple use wetland.

Acquisition wetlands are required to be placed in an appropriate management body (e.g. CALM or local government). One option may be to covenant a wetland and allow community groups to undertake ongoing management. There may also be other innovative approaches that could be appropriate.

Criteria for finding appropriate replacement wetlands.

In the context of the above issues the hierarchy of criteria which should be attempted to be addressed are listed below:

The wetland must be:

- Of the same management category/ in the same condition or better. As discussed above this means a resource enhancement wetland may need to be rehabilitated to mitigate for a conservation category wetland.
- Threatened: There must be a proposed threat from current or proposed land use. For example urban and industrial development or rural land uses which are currently threatening and degrading the wetland. The threatening impacts should be eliminated or controlled. For example if a wetland is proposed to be cleared and filled as part of a development it should be purchased with an appropriate buffer. Some resolution on the management of drainage and other impacts should be negotiated with the developer. In the situation of a rural wetland the threat may be grazing and trampling by cattle. The wetland should be purchased or covenanted, an adequate buffer applied and the whole area fenced. The buffer and wetland should be rehabilitated.
- It is preferable that the wetland is not already identified to be protected by some other mechanism eg Is part of the EPP or Bushplan where there is already a presumption against development.
- Of the same area. It will not be appropriate to replace a conservation category wetland of a substantial size with something much smaller. A number of wetlands may be used in this type of situation. However, it could be appropriate that a smaller wetland of much better condition and with higher values with a good buffer replaces a larger wetland.
- Of the same type. For example a sumpland should be replaced with a sumpland.
- Contain the same vegetation types. For example if a wetland contains a closed forest *Melaleuca rhaphiophylla* community type a wetland with the same community type should be found.
- Be part of the same consanguineous suite.
- Occur in the local area

Other issues: It may be appropriate to replace a number of small wetlands with one larger area of wetlands which is easier to manage. However it must be considered in the context of the above issues.

Wetland Mitigation Hierarchy

Best Management Practices

Can wetlands and their buffers be avoided? → Yes → No further action required

Can the impact on wetlands and their buffers be minimised → Yes → Implementation of appropriate Best Management Practices → Monitoring and evaluation

No

Mitigation

Description of wetland impacts

Assess wetland attributes, functions and values impacted inside and outside the road reserve

Determine significance of impacts and degree of mitigation required for wetland and buffer

Identify mitigation options for each wetland and buffer

Using agreed criteria, determine suitability of mitigation options for each wetland and buffer

Implement mitigation

Monitoring and maintenance

Identify mitigation options available

Time commitments for stages implemented and completion of mitigation

Identify wetland attributes, functions and values of alternative wetlands identified for mitigation

Auditing, compliance and reporting

Conservation Category: acquisition of equivalent wetland and buffer, vesting and covenanting with appropriate body — **PRIORITY 1**

Resource Enhancement Category: acquisition or restoration of wetland and buffer or buffers/corridors and vesting and covenanting with appropriate body — **PRIORITY 2**

Multiple Use Category: Best Practice management on case by case basis e.g. utilised in water management designs — **PRIORITY 3**

Flora Species List for the Project Area

Appendix 3

BIOta

016A ZAMIACEAE
Macrozamia riedlei

031 POACEAE
**Aira caryophyllea*
**Aira cupaniana*
Amphipogon amphipogonoides
Amphipogon turbinatus
Austrostipa compressa
**Briza maxima*
**Briza minor*
**Ehrharta calycina*
**Eragrostis curvula*
**Lagurus ovatus*
**Pentaschistis airoides*

032 CYPERACEAE
**Isolepis marginata*
Lepidosperma leptostachyum
Lepidosperma longitudinale
Lepidosperma squamatum
Mesomelaena pseudostygia
Schoenus curvifolius
Schoenus efoliatus

039 RESTIONACEAE
Alexgeorgea nitens
Desmocladus fasciculatus
Desmocladus flexuosus
Hypolaena exsulca
Lyginia barbata
Lyginia imberbis
Meeboldina cana
Meeboldina scariosa

040 CENTROLEPIDACEAE
Centrolepis drummondiana

054C DASYPOGONACEAE
Chamaexeros serra
Dasypogon bromeliifolius
Lomandra caespitosa

054D XANTHORRHOEACEAE
Xanthorrhoea preissii

054F ANTHERICACEAE
Arnocrinum preissii
Corynotheca micrantha
Johnsonia pubescens
Laxmannia ramosa subsp. *ramosa*
Thysanotus arbuscula
Thysanotus manglesianus / patersonii
Thysanotus multiflorus
Tricoryne elatior

054J COLCHICACEAE
Burchardia umbellata

055 HAEMODORACEAE
Anigozanthos humilis subsp. *?humilis*
Conostylis aurea
Conostylis juncea
Conostylis setigera subsp. *setigera*
Conostylis sp. (sterile)
Phlebocarya ciliata
Phlebocarya filifolia

060 IRIDACEAE
**Gladiolus caryophyllaceus*
Patersonia occidentalis
**Romulea rosea*

066 ORCHIDACEAE
Caladenia denticulata
Caladenia longicauda ?subsp. (prev. survey)
Microtis media subsp. *?media*
Oligochaetochilus vittata

070 CASUARINACEAE
Allocasuarina fraseriana
Allocasuarina humilis

090 PROTEACEAE
Adenanthos cygnorum var. *cygnorum*
Banksia attenuata
Banksia littoralis
Banksia menziesii
Hakea sulcata
Petrophile linearis
Stirlingia latifolia
Synaphea spinulosa subsp. *spinulosa*

097 LORANTHACEAE
Nuytsia floribunda

110A MOLLUGINACEAE
Macarthuria keigheryi

113 CARYOPHYLLACEAE
**Silene gallica*

131 LAURACEAE
Cassytha flava
Cassytha racemosa forma. ? (sterile)

143 DROSERACEAE
Drosera ?menziesii subsp. menziesii
Drosera nitidula subsp. nitidula
Drosera stolonifera ?subsp. (prev. survey)

149 CRASSULACEAE
Crassula sp. (dead)

152 PITTOSPORACEAE
Marianthus sp. (sterile)

163 MIMOSACEAE
Acacia huegelii
Acacia pulchella var. *goadbyi*
Acacia sphacelata ?subsp. (prev. survey)
Acacia sessilis

165 PAPILLIONACEAE
Bossiaea eriocarpa
Daviesia decurrens
Daviesia physodes
Daviesia triflora
Euchilopsis linearis
Eutaxia virgata
Gompholobium tomentosum
Hovea trisperma
Isotropis cuneifolia
Jacksonia 'floribunda' complex
Jacksonia furcellata
Jacksonia restioides
Kennedia prostrata
Sphaerolobium linophyllum

167 GERANIACEAE
**Pelargonium capitatum*

175 RUTACEAE
Boronia sp. (juvenile)
Philotheca spicata

182 TREMANDRACEAE
Platytheca galioides

183 POLYGALACEAE
Comesperma virgatum

185 EUPHORBIACEAE
**Euphorbia peplus*
Phyllanthus calycinus
Poranthera microphylla

226 DILLENIACEAE
Hibbertia huegelii
Hibbertia hypericoides
Hibbertia sp. (sterile)
Hibbertia stellaris
Hibbertia subvaginata

263 THYMELACEAE
Pimelea angustifolia

273 MYRTACEAE
Astartea fascicularis
Calothamnus lateralis
Calytrix ?depressa
Calytrix flavescens
Calytrix fraseri
Corymbia calophylla
Eremaea pauciflora var. *pauciflora*
Eucalyptus todtiana
Hypocalymma angustifolium
**Leptospermum laevigatum*
Melaleuca lateritia
Melaleuca preissiana
Melaleuca rhaphiophylla
Melaleuca seriata
Melaleuca viminea ?subsp. (prev. survey)
Pericalymma ellipticum var. *ellipticum*
Scholtzia involucrata
Verticordia drummondii
Verticordia lindleyi subsp. *lindleyi*
Verticordia densiflora var. *densiflora*
Verticordia sp. (sterile)

276 HALORAGACEAE
Gonocarpus cordiger

281 APIACEAE
Platysace ramosissima
Trachymene pilosa

288 EPACRIDACEAE
Astroloma stomarrhena
Conostephium pendulum
Leucopogon aff. *squarrosus*
Leucopogon conostephioides
Leucopogon pulchellus
Leucopogon sp. (sterile)
Leucopogon sp. Murdoch (M.Hislop 1037)

293 PRIMULACEAE
**Anagallis arvensis* ?var. (sterile)

303 GENTIANACEAE
**Centaurium spicatum*

303A MENYANTHACEAE
Villarsia albiflora

310 BORAGINACEAE
**Echium plantagineum*

313 LAMIACEAE
Hemiandra linearis

315 SOLANACEAE
**Solanum nigrum*

316 SCROPHULARIACEAE
**Dischisma arenarium*
Gratiola pubescens

339 CAMPANULACEAE
Wahlenbergia preissii

340 LOBELIACEAE
Lobelia heterophylla
Lobelia rhombifolia

341 GOODENIACEAE
Dampiera alata
Dampiera linearis
Lechenaultia expansa
Scaevola repens

343 STYLIDIACEAE
Levenhookia sp. (juvenile)
Stylidium brunonianum
Stylidium bulbiferum
Stylidium calcaratum
Stylidium dichotomum
Stylidium diuroides subsp*. ?diuroides*
Stylidium miniatum
Stylidium piliferum subsp*. piliferum*
Stylidium repens
Stylidium schoenoides

345 ASTERACEAE
**Gamochaeta falcata*
Helichrysum macranthum
Hyalosperma pusillum
**Hypochaeris glabra*
Podotheca angustifolia
Senecio quadridentatus
Siloxerus filifolius
Siloxerus humifusus
**Sonchus oleraceus*
**Ursinia anthemoides*

Systematic Flora Survey Site Data

Appendix 4

BIOta

SITE: AR01

Date:	19/11/02
Described by:	KBM
Dimensions:	10x10m
Location:	AMG Zone 50: Easting 403341, Northing 6461519 (WGS84)
Habitat:	Low sandy rise adjacent to sumplands.
Soil:	Grey sand.
Vegetation:	*Banksia attenuata* and *B. menziesii* woodland over diverse low shrubland.
Condition:	Very Good (occasional weeds, some tree deaths).

Trees 5-15m	30-70%:	*Banksia attenuata* (25%), *Banksia menziesii* (35%), *Allocasuarina fraseriana* (5%)
Trees <5m	2-10%:	*Banksia attenuata, Banksia menziesii* (5%)
Shrubs >2m	-	-
Shrubs 1.5-2m	-	-
Shrubs 1-1.5m	10-30%:	*Acacia pulchella* var. *goadbyi* (2-5%), *Allocasuarina humilis* (2-5%), *Xanthorrhoea preissii* (8-10%)
Shrubs 0.5-1m	10-30%:	*Hibbertia hypericoides* (5%), *Stirlingia latifolia, Allocasuarina humilis, Eremaea pauciflora* var. *pauciflora* (2%), *Acacia sessilis*
Shrubs <0.5m	30-70%:	*Acacia sessilis, Astroloma stomarrhena, Bossiaea eriocarpa* (2-5%), *Dampiera alata, Dampiera linearis, Daviesia triflora, Gompholobium tomentosum, Hemiandra linearis, Hibbertia huegelii, Hibbertia hypericoides* (5%), *Hovea trisperma, Leucopogon conostephioides, Petrophile linearis* (2%), *Phyllanthus calycinus, Pimelea angustifolia, Scaevola repens* (2-5%), *Stirlingia latifolia* (10%), *Synaphea spinulosa* subsp. *spinulosa* (2-5%)
Grasses	0-2%:	*Amphipogon turbinatus, Austrostipa compressa, *Briza maxima, *Briza minor, *Ehrharta calycina*
Herbs	2-10%:	*Anigozanthos humilis* subsp. *?humilis, Burchardia umbellata, Conostylis aurea, Conostylis setigera* subsp. *setigera, Dasypogon bromeliifolius* (5%), **Gladiolus caryophyllaceus, *Hypochaeris glabra, Isotropis cuneifolia, Lobelia heterophylla, Lomandra caespitosa, Patersonia occidentalis, Phlebocarya ciliata, *Solanum nigrum, *Sonchus oleraceus, Stylidium calcaratum, Stylidium piliferum* subsp. *piliferum, Stylidium repens* (2%), *Trachymene pilosa, Tricoryne elatior, *Ursinia anthemoides, Wahlenbergia preissii*
Sedges 0.5-1m	0-2%:	*Lepidosperma leptostachyum*
Sedges <0.5m	10-30%:	*Desmocladus fasciculatus, Desmocladus flexuosus* (10-15%), *Hypolaena exsulca* (2-5%), *Lyginia barbata, Mesomelaena pseudostygia* (2-5%)
Climbers	-	-

SITE: AR02

Date:	25/11/02
Described by:	MM
Dimensions:	10x10m
Location:	AMG Zone 50: Easting 403511, Northing 6461361 (WGS84)
Habitat:	Plain adjacent to wetland.
Soil:	Pale grey sand.
Vegetation:	*Eremaea pauciflora* var. *pauciflora* low shrubland with *Patersonia occidentalis* and *Alexgeorgea nitens.*
Condition:	Very Good (occasional aggressive weeds, some litter).

Trees 5-15m	-	-
Trees <5m	-	-
Shrubs >2m	-	-
Shrubs 1.5-2m	-	-
Shrubs 1-1.5m	-	-
Shrubs 0.5-1m	2-10%:	*Leucopogon* sp. Murdoch (M.Hislop 1037), *Pericalymma ellipticum* var. *ellipticum, Philotheca spicata, Xanthorrhoea preissii* (3%)
Shrubs <0.5m	30-70%:	*Acacia huegelii, Acacia pulchella* var. *goadbyi, Bossiaea eriocarpa, Dampiera linearis, Eremaea pauciflora* var. *pauciflora* (30-50%), *Gompholobium tomentosum, Hibbertia hypericoides, Hovea trisperma, Hypocalymma angustifolium, Melaleuca seriata, Scholtzia involucrata*
Grasses	0-2%:	*Austrostipa compressa, *Briza maxima, *Briza minor, *Ehrharta calycina, *Lagurus ovatus, *Pentaschistis airoides*
Herbs	10-30%:	*Arnocrinum preissii, Centaurium spicatum, Conostylis aurea, Dasypogon bromeliifolius, *Gladiolus caryophyllaceus, Hyalosperma pusillum, *Hypochaeris glabra, Laxmannia ramosa* subsp. *ramosa, Oligochaetochilus vittatus, Patersonia occidentalis* (10%), *Phlebocarya filifolia, Podotheca angustifolia, *Silene gallica, Siloxerus humifusus, Stylidium calcaratum, Stylidium repens, *Ursinia anthemoides*
Sedges 0.5-1m	0-2%:	*Lyginia barbata*
Sedges <0.5m	10-30%:	*Alexgeorgea nitens* (10-20%), *Hypolaena exsulca, Lepidosperma squamatum*
Climbers	0-2%:	*Cassytha flava*

SITE: AR03

Date:	25/11/02
Described by:	KBM
Dimensions:	10x10m
Location:	AMG Zone 50 Easting 403470, Northing 6461410 (WGS84)
Habitat:	Sumpland flats.
Soil:	Peaty, clayey pale sand.
Vegetation:	*Pericalymma ellipticum* var. *ellipticum* shrubland over open sedges *Meeboldina scariosa* and *Hypolaena exsulca.*
Condition:	Very Good to Excellent (occasional weeds, some shrubs recently flattened).

Trees 5-15m	-	-
Trees <5m	-	-
Shrubs >2m	-	-
Shrubs 1.5-2m	-	-
Shrubs 1-1.5m	70-100%:	*Acacia pulchella* var. *goadbyi, Calothamnus lateralis, Pericalymma ellipticum* var. *ellipticum* (70-80%)
Shrubs 0.5-1m	10-30%:	*Daviesia physodes, Euchilopsis linearis, Melaleuca seriata, Pericalymma ellipticum* var. *ellipticum* (10-15%), *Stirlingia latifolia* (5%), *Verticordia plumosa, Xanthorrhoea preissii*
Shrubs <0.5m	2-10%:	*Euchilopsis linearis, Gompholobium tomentosum, Hypocalymma angustifolium, Lechenaultia expansa* (1%), *Melaleuca seriata* (2%),
Grasses	0-2%:	**Aira cupaniana*
Herbs	2-10%:	*Conostylis juncea, Dasypogon bromeliifolius* (2%), **Gladiolus caryophyllaceus, Patersonia occidentalis* (3%), *Phlebocarya ciliata* (2%), *Stylidium dichotomum, Stylidium calcaratum, Stylidium brunonianum, Thysanotus multiflorus*
Sedges 0.5-1m	10-30%:	*Meeboldina scariosa* (2-5%), *Hypolaena exsulca* (10-15%), *Lyginia imberbis* (5%), *Schoenus efoliatus*
Sedges <0.5m	10-30%:	*Desmocladus fasciculatus, Hypolaena exsulca* (10-15%)
Climbers	2-10%:	*Cassytha racemosa* forma. ? (sterile)(5%)

SITE: AR05

Date:	25/11/02
Described by:	KBM
Dimensions:	10x10m
Location:	AMG Zone 50 Easting 403544, Northing 6461406 (WGS 84)
Habitat:	Gentle rise in low-lying area adjacent to wetland.
Soil:	White sand with clay and peat component.
Vegetation:	*Banksia menziesii* woodland over low mixed shrubland dominated by *Eremaea pauciflora* subsp. *pauciflora* and *Hibbertia hypericoides*.
Condition:	Good to Very Good (some sparse **Ehrharta calycina* and scattered minor weeds).

Trees 5-15m	-	-
Trees <5m	30-70%:	*Banksia menziesii* (35-40%), *Nuytsia floribunda* (2%)
Shrubs >2m	-	-
Shrubs 1.5-2m	-	-
Shrubs 1-1.5m	0-2%:	*Acacia pulchella* var. *goadbyi*
Shrubs 0.5-1m	30-70%:	*Acacia huegelii, Acacia pulchella* var. *goadbyi, Eremaea pauciflora* var. *pauciflora* (25-30%), *Hibbertia hypericoides* (5-10%), *Macrozamia riedlei, Melaleuca seriata* (5%), *Philotheca spicata, Scholtzia involucrata, Xanthorrhoea preissii*
Shrubs <0.5m	10-30%:	*Bossiaea eriocarpa, Dampiera linearis, Eremaea pauciflora* var. *pauciflora* (5%), *Gompholobium tomentosum, Gonocarpus cordiger, Hemiandra linearis, Hibbertia hypericoides* (5-10%), *Leucopogon conostephioides, Philotheca spicata, Stirlingia latifolia*
Grasses	2-10%:	**Aira cupaniana, Amphipogon turbinatus, Austrostipa compressa, *Briza maxima, *Ehrharta calycina* (5%)
Herbs	2-10%:	**Anagallis arvensis, Arnocrinum preissii, Burchardia umbellata, Conostylis aurea, Conostylis juncea, Dasypogon bromeliifolius, *Gladiolus caryophyllaceus, Laxmannia ramosa* subsp. *ramosa, Lomandra caespitosa, Patersonia occidentalis, Phlebocarya ciliata, Podotheca angustifolia, Poranthera microphylla, Siloxerus humifusus, *Sonchus oleraceus, Stylidium repens* (2%), *Thysanotus arbuscula, Trachymene pilosa, *Ursinia anthemoides*
Sedges 0.5-1m	-	-
Sedges <0.5m	30-70%:	*Lyginia barbata* (5%), *Desmocladus flexuosus* (30-35%)
Climbers	-	-

SITE: AR06

Date:	25/11/02
Described by:	MM
Dimensions:	10x10m
Location:	AMG Zone 50 Easting 403600, Northing 6461503 (WGS 84)
Habitat:	Low sandy rise in low lying area
Soil:	Grey sand to sandy loam.
Vegetation:	*Banksia attenuata* and *B. menziesii* low woodland over low shrubland of *Eremaea pauciflora* subsp. *pauciflora* and *Leucopogon conostephioides*.
Condition:	Very Good (Some dead *Banksia*, occasional **Ehrharta calycina*, rabbits).

Trees 5-15m	2-10%:	*Banksia attenuata, Banksia menziesii*
Trees <5m	10-30%:	*Banksia attenuata* (10-15%), *Banksia menziesii* (10-15%)
Shrubs >2m	-	-
Shrubs 1.5-2m	0-2%:	*Calytrix fraseri*
Shrubs 1-1.5m	0-2%:	*Acacia pulchella* var*. goadbyi, Calytrix fraseri*
Shrubs 0.5-1m	10-30%:	*Calytrix fraseri, Eremaea pauciflora* var*. pauciflora* (10-20%)
Shrubs <0.5m	10-30%:	*Acacia huegelii, Bossiaea eriocarpa, Calytrix flavescens, Conostephium pendulum, Eremaea pauciflora* var*. pauciflora, Gompholobium tomentosum, Gonocarpus cordiger, Hibbertia hypericoides, Leucopogon conostephioides* (20-30%), **Pelargonium capitatum, Petrophile linearis, Scholtzia involucrata*
Grasses	0-2%:	**Aira caryophyllea, Amphipogon turbinatus, Austrostipa compressa, *Ehrharta calycina*
Herbs	2-10%:	*Burchardia umbellata, Conostylis juncea, Johnsonia pubescens, Laxmannia ramosa* subsp*. ramosa, Podotheca angustifolia, Siloxerus humifusus, *Sonchus oleraceus, Stylidium calcaratum, Stylidium repens, Thysanotus manglesianus, Trachymene pilosa, Wahlenbergia preissii*
Sedges 0.5-1m	0-2%:	*Lyginia imberbis*
Sedges <0.5m	2-10%:	*Alexgeorgea nitens, Desmocladus flexuosus, Lyginia barbata*
Climbers	-	-

SITE: AR07

Date:	25/11/02
Described by:	KBM MM
Dimensions:	5x20m
Location:	AMG Zone 50 Easting 403523, Northing 6461458 (WGS 84)
Habitat:	Sumpland (shallow periodically inundated basin).
Soil:	Pale clayey sand.
Vegetation:	Paperbark *Melaleuca preissiana* and *M. rhaphiophylla* woodland over sparse shrubs and dense rush *Meeboldina scariosa*.
Condition:	Very Good (occasional weeds)

Trees 5-15m	30-70%:	*Melaleuca preissiana* (40%)
Trees <5m	10-30%:	*Banksia littoralis* (2%), *Melaleuca rhaphiophylla* (20%)
Shrubs >2m	-	-
Shrubs 1.5-2m	-	-
Shrubs 1-1.5m	10-30%:	*Astartea fascicularis* (5%), *Calothamnus lateralis, Melaleuca lateritia, Pericalymma ellipticum* var*. ellipticum* (5%)
Shrubs 0.5-1m	0-2%:	*Astartea fascicularis, Eutaxia virgata, Melaleuca lateritia, Pericalymma ellipticum* var*. ellipticum*
Shrubs <0.5m	-	-
Grasses	0-2%:	**Briza minor*
Herbs	0-2%:	*Drosera nitidula subsp. nitidula, Gratiola pubescens, Helichrysum macranthum, *Hypochaeris glabra, Microtis media* subsp*. ?media, Senecio quadridentatus, Siloxerus filifolius, *Sonchus oleraceus*
Sedges 0.5-1m	70-100%:	*Meeboldina scariosa* (70-80%)
Sedges <0.5m	2-10%:	*Lepidosperma longitudinale* (5%)
Climbers	-	-

Opportunistically Collected Flora
Adenanthos cygnorum subsp*. cygnorum*
Centrolepis drummondiana
Comesperma virgatum
Corymbia calophylla
Corynotheca micrantha
**Dischisma arenarium*
**Echium plantagineum*
**Eragrostis curvula*
Eucalyptus todtiana
**Gamochaeta falcata*
Gonocarpus cordiger
Hibbertia stellaris
**Isolepis marginata*
Jacksonia furcellata
Kennedia prostrata
**Leptospermum laevigatum*
†*Macarthuria keigheryi*
†*Platysace ramosissima*
Platytheca galioides
Schoenus curvifolius
†*Verticordia lindleyi* subsp*. lindleyi*

Bird Species Records for the Project Area

Appendix 5

BIOta

Appendix 5: Avifauna records from the project area (***** denotes introduced species, **†** denotes Significant Bird Species of the Swan Coastal Plain; Habitats: MW=*Melaleuca* Woodland, BW=*Banksia* Woodland, PS=*Pericalymma* Shrubland, AS=*Adenanthos* Shrubland. Numbers = records from 2002 surveys for this PER; ✓ = recorded from the project area by How et al. (1996); + =recorded elsewhere at the airport in habitats present in the project area by How et al. (1996)).

	Habitats			
Species	**MW**	**BW**	**PS**	**AS**
ARDEIDAE				
White-faced Heron - *Ardea novaehollandiae*			+	
ACCIPITRIDAE				
Black-shouldered Kite – *Elanus caeruleus axillaris*			+	+
†Collared Sparrowhawk – *Accipiter c. cirrocephalus*			+	
†Brown Goshawk – *Accipiter f. fasciatus*			+	+
†Little Eagle – *Aquila m. morphnoides*	✓	✓	+	+
FALCONIDAE				
Australian Kestrel - *Falco c. cenchroides*		✓	+	+
CHARADRIIDAE				
Black-fronted Dotterel – *Charadrius melanops*				+
COLUMBIDAE				
*Laughing Turtle-dove – *Streptopelia senegalensis*		✓	+	+
*Spotted Turtle-dove – *Streptopelia chinensis*	✓			+
PSITTACIDAE				
Red-capped Parrot – *Platycercus spurius*	✓		+	
Elegant Parrot – *Neophema elegans*			+	
CUCULIDAE				
Horsfield's Bronze-Cuckoo - *Chrysococcyx basalis*			+	
Shining Bronze-cuckoo - *Chrysococcyx lucidus plagosus*			+	
HALCYONIDAE				
Sacred Kingfisher – *Todiramphus s. sanctus*		✓		
MEROPIDAE				
Rainbow Bee-eater - *Merops ornatus*		✓	+	+
MALURIDAE				
†Splendid Fairy-wren – *Malurus s. splendens*			+	
PARDALOTIDAE				
Striated Pardalote - *Pardalotus striatus westraliiensis*	✓		+	
ACANTHIZIDAE				
†Inland Thornbill – *Acanthiza apicalis*	3		+	
†Yellow-rumped Thornbill – *Acanthiza chrysorrhoa*	✓			
†White-browed Scrubwren – *Sericornis frontalis maculatus*	3			
MELIPHAGIDAE				
Brown Honeyeater – *Lichmera i. indistincta*	✓	✓	+	+
Singing Honeyeater – *Lichenostomus virescens*	✓	✓	+	+
†White-cheeked Honeyeater – *Phylidonyris nigra gouldii*		✓	+	+
†Tawny-crowned Honeyeater – *Phylidonyris melanops*			+	+
Western Spinebill – *Acanthorhynchus superciliosus*		✓	+	+
Western Little Wattlebird – *Anthochaera lunulata*		✓	+	+

Appendix 5: Avifauna records from the project area (***** denotes introduced species, **†** denotes Significant Bird Species of the Swan Coastal Plain; Habitats: MW=*Melaleuca* Woodland, BW=*Banksia* Woodland, PS=*Pericalymma* Shrubland, AS=*Adenanthos* Shrubland. Numbers = records from 2002 surveys for this PER; ✓ = recorded from the project area by How et al. (1996); + =recorded elsewhere at the airport in habitats present in the project area by How et al. (1996)).

	Habitats			
Species	**MW**	**BW**	**PS**	**AS**
Red Wattlebird – *Anthochaera carunculata*	✓		+	+
White-fronted Chat – *Ephthianura albifrons*			+	
NEOSITTIDAE				
†Varied Sitella – *Daphoenositta chrysoptera pileata*		✓	+	
PACHYCEPHALIDAE				
Rufous Whistler – *Pachycephala r. rufiventris*	✓	✓	+	+
DICRURIDAE				
Magpie-lark - *Grallina c. cyanoleuca*		✓	+	
Willy Wagtail – *Rhipidura l. leucophrys*			+	+
CAMPEPHAGIDAE				
Black-faced Cuckoo-shrike - *Coracina n. novaehollandiae*		✓	+	
White-winged Triller – *Lalage sueurii*			+	+
ARTAMIDAE				
†Black-faced Woodswallow – *Artamus cinereus*			+	+
CRACTICIDAE				
Grey Butcherbird - *Cracticus t. torquatus*	✓	✓	+	
Australian Magpie - *Cracticus tibicen dorsalis*			+	+
CORVIDAE				
Australian Raven - *Corvus coronoides perplexus*		✓	+	+
HIRUNDINIDAE				
Welcome Swallow – *Hirundo neoxena*		✓	+	+
Tree Martin – *Hirundo nigricans*		✓	+	+
Fairy Martin – *Hirundo ariel*		✓		
ZOSTEROPIDAE				
Grey-breasted White-eye - *Zosterops lateralis gouldi*	✓	✓	+	+
SYLVIIDAE				
Rufous Songlark – *Cincloramphus mathewsi*			+	
DICAEIDAE				
Mistletoe Bird – *Dicaeum h. hirundinaceum*			+	
MOTACILL IDAE				
Australian Pipit – *Anthus australis*			+	
Species richness:	**13**	**20**	**39**	**24**

Aquaterra Desktop Hydrological Study

Appendix 6

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BIOTA ENVIRONMENTAL SCIENCES / MAIN ROADS WESTERN AUSTRALIA

ABERNETHY ROAD – TONKIN HIGHWAY ON-RAMP, FORRESTFIELD : DESKTOP INVESTIGATION OF HYDROLOGY AND HYDROGEOLOGY

APRIL 2003

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Project No. 348
Document No. R001-e

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SECTION 1 - INTRODUCTION

Aquaterra are assisting Biota Environmental Sciences in the preparation of a Public Environmental Review (PER) document for the proposed construction of an on-ramp from Abernethy Road to the Tonkin Highway, Forrestfield for Main Roads WA. The Environmental Protection Authority (EPA) requires the proponent to undertake a PER document which includes the following information :

- Description of the proposal.
- Description of the receiving environment.
- Outline of the potential impacts on environmental factors.
- Strategies to protect the environmental factors.

This report aims to describe the prevailing hydrological and hydrogeological conditions, evaluate potential effects on the hydrology and hydrogeology and recommend strategies necessary to achieve the three EPA objectives listed in Section 1.2. This report will form an appendix to the PER document.

1.1 BACKGROUND

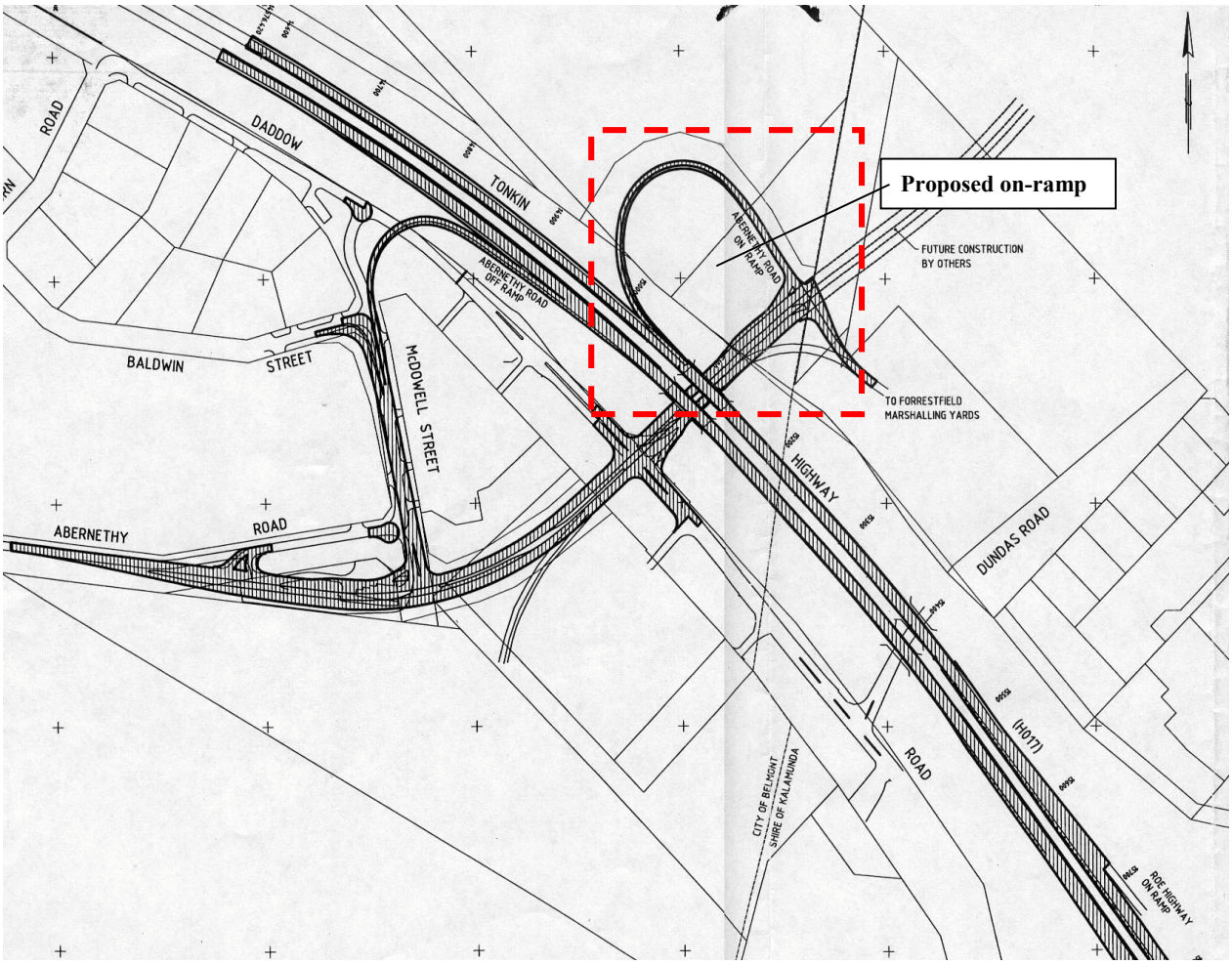
The Forrestfield industrial area, especially around the CBH Metropolitan Grain Terminal, attracts a large volume of semi trailer and road train traffic. It has become necessary to develop an on-ramp from the area to the Tonkin Highway to improve traffic flow and safety. Main Roads Western Australia (MRWA) has investigated a number of alternatives to the Abernethy Road option, but all are inferior to the Abernethy Road option (Millar and Associates, 2000). The location of the proposed on-ramp is shown in Figure 1.

1.2 PROJECT AIMS

The PER process requires a formal assessment of the likely impacts related to the on/off ramp development. Based on the “Guide to EIA Environmental factors and Objectives” (EPA, June 2002), the objectives related to surface water and groundwater issues are:

- To maintain the integrity, ecological functions and environmental values of wetlands.
- To maintain the quality of water so that the existing and potential environmental values, including ecosystem maintenance, are protected.
- To ensure that emissions do not adversely affect environmental values or health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

Figure 1
Location of Proposed New Abernethy Road On-Ramp
(from Main Roads Western Australia, 2002)



SECTION 2 - DESCRIPTION OF THE STUDY AREA

2.1 TOPOGRAPHY

The study area is a relatively flat area bounded by the Tonkin Highway and a NW-SE trending ridge (~ 150m to the north east of the site). On the proposed site, the surface is relatively flat, with a slight gradient to the southern corner. Along the southern and western boundaries of the site, a boundary road has been opened through the bush. Construction of this road has developed a small berm along the southern boundary of the site.

2.2 CLIMATE

The climate for Perth can be characterised as Mediterranean with warm, wet winters and hot dry summers. The average climatic data for Perth, obtained from the Bureau of Meteorology, is presented in Table 1.

Table 1
Average Climate Data for Perth

Month	Rainfall (mm)	Class-A Pan Evaporation (mm)	Mean Max. Temp. (deg Celsius)	Mean Hours of Daily Sunshine	Mean Wind Speed (km/hr)
January	8	270	29.6	10.5	18.8
February	12	232	31.1	10.1	18.2
March	20	203	28.9	9.0	16.7
April	45	121	24.7	7.4	14.5
May	124	88	21.5	5.9	13.8
June	183	65	19.1	4.9	14.3
July	174	67	18.5	5.3	14.8
August	137	81	17.9	6.2	15.0
September	80	110	19.4	7.2	15.4
October	55	162	21.2	8.3	16.3
November	21	196	24.6	9.7	17.5
December	14	250	28.5	10.6	18.3
Annual Average	**873**	**1845**	**23.7**	**7.9**	**16.1**

Average monthly rainfall varies from a maximum of 183mm in June to a minimum of 8mm in January. The average evaporation pattern is diametrically opposed to rainfall, and varies from a maximum of 270mm in January to a minimum of 65mm in June. Evaporation exceeds rainfall in all months except May to August.

Wind data has been obtained from the Bureau of Meteorology for the Perth Airport Climate Station at Belmont, which is representative of the site. From the data, it can be seen that in the morning (0900 hours), easterly winds are dominant in summer and spring. Generally weaker east to north easterly or no wind conditions occur in the winter and autumn months. In the afternoon (1500 hours), westerly and south westerly winds dominate all year round tending to be strongest during the summer months. The summer south westerly is commonly associated with sea breezes.

2.3 GEOLOGY

Davidson (1995) shows the shallow geology of the site to consist of Bassendean Sands, overlying the Guildford Formation (both part of the Superficial Formations). Bassendean Sand consists of pale grey to white, predominantly medium grained sands of aeolian origin. In many cases on the Swan Coastal Plain, a limonite cemented sand, known colloquially as coffee rock, is found near the water table. The Guildford Formation consists predominantly of a pale brown, silty to sandy clay of fluvial origin (Davidson, 1995).

The Perth Groundwater Atlas (Water and Rivers Commission, 1997) shows the base of the Superficial Formations to be at approximately –7 m AHD, therefore the thickness is 27m. Data obtained from the Water and Rivers Commission's WIN database, indicates a bore 870m to the south-east with 23m of Superficials, before encountering the underlying Kings Park Formation (bore WIN site ID 5829.).

2.4 HYDROGEOLOGY

Bassendean Sands form the aquifer which is of most relevance to groundwater on the site. This aquifer is underlain by the Guildford Clays which form an aquiclude at depths of between 4 – 6 m below surface (HydroSolutions, 2001). Annual fluctuations in water levels for the Swan Coastal Plain are usually between 1- 1.5m. Water levels measured in the three Airports Company monitoring bores closest to the study area (Figure 2) varied seasonally in the range of 1.8 – 3.5m below the surface over the 2001-2002 period (Figure 3) – this is within the expected range of 1 – 1.5m per annum. The Airports Company bores are between 600 – 2000m away from the study area. The study area is slightly less elevated than the Airports Company bores, so water levels are probably shallower, although annual water level fluctuations are expected to be similar. Water levels on the site are expected to be in the range of 0.5 – 1.5m below surface during summer and shallower during winter.

The larger scale assessments of the area (Perth Groundwater Map, 1997; Davidson, 1995) do not show adequate detail to accurately delineate groundwater flow directions at the site, although regional groundwater flow is indicated as being from east to west. However, more detailed assessments undertaken on the Perth Airport property utilising actual water levels from bores with accurate surveyed bore elevations (HydroSolutions, 2001) indicate a north easterly – south westerly flow direction at the site (Figure 2).

2.5 HYDROLOGY

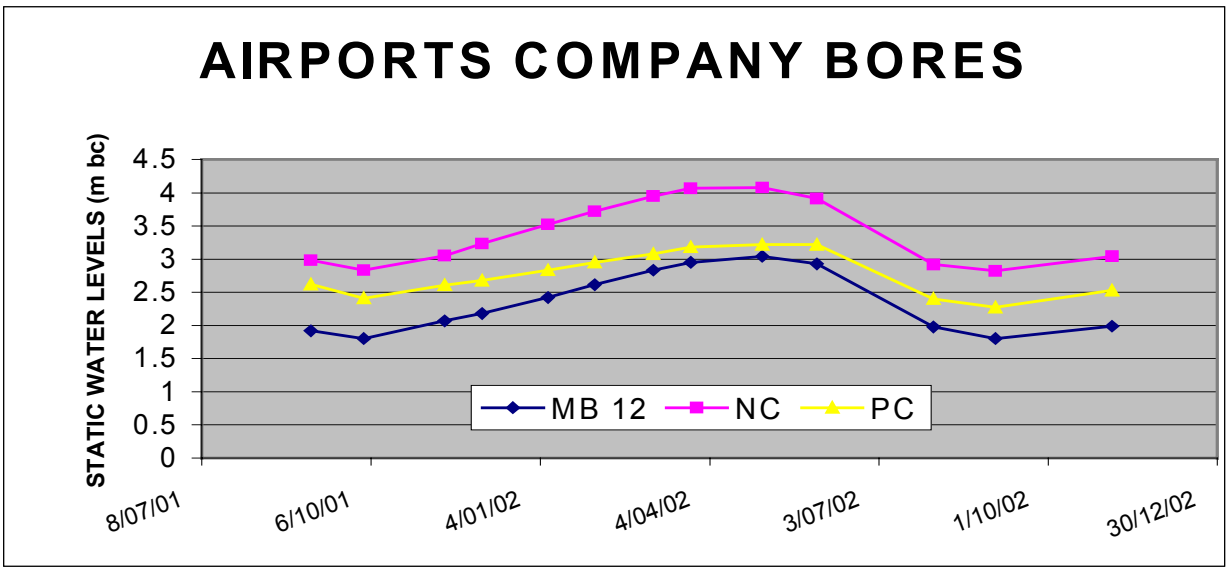
The surface water catchment of the proposed Abernethy Road on-ramp is bounded by the Tonkin Highway Road embankment to the south west and Abernethy Road to the south east. Elevation data (obtained from Water Corporation) shows the area upgradient of the study area to have low gradients – unfortunately the accuracy of the data available does not allow for delineation of the watershed boundaries. The best estimate of the extent of the catchment suggests it extends some 800 metres from the Tonkin Highway/Abernethy Road intersection to the north (Figure 2). The catchment consists predominantly of wetlands within the Perth Airport site. The vegetation is typically low scrub, but some

small areas exist with Melaleuca trees with little surrounding scrub indicating a shallow depth to groundwater. These areas are depression storages as they do not appear to have an overland flow outlet.

The catchment geomorphology is typically of highly permeable sandy soil with a generally flat topography separated by numerous localised mounds and depression storages. There is no evidence of open drains or swales in the catchment to convey surface water runoff. Runoff is likely to be sheet flow from the mounds to the depressions, although some infiltration on the mounds will also occur. As there does not appear to be an overland flow outlet for the storages, the storage depressions are likely to store rainfall prior to it infiltrating to groundwater.

There is a pipe culvert (approximately 300mm diameter) underneath Abernethy Road at the toe of the Tonkin Highway embankment. This culvert is likely to drain the surrounding small localised depression. Downstream of the culvert is an open drain.

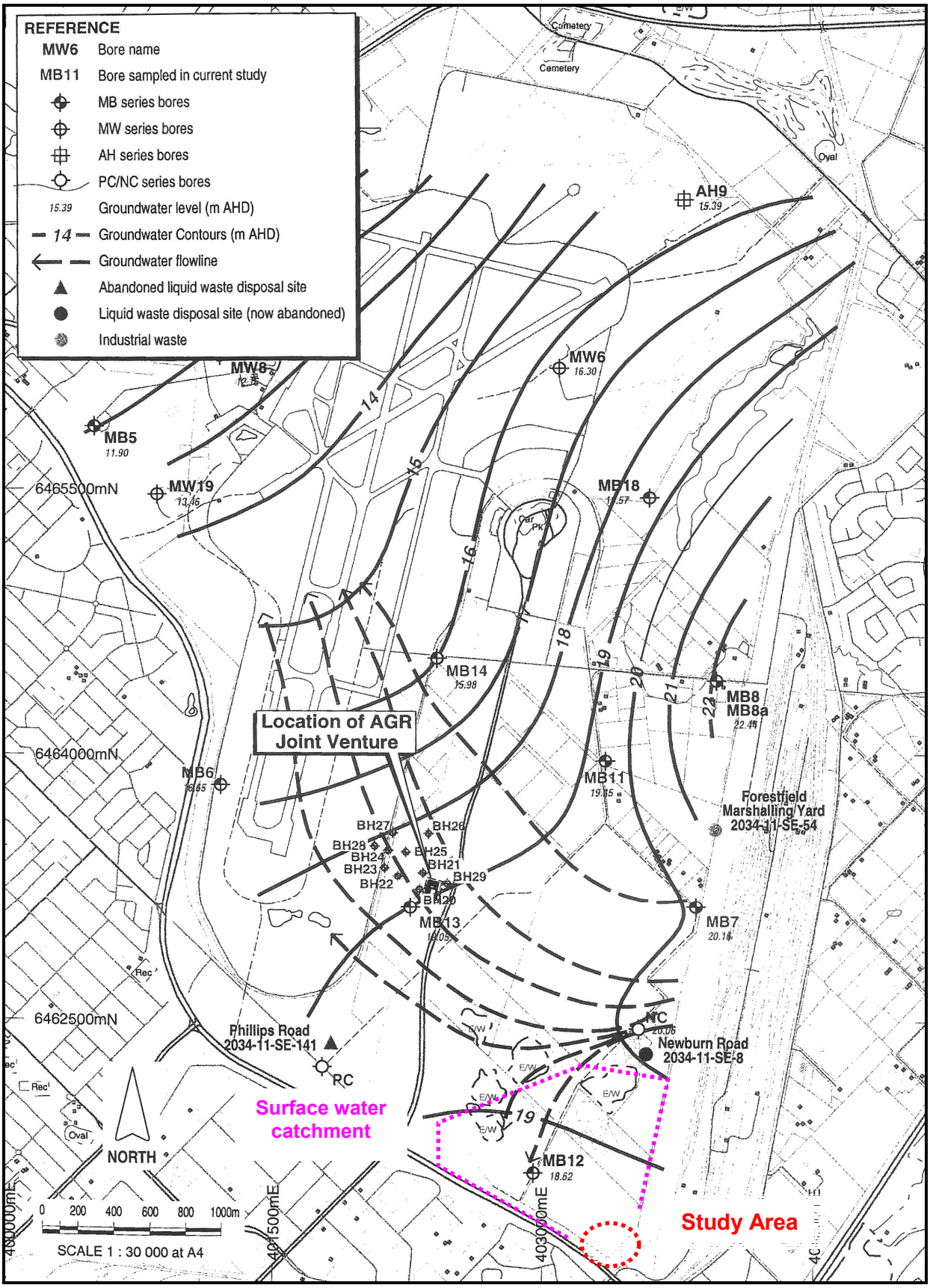
Figure 3
Seasonal Groundwater Level Fluctuations



2.6 WETLAND HYDROLOGY

The closest bore to the site (MB12) has a water table with highest levels of just under 2m below the surface. This hole is slightly elevated compared to the study area and water levels on the site are probably closer to the surface. During the site inspection (November 2002) water levels in the base of the depression existing in the study area were deeper than 0.5m below surface, estimated to be between 0.5 - 1.5 m below surface. Surface water found in the wetlands on the site are not therefore surface expressions of groundwater, but will be related to surface water run-off during and after rainfall events. The shallow groundwater levels will however allow capillary rise of water levels to the surface, with the majority of the wetland vegetation being reliant on groundwater during the summer periods. Greater details on the wetland ecology are contained in reports PER document.

Figure 2 : Bore locations and groundwater contours (from Hydrosolutions, 2001)



SECTION 3 IMPACT ASSESSMENT

3.1 PROJECT DESCRIPTION

The on-ramp will be constructed from the Abernethy Road level and will be ramped up to the Tonkin Highway. An area of 1.5 ha of bush will be affected (indirectly impacted upon) by the new road (see Figure 1). All surface water runoff from the roads will be drained to a central retention basin in the middle of the on-ramp.

3.2 IMPACTS ON SURFACE WATER

3.2.1 Surface Water Flow

The Abernethy Road on-ramp will have minimal impact on the surface water hydrology. Surface water flow direction in this location is north-south. The proposed location of the on-ramp is in the very bottom corner of the catchment and the majority of the wetlands are upgradient of the planned on-ramp, so will not be affected by the new ramp. The road pavement runoff and runoff internal to the ramp will discharge into the proposed retention basin to be constructed in the centre of the ramp loop. There may be a small amount of surface runoff that currently flows into the proposed ramp location which would be obstructed by this flow and would now flow to the wetland. The wetlands is unlikely to be impacted by this small amount of flow (in terms of duration and volume), since the area of the on-ramp which could contribute flow to the wetland is approximately 2% of the total surface water catchment.

3.2.2 Surface Water Quality

Any hydrocarbon spillage or other pollutants accumulated on the road will flow to the on-ramp retention basin. As the retention basin outlet is predominantly by infiltration, with a minimal amount by evaporation, the pollutants will be retained in the basin or filtered by the sand below. The groundwater flow direction is away from the wetlands, located to the north of the ramp, so any pollutants that pass through the sand filter at the base of the basin and into the groundwater will not affect the upgradient wetlands.

3.3 IMPACTS ON GROUNDWATER

The impact that the development could have on groundwater depends on the groundwater flow direction, the rate of any infiltration to the aquifer and potential contaminants.

3.3.1 Groundwater Flow Directions

As discussed previously groundwater flow is away from the wetlands, towards the south-west. During the site inspection undertaken by Aquaterra on 29 Oct 2002, spring flow was seen to be occurring south of Abernethy road, with the water flowing along a stream line parallel to the Tonkin highway. This spring flow, together with the general groundwater flow, will ensure that any contaminants which would infiltrate into the aquifer from road runnoff or from the retention basin, will not enter the wetland in the study area.

3.3.2 Groundwater Recharge

The on-ramp will take up an area of 1.5 ha, the total recharge area feeding the on-ramp area of 75 ha. As a result, the on-ramp site only makes up 2% of the local groundwater catchment. The development of the on-ramp will not however, affect local recharge to the aquifer, since rainfall falling on the site will still be recharged to the aquifer via the retention basin. The on-ramp will not therefore have any effect on the total rainfall recharge to the aquifer system.

3.3.3 Groundwater Quality

Contaminants resulting from normal road use, or from spillage's on the on ramp, will be directed internally to the retention basin. As a result, any contamination will be in a central area where is can be managed more easily. It is suggested that drainage into the basin should first pass through a combined sediment trap / hydrocarbon interceptor, before entering the infiltration area. These traps will have to be cleaned out regularly.

3.3.4 Groundwater Users

Even though contamination of the groundwater could potentially take place, contamination risks need to be seen in the light of potential groundwater users downstream of the site. Based on data obtained from the Water and Rivers Commission and a brief field survey of the properties directly downstream of the site, no groundwater use takes place within 1km of the site. As a result there do not appear to be any adjacent users at risk. Even if a major pollution incident occurred, the central retention basin, the slow groundwater flow rates and a thin upper aquifer zone with a clay base, all allow for relatively easy control and rehabilitation of any polluted groundwater. The area downstream of the proposed on-ramp consists of business and industrial properties – although it is difficult to predict future groundwater use in the area, it is probable that groundwater abstracted would not be for domestic consumption, but would be used for garden irrigation.

3.4 IMPACTS ON THE WETLAND

From a hydrological and hydrogeological perspective, the on-ramp development will have a limited effect of the wetlands to the north, since both surface water sheetflow and groundwater flow are from the north towards the on-ramp and not vice versa. The footprint of the on-ramp will fall on some areas of wetland, but water supplies to wetlands north of the footprint area will not be affected.

A spring (and associated wetland vegetation) occurs just to the south of Abernethy Road, 40m from the Tonkin Highway bridge – since groundwater flow direction and flow rates will not be effected by the on-ramp, this spring and its vegetation will also not be affected. This spring feeds the vegetation adjacent to the seep, but is not utilized for any human purposes. At the time of the site inspection (November 2002), the water from the spring was flowing down a water course at a flow rate of under 1 L/sec, for a distance of under 100m, whereafter the stream dried up as a result of the water seeping into the sands).

This spring could potentially be influenced by large scale contamination incidents taking place on the on-ramp, if the contamination was not cleaned up quickly.

3.5 ACID SULPHATE SOILS

Acid sulphate soils develop when dewatering as a result of groundwater abstraction, results in a drop in water levels in soils with high iron sulphide levels. No change to groundwater levels is expected as a result of the development of the on-ramp, so the development of acid sulphate soils should not take place.

SECTION 4 - IMPACT MINIMISATION

4.1 SURFACE WATER

The two main potential impacts of the on-ramp on the surface water hydrology are:

- The ramp embankment cuts off surface water runoff to the southern corner of the property.
- Pollutants from the new ramp could be generated.

To manage the interception of surface water flow by the ramp embankment, it is recommended that a toe drain be constructed at the base of the embankment to store this water prior to it infiltrating. The quantity of water collected in the toe drain should be minimal as the on-ramp catchment topography is generally flat and the soil highly permeable, so the majority of rainfall falling on the catchment should infiltrate rather than runoff.

To manage the generation of pollution from the new ramp, a regular maintenance program of the retention basin should be implemented to periodically remove the build-up of pollutants such as hydrocarbons and litter from the basin. Super-elevated road pavements and kerbing should prevent any surface water runoff from escaping from the ramp drainage network which directs all surface water runoff to the retention basin. The risk of contamination of the wetlands to the north from pollutants generated from the new ramp is negligible as the basin is landlocked, so that the only outlet is by infiltration. The wetlands on the site are upgradient of the basin, so any potentially polluted groundwater is likely to flow away from the wetlands.

4.2 GROUNDWATER

The only risk to groundwater resources is that of pollution from road runoff or pollution incidents on the roads. Since downstream users are over 1km away, considerable opportunities exist for natural attenuation of minor contaminants. Large pollution incidents will have to be cleaned if or when the contaminants collect in the retention basin.

SECTION 5 - CONCLUSIONS

The development of the on-ramp is unlikely to have any major affects on either surface water or groundwater resources, or on any of the adjacent wetlands located adjacent to the on-ramp footprint. Recharge to the groundwater system, groundwater levels and groundwater flow directions are not expected to be influenced by the development of the on-ramp.

As a result of the flow directions, and the design of a central retention basin to capture any runoff from the new roads, contamination of the upgradient wetlands is unlikely to take place. Downstream groundwater users are more than 1km downstream of the site and utilise water from deeper aquifer systems than the shallow aquifer (< 6m below surface) which underlies the site. The wetland and spring to the south of Abernethy Road could be affected by any large scale contamination events if contaminant clean up was not immediate. Any small scale contamination incidents are likely to be attenuated before the pollution plume reaches the downstream users, while the retention basin provides a facility for large pollution incidents to be contained, managed and remediated .

SECTION 6 - REFERENCES

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