TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INCORPORATED

CLONTARF RESIDENTIAL SUBDIVISION, WATERFORD

PUBLIC ENVIRONMENTAL REVIEW (EPA ASSESSMENT NO. 1467)

VOLUME I

VERSION 5

JUNE 2004

REPORT NO: 2003/91

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LIST OF APPENDICES

AN INVITATION TO COMMENT ON THIS PUBLIC ENVIRONMENTAL REVIEW

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

The Trustees of the Christian Brothers in Western Australia Incorporated is proposing a residential subdivision at Clontarf in Waterford, Perth Western Australia. Should all approvals be in place, development will commence in the third quarter 2004.

A Public Environmental Review (PER) has been prepared by the company to examine the environmental effects associated with the proposed development and how they will be managed, in accordance with Western Australian Government procedures. The PER describes the proposal, examines the likely environmental effects and the proposed environmental management procedures.

The PER is available for public review for up to 8 weeks from 8 June 2004 to 3 August 2004.

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.

Submissions may be fully or partially utilised in compiling a summary of the issues raised or where complex or technical issues are raised, a confidential copy of the submission (or part of it) may be sent to the proponent.

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

Why not join a group?

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

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

If you form a small group (up to ten 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 the 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 section you are considering.

- Attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- your address;
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is:

3 August 2004

Submission should be emailed to: rachael.mercy@environ.wa.gov.au or addressed to:

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

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An internal quality review process has been applied to each project task undertaken by us. Each document is carefully reviewed by core members of the consultancy team and signed off at Director level prior to issue to the client. Draft documents are submitted to the client for comment and acceptance prior to final production.

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Checked by: Signed: 

Name: Bernadette Van der Wiele Date: 2 June, 2004

Approved by: Signed: 

Name: Paul van der Moezel Date: 2 June, 2004

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EXECUTIVE SUMMARY

Introduction

The Trustees of the Christian Brothers in Western Australia Incorporated propose to develop their land at Clontarf in Waterford for a residential subdivision. The Christian Brothers have owned the land for over 100 years.

The East Clontarf site is located approximately 8km south-east of the Perth Central Business District (Figure 1). The site is bound by Manning Road to the north, Centenary Avenue to the east, the Clontarf Campus to the west, and Canning River to the south (Figure 2). The site is approximately 18ha in size and is zoned 'Urban' in the Metropolitan Region Scheme (MRS) and 'Residential' in the City of South Perth Town Planning Scheme. The southern strip adjacent to the Canning River is reserved for Parks and Recreation in the MRS and is still in the ownership of the Christian Brothers.

The Proposal

The residential subdivision of the East Clontarf area is part of a larger long-term plan by the Trustees of the Christian Brothers for the whole ~32ha Clontarf site which includes:

- Clontarf Campus – the central and central-western portions of the site combining the existing Clontarf Campus buildings;
- Canning River Foreshore – extending along the southern boundary of the Project Area; and
- East Clontarf – the eastern portion of the site, to be the subject of residential subdivision.

The objectives of the Christian Brother's for the entire Clontarf site are:

1. To create a separate Clontarf Campus site and transfer it to an Aboriginal ownership group for the protection of heritage buildings and the development of Aboriginal cultural, educational and spiritual groups;
2. To create a residential development on the undeveloped East Clontarf portion of the site thereby permitting funds from the development to be set aside in order to generate recurrent income for the Clontarf Campus and other community outreach programmes operated by the Christian Brothers in Western Australia; and
3. To improve the environmental attributes of the site by rehabilitating the degraded wetland that exists on the East Clontarf site and improving the river foreshore environment.

The proposed residential development of the East Clontarf area involves:

1. Creating up to 200 residential allotments.

2. Setting aside approximately 4ha of rehabilitated and re-contoured wetland area in addition to approximately 8000m^2 of public open space (approximately 24% of the developable area of the site).

3. Improving the riparian environment along the banks of the Canning River by re-creating habitat that previously existed in the area including constructing a Paperbark wetland adjacent to the river and connecting the foreshore environment to the inland wetland.

4. Providing additional protection of the existing Canning River foreshore area by widening the river flats/ foreshore by approximately 6000m^2.

5. Protecting a stand of significant Marri trees on the site.

6. Revegetating and integrating some upland native vegetation to the site between the wetland and the Campus buildings.

Proposal Justification and Alternatives

The East Clontarf site is zoned 'Urban' in the MRS and 'Residential' in the City of South Perth Town Planning Scheme.

Residential land use is an approved use within these zones. Development of the site will allow the Trustees of the Christian Brothers to meet their long-term goals for the whole Clontarf site. A portion of funds from the residential development will generate recurrent income required to assist in the funding and ongoing maintenance of the Clontarf Campus.

Residential development will also allow the environmental functions of the site to be increased greatly from its current degraded state. Funds from the development will allow the wetland on the site to be rehabilitated and the creation of additional riparian vegetation adjoining a portion of Canning River foreshore.

No development on the site or a smaller development will not generate sufficient funds to meet the objectives for the Clontarf Campus or the environmental improvements.

Public Environmental Review

The Public Environmental Review (PER) describes the impact of the proposed development on the following environmental factors:

- Vegetation
- Significant Flora
- Fauna

- Significant Fauna
- Foreshore
- Wetlands
- Surface water Quality
- Groundwater Quality
- Soil Quality
- Acid Sulfate Soils
- Noise
- Dust
- Aboriginal Heritage

The PER provides a description and justification of the project on a site specific, local and regional scale. Consultation has been undertaken with various stakeholders and interested parties. Each of the environmental factors listed is addressed with a description of the existing environment, potential impacts, proposed management and commitments made by the proponent. Issues in relation to pollution control are also discussed.

The implication of the residential development for each of the environmental factors is summarised in Table A1. The proponent has made a number of commitments in this PER to minimise the environmental impact of this development. A summary of these commitments is provided in Table A2.

TABLE A1
EAST CLONTARF RESIDENTIAL DEVELOPMENT
RELEVANT ENVIRONMENTAL FACTORS

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
BIOPHYSICAL				
Vegetation	Subject site (approx. 18ha)	To maintain the abundance, diversity, geographic distribution and productivity of vegetation communities.	Development will involve clearing approximately 1.57ha of native and exotic wetland vegetation.	Retention of small stands of dryland remnant vegetation. Approximately 4ha of wetland vegetation will be retained and rehabilitated. Areas of vegetation not proposed to be cleared will be flagged and specifically identified in site inductions. Develop and implement a Wetland Management Plan to the satisfaction of the DoE, that will include but not be limited to: • Identification of existing wetland area to be retained; • Avoiding direct and minimising indirect impacts on the wetland; • Ensuring no net loss of wetland values and functions; • Rehabilitation techniques to be employed; • Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats; • Mitigation strategies for loss of any vegetation will be investigated including both on-site and off-site options;

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				• Creation of a new Paperbark/Flooded Gum wetland area to be located adjacent to the existing wetland and the river foreshore and planted with tree, understorey sedge and shrub species common to the local riverine and wetland environment; • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.
Significant Flora	Subject site (approx. 18ha)	To protect Declared Rare and Priority Flora consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect other flora of conservation significance.	No loss of, or disturbance to, any species of Declared Rare and Priority Flora on site.	Areas of vegetation not proposed to be cleared will be flagged and specifically identified in site inductions.
Fauna	Subject site (approx.18ha) and adjacent river	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Habitat loss associated with vegetation/wetland clearing and/or modification. Rehabilitation and revegetation has the potential to create additional habitat and may strengthen the linkage between the wetland and Clontarf Bay.	River foreshore vegetation and fauna corridor to be maintained and habitat connection between river and wetland to be enhanced. Modification and rehabilitation of the wetland with local wetland and dryland species to maintain and enhance existing habitats. Develop and implement a Wetland Management Plan to the satisfaction of the DoE, that will include but not be limited to: • Identification of existing wetland area to be retained; • Avoiding direct and minimising indirect

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				impacts on the wetland; • Ensuring no net loss of wetland values and functions; • Rehabilitation techniques to be employed; • Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats; • Mitigation strategies for loss of any vegetation will be investigated including both on-site and off-site options; • Creation of a new Paperbark/Flooded Gum wetland area to be located adjacent to the existing wetland and the river foreshore and planted with tree, understorey sedge and shrub species common to the local riverine and wetland environment; • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.
Significant Fauna	Subject site (approx. 18ha)	Protect Specially Protected (Threatened) Fauna and Priority Fauna species and their habitats, consistent with provisions of the *Wildlife Conservation Act 1950.*	No Specially Protected or Priority fauna was recorded within the site. Potential habitat impacts for several Significant Birds as identified in Bush Forever and species listed under JAMBA/CAMBA agreements occur within or adjacent to the site.	Develop and implement a Foreshore Management Plan to the satisfaction of the SRT, DPI and City of South Perth, that will include but not be limited to: • Comprehensive weed eradication program; • Revegetating and restoring foreshore POS adjoining conservation areas with appropriate indigenous flora of the Canning River; • Increase the area contained within POS adjoining Bush Forever Site No. 333; • Creation of habitat and wildlife corridors; • Controlling vehicle and pedestrian access;

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				• Provision of public facilities; • Soil and plant source material hygiene; • Fire management including provision of fire hydrants; • Provision of educational and interpretative materials within the area to raise awareness of JAMBA/CAMBA species that frequent the area; • Encouraging community involvement and awareness promoting control of pets (eg cats and dogs); • Water conservation principles; • Monitoring criteria to determine the success of the revegetation and weed eradication program; • Progress and compliance reporting; and • Timing and implementation schedule.
Foreshore	The Canning River foreshore reserve area (Bush Forever Site No. 333) forming the site's southern boundary.	To maintain the integrity, ecological functions and environmental values of the foreshore environment.	Potential indirect impacts include the introduction of further weeds during construction activities and an increased use of the area by both residents and visitors potentially resulting in trampling of vegetation and disturbance of fauna.	The proposed development includes an additional setback (~6000m^2) resulting in an overall increase in foreshore area protecting on-site samphire vegetation. Develop and implement a Foreshore Management Plan to the satisfaction of the SRT, DPI and City of South Perth, that will include but not be limited to: • Comprehensive weed eradication program; • Revegetating and restoring foreshore POS adjoining conservation areas with appropriate indigenous flora of the Canning River; • Increase the area contained within POS adjoining Bush Forever Site No. 333; • Creation of habitat and wildlife corridors; • Controlling vehicle and pedestrian access;

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				• Provision of public facilities; • Soil and plant source material hygiene; • Fire management including provision of fire hydrants; • Provision of educational and interpretative materials within the area to raise awareness of JAMBA/CAMBA species that frequent the area; • Encouraging community involvement and awareness promoting control of pets (eg. cats and dogs); • Water conservation principles; • Monitoring criteria to determine the success of the revegetation and weed eradication program; • Progress and compliance reporting; and • Timing and implementation schedule.
Wetland	Wetland protected by EPP and mapped as Conservation category by WRC, Canning River and foreshore environment.	To maintain the integrity, ecological functions and environmental values of the wetlands environment.	Project will result in no net loss of wetland function, vegetation and area.	The wetland will be revegetated using indigenous species of local provenance. Any proposed modifications to the wetland will ensure that the water balance, hydrological regime and flow rates will not be adversely altered. Develop and implement a Wetland Management Plan to the satisfaction of the DoE, that will include but not be limited to: • Identification of existing wetland area to be retained; • Avoiding direct and minimising indirect impacts on the wetland; • Ensuring no net loss of wetland values and functions;

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				• Rehabilitation techniques to be employed; • Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats; • Mitigation strategies for loss of any vegetation will be investigated including both on-site and off-site options; • Creation of a new Paperbark/Flooded Gum wetland area to be located adjacent to the existing wetland and the river foreshore and planted with tree, understorey sedge and shrub species common to the local riverine and wetland environment; • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.
POLLUTION MANAGEMENT				
Surface water Quality	Water contained within and entering the wetland, and entering the river from the site.	To ensure emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Residential development and proposed wetland modifications may temporarily interrupt or alter current water balance, water quality and flow rates within the wetland. Potential adverse nutrient export and drainage impacts on the wetland on site and adjacent river environment. Potential impacts to surface water quality during construction phase.	Develop and implement a Drainage, Nutrient Irrigation and Water Quality Management Plan (DNIWQMP) to the satisfaction of the SRT and DoE, to include but not be limited to: • Design and construct the detention/infiltration basin; • Periodic monitoring of the infiltration basin (post-construction) to ensure continued function and maintenance as required; • Maximising infiltration of uncontaminated stormwater at sources to recharge the groundwater system; • Water conservation principles;

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				• Nutrient control; • Prescribed fertilizer applications for areas of POS; • Determination of flushing requirements, associated impacts and management options; • Treating contaminated stormwater via gross pollutant and sediment traps; • Directing treated stormwater into the Canning River along the south-eastern corner boundary of the site (as per DoE advice); • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.
Groundwater Quality	Groundwater below the site and down hydraulic gradient for a distance of 200m from the subject site.	To ensure emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Potential unacceptable health and environmental impacts associated with the disturbance and development of contaminated groundwater on site.	Develop and implement a Groundwater Management Plan as a component of the CEMP to the satisfaction of the DoE, that will include but not be limited to: • Determining the nature and extent of groundwater contamination; • Groundwater flow characteristics; and • Groundwater contamination plume management. Develop a Dewatering Program as a component of the CEMP to the satisfaction of the DoE to determine the potential impacts of dewatering during the construction phase on the vegetation within the wetland areas, Canning River and groundwater quality.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				Prior to commencing any dewatering, the proponent or their chosen contractor will apply for and obtain from the DoE a 'Licence to Take Water'. All dewatering will be carried out in accordance with the conditions of the 'Licence to Take Water'. Should the dewatering activities require water to be discharged offsite, the proponent (or contractor) shall apply to the DoE for a 'Disposal Licence'. Any discharge of water offsite shall be carried out in accordance with the 'Disposal Licence'.
Noise	The subject area, surrounding residential area including nearest residences.	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	The nearest noise sensitive premise is located approximately 50m east of the site boundary. Noise can be generated at the site by the operation of construction equipment including mobile earthmoving equipment. Construction noise may impact on the health, welfare and amenity of nearby existing residents. Noise received at future residences located adjacent to the northern and eastern boundaries of the development site will receive noise from vehicles travelling along Manning Road and Centenary Avenue. Transport noise can impact on the health, welfare and amenity of future residents.	Construction noise received at existing residences opposite the proposed development will need to comply with the requirements of the *Environmental Protection (Noise) Regulations 1997* specifically Regulation 13 "Construction sites". To ensure noise emissions from construction activities comply with the regulations Construction Noise Management Procedures will be developed and implemented within the CEMP and to the satisfaction of the DoE and City of South Perth. In relation to road noise, any noise reduction required by building construction can be achieved, amongst others, by any or all of the following measures: • Construction of noise barriers between the roadway and residential lots; • Specification of construction methods and

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				materials (in keeping with "quiet house design" principles); and • Appropriate setbacks from existing roadways.
Dust	The subject area, surrounding residential area including nearest residences.	To protect the surrounding land users such that dust and particulate emissions will not adversely impact on their welfare and amenity or cause health problems in accordance with EPA's *Guidance Statement No. 18 Prevention of Air Quality Impacts from Land Development Sites*.	The nearest dust sensitive premise is located approximately 50m east and 150m north-east of the site boundary. Dust may be generated at the site by the operation of construction equipment including mobile earthmoving equipment. Dust may impact on the health, welfare and amenity of nearby existing residents.	Dust will be controlled so as to comply with the requirements of the EPA's Guidance No. 18: *Prevention of Air Quality Impacts from Land Development Sites*. Construction Dust Management Procedures will be developed and implemented within the CEMP, to the satisfaction the DoE. These will include, but are not limited to: • Watering of exposed surfaces; • Minimising working surfaces at any one time; • Wind fencing; and • Progressive stabilisation of disturbed areas (eg hydromulching).
Soil Quality	Subject site (approx. 18ha)	To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use and consistent with appropriate criteria.	For environmental or health impacts to occur, it is necessary that both the concentration of the contaminant is sufficient to cause on impact on a receptor and an exposure pathway exists which brings the contaminant in contact with the receptor. The nature of the contaminants detected in soils on the subject land (predominantly metals and asbestos) is such that the predominant pathways of concern are inhalation and ingestion.	Areas of soil identified as contaminated in excess of EIL criteria will be excavated and the base and walls of the excavations validated in accordance with relevant DoE Guidelines for the Remediation of Contaminated Land (DEP, 2001, a, b and c). The excavated soil will then be assessed to determine the appropriate management option. The currently preferred management option for excavated soils is disposal off-site but a final decision on the management of excavated

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				contaminated soils will be made once analytical results are available for excavated soil. An alternative that may be considered is to screen the material to remove geotechnically unsuitable materials and then re-use the material as fill in appropriate areas on the site such as POS. Approval will be sought from the DoE before re-using excavated soils in this manner. A detailed remediation assessment report will be submitted to DoE on conclusion of remediation works that provides detailed information on: • The remediation strategy implemented; • The results of validation and stockpile sampling; and • Details of the management of all contaminated material.
Acid Sulfate Soils	Subject site (approx.18ha)	Plan and manage development that may potentially impact on ASS to avoid adverse effects on the natural and built environment and human activities and health.	There is the potential for acid sulfate soils to be present within the site as a result of ground disturbance associated with the proposed development.	Develop and implement an Acid Sulfate Soil Management Plan as a component of the CEMP and to the satisfaction of the DoE that will include but not be limited to: • The area of PASS soils to be disturbed by excavation or dewatering will be minimised as far as possible; • Where ASS must be disturbed: - Earthworks will be completed as quickly as possible to minimise the time that the walls and base of excavations are exposed to the atmosphere;

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				- Un-neutralised ASS/PASS will be stored for only limited periods on on-site bunded hardstand areas constructed from alkaline materials; - The quality of groundwater and dewatering effluents will be monitored regularly to ensure early detection of any alteration in water chemistry; and - if necessary dewatering effluent will be treated to ensure appropriate water quality is maintained; and • Where excavated soils must be directed for off-site disposal, they will be directed to a site approved for acceptance and/or treatment of ASS by the DoE.
SOCIAL				
Aboriginal Heritage	Subject site (approx. 18ha).	To ensure changes to the biophysical environment resulting from the proposal does not adversely affect historical and cultural associations within the area and comply with the requirements of relevant Aboriginal and heritage legislation.	Proposed modification/clearing to wetland/adjacent site identified as having general significance.	Provisions of the *Aboriginal Heritage Act 1972* will be complied with. The proponent will apply for clearance under Section 18 of the Act to remove both previously recorded sites and any new sites that emerge as a result of earthmoving procedures located within the site that will be impacted by the proposed development. The proponent will also undertake further archaeological investigations if required as part of the Section 18 clearance. Such investigations may include, but not be limited to: • Surface recording, mapping and collection of archaeological material; • Archaeological excavation and/or sub-

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Proposed Management
				surface evaluation; • Recovery of samples for radiometric dating; and • Analysis of recovered material.

TABLE A2
EAST CLONTARF RESIDENTIAL DEVELOPMENT
SUMMARY TABLE OF PROPONENTS COMMITMENTS

	Topic	Objective	Action	Timing	Advice
1.	Construction Management	To protect the remnant wetland vegetation identified for protection within *Bush Forever* adjoining the development from potential impacts associated with construction. To minimise (direct and indirect) impacts associated with the construction of the residential development and surrounds on fauna, surface and groundwater quality and quantity and local residents.	The proponent and contractors will prepare a Construction Environmental Management Plan (CEMP) which addresses: • Dewatering Program; • Detailed Remediation Assessment of Contaminated Soils; • Acid Sulfate Soils Management Plan; • Construction Noise Management Procedures; and • Construction Dust Management Procedures.	Prepared and approved prior to construction and implemented during construction. Audits to be completed during construction works and post-construction.	Bush Forever Office (DPI) City of South Perth DoE
2.	Construction Management	As for Commitment 1.	The proponent and contractors will implement the CEMP.	During design and construction.	Bush Forever Office (DPI) City of South Perth DoE
3.	Foreshore Management	To protect the conservation values identified for protection within the development adjacent to the Canning River foreshore. To mitigate proposed clearing within the development and enhance linkages and habitat value.	The proponent will develop a detailed Foreshore Management Plan that will include but not be limited to: • Comprehensive weed eradication program; • Revegetating and restoring foreshore POS adjoining conservation areas with appropriate indigenous flora of the Canning River; • Increase the area contained within POS adjoining Bush Forever Site No. 333; • Creation of habitat and wildlife corridors; • Controlling vehicle and pedestrian access;	Preparation prior to construction.	Bush Forever Office (DPI) Swan River Trust City of South Perth

	Topic	Objective	Action	Timing	Advice
			• Provision of public facilities; • Soil and plant source material hygiene; • Fire management including provision of fire hydrants; • Provision of educational and interpretative materials within the area to raise awareness of JAMBA/CAMBA species that frequent the area; • Encouraging community involvement and awareness promoting control of pets (eg cats and dogs); • Water conservation principles; • Monitoring criteria to determine the success of the revegetation and weed eradication program; • Progress and compliance reporting; and • Timing and implementation schedule.		
4.	Foreshore Management	As for Commitment 3.	The proponent will implement the Foreshore Management Plan.	Implementation to be as per determined in Schedule within the Foreshore Management Plan.	Bush Forever Office (DPI) City of South Perth Swan River Trust
5.	Wetland Management	To minimise impacts on wetlands and to offset any wetland impacts to ensure no net loss of function or value.	The proponent will develop a Wetland Management Plan that will include but not be limited to: • Identification of existing wetland area to be retained; • Avoiding direct and minimising indirect impacts on the wetland; • Ensuring no net loss of wetland values and functions; • Rehabilitation techniques to be employed; • Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats; • Mitigation strategies for loss of any vegetation will be investigated including both on-site and off-site options; • Creation of a new Paperbark/Flooded Gum wetland	Preparation prior to construction.	DoE

	Topic	Objective	Action	Timing	Advice
			area to be located adjacent to the existing wetland and the river foreshore and planted with tree, understorey sedge and shrub species common to the local riverine and wetland environment; • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.		
6.	Wetland Management	As for commitment 5.	The proponent will implement the Wetland Management Plan.	Implementation to be as per determined in Schedule within the Wetland Management Plan.	DoE
7.	Groundwater Management	To ensure emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Develop a Groundwater Management Plan as a component of the CEMP to the satisfaction of the DoE, that will include but not be limited to: • Determining the nature and extent of groundwater contamination; • Groundwater flow characteristics; and • Groundwater contamination plume management. Develop a Dewatering Program as a component of the CEMP to the satisfaction of the DoE to determine the potential impacts of dewatering during the construction phase on the vegetation within the wetland areas, Canning River and groundwater quality. Prior to commencing any dewatering, the proponent or their chosen contractor will apply for and obtain from the DoE a 'Licence to Take Water'. All dewatering will be carried out in accordance with the conditions of the 'Licence to Take Water'.	Preparation of Groundwater Management Plan and Dewatering Program prior to construction.	

	Topic	Objective	Action	Timing	Advice
			Should the dewatering activities require water to be discharged offsite, the proponent (or contractor) shall apply to the DoE for a 'Disposal Licence'. Any discharge of water offsite shall be carried out in accordance with the 'Disposal Licence'.		
8.	Groundwater Management	As for Commitment 7.	Implement the Groundwater Management Plan and Dewatering Program.	Implementation as per Plan/Program.	
9.	Drainage, Nutrient, Irrigation and Water Quality Management	To maintain acceptable water quality within the wetland and the Canning River. To ensure that no road surface run-off directly enters the wetland. To ensure that there is provision for contaminant spillage entrapment.	The proponent will prepare a Drainage, Nutrient, Irrigation and Water Quality Management Plan (DNIWQMP) that will include but not be limited to: • Design and construct the detention/infiltration basin; • Periodic monitoring of the infiltration basin (post-construction) to ensure continued function and maintenance as required; • Maximising infiltration of uncontaminated stormwater at sources to recharge the groundwater system; • Water conservation principles; • Nutrient control; • Prescribed fertilizer applications for areas of POS; • Determination of flushing requirements, associated impacts and management options; • Treating contaminated stormwater via gross pollutant and sediment traps; • Directing treated stormwater into the Canning River along the south-eastern corner boundary of the site (as per DoE advice); • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.	Preparation prior to construction.	DoE SRT

	Topic	Objective	Action	Timing	Advice
10.	Drainage Nutrient Irrigation and Water Quality Management	As for Commitment 9.	The proponent will implement or require the implementation of the DNIWQMP.	Implementation to be as per determined in Schedule within the DNIWQM Plan.	DoE
11.	Site Contamination Assessments	To determine nature and extent of any soil or groundwater contamination present within the site which may pose a risk to human health or the environment.	Areas of soil identified as contaminated in excess of EIL criteria will be excavated and the base and walls of the excavations validated in accordance with relevant DoE Guidelines for the Remediation of Contaminated Land (DEP, 2001, a, b and c). The excavated soil will then be assessed to determine the appropriate management option. The currently preferred management option for excavated soils is disposal off-site but a final decision on the management of excavated contaminated soils will be made once analytical results are available for excavated soil. An alternative that may be considered is to screen the material to remove geotechnically unsuitable materials and then re-use the material as fill in appropriate areas on the site such as POS. Approval will be sought from the DoE before re-using excavated soils in this manner. A detailed remediation assessment report will be submitted to DoE on conclusion of remediation works that provides detailed information on: • The remediation strategy implemented; • The results of validation and stockpile sampling; and • Details of the management of all contaminated material.	Prior to site works in areas identified in the DSI as potentially contaminated.	Land and Water Quality, DoE
12.	Water Conservation Principles	Water is an important public resource and availability within	Water conservation measures are recognised by the proponent as important design elements and will be applied	To be considered within preparation of the Foreshore	DoE

	Topic	Objective	Action	Timing	Advice
		the Perth Metropolitan Area is limited.	within the development. These include but are not limited to: • Promoting the use of plant species that have low water and fertiliser requirements; • Utilising local native plant varieties in landscaping; • Considering re-injection of stormwater into the superficial aquifer; • Promoting landscape treatments sympathetic to climatic conditions and prevailing site conditions – soil types, topography, environment, wetlands etc.; • Utilising "cluster or clump" plantings to provide useable shade areas and better use of reticulated water in preference to single item or symmetrical planting regimes; • Irrigating POS areas at appropriate time so as to reduce evaporative loss and minimise transpiration losses; and • Ensuring the irrigation regime applied to areas of POS is responsive to prevailing weather conditions.	Management Plan, Groundwater Management Plan and the DNIWQMP (Commitments 3 and 9).	
13.	Noise	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	Noise impacts from construction activities will comply with the requirements of *the Environmental Protection (Noise) Regulations 1997*. Noise Management Procedures will be developed for the site as part of the overall CEMP (see Commitments 1 and 2). Measures to minimise noise levels received by proposed residences within the development from existing roadways will include but not be limited to: • Construction of noise barriers between the roadway and residential lots;	Prepared and approved prior to construction. Implemented during construction. Audits completed during construction works and post-construction.	DoE City of South Perth

	Topic	Objective	Action	Timing	Advice
			• Specifying appropriate setbacks of proposed residences from existing roadways; and • Specification of construction methods and materials (in keeping with "quiet house design" principles).		
14.	Dust	To protect the surrounding land users such that dust and particulate emissions will not adversely impact on their welfare and amenity or cause health problems in accordance with the EPA's Guidance Statement No. 18: Prevention of Air Quality Impacts from Land Development Sites.	Dust generated during construction will be minimised by the application of EPA guidelines and best practice in dust suppression. Dust Management Procedures will be developed for the site as part of the overall CEMP (see Commitments 1 and 2). Measures to minimise dust levels will include but not be limited to: • Watering of exposed surfaces; • Minimising working surfaces at any one time; and • Progressive rehabilitation of disturbed areas.	Prepared and approved prior to construction. Implemented during construction. Audits to be completed during construction works and post-construction.	DoE
15.	Acid Sulfate Soil (ASS)	To plan and manage development that may potentially impact on ASS to avoid adverse effects on the natural and built environment and human activities and health.	Develop an Acid Sulfate Soil Management Plan as a component of the CEMP to the satisfaction of the DoE that will include but not be limited to: • The area of PASS soils to be disturbed by excavation or dewatering will be minimised as far as possible; • Where ASS must be disturbed: - Earthworks will be completed as quickly as possible to minimise the time that the walls and base of excavations are exposed to the atmosphere; - Un-neutralised ASS/PASS will be stored for only limited periods on on-site bunded hardstand areas constructed from alkaline materials; - The quality of groundwater and dewatering effluents will be monitored regularly to ensure	Prior to commencement of any earthworks or dewatering in areas identified as having potential for Acid Sulfate Soils.	Land and Water Quality, DoE

	Topic	Objective	Action	Timing	Advice
			early detection of any alteration in water chemistry; and - if necessary dewatering effluent will be treated to ensure appropriate water quality is maintained; and • Where excavated soils must be directed for off-site disposal, they will be directed to a site approved for acceptance and/or treatment of ASS by the DoE.		
16.	Acid Sulfate Soil (ASS)	As for Commitment 15.	Implement the Acid Sulfate Soil Management Plan.	During construction.	Land and Water Quality, DoE
17.	Archaeological Investigations	To fulfil the requirements stipulated on the Section 18 clearance of the *Aboriginal Heritage Act 1972.*	The proponent will apply for clearance under Section 18 of the *Aboriginal Heritage Act 1972* to remove both previously recorded sites and any new sites that emerge as a result of earthmoving procedures located within the site that will be impacted by the proposed development. The proponent will also undertake further archaeological investigations if required as part of the Section 18 clearance. Such investigations may include, but not be limited to: • Surface recording, mapping and collection of archaeological material; • Archaeological excavation and/or sub-surface evaluation; • Recovery of samples for radiometric dating; and • Analysis of recovered material.	Site Heritage Protocol prepared prior to commencement of construction and implemented during construction, with any statutory processes followed as per the requirements of the *Aboriginal Heritage Act 1972*.	DIA

List of Abbreviations: DoE = Department of Environment
SRT = Swan River Trust
DIA = Department of Indigenous Affairs

1. INTRODUCTION

1.1 Project Background

The Trustees of the Christian Brothers propose to develop a residential estate at East Clontarf. The Clontarf site is located approximate 8km south of the Perth Central Business District and is bound by Manning Road to the north, Centenary Avenue to the east, the Canning River to the South and the Waterford Estate to the west (Figure 1).

The total area of the site is approximately 32ha comprising three distinct parts, all of which are the subject of the Clontarf Subdivision Application. In summary, the Project's components area:

- Clontarf Campus – the central and central-western portions of the site combining the existing Clontarf Campus buildings;
- Canning River Foreshore – extending along the southern boundary of the Project Area; and
- East Clontarf – the eastern portion of the site, to be the subject of residential subdivision.

This PER document deals specifically with the latter two components: Canning River Foreshore and East Clontarf.

1.2 The Proponent

The proponent for the proposed subdivision of:

- Lot 500: Vol 2222; Folio 237; Deposited Plan 30878; 10.8067ha
- Portion of Lot 501: Vol 2222; Folio 238; Deposited Plan 30878; 14.1730ha
- Lot 829: Vol 2048; Folio 180; Deposited Plan 88770; 1.4526ha
- Lot 83: Vol 2048; Folio 181; Deposited Plan 2461; 5.21ha

in the City of South Perth, is the Trustees of the Christian Brothers in Western Australia Incorporated.

Contact details for the proponent are as follows:

Trustees of the Christian Brothers in Western Australia Incorporated
c/- Richard Noble & Company
Level 10
200 St Georges Terrace
Perth WA 6000

Point of Contact: Mr Alex Gregg
Phone: (08) 9321 7562

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

1.3 Statutory Requirements

In addition to meeting the requirements of the *Environmental Protection Act 1986*, the Trustees of the Christian Brothers in developing the East Clontarf site are required to comply with, amongst others, any or all of a number of Acts of Parliament and Regulations at the State or Commonwealth level as listed below. A brief description of some of the more relevant legislation (bolded) for this proposal is also given.

Aboriginal Heritage Act 1972;
Australian Heritage Commission Act;
Conservation and Land Management Act 1994;
Environment Protection and Biodiversity Conservation Act, 1999 (Commonwealth)
Environmental Protection Act 1986
Environmental Protection (Noise) Regulations 1997;
Heritage of Western Australia Act 1990;
Local Government Act;
Occupational Health, Safety and Welfare Act 1984-1987;
Water and Rivers Commission Act 1995; and
Wildlife Conservation Act 1950-1980.

Aboriginal Heritage Act 1972

The purpose of this legislation that is regulated and enforced by the Department of Indigenous Affairs, is to protect relics and significant areas of land from undue interference, while at the same time leaving traditional Aboriginal cultural rights in relation to such objects or areas unaffected, in so far as they are not inconsistent with the provisions of the Act.

The Act establishes the Aboriginal Cultural Material Committee. The Aboriginal Cultural Material Committee (ACMC) provides advice for the assessment of Section 18 Notices which developers are obliged to submit so the ACMC can determine whether or not an Aboriginal site should be disturbed by the development. The ACMC makes a recommendation to the Minister for Indigenous Affairs who makes the final decision as to whether consent for a development should be granted. Sacred beliefs and ritual or ceremonial usage are to be the primary considerations in the evaluation of places under the Act.

The Act also permits the Trustees of the Western Australia Museum to delegate their powers and duties for the care and protection of sites and objects to a representative group of Aboriginal people whom have a traditional interest in the place.

Conservation and Land Management Act 1994

The purpose of this Act, regulated by the Department of Conservation and Land Management (CALM), is to "make better provision for the use, protection and management of certain public lands and waters and the floras and fauna thereof, to establish authorities to be responsible therefor, and for incidental or connected purposes".

The Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

The *Environment Protection and Biodiversity Conservation Act, 1999* (Commonwealth) established a legislative framework to enable the Commonwealth to deal with current and emerging issues and allow Australia to meet the environmental challenges of the twenty-first century.

The Act provides protection for matters of National Environmental Significance (NES). These are:

- World Heritage properties;
- RAMSAR wetlands of international importance;
- Nationally threatened animal and plant species and ecological communities;
- Internationally protected migratory species;
- Commonwealth marine areas; and
- Nuclear actions.

Environment Australia and the Commonwealth Environment Minister administer this Act.

In relation to the assessment of the impact of proposals, it remains that generally the responsibility for environmental protection lies with the States and the Government of the Northern Territory. However, the power of the States to legislate is effectively curtailed only by the existence of conflicting Commonwealth legislation. Particular Commonwealth powers, which may be used to promote environmental objectives, include those relating to trade and commerce, taxation, external affairs, corporations and “people of any race”. All of these are written into S51 of the Constitution.

A joint assessment process between responsible State and Federal Government authorities may be initiated if, due to the nature of the proposal, the Commonwealth has jurisdiction, but it is not proposed for Commonwealth lands. This may be the case, for example, when funding for the proposal requires approval of the Foreign Investment Review Board, thus triggering S51 (20) of the Constitution - the Corporations Power, or if implementation of the proposal may impact on components of the environment where Australia has entered into international agreements.

The procedure for joint assessments is identified in the document *Basis for a National Agreement on Environmental Impact Assessment.* These joint assessments generally take the form of the local state process, following which the Commonwealth publishes its own report. The lead Commonwealth Agency in a joint assessment is Environment Australia.

Environmental Protection Act 1986

This Act, administered by the Department of Environmental Protection, provides for an Environmental Protection Authority that has powers for preventing, controlling and abating environmental pollution. It also provides for conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the above. The Act establishes head powers to provide mechanisms for the development of Environmental Protection Policies, the referral and assessment of proposals (Environmental Impact Assessment), the control of pollution and enforcement.

The most relevant functions of the Act are to control the review of environmental impacts of proposed developments and to control pollution. The Act binds the Crown and it prevails over other State legislation with the exception of State Agreement Acts, which received Royal ascent before 1 January 1972.

Health Act 1911 and Regulations

The objective of this Act is to consolidate the law relating to Public Health. The Act is administered by the relevant Minister, and each local Government is authorised and directed to carry out the provisions of the Act in its' district.

The Act contains far-reaching provisions on a wide range of matters, which are divided into parts: Sanitary Provisions (Part 5), Dwellings (Part 6), Public Buildings (Part 7), Nuisances and Offensive Trades, Animal Produce, Drugs, Medicines, Disinfectants, Therapeutic Substances and Pesticides (Part 7A), Food (Part 8) and various Disease, Hospital and Medical related provisions (Parts 9-13).

Water and Rivers Commission Act 1995

The Water and Rivers Commission administers the *Water and Rivers Commission Act 1995* to ensure that the State's water resources are managed to support sustainable development and conservation of the environment, for the long-term benefit of the community.

Wildlife Conservation Act 1950-1979

The *Wildlife Conservation Act 1950-1979* provides for the "conservation and protection of wildlife" and is administered by the Department of Conservation and Land Management.

Native flora and fauna are 'protected' under the provisions of Section 14 of the Act. The Act provides penalties for taking protected flora or fauna unlawfully. It also contains provisions for the declaration of species as "rare or likely to become extinct" (ie, endangered). "Fauna" is defined as meaning any animal indigenous to any State or Territory of the Commonwealth or the territorial waters thereof (ie, it includes fish), and "flora" as any plant, which is native to the State. Prior to passage of the *Conservation and Land Management Act* 1984, responsibility for wildlife management and management of nature reserves was held by the Fisheries and Wildlife Development Proposals (Part 8).

1.4 Relevant Environmental Factors

The environmental factors relevant to this PER have been identified in the Scoping Document approved by the EPA in October 2003 (ATA Environmental, 2003) and are identified as follows:

- Vegetation
- Significant Flora
- Fauna
- Significant Fauna
- Foreshore
- Wetlands
- Surface water Quality
- Groundwater Quality
- Soil Quality
- Acid Sulphate Soils
- Noise
- Dust
- Aboriginal Heritage

These environmental factors have provided a framework against which the structure and scope of this PER document has been written. Each of the relevant environmental factors has been individually addressed in Section 3 of this PER document. Table 1 includes an summary of the potential impacts, additional investigations required to be undertaken and proposed management as determined in the Scoping Document for each of the environmental factors previously identified for the site at East Clontarf (ATA Environmental, 2003c).

1.5 Previous Studies

The redevelopment of Clontarf has been under discussion by the Trustees of the Christian Brothers since 1999. As a result, a series of studies have been completed to date. These include:

- East Clontarf, Manning – Report on Geotechnical Studies (Coffey, 2000).
- Archaeological and Ethnographic Studies (Thomas O'Reilly and Macintyre Dobson and Associates, 2000).
- Environmental Assessment East Clontarf, Manning (ATA Environmental, 2001)
- Clontarf Subdivision Application (Development Planning Strategies (Development Planning Strategies, 2002).
- Detailed Soil/Groundwater Contamination and Preliminary Acid Sulphate Soils Investigation Sampling and Analysis Program (ATA Environmental, 2002a).
- Preliminary Assessment – Asbestos Contamination (ATA Environmental, 2002b).
- Remediation Report Asbestos Contamination Clontarf Aboriginal College, Manning (ATA Environmental, 2002c).
- East Clontarf Hydrological Investigation (JDA Consultant Hydrologists, 2004).
- Preliminary Acid Sulfate Soil Investigation, East Clontarf, Waterford (ATA Environmental, 2003a).

- Detailed Soil and Groundwater Investigation, East Clontarf, Waterford (ATA Environmental, 2003b).
- Clontarf Residential Subdivision, Waterford – Public Environmental Review Environmental Scoping Document Assessment No. 1467 (ATA Environmental, 2003c).
- East Clontarf Project Heritage Impact Statement (Hocking Planning and Architecture, 2003).

TABLE 1
RELEVANT ENVIRONMENTAL FACTORS

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
Biophysical					
Vegetation	Subject site (approx. 18ha)	To maintain the abundance, diversity, geographic distribution and productivity of vegetation communities.	Development will involve clearing approximately 1.57ha of native and exotic wetland vegetation.	No further investigations proposed.	Retention of small stands of dryland remnant vegetation. Management of this area to maintain/enhance values. Approximately 4ha of wetland vegetation will be retained and rehabilitated. Develop and implement a Wetland Management Plan as a component of the CEMP to the satisfaction of the WRC including but not limited to procedures to maintain and enhance wetland vegetation. Areas of vegetation not proposed to be cleared will be flagged and specifically identified in site inductions. Mitigation strategies for loss of any vegetation will be investigated including both on-site and off-site options.
Significant Flora	Subject site (approx. 18ha)	To protect Declared Rare and Priority Flora	No loss of, or disturbance to, any species of Declared Rare and	A spring flora survey has been completed. No further	Areas of vegetation not proposed to be cleared will be

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
		consistent with the provisions of the Wildlife Conservation Act 1950. Protect other flora of conservation significance.	Priority Flora on site.	investigations proposed.	flagged and specifically identified in site inductions.
Fauna	Subject site (approx. 18ha) and adjacent river	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Habitat loss associated with vegetation/wetland clearing and/or modification. Rehabilitation and revegetation has the potential to create additional habitat and may strengthen the linkage between the wetland and Clontarf Bay.	An assessment of the value and significance of the area to fauna at the local and broader level. This will include: • An assessment of the linkage between the foreshore habitat of nearby Bush Forever Sites 227 & 224. • An assessment of the use of the habitats by birds and the role of the site as an ecological linkage to other sites in the region. • An assessment of the significance of the site for birds included in the JAMBA/CAMBA Agreements. • An assessment of the potential impacts on waterbirds in the Canning River, particularly Black Swans. • Further assessment on the significance of frogs and additional site	Regionally significant vegetation recognised for protection in Bush Forever/foreshore area to be protected from this development and appropriately managed to protect its values. River foreshore vegetation and fauna corridor to be maintained and habitat connection between river and wetland to be enhanced. Modification and rehabilitation of the wetland with local wetland and dryland species to maintain and enhance existing habitats. Develop a Wetland Management Plan as a component of the CEMP to the satisfaction of the WRC, that will include but not be limited to: • Selection of appropriate local wetland and dryland species to

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
				survey for reptiles on the site.	maintain and enhance existing habitats.
Significant Fauna	Subject site (approx. 18ha)	Protect Specially Protected (Threatened) Fauna and Priority Fauna species and their habitats, consistent with provisions of the *Wildlife Conservation Act 1950.*	No Specially Protected or Priority fauna was recorded within the site. Potential habitat impacts for several Significant Birds as identified in Bush Forever and species listed under JAMBA/CAMBA agreements occur within or adjacent to the site.	Fauna surveys have already been completed. No further surveys proposed.	Develop and implement a Foreshore Management Plan as a component of the CEMP to the satisfaction of the SRT, DPI and City of South Perth, that will include but not be limited to: • Protection of the riverine environment as part of the development; and • To retain or improve habitats for significant fauna species.
Foreshore	The Canning River foreshore reserve area (Bush Forever Site No. 333) forming the site's southern boundary.	To maintain the integrity, ecological functions and environmental values of the foreshore environment.	Potential indirect impacts include the introduction of further weeds during construction activities and an increased use of the area by both residents and visitors potentially resulting in trampling of vegetation and disturbance of fauna.	No further investigations are required.	The proposed development includes an additional setback (~6000m^3) resulting in an overall increase in foreshore area protecting on-site samphire vegetation. Develop and implement a Foreshore Management Plan as a component of the CEMP to the satisfaction of the SRT, DPI and City of South Perth, that will include but not be limited to: • Protection of the riverine environment as part of the development; and

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
					• To retain or improve habitats for significant fauna species. .
Wetland	Wetland protected by EPP and mapped as Conservation category by WRC, Canning River and foreshore environment.	To maintain the integrity, ecological functions and environmental values of the wetlands environment.	Project will result in no net loss of native wetland vegetation.	Investigations are currently in progress to define the water balance and flows within and between the wetland and the river. Wetland vegetation and boundaries have been mapped/assessed and have been submitted to WRC for ratification. No further investigations proposed.	The wetland will be revegetated using indigenous species of local provenance. Any proposed modifications to the wetland will ensure that the water balance, hydrological regime and flow rates will not be adversely altered. Develop and implement a Wetland Management Plan as a component of the CEMP to the satisfaction of the WRC, that will include but not be limited to: • Identification of wetland area to be retained; • Avoiding direct and minimising indirect impacts on the wetland; • Ensuring no net loss of wetland values and functions; and • Rehabilitation techniques to be employed.
Pollution Management					

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
Surface water quality	Water contained within and entering the wetland, and entering the river from the site.	To ensure emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Residential development and proposed wetland modifications may temporarily interrupt or alter current water balance, water quality and flow rates within the wetland. Potential adverse nutrient export and drainage impacts on the wetland on site and adjacent river environment. Potential impacts to surface water quality during construction phase.	Identification of mechanisms and processes by which contaminants are filtered from the water within the wetland. The impact of proposed dewatering on the wetland. Affect of the removal of weed species and creation of open water sections within the wetland on the filtration functions and current water balance. Potential for contaminant and nutrient release from sediments during the recontouring of the wetland. Impact of the proposed method of stormwater drainage of the subdivision on the current water balance of the wetland.	Develop and implement a Drainage and Nutrient Management Plan (DNMP) to the requirements of the SRT and the WRC to include but not be limited to: • Maximise infiltration of uncontaminated stormwater at source to recharge the groundwater system; • Treat contaminated stormwater via gross pollutant and sediment traps; • Direct treated stormwater into the Canning River along the south-eastern corner boundary; • Nutrient management strategies; • Recommendations for plant species in landscaping; and • Prescribed fertilizer applications on areas of POS. Stormwater will be treated prior to discharge into the river as per WRC advice. A dewatering program will be

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
					developed as part of a CEMP to minimise the potential impacts of dewatering during the construction phase on the surface water quality entering the Canning River.
Groundwater quality	Groundwater below the site and down hydraulic gradient for a distance of 200m from the subject site.	To ensure emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Potential unacceptable health and environmental impacts associated with the disturbance and development of contaminated groundwater on site.	Investigations will be undertaken to determine the nature and extent of groundwater contamination beneath the site in accordance with DEP criteria and guidelines.	Potential limitations on private and public bore use within the development. Water conservation measures are recognised as important design elements and will be applied within the development. These include, but are not necessarily limited to, the following: • Promoting the use of plant species that have low water and fertiliser requirements; • Promoting landscape treatments sympathetic to climatic conditions and prevailing site conditions; • Irrigating POS grass and garden areas at appropriate times; • Ensuring the irrigation regime is responsive to prevailing weather conditions.
Noise	The subject	To protect the amenity of	The nearest noise sensitive premise	Noise modelling will need to be	Construction noise received at

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
	area, surrounding residential area including nearest residences.	nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	is located approximately 50m east of the site boundary. Noise can be generated at the site by the operation of construction equipment including mobile earthmoving equipment. Construction noise may impact on the health, welfare and amenity of nearby existing residents. Noise received at future residences located adjacent to the [direction] boundary of the development site will receive noise from vehicles travelling along Manning Road and Centenary Avenue. Transport noise can impact on the health, welfare and amenity of future residents.	undertaken to assess predicted noise levels received along the northern and eastern boundaries of the proposed residential development. Identify abatement methods to be incorporated into housing design.	existing residences opposite the proposed development will need to comply with the requirements of the *Environmental Protection (Noise) Regulations* 1997. To ensure noise emissions from construction activities comply with the regulations; noise management will be incorporated into the CEMP for the site. In relation to road noise, any noise reduction required by building construction can be achieved, amongst others, by any or all of the following measures: • Construction of noise barriers between the roadway and residential lots; and • Specification of construction methods and materials (eg double brick construction).
Dust	The subject area, surrounding residential area including nearest residences.	To protect the surrounding land users such that dust and particulate emissions will not adversely impact on their welfare and amenity or cause health problems in accordance	The nearest dust sensitive premise is located approximately 50m east and 150m north-east of the site boundary. Dust can be generated at the site by the operation of construction		The impact of dust resulting from construction activities will be managed according to industry best practice and in accordance with applicable government regulations.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
		with EPA's *Guidance Statement No. 18 Prevention of Air Quality Impacts from Land Development Sites*.	equipment including mobile earthmoving equipment. Dust may impact on the health, welfare and amenity of nearby existing residents.		Dust will be controlled so as to comply with the requirements of the EPA's Guidance No. 18: *Prevention of Air Quality Impacts from Land Development Sites*. Dust generated during construction will be minimised by the application of DoE guidelines. Dust management procedures will be developed within the CEMP, in consultation with the DoE and City of South Perth. These include, but are not necessarily limited to, the following: • Watering of surfaces; • Minimisation of working surfaces at any one time; and • Progressive stabilisation of disturbed areas (eg hydromulching).
Soil Quality	Subject site (approx. 18ha)	To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use and consistent with appropriate criteria.	Potentially unacceptable health and environmental impacts associated with the disturbance/development of contaminated soils on-site.	Consistent with State guidelines, areas of soil identified as contaminated in excess of EIL criteria will be excavated and the base and walls of the excavations validated.	A Site Remediation Plan will be incorporated into the CEMP in accordance with relevant DoE Guidelines for the Remediation of Contaminated Land.
Acid Sulfate	Subject site	Plan and manage	There is the potential for acid	Additional sampling is currently	An Acid Sulphate Soils

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
Soils	(approx. 18ha).	development that may potentially impact on ASS to avoid adverse effects on the natural and built environment and human activities and health.	sulfate soils to be present within the site as a result of ground disturbance associated with the proposed development.	being undertaken to assess the presence and extent of ASS on site.	Management Plan will be developed as part of the CEMP to be prepared for the site in accordance with DEWCP guidelines. The management plan will be implemented throughout the construction phase of the proposed subdivision. The general principles that will be applied will include: • The area of PASS soils to be disturbed by excavation or dewatering will be minimised as far as possible; • Where ASS soils must be disturbed: - Earthworks will be completed as quickly as possible to minimise the time that the walls and base of excavations are exposed to the atmosphere; - Un-neutralised ASS/PASS soils will be stored for only limited periods on site on bunded hardstand areas constructed from alkaline materials; - The quality of groundwater and dewatering effluents will be monitored regularly

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
					to ensure early detection of any alternation in water chemistry; and - if necessary dewatering effluent will be treated to ensure appropriate water quality is maintained.
Social Surroundings					
Aboriginal heritage	Subject site (approx. 18ha).	To ensure changes to the biophysical environment resulting from the proposal does not adversely affect historical and cultural associations within the area and comply with the requirements of relevant Aboriginal and heritage legislation.	Proposed modification/clearing to wetland/adjacent site identified as having general significance.	Investigations have already been conducted. No further investigations proposed.	Provisions of the Aboriginal Heritage Act will be complied with. Planning for the project and subdivision design has been undertaken in consultation with the Nyungar Native Title Claimants for the area. Management measures to enhance Aboriginal involvement with the development will include liaison with the relevant Nyungar representatives in relation to the overall landscaping and enhancement of the wetland. The CEMP will include the following protocols for managing Aboriginal heritage on site: • Induction of all site employees and site subcontractors;

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Proposed Management
					• Management of identified site; • Actions to be taken should further sites be identified.

2. THE PROPOSAL

2.1 Description of the Proposal

In total, the Clontarf project area covers approximately 32ha and includes:

- The undeveloped East Clontarf site;
- Canning River Foreshore; and the
- Clontarf Campus site.

The objectives of the Christian Brother's Clontarf proposal are as follows:

1. To create a separate Clontarf Campus site and transfer it to an Aboriginal ownership group for the protection of heritage buildings and the development of Aboriginal cultural, educational and spiritual groups;

2. To create a residential development on the undeveloped East Clontarf portion of the site thereby permitting funds from the development to be set aside in order to generate recurrent income for the Clontarf Campus and other community outreach programmes operated by the Christian Brothers in Western Australia; and

3. To improve the environmental attributes of the site by rehabilitating the degraded wetland that currently exists on the East Clontarf site and improving the river foreshore environment.

The proposed East Clontarf Residential Subdivision is located on undeveloped land lying between Centenary Avenue to the east, Manning Road to the north and the Clontarf Campus to the west, and covers an area of approximately 18ha. The Clontarf Campus covers an area of approximately 10.8ha encompassing the campus buildings and playing fields.

The Canning River Foreshore has been defined within the MRS. The Clontarf Subdivision Application has adopted the MRS line and will provide the mechanism for ceding this area to the Crown (DPS, 2002).

Planning and design objectives have been defined to achieve the following outcomes (DPS, 2002):

- to draw maximum benefit from existing physical characteristics and provide strong relationships with the Canning River, the wetland area of East Clontarf and the Clontarf Campus buildings;

- to promote interaction and connectivity between East Clontarf and the Clontarf Campus;

- to create strong vistas and view corridors throughout the East Clontarf subdivision area for road users, pedestrians, cyclists and future residents;

- to sensitively and appropriately integrate the existing wetland with proposed future residential estate;
- to facilitate access to, and then appropriate treatments within the Canning River foreshore interface area;
- to retain significant trees wherever possible; and
- to achieve a high quality living environment for future residents.

Specifically, the residential subdivision proposal involves:

1. Creating up to 200 residential allotments.
2. Setting aside approximately 4ha of rehabilitated and re-contoured wetland area in addition to approximately 8000m^2 of public open space (approximately 24% of the developable area of the site).
3. Improving the riparian environment along the Canning River foreshore interface by re-creating habitat that previously existed in the area including constructing a Paperbark wetland adjacent to the river and ensuring the link between the foreshore environment and the inland wetland is maintained.
4. Providing additional protection of the existing Canning River foreshore area by widening the river flats/ foreshore by approximately 6000m^2.
5. Protecting a stand of significant Marri trees on the site.
6. Revegetating and integrating some upland native vegetation between the wetland and the Clontarf Campus buildings.

Consistent with the Clontarf Foreshore Management Plan and MRS reservation, the foreshore area adjoining the MRS Reserve will be protected with the design incorporating controlled access (boardwalks/dual use pathways), vegetation rehabilitation and signage.

The entire Clontarf site has been planned as one entity to ensure integration and appropriate physical and visual connections between residents and open space areas. The design concept for the East Clontarf urban zoned land responds to and draws maximum benefit from the site's natural and physical characteristics. Accordingly, the design aims to provide strong physical and visual connections to and relationships with the Canning River, the wetland area and the Clontarf Campus buildings. In particular, the design promotes interaction and connectivity with the Clontarf Campus. Site analysis work undertaken by consultant landscape architects PlanE has resulted in the integration of these design elements into the final concept plans (as shown in Figures 2, 3 and 4).

Integral elements of the design include the creation of environmental corridors, sensitive integration of the wetland with the proposed residential estate, protection and creation of vistas and view corridors, appropriate treatment of the foreshore interface area and retention of significant trees on site where possible.

In total, approximately 186 lots are proposed for the site of which 184 are residential. Table 2 describes how the Clontarf project area is to be subdivided:

TABLE 2
SITE SUBDIVISION DETAILS

	AREA (ha)
Canning River Foreshore	2.2977
Clontarf Campus including Capel & Christian Brothers houses, excluding the old gym site)	11.2784
East Clontarf	18.0662
TOTAL	**31.6423**

Source: DPS, 2002

The City of South Perth's Town Planning Scheme No. 6 provides for a residential density of R20 across the site allowing for an average lot size of 500m^2 with a minimum of 450m^2. The proposal will achieve this with an average lot size of 480m^2 being achieved.

The City of South Perth has previously indicated support for densities greater than R20 within East Clontarf given its locational advantages (close to transport, community, recreation and education facilities) and in recognition of the quantity of wetland area to be retained, recontoured and rehabilitated. Taking these factors into account, the site has been divided into two halves in terms of minimum lot size and therefore residential density.

On the basis that the area north of the wetland and the Manning Road entry are likely to be constructed first, a minimum lot size of 450m^2 will be provided. It is expected that the group-housing site in the north-eastern corner of the site will ultimately be re-coded to allow a higher density of development to be achieved.

Lot sizes south of the wetland and along the eastern entry point fall below 450m^2 following an R30 recoding request.

Table 3 highlights the residential lot summary reflecting the Clontarf Subdivision Application and the 'ultimate development scenario' in terms of residential density (DPS, 2002).

In keeping with other high quality residential developments, it is proposed that the urban form within East Clontarf will be tightly controlled via guidelines and Detailed Area Plans as specified in the new Residential Design Codes.

TABLE 3
PROPOSED RESIDENTIAL LOT SUMMARY

LOT SIZE	No. of LOTS
300-400m^2 (average 384m^2)	3
400-500m^2 (average 456m^2)	134
500-600m^2 (average 530m^2)	36
600-700m^2 (average 627m^2)	8
700-900m^2 (average 731m^2)	2
Grouped Housing (4366m^2)	1
TOTAL	**184**

Source: DPS, 2002

The proponent is committed to developing a strong working relationship with the City of South Perth so that the design guidelines are developed in a collaborative manner. It is anticipated that these guidelines will influence design elements such as:

- fencing: details such as height, materials, colours, consistency and longevity need to be considered;
- lot access/cross overs: several public access ways and laneway type arrangements are proposed;
- dwelling scale and orientation: dwellings on lots directly abutting parklands will address these public spaces and need to be of an appropriate residential scale. Maximisation of northern sunlight into courtyards will be encouraged;
- overlooking/privacy: given the obvious desire to achieve views of the Canning River or the wetland, consideration will be given to overlooking and privacy within lots; and
- corner lots/dual aspect: minimisation of side fencing to corner lots will be given a priority.

2.2 Vehicular & Pedestrian Movement

Traffic analysis has previously been undertaken by Riley Consulting to ensure that the proposed internal and external road movements are safe and appropriate (DPS, 2002).

In terms of external traffic movement, the East Clontarf site is bound by two major roads namely Manning Road to the north and Centenary Avenue to the east. The two proposed exit/entry points have since been endorsed in terms of safety and sight distances, as required by the standard Main Roads Western Australian policy.

Internal roads have been designed to maximise views and accessibility to the river and wetland areas. Emphasis has been placed on north-south and/or east-west oriented roads to facilitate 'correct' solar aspect into lots and courtyards (DPS, 2002).

The indirect passage of vehicles through the project area is intentional to avoid encouraging motorists from taking a short cut between Centenary Avenue and Manning Road. Several one-way roads are also proposed for the site.

Proposed pedestrian and cycle movement networks have been designed in order for residents to be able to access the Canning River foreshore, circulate and traverse the site's internal wetlands and access external pathway networks. Planned boardwalks and pathways within the wetland area will form the main non-vehicular routes throughout East Clontarf connecting the site into existing and planned regional cycle networks (DPS, 2002). Their location is shown on Figure 3.

2.3 Vistas and View Corridors

The East Clontarf subdivision is proposed to be physically and visually integrated with the Clontarf campus site and has also been designed to optimise the vistas and view corridors through the proposed development towards the Clontarf campus buildings (Hocking Planning and Architecture, 2003).

The Manning Road and Centenary Avenue entries provide views towards the river and Clontarf Chapel respectively. Both entries provide views across the wetland areas that will be recontoured and rehabilitated. In addition to vistas along roads, several pedestrian-only passages have been incorporated to extend views throughout the proposed development.

Evening views toward an 'up-lit' Clontarf Chapel and down along streetscaped, tree-lined roads toward the river will define Clontarf's identity (DPS, 2002).

2.4 Wetland Integration and Treatments

The proposed development aims to sensitively integrate conservation objectives in line with the ecological importance of the East Clontarf wetland with a desire to gain maximum development and social objectives. This will achieve a 'triple bottom line' result, in line with the State Government's objectives for sustainable development in Western Australia.

A range of interface treatments is proposed between the conservation areas and the development. These treatments include direct lot frontage interface involving a boardwalk structure extending over the rehabilitated wetland up to the lot boundary, road frontage, a natural transition to the Canning River foreshore and a steep rise embankment to Clontarf Campus. The dimension of setback of lots from the Foreshore Reserve boundary is approximately 26.1m along the western lots and 41.426m on the eastern side. These areas are subject to survey.

A reduction in the eastern portion of the wetland by approximately 1.57ha and an increase in the newly created wetland areas between the wetland and the river foreshore area of approximately 2.10ha are proposed. The increased western and south-western extent of the new recontoured wetland provides the benefits of

physically separating future homes from the campus whilst at the same time recreating the link between the river and wetland that originally existed.

Interface treatments proposed for the Canning River foreshore will add 6000m^2 of public open space (POS) adjacent to the Foreshore Reserve. This area of POS comprises mostly native salt marsh vegetation and will enable increased protection and expansion of salt-marsh vegetation in this portion of the Canning River.

The Landscape Concept Plan for the site, designed by PlanE the consultant landscape architects for the proponent, is included as Figure 3. All of the design elements discussed above are clearly shown in this figure. A number of cross-sections appear on Figure 3, and in order to create a visual impression of how the Concept Plan will look, these cross-sections have been included on Figure 4.

2.5 Land Status

2.5.1 Ownership and Legal Descriptions

Wholly owned by the Trustees of the Christian Brothers in Western Australia Incorporated, the project area encompasses the following lots (or parts thereof):

- Lot 500: Vol 2222; Folio 237; Deposited Plan 30878; 10.8067ha
- Portion of Lot 501: Vol 2222; Folio 238; Deposited Plan 30878; 14.1730ha
- Lot 829: Vol 2048; Folio 180; Deposited Plan 88770; 1.4526ha
- Lot 83: Vol 2048; Folio 181; Deposited Plan 2461; 5.21ha

2.5.2 Metropolitan Region Scheme (MRS)

With the exception of land along the Canning River foreshore, the project area is zoned 'Urban' under the MRS.

Although currently reserved for 'Parks and Recreation', the foreshore area is currently within the ownership of the proponent. The foreshore reservation, as defined by the MRS, is expected to be ceded to the Crown as a condition of subdivision approval (DPS, 2002).

Manning Road that forms the project area's northern boundary is reserved for 'Other Regional Roads' within the MRS.

2.5.3 City of South Perth – Town Planning Scheme No. 6 (TPS No. 6)

The East Clontarf area is zoned 'Residential R20' under TPS No. 6. The Clontarf Campus is zoned 'Special Use – Private Institution' with an applicable density code of R20. Consistent with the MRS, the foreshore is reserved for 'Parks and Recreation' (DPS, 2002).

2.6 Community Consultation

Extensive community consultation has been undertaken by Estill & Associates Pty. Ltd., on behalf of the proponent, prior to finalising the design concept for the site. Consultation has focused upon native title issues and the associated environmental matters regarding the wetland. In addition, the consultation was undertaken to ensure that, as part of the development, Aboriginal spiritual and cultural links with the site were taken into consideration as well as the aspirations of local residents and other community members.

The Clontarf Community Consultation Report, prepared by Estill & Associates Pty. Ltd., has been included as Appendix 1. The report describes in detail the purpose, rationale, methodology, outcomes and conclusions as a result of the community consultation undertaken by Estill & Associates on behalf of the proponent. Figure 5 summarises the consultation methodology undertaken by Estill & Associates Pty. Ltd. on behalf of the proponent.

2.6.1 Stakeholder Groups

The consultation program has successfully created a good working relationship between the Christian Brothers and Clontarf Development Team with the relevant stakeholders including the following:

State Government Agencies
- Department of Environment
- Water and Rivers Commission
- Swan River Trust
- Department for Planning and Infrastructure
- Bush Forever Office

Local Government
- City of South Perth
- City of Canning

Aboriginal Groups/Individuals
- Clontarf Campus Directors Management Group
- Clontarf Campus Elders Working Party
- Combined Swan River and Swan Coastal Plains Native Title Claims Group
- Other local Aboriginal people including: Cedric Jacobs, Greg and Kelvin Garlett and Ken Colbung

Local Community
- Local Residents
- Environmental Groups
- Other Interest Groups

2.6.2 Issues Arising from Community Consultation

Major issues identified during the course of community consultation included:

- environmental considerations including the preservation and enhancement of the wetland;
- preservation of the Canning River foreshore;
- integration of the development landscape with the Clontarf Campus;
- harmonious integration of the residential development with the river and the wetland;
- safe road access to the development from both the Manning Road and Centenary Avenue entry points; and
- cultural considerations associated with the Native Title Claim with regard to the Canning River and its tributaries.

The outcomes of the consultation showed sufficient stakeholder support for the proponent to proceed with the project. The proponent is committed to providing ongoing information on the progress of the development be made available to the various project stakeholders identified in Section 2.6.1.

2.7 Evaluation of Options

Various development designs were considered during preparation of the proposed residential subdivision plan of the subject site. Alternatives involved greater areas of development, development closer to the river, and over different portions of the site and wetland. Alternative options previously considered will be discussed within the PER document in order to justify the preferred option.

The preferred option proposes to develop the eastern Clontarf landholding in accordance with current zoning and reservations. The selected development option for the subject site has been prepared following a series of workshops and consultation with the Department of Environment, City of South Perth, relevant agencies, Aboriginal community representatives and the public.

2.8 Project Timing

The proposed residential subdivision of land at Clontarf in Waterford was referred to the EPA under Section 38 of the *Environmental Protection Act 1986* in January 2003.

The EPA resolved to formally assess the project on the basis of the potential environmental impacts on the project and set the level of assessment as a Public Environmental Review (PER) (Assessment No. 1467).

A Scoping Document, used to assist the EPA in identifying the work required to ensure that all significant issues are properly considered as part of the EPA's environmental assessment process was prepared in accordance with the *Guide to Preparing an Environmental Scoping Document* (EPA, 2002) and approved in November 2003.

The timing for project implementation is contingent on the completion of the formal approval process of which this PER forms a part. It is the proponent's considered intention to commence on-site earthworks within the Project Area during the 2003-2004 financial year.

3. ENVIRONMENTAL ASSESSMENT

3.1 General Site Description

The East Clontarf site is characterised by a relatively large wetland (~4ha in size) located in the centre of the site (Figure 6). The boundary of the wetland has been significantly modified as a result of past filling operations and the vegetation is currently a mix of native and introduced plants (these issues are discussed in more detail in Sections 3.2 and 3.6).

An excavated channel connecting the wetland to the Canning River is another noticeable and important feature of the site. The Canning River lies adjacent to the southern boundary of the site and has a narrow band of fringing foreshore vegetation.

The remainder of the site has been mostly cleared as a result of past land uses and contains only a relatively few native and introduced trees and shrubs.

The East Clontarf site contains two different landforms. The northern part of the site slopes downwards from Manning Road from an elevation of approximately 9mAHD down to the wetland that lies at an elevation of approximately 2mAHD. The wetland is part of a flat plain lying adjacent to the river. The area between the wetland and the river ranges in elevation from approximately 2.5m - 3mAHD.

A small hill (up to 6mAHD) exists to the south of the wetland near Centenary Avenue. The western boundary of the wetland rises up to an elevation of approximately 6m -7mAHD in the vicinity of the Clontarf Campus. Topographic contours are shown on Figure 6.

The surrounding land uses to the East Clontarf site are residential development to the east, north and north-east, an old landfill site to the south-east, the Clontarf Campus to the west and the Canning River to the south. Manning Road and Centenary Avenue are the major traffic routes in the area.

3.2 Vegetation

3.2.1 EPA Objective

To maintain the abundance, diversity, geographic distribution and productivity of vegetation communities.

3.2.2 Existing Environment

Vegetation Description

Most of the site has been cleared of native vegetation as a result of past land use activities including cattle grazing, community farm, orchard and infilling to potentially create a sports field. An aerial photograph for the site is included as Figure 6 and a general paucity of remnant native vegetation is apparent on this photograph.

The wetland in the centre of the site is completely covered in vegetation, with no areas of open water (see Figures 6 and 7). The western half of the wetland consists of a mix of dense Bulrush (*Typha orientalis*) and Lake Club-rush (*Schoenoplectus validus*) Sedgelands. The eastern half of the wetland also consists of some Bulrush and Lake Club-rush Sedgeland and a large patch of introduced Paspalum Grass (*Paspalum dilatatum*). A small area of native shrubs, predominantly Swishbush *(Viminaria juncea)* and *Astartea fascicularis* occurs in the south-east corner of the wetland. The eastern end of the wetland adjacent to Centenary Avenue contains a stand of eucalypt trees including native Flooded Gum (*Eucalyptus rudis*) and exotic *Eucalyptus* plantings, mostly River Red Gum *(E. camaldulensis)* and Swamp Mahogany (*E. robusta*).

A zone of Bracken Fern (*Pteridium esculentum*) lies adjacent to the northern perimeter of the wetland and also along some of the southeastern portion. The Bracken occurs on land elevated above the natural contour of the wetland (see Section 3.6.2).

Adjacent to the western perimeter of the wetland is a stand of young Lemon-scented Gum *(E. citriodora)* trees up to 8m tall.

Immediately adjacent to the south central side of the wetland are three large areas of Tree Lucerne or Tagasaste (*Cytissus proliferus*) up to 4m tall and some individual exotic Eucalypts. The Tree Lucerne is an exotic species that was planted to provide fodder for grazing animals many years ago.

The northern boundary of the site adjacent to Manning Road contains a line of exotic River Red Gums close to, but not in, the road reserve. The north-west corner of the site contains a small clump of *Eucalyptus*, including Flooded Gum trees *(E. rudis)* and some Victorian Teatree *(Leptospermum laevigatum).*

The drain from the wetland to the river in the south-west corner of the site consists of planted *Eucalyptus* trees including River Red Gum, Swamp Mahogany and Lemon-scented Gum. An examination of historic aerial photographs indicates that these trees were planted between 1968 and 1978.

The Canning River foreshore area contains a narrow zone of *Juncus kraussii* ranging in width from 10m to 30m from the edge of the river. Low Samphire *(Halosarcia halocnemoides)* shrubland also occurs in patches along the foreshore.

A stand of Marri trees *(Corymbia calophylla)* and Swishbush is located between the wetland and the foreshore. The Marri trees are believed to be natural remnants of the original vegetation as they are evident as mature trees in a 1948 aerial photograph.

Vegetation Condition

The condition of the wetland vegetation is classified as Good according to the vegetation condition rating of Keighery (1994) used in Bush Forever (Government of Western Australia, 2000). Good vegetation is defined as vegetation whose structure is significantly altered by very obvious signs of multiple disturbances but retains the ability to regenerate its basic structure. The foreshore vegetation is classified as Very

Good although there are some Completely Degraded areas which have been severely impacted by filling. The remainder of the site is classified as Completely Degraded as the basic vegetation structure has been lost and is almost completely without native species.

Vegetation Significance

Bush Forever (Government of Western Australia, 2000) identifies regionally significant vegetation for protection on the Swan Coastal Plain within the Perth Metropolitan area. The Foreshore Reserve vegetation has been included in Bush Forever Site No.333 "Canning River Foreshore, Salter Point to Wilson". The native vegetation on the remainder of the site has not been identified as a Bush Forever site.

Given the condition of the native vegetation on the site it is not possible to assign any of the mapped vegetation types to a particular Floristic Community Type. Accordingly, the vegetation would not belong to any Threatened Ecological Communities according to the Commonwealth list of Endangered Communities and the Department of Conservation and Land Management's list for Western Australia (2000).

3.2.3 Potential Impacts

The proposed residential development will mostly be constructed on cleared land as shown on Figure 2. The development would have the following impacts on native vegetation:

- the western portion of the wetland will be retained in the development and rehabilitated to be a more natural wetland, including removal of Bulrushes and planting of Paperbark trees around the margins;
- approximately 1.57ha of the eastern portion of the wetland will be filled in and replaced by a newly constructed Paperbark and Flooded Gum wetland of approximately 2.10ha linking the western half of the wetland with the Canning River foreshore;
- the upland area between the wetland and the Clontarf Campus will be rehabilitated with native dryland species such as a Marri/*Banksia* woodland with particular emphasis on using plants with Aboriginal significance;
- the existing stand of Marri trees located in the south-eastern corner of the site will be retained in Public Open Space and linked to the Foreshore Reserve; and
- the vegetation fringing the Canning River will remain in the Foreshore Reserve.

3.2.4 Proposed Management

The development of East Clontarf will result in no net loss of wetland vegetation and a net increase in native vegetation on the site overall through planting of dryland native vegetation in the western buffer of the wetland.

The proponent is committed to preparing a Wetland Revegetation Plan and Foreshore Management Plan for that part of the foreshore abutting the whole of the East Clontarf site.

The Wetland Revegetation Plan will include, among other things, addressing the following issues:

- Means of removing Bulrushes from the parts of the wetland to be retained. Rehabilitation expert John Quilty (Quilty Environmental) has suggested several ways to control Bulrushes including mechanical removal by excavator or dragline, by slashing below water level or by spraying or surface wiping with a suitable herbicide. The use of herbicide may not be suitable in this environment close to the river. The density of Bulrushes in the wetland at East Clontarf indicates that mechanical removal is likely to be the most practical option for initial control. Removal may cause turbidity of peaty sediments and the release of nutrients into the wetland and river. To contain this risk, removal of Bulrushes would best start from the eastern end of the wetland, furthest from the outlet to the Canning River and progress steadily westwards;

- Methods of planting the margins of the wetland with Paperbark (*Melaleuca rhaphiophylla*) trees. It is envisaged that clumps of Paperbarks will be planted on slightly raised portions of the wetland edge where ground conditions are suitable for Paperbarks. Plantings will be sited to allow strategic views and vistas to be maintained; and

- A plan for the new Paperbark/Flooded Gum wetland area to be created between the existing wetland and the river foreshore. The area currently contains Kikuyu grass at an elevation of 1 - 2mAHD. Earthworking will be required to achieve a finished ground level of approximately 0.5mAHD which should be sufficient to plant with Paperbarks, Flooded Gums and understorey sedge and shrub species.

Table 4 contains a list of suggested species provided by Quilty Environmental for revegetating the wetland and fringing areas. Quilty Environmental's Wetland Rehabilitation report is included as Appendix 2.

TABLE 4
REVEGETATION SPECIES LIST

Rushes & Sedges	*Carex fascicularis* *Baumea juncea* *Juncus kraussii* *Juncus pallidus* *Lepidosperma longitudinale*
Shrubs & Herbaceous	*Acacia pulchella* *Anigozanthos viridis* *Aotus gracillima* *Astartea fascicularis* *Agonis linearifolia* *Dampiera linearis* *Pericalymma ellipticum*

	Viminaria juncea
Trees	*Casuarina obesa* *Banksia littoralis* *Eucalyptus rudis* *Melaleuca rhaphiophylla* (indigenous)

3.3 Significant Flora

3.3.1 EPA Objective

To protect Declared Rare and Priority Flora consistent with the provisions of the Wildlife Conservation Act 1950. Protect other flora of conservation significance.

3.3.2 Existing Environment

Several flora surveys of the site have been conducted between 2001 to 2003 for the purposes of this environmental assessment.

A total of 69 plant species have been identified on the site of which 47 are introduced species. The flora comprises representatives from 25 families with the Papilionaceae (pea family) (11 genera), Poaceae (grass family) (11 genera), Asteraceae (daisy family) (eight genera) and Myrtaceae (Eucalypt family) (seven genera), being the most common. The list of plant species identified on the site is presented in Appendix 3.

The number of plant species is low for an area of this size but is consistent with the mostly degraded and cleared nature of the site.

A search was undertaken of the Department of Conservation and Land Management's (DCLM) Threatened (Declared Rare) and Priority Flora database (February 2000) and the WA Herbarium Specimen database (February 2000) to identify any known populations of significant flora in the vicinity of East Clontarf.

The following list of flora species was provided by DCLM:

SPECIES	**CONSERVATION STATUS**
Angianthus micropodioides	(P3)
Andersonia gracilis	(R)
Angianththus micropodioides	(P3)
Anthotium junciforme	(P4)
Aotus cordifolia	(P3)
Baeckea tenuifolia	(P3)
Boronia tenuis	(P4)
Byblis lindleyana	(P2)
Caladenia huegelii	(T)
Conostephium minus	(P4)
Dillwynia dillwynioides	(P3)
Grevillea thelemanniana	(P4)

Haloragis aculeolata	(P2)
Hydrocotyle lemnoides	(P4)
Lepidosperma rostratum	(R)
Schoenus natans	(P4)
Schoenus pennisetis	(P1)
Synaphea acutiloba	(P3)
Templetonia drummondii	(P4)
Tetraria australiensis	(R)
Tripterococcus paniculatus ms	(P1)
Verticordia lindleyi subsp. *lindleyi*	(P4)

The following priority species on this list occur nearby in similar foreshore habitats to that of East Clontarf:

- *Angianthus micropodioides* (P3)
- *Anthotium junciforme* (P4)
- *Dillwynia dillwynioides* (P3)

No Declared Rare or Priority flora species were recorded on the site during the flora surveys.

3.3.3 Potential Impacts

No Declared Rare or Priority flora species will be affected by the development.

3.3.4 Proposed Management

No management is required for this factor.

3.4 Fauna

3.4.1 EPA Objective

To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

3.4.2 Existing Environment

Information regarding the fauna of the East Clontarf site has been obtained though a series of site surveys undertaken at various times throughout the year in 2000 by ATA Environmental in association with Bamford Consulting Ecologists.

Site surveys were conducted on five occasions between May and December 2000. Surveys typically involved walking around the site and wetland, and along the river foreshore from mid to late afternoon, then staying until sunset to listen for frogs. In December effort was also made to record bat species.

The list of fauna species recorded during the survey is presented in Appendix 4.

Fauna Habitats

The main fauna habitats on the site are considered to be:

- the wetland;
- grassland surrounding the wetland;
- Canning River including the adjoining foreshore; and
- scattered individual or small stands of exotic and locally occurring trees.

Faunal Assemblage

Surveys undertaken by ATA Environmental in association with Bamford Consulting Ecologists recorded 12 species of herpetofauna, 52 species of avifauna and four species of mammals occurring within the project area (Appendix 4).

Herpetofauna

Of the 31 species of herpetofauna 'potentially' occurring within the project area (nine frog and 23 reptile species), six species of frogs, five reptiles and one tortoise were recorded during the surveys. One of the species of frogs, the Pobblebonk (*Limnodynastes dorsalis*) was recorded only from nearby sites.

Frogs were recorded within portions of the wetland, drainage lines, in a highly disturbed pit or sand hill on the site and along the river. Within the wetland, records of frogs were curiously restricted to the western side nearest to the buildings of Clontarf, the drainage line extending to the river, and within the drain that passes under Centenary Ave. Three species were recorded within the disturbed sand hill area south of the wetland towards the eastern side of the property. This sand hill and wheel ruts provide ideal breeding habitat for the Moaning Frog (*Heleioporus eyrei*) and Quacking Frog (*Crinia georgiana)* although the latter frog was not found on site.

The absence of *Litoria adelaidensis* (Slender Tree Frog), which was calling abundantly elsewhere around Perth during the survey, strongly suggests this species is not present, although the site appears suitable. *Litoria moorei* (Motorbike Frog) was recorded only within the marsh areas adjacent to the river although the habitat within the wetland also appears suitable for this species.

While 23 species of reptiles are thought to potentially occur within the project area, only six species of reptile, *Chelodina oblonga* (Long-necked Tortoise*), Acritoscincus trilineatum, Cryptoblepharus plagiocephalus* (Fence Skink), *Lerista elegans, Notechis scutatus* (Tiger Snake) and *Pseudonaja affinis* (Dugite) were recorded as present during the surveys. This can be attributed generally to the disturbed and highly modified nature of the habitats. All of the species are typical of the habitats present at East Clontarf and often persist in modified areas. Tortoise shells were found on two occasions suggesting that the species may occur in the wetland or may access the site from the river to lay eggs.

Avifauna

Fifty-two bird species were recorded during the site visits. Eighteen waterbird species

were recorded on the river, while only six wetland dependant species were observed or heard within the wetland area on the site. The observation of a pair of Pacific Black Ducks (*Anas superciliosus*) with nine ducklings may indicate the importance of this part of the river for the breeding of this and other waterbird species.

The wetland on the site provides habitat for three species of waterbirds, the Spotless Crake (*Porzana tabuensis*), Clamorous Reed-Warbler (*Acrocephalus stentoreus*) and Little Grassbird (*Megalarus gramineus*) which were not recorded along the river. The Spotless Crake was recorded in rushes of the wetland from calls only, so identification is tentative. One of the other small crakes, such as Baillon's Crake (*Porzana pusilla*), could possibly occur in the wetland.

The terrestrial species recorded are generally typical of the disturbed habitats and stands of mature eucalypts and other trees available on the site. A notable record was the presence of at least one Fairy-wren, likely to be the Splendid *Malarus splendens* in rushes on the southern edge of the wetland area.

The stands of Tree Lucerne (an introduced species) are known to be habitat for the New Holland Honeyeater (*Phylidonyris novaehollandiae*). According to the City of South Perth, this is thought to be one of the few sites in the City of South Perth where the New Holland Honeyeater is currently breeding.

Mammals

No native mammals were recorded during the site survey. The survey revealed evidence (mainly of scats and tracks) that foxes (*Vulpes vulpes*), rabbits (*Oryctolagus cuniculus*), feral or semi-domestic cats (*Felis catus*) and at least one species of introduced rat (*Rattus rattus*) are likely to occur within the site.

Predation by cats and foxes is expected to have an impact on the abundance and species occurring at the site. The remains of two tortoises, presume to have been killed by foxes, were located on the site.

Other

The introduced Mosquito Fish (*Gambusia holbrooki*) is present within the wetland.

Gilgies (*Cherax quinquecarinata*) also occur within the wetland, especially where it flows from the wetland to the river.

In relation to the significance of the habitats of East Clontarf to fauna, the main observations or findings of the vertebrate fauna surveys are as follows:

- the sheltered cove of the adjacent Canning River is important for a range of waterbirds, probably due to several factors but the inflow of freshwater from the East Clontarf site may attract Black Swans, Musk Ducks and several other species that need to drink freshwater regularly to the location;

- the small area of salt marsh on the river foreshore together with the other largely well vegetated sections of foreshore is attractive to a range of fauna. The

foreshore forms an important part of a largely continuous riparian habitat for fauna moving along the Canning River (such as Water Rats, Southern Brown Bandicoots and various birds);

- the wetland, from the extensive rush-beds to the short freshwater stream that flows into the Canning River, supports wetland species, including waterbirds that require freshwater habitats, a variety of frogs, and Long-necked Tortoise;

- fringing vegetation of the wetland such as bracken fern and some remnant riparian vegetation provides cover and protection for wetland species, including possibly the Southern Brown Bandicoot and some reptile species. Flowering of fringing vegetation including introduced Tree Lucerne supports nectar-feeding birds that are able to move through the area.

3.4.3 Potential Impacts

The most significant part of the East Clontarf site for fauna was found to be the Canning River including the adjoining foreshore. As the proposed residential development will mostly be constructed on cleared land, the direct impact on fauna habitat will be negligible. The development would have the following impacts on fauna habitat:

- the western half of the wetland will be retained in the development and rehabilitated to be a more natural wetland;

- approximately 1.57ha of the eastern portion of the wetland will be filled in and replaced by a newly constructed Paperbark and Flooded Gum wetland linking the western half of the wetland with the Canning River foreshore;

- the upland area between the wetland and the Clontarf Campus will be rehabilitated with native dryland species such as a Marri/*Banksia* woodland and understorey species creating fauna habitat that currently does not exist on the site;

- the stands of Tree Lucerne which provide significant local habitat for the New Holland Honeyeater will be removed with some planting of Tree Lucerne being carried out on the Clontarf Campus side of the proposed wetland;

- exotic and local *Eucalyptus* trees will be removed from the eastern and western side of the wetland;

- the stand of Marri trees will be retained in POS and linked to the Foreshore Reserve; and

- the vegetation fringing the Canning River will remain in the Foreshore Reserve.

Potential indirect impacts on the important Canning River habitat include:

- alteration to the fresh water flow volumes and/or quality to the river from the wetland;

- pollution of the river ecosystem by sediment and nutrients from earthworks associated with the wetland reconstruction activities; and

- pollution of the river ecosystem by acidic water as a result of acid sulphate soil reactions associated with the wetland reconstruction activities.

3.4.4 Proposed Management

The development of East Clontarf will result in no net loss of wetland fauna habitat and a net increase in fauna habitat on the site overall through planting of dryland native vegetation in the western buffer of the wetland.

Stormwater drainage from the residential development will be directed into an infiltration basin (to be located within public open space adjacent to the foreshore reserve) and not to the wetland.

The amount of grassed landscaping requiring fertiliser application has been kept to a minimum in the development. Residential lot sizes will limit the amount of gardens on each lot. In addition new residents will receive an information package that promotes water-wise gardens to reduce water and nutrient application.

Details on stormwater and nutrient management will be provided in a Drainage, Irrigation, Nutrient Water Quality Management Plan to be prepared as a condition of subdivision. The development, therefore, will minimise changes to the water flow volume or quality from the wetland to the river.

The potential for contamination of the Canning River during wetland reconstruction activities and general site earthworks will be managed through a Construction Environmental Management Plan to be prepared as a condition of subdivision.

3.5 Significant Fauna

3.5.1 EPA Objective

Protect Specially Protected (Threatened) Fauna and Priority Fauna species and their habitats, consistent with provisions of the Wildlife Conservation Act 1950.

3.5.2 Existing Environment

A search of DCLM's database of Specially Protected and Priority Fauna species identified the following species as possibly occurring in the vicinity of East Clontarf:

- Short-billed Black-Cockatoo or Carnaby's Cockatoo - Schedule 1.
- Peregrine Falcon - Schedule 4.
- Southern Brown Bandicoot or Quenda - Priority 4.

Schedule 1 designates fauna which are "rare or likely to become extinct" and Schedule 4 designates fauna which are "otherwise specially protected" but are not considered to be rare or likely to become extinct. These are known as Specially

Protected (Threatened) Fauna and are protected by the *Wildlife Conservation Act 1950*.

Species listed as Priority Fauna do not have any special protection afforded them and are in need of monitoring. Priority 4 species are defined by DCLM as "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.

The Short-billed Black-Cockatoo or Carnaby's Cockatoo *(Calyptorhynchus latirostris)* may be a seasonal visitor in the area using large eucalypts as roosting sites. Nomadic flocks of this species are relatively common throughout much of the Perth Metropolitan Region.

The Peregrine Falcon *(Falco peregrinus)* may occur as a vagrant in the area mostly in flooded gum woodlands along the Canning River. The species is fairly common in certain habitats in the Perth Metropolitan Region and even occurs in the Central Business District. At most, a single bird or pair may be present at East Clontarf as a seasonal or occasional visitor but would occupy a much larger territory.

The Southern Brown Bandicoot or Quenda *(Isoodon obesulus fusciventer)* has been recorded nearby in Wilson and may be present on the site. This species typically prefers low dense vegetation without too much water. Due to the disturbed nature of the site and the presence of foxes it is unlikely that populations of the Quenda persist at the Clontarf site. This species may however colonise the area periodically from other habitats that adjoin the river in nearby localities provided continuous access is available along the river.

In addition, the Water Rat (*Hydromys chrysogaster*) could occur along sections of the river and may occasionally access the site. No evidence of this species was recorded during the site surveys, however the species may move along the river foreshore area and colonise the section of the Canning River adjoining East Clontarf.

The list of bird species recorded during the surveys included four species identified as category 3 or 4 Significant Birds on the Swan Coastal Plain in the Perth metropolitan area in Bush Forever (Government of WA, 2000). These bird species are considered to be habitat specialists with reduced distribution on the Swan Coastal Plain (Category 3) or wide-ranging species with reduced populations on the Swan Coastal Plain (Category 4). A further 11 species could be expected to occur and another six species are considered possible based on distribution and habitats.

Ten of the Significant Bird species recorded or possible at the site are waterbirds that would primarily use the wetland and/or riverine habitats. Seven are birds of prey that may hunt at the site or adjacent river and/or opportunistically perch in the trees. The remainder could occur within the shrubs and trees of the upland and fringing wetland/riverine areas.

The list of Significant Bird species expected to be found at the East Clontarf site, in addition to where on the site they were observed are given in Table 5.

TABLE 5
SIGNIFICANT BIRDS OF THE SWAN COASTAL PLAIN

Scientific Name	Common Name	Significant Bird Species
Order: ANSERIFORMES		
Family: ANATIDAE		
Oxyura autralis	Blue Billed Duck	3
Biziura lobata	Musk Duck	3
Anas rhynchotis	Australasian Shoveler	3
Order: CICONIIFORMES		
Family: ARDEIDAE		
Nycticorax caledonicus	Rofous Night Herron	4
Order: FALCONIFORMES		
Family: ACCIPITRIDAE		
Haliastur sphenunus	Whistling Kite	4
Accipiter fasciatus	Brown Goshawk	4
Aquila morphnoides	Little Eagle	4
Aquila audax	Wedge-Tailed Eagle	4
Family: FALCONIDAE		
Falco berigora	Brown Falcon	4
Falco peregrinus	Peregrine Falcon	1,4
Order: CHARADIFORMES		
Family: SCOLOPACIDAE		
Tringa nebularia	Common Greenshank	2
Tringa glareola	Wood Sandpiper	2
Tringa hypoleucos	Common Sandpiper	2
Order: PASSERIFORMES		
Family: MALURIDAE		
Malurus splendens	Splendid Fairy-Wren	3
Family: MELIPHAGIDAE		
Phylidonyris novaehollandiae	New Holland Honeyeater	4
Phylidonyris nigra	White-cheeked Honeyeater	4
Anthochaera lunulata	Western Little Wattlebird	4
Family: ARTAMIDAE		
Artamus cinereus	Black-faced Woodswallow	4

* Source: Department of Environmental Protection, 2000 Bush Forever Vol. 2

Significant Bird Species

1 = species listed under the *Wildlife Conservation Act 1950*
2 = species listed on the JAMBA/CAMBA agreements
3 = habitat specialists with a reduced distribution on the Swan Coastal Plain
4 = wide-ranging species with reduced populations on the Swan Coastal Plain locally extinct.

Three species listed on JAMBA/CAMBA international agreements relating to migratory birds were recorded during the surveys and a further three are listed as possible for the site. All of the species that were recorded were located in habitats associated with the Canning River.

3.5.3 Potential Impacts

There is no Specially Protected or Priority Fauna recorded within the site. However potential habitat impacts for several Significant Birds as identified in Bush Forever

and species listed under JAMBA/CAMBA Agreements occur within or adjacent to the site. All of the Significant Bird and JAMBA/CAMBA species recorded were located in habitats associated with the Canning River.

Potential indirect impacts on the important Canning River habitat include:

- alteration to the fresh water flow volumes and/or quality to the river from the wetland;
- pollution of the river ecosystem by sediment and nutrients from earthworks associated with the wetland reconstruction activities; and
- pollution of the river ecosystem by acidic water as a result of acid sulphate soil reactions associated with the wetland reconstruction activities.

Several introduced mammal species are known or are expected to presently occur within the area and may increase following development of the site. These species could have significant impact on the local native fauna.

Cats and foxes are known to predate on native fauna and dogs are known to also disturb and kill native fauna. These species could potentially deplete populations sufficiently to result in local extinction within the foreshore area.

3.5.4 Proposed Management

Given the habitat type and condition at East Clontarf, it is expected that development of East Clontarf is unlikely to have a significant impact on any Specially Protected (Threatened) Fauna.

A Foreshore Management Plan will be prepared to help manage the impacts of urbanisation on the foreshore and riverine environments. Management of fauna in the Foreshore Reserve area will focus on maintaining or improving habitat and refuge for fauna. By minimising loss and alteration of the habitats, the local populations may be able to be sustained and be more resilient to the effects of predation or disturbance.

Weed removal and revegetation with local species could be undertaken to improve the habitat for fauna. In particular, the progressive removal of weeds from sections of the foreshore margins and establishment of sedges would provide habitat that is presently limited along this section of the Canning River.

Interpretive signage could be used to inform visitors of species of fauna occurring along the foreshore and the river. In particular, signage and interpretive information should raise awareness of the occurrence of the following JAMBA/CAMBA species that frequent the general area:

- Great Egret (*Egretta alba*)
- White-bellied Sea Eagle (*Haliaetus leucogaster*)
- Crested Tern (*Sterna bergii*)
- Grey Plover (*Pluvialis squatarola*)
- Common Greenshank (*Tringa nebularia*)

- Wood Sandpiper (*T. glareola*) and
- Common Sandpiper (*T. hypoleucos*).

Access to the Foreshore Reserve will be controlled to ensure there are at least some locations adjacent to the river that have minimal disturbance to fauna.

In regard to controlling pets, community involvement and awareness promoting control of pets such as cats and dogs is an important aspect of managing predation by introduced species. Dogs should be prohibited from the Foreshore Reserve and POS area unless on a lead, while owners of cats should be encouraged to keep them in at night, and preferably at all times.

Details on stormwater and nutrient management within the development will be provided in a Drainage, Nutrient, Irrigation and Water Quality Management Plan to be prepared as a condition of subdivision.

The potential for contamination of the Canning River during wetland reconstruction activities and general site earthworks will be managed through a Construction Environmental Management Plan to be prepared as a condition of subdivision.

3.6 Wetlands

3.6.1 EPA Objective

To maintain the integrity, ecological functions and environmental values of the wetlands environment.

3.6.2 Existing Environment

The Wetland Atlas (Hill *et al*., 1996) and WALIS database indicate that the southern half of the site is mapped as a wetland. This section of the PER provides information on the actual location of wetlands on the site and their ecological and hydrological function.

The assessment of the wetlands are based on the following studies:

- detailed wetland mapping on-site;
- wetland classification and re-evaluation using EPA Bulletin 686 (EPA, 1993) according to the DoE re-evaluation protocol;
- a limited groundwater investigation was undertaken as part of the Preliminary Contamination Investigation (ATA, 2001);
- an investigation of the hydrology and hydrogeology of the wetland and the area's groundwater regime was undertaken by JDA Consulting Hydrologists (2003) (reproduced in Appendix 6); and

- further investigations on groundwater and surface water quality undertaken by ATA Environmental in 2004.

General Description

The Wetland Atlas (Hill *et al*., 1996) maps a large portion of the site as a peripheral estuary wetland associated with the Canning River. The Geomorphic Wetland Mapping Dataset, as provided on the WALIS website, indicates the peripheral estuary wetland on the site has two management categories that reflect the degree of natural vegetation on the site. The part of the wetland closest to the river, known as Clontarf River Flats, has been assigned a Conservation management category. The northerly wetland area is classified as Resource Enhancement.

The northern portion of this mapped wetland is included in the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP Lakes). This EPP wetland located in the central portion of the East Clontarf site extends in an east-west direction across the site and covers approximately 4ha.

According to Miscellaneous Plan 1815, the EPP wetland boundary extends up into parts of the site as high as 9mAHD (Figure 6).

Site surveys were undertaken by ATA Environmental to confirm the wetland boundary on the site. The surveys indicated that the area generally identified as the EPP lake did contain a wetland, but that the area between this wetland and the Canning River did not contain characteristics of a wetland. The boundary of the EPP wetland was considered to be smaller than that mapped on Miscellaneous Plan 1815. The boundary was determined based on vegetation types and ground levels. The boundary roughly coincided with the 2mAHD contour level.

Historical photographs to 1948 indicate the wetland area has undergone considerable modification including possible use of the area for market gardens, excavation of a drainage line to the Canning River, and infilling of sections of the wetland.

As a result, the natural wetland has been significantly modified over time. The wetland currently is completely covered in vegetation, predominantly reeds, some of which are introduced or non-native species. The western portion of the wetland consists mostly of dense Bulrush (*Typha orientalis*) Sedgeland and Lake Club-rush (*Schoenoplectus validus*) Sedgeland. The eastern portion of the wetland also consists of some Bulrush and Lake Club-rush Sedgeland with a small section of native shrubs in the south-eastern portion of the wetland containing Swishbush (*Viminaria juncea*), *Astartea fascicularis* and a stand of *Eucalyptus* trees, including Native Flooded Gum (*E. rudis*), River Red Gum (*E. camaldulensis*) and Swamp Mahogany (*E. robusta*). Exotic *Paspalum* Grassland covers a large portion of the eastern half of the wetland (Figure 7).

The Bracken Fern vegetation on the northern side of the wetland appears on aerial photographs to form part of the wetland but on close inspection is shown to be located on sloping ground above the wetland.

The land between the wetland area mapped during the initial site inspection (2001) and the river foreshore has been largely filled with sand and some builders' rubble. This area is mapped as a Conservation category wetland according to the wetland mapping (WALIS and Hill *et al*., 1996), however it presently does not display characteristics of a wetland.

A small wetland area was identified between the EPP wetland and the river, close to the eastern boundary. This wetland area contained Swishbush and a weedy ground cover.

Application of the questionnaire published in the EPA Bulletin 686 indicates the wetland area centrally located within the property indicates the Resource Enhancement management category is appropriate. Resource Enhancement wetlands are partly modified but still support substantial functions and attributes. Management priorities for Resource Enhancement wetlands should aim at wetland restoration through the maintenance and enhancement of wetland functions and attributes. The small wetland between the EPP wetland and the river was identified as a Multiple Use category wetland.

The wetland boundary and management category assessment conducted by ATA Environmental was endorsed by the Wetlands Branch of the DoE. Information on the boundary of the river wetland is included in Section 3.9.2.

The soils of the EPP wetland are predominantly peat and peaty sands extending from the surface to approximately 1m depth (Figure 14). The peaty soils overlie sand and silty sand at shallow depths.

The hydrology of the wetland is described in Section 3.8.2. In summary, the wetland is fed by a constant inflow of groundwater across a seepage face along the northern boundary of the wetland. Discharge from the wetland occurs predominantly via a channel connecting the south-west tip of the wetland with the Canning River. This discharge is virtually constant throughout the year. As a result of the constant inflow and outflow of the river, the water level in the wetland has a small seasonal variation of around 0.03m.

The wetland category of Resource Enhancement acknowledges that the wetland has been partly modified but still supports substantial functions and attributes. Those functions are summarised below with more detailed descriptions provided in the sections referenced:

Wetland Functions

- The wetland supports a variety of vegetation types, both native and individual as follows (see Section 3.2.2):

    - Bulrush (*Typha orientalis*) Sedgeland
    - *Schoenoplectus validus* Sedgeland
    - Mixed Bulrush/*Schoenoplectus* Sedgeland
    - *Kikuyu* Grassland
    - *Paspalum* Grassland

- *Agonis linearifolia* Shrubland
- *Viminaria juncea* Shrubland
- *Astartea fascicularis* Closed Heath
- *Eucalyptus* Woodland

- The wetland provides habitat for a variety of fauna (see Section 3.4.2) including:

  - Long-neck Tortoise
  - A variety of frogs and reptiles
  - Six wetland dependent birds (including the Spotless Crake, Clamorous Reed Warbler, Little Grassbird) which do not occur along the river
  - Gilgies
  - Mosquito Fish

- The water outflow to the river provides a constant source of freshwater that may be significant in terms of waterbird usage in Clontarf Bay.

3.6.3 Potential Impacts

Opportunities

The description of the wetland has identified that the wetland has a range of functions that are important to maintain. It has also identified that the wetland has been affected by past land use resulting in portions of the wetland containing introduced grasses and Bulrush. The upland area around the wetland is virtually devoid of native vegetation and sections of the wetland have been filled in on the southern side and in the area between the current wetland and the river.

The East Clontarf development proposes to re-create some of these functions including the link between the river and the wetland and provision of some upland native vegetation. In order to do this cost effectively, the eastern portion of the wetland will be reduced in size and developed for housing.

The proposed residential development will have the following impacts on the wetland on site:

- the western portion of the wetland will be retained in the development and rehabilitated to be a more natural wetland, including removal of Bulrushes and planting of Paperbark trees around the margins;

- approximately 1.57ha of the eastern portion of the wetland will be filled in a newly constructed Paperbark and Flooded Gum wetland (2.10 ha) will be constructed in the south-west part of the site providing a wider link between the western half of the wetland and the Canning River foreshore; and

- a portion of the upland area between the wetland and Clontarf Campus will be revegetated with native dryland species.

The development will result in *no net loss of wetland area* and will achieve a *net gain in wetland function*. The gain in wetland function will be achieved by reconstructing riparian Paperbark/Flooded Gum habitat as a replacement for the Bulrush/Lake Club-rush Sedgeland that will be removed from the eastern portion of the wetland.

The constructed wetland will be designed to integrate visually with the wetland outflow channel but will not alter the current channel dimensions.

The majority of the new wetland area, following construction of the new area adjacent to the river and filling in part of the eastern half of the wetland, will have houses roads and a small area of public open space directly abutting the wetland. A portion of the upland area will be revegetated with native species. However, the provision of a buffer between the wetland and adjoining development is considered unnecessary for the following reasons:

1. the wetland currently functions with an upland area almost totally devoid of native species;

2. the wetland water level cannot rise and flood surrounding areas as the level is controlled by the outflow channel;

3. the constant flow of water will prevent midges and mosquitoes from breeding; and

4. any nutrients entering the groundwater and into the wetland will have a negligible impact on water quality due to the size of gardens on the lots, the small number of lots and the minor contribution of the shallow groundwater to the overall water balance of the wetland.

Potential impacts on water quality are discussed in Section 3.8.3.

3.6.4 Proposed Management

The successful rehabilitation and reconstruction of the new wetland area adjacent to the river will by guided by the preparation of a Wetland Management Plan.

The Wetland Management Plan will include, among other things, the following issues:

- methods of removing Bulrushes from the parts of the wetland to be retained. Mechanical removal is likely to be the most practical option for initial control of Bulrushes. Removal may cause temporary turbidity of peaty sediments and the release of nutrients into the wetland and river. To contain this risk, removal of Bulrushes will start from the eastern end of the wetland, furthest from the outlet to the Canning River and progress steadily westwards;

- methods of planting the margins of the wetland with Paperbark (*Melaleuca rhaphiophylla*) trees. It is envisaged that clumps of Paperbarks will be planted on slightly raised portions of the wetland edge where ground conditions are

suitable for Paperbarks. Plantings will be sited to allow strategic views and vistas to be maintained; and

- a plan for the new Paperbark/Flooded Gum wetland area to be created between the existing wetland and the river foreshore (to the south of the existing Clontarf Campus). The area currently contains Kikuyu grass at an elevation of 1m - 2mAHD. Earthworking will be required to achieve a finished ground level of approximately 0.5mAHD that should be sufficient to plant with Paperbarks, Flooded Gums and understorey sedge and shrub species.

3.7 Groundwater Quality

3.7.1 EPA Objective

To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting Statutory requirements and acceptable standards.

3.7.2 Existing Environment

Hydrogeology

The site lies on the northern bank of the Canning River within the Cloverdale groundwater flow area of the superficial formation aquifer (Davidson, 1995). The superficial formation extends down to approximately 25 metres below AHD and is underlain by the Leederville Formation aquifer which is approximately 300m thick. Davidson (1995) indicates an upward head between the two aquifers indicating that the area is one of groundwater discharge from the Leederville to the superficial aquifer.

The direction of groundwater flow in the superficial formation is essentially south towards the Canning River.

Groundwater is discharged from the superficial formation into the wetland area and probably also beneath the Canning River itself. The existing open drain at the southern end of the wetland flows at approximately 20 l/sec, sourced from the superficial aquifer. This flow rate exceeds the official (Davidson, 1995) average value of approximately 2.4 l/sec from the superficial aquifer to the river.

Groundwater salinity beneath the site is described by Davidson (1995) as fresh (<1,000mg/l) although salinity increases along the Canning River foreshore due to mixing with higher salinity river water.

The water table gradient for the northern part of the site, north of the wetland, is typical of that of the region beyond the site. Within the wetland and south of it to the Canning River the gradient is far less, due to it being a zone of groundwater discharge with the water table effectively at the natural surface. In this area because of the low gradient of the natural surface, the water table, which is virtually coincident with the natural surface, also has a lower gradient than north of the wetland. There is no

evidence that the peat deposits beneath the wetland are less permeable than surrounding soil materials, nor that they form a barrier to groundwater flow.

The site is not located within a DoE Underground Water Pollution Control Area.

Groundwater was encountered during the geotechnical investigation at 21 sites including the installed standpipe piezometers, EFCP holes that remained open after testing, and test pits carried out in the East Clontarf site (Coffey International, 2000).

Coffey International's interpretation of groundwater elevations in October 2000 indicated that groundwater levels fall from in excess of 4m AHD in the north-eastern corner, near the junction of Centenary Avenue and Manning Road, to less than 0.5m AHD at test sites closest to the river. Comparatively elevated water levels were recorded adjacent to the eastern corner of the site, Centenary Avenue, and the old landfill area (Coffey International, 2000).

Groundwater Quality

A limited groundwater investigation was undertaken as part of the Preliminary Contamination Investigation (ATA Environmental, 2001).

Groundwater samples were collected from four piezometers (ECB1, ECB2, ECB3 and ECB4) on 6 November 2000. ECB1 and ECB2 are located on the boundary of the abandoned landfill. ECB3 is located to the south of the former market garden area and ECB4 is located to the west of ECB3 and south of Manning Road. Both bores are located in areas comprising natural soils profile.

ECB1 and ECB2 was considered to be up hydraulic gradient of groundwater flow onto the site whereas ECB3 and ECB 4 were considered cross hydraulic gradient, and possibly slightly down hydraulic gradient of the rehabilitated landfill area.

The samples were submitted to the laboratory for analysis of organochlorine pesticides, heavy metals, total petroleum hydrocarbons and nutrients (ammonia-N, nitrate-N, nitrite-N, total Kjeldahl nitrogen, orthophosphate and total phosphorous).

Analyte concentrations were compared to ANZECC (2000).

The groundwater sample collected from ECB1 contained:

- Cadmium (0.005mg/L), chromium (0.02mg/L), copper (0.02mg/L), lead (0.01mg/L) and zinc (0.21mg/L) above the assessment criteria. The concentration of dieldrin (0.002µg/L) was equal to the assessment criterion.

The groundwater sample collected from ECB2 contained:

- Cadmium (0.005mg/L) and dieldrin (0.004µg/L) above the assessment criteria.

The groundwater samples collected from ECB3 and ECB4 contained:

- Concentrations of zinc (1.7mg/L and 0.74mg/L respectively) and dieldrin (0.007µg/L and 0.003µg/L respectively) above the assessment criteria.

The data from these temporary piezometers should be regarded as indicative only as the piezometers were not constructed as permanent monitoring wells. The results of the single round of sampling suggested that groundwater quality has been affected by both surrounding land uses and historical groundwater uses on the site.

Further groundwater monitoring was conducted as part of the Detailed Site Investigation was undertaken (ATA Environmental 2003b) to:

- further investigate the source of the metal and pesticide contamination in groundwater; and

- quantitatively evaluate the contaminant concentrations versus the water quality guidelines (DEP, 2000).

Five (5) groundwater monitoring wells were sampled during the detailed groundwater contamination investigation. Figure 12 illustrates the location of monitoring wells installed on the site.

Groundwater sampling was conducted in general accordance with *AS/NZS5667.1:1998* and *AS/NZS 5667.11:1998* "Water Quality – Sampling".

The groundwater samples were submitted to Analytical Reference Laboratories (WA) Pty Lt (ARL) who hold NATA registration for the particular parameters and methodologies required for the groundwater analyses.

The drinking water guidelines were not used as the proposed residential development includes the provision of municipal drinking water supply.

The results of the additional groundwater investigation are summarised in Appendix 5.

The following conclusions are drawn from the sample data:

- Aluminium concentration was above the freshwater aquatic ecosystem assessment criterion for the reported pH for samples collected from MW 1, MW2 and MW3.

- Total nitrogen concentrations of the samples collected from MW1 and MW3 were above the ANZECC and ARMCANZ (2000) lower river assessment criterion.

- Total phosphorus concentrations of samples collected from MW1 and MW3 were above the ANZECC and ARMCANZ (2000) lower river assessment criterion.

- Copper concentrations could not be assessed against the assessment criterion as the limit of reporting specified in the SAP was above the respective criterion.

Copper concentrations were below 10ug/L in groundwater collected from all monitoring wells during the sampling event. Copper concentrations of samples collected from all monitoring wells were below the irrigation assessment criterion.

- Zinc concentration of the sample collected from MW4 was above the freshwater ecosystem criterion.
- Total nitrogen concentration of the sample collected from MW4 was above the ANZECC and ARMCANZ (2000) lower river assessment criterion.
- Total nitrogen and ammoniacal nitrogen concentration of the sample collected from MW5 was above the ANZECC and ARMCANZ (2000) lower river assessment criterion.
- Cadmium concentration in sample collected from MW5 was above the freshwater aquatic ecosystem assessment criterion.

Further groundwater and surface water tests were undertaken by ATA Environmental in March 2004 in order to determine any effect of the wetland on water quality entering Canning River (see Appendix 7).

Three superficial bores (MW1, MW2 and MW3) upgradient of the wetland were sampled for a range of metals, nutrients and pesticides. In addition, a sample of surface water was taken from the wetland at the culvert between the wetland and the drainage channel. The results are provided in Appendix 5. The results indicate that the surface water is similar in quality for a range of analytes but was lower in concentration for Nox-N, TKN, TN, FRP, TP, Aluminium and Dieldrin.

These results indicate either that these elements are being absorbed in the sediments and plant matter or that significant dilution was occurring with water of lower concentration (refer to Appendix 7). The groundwater investigations conducted by JDA Consulting Hydrologists (Section 3.8) revealed that the outflow from the wetland probably represented the whole of the superficial formation which extends down to about 25m below natural surface. As the impacts of past land use are most likely to be concentrated in the top sections of the superficial aquifer (as sampled in MW1, 2 and 3), it is highly likely that the remainder of the aquifer has lower concentrations not affected by land use immediately over or near the site.

The elevated concentrations of various water quality parameters detected in shallow monitoring bores within the superficial formation aquifer are probably a result of previous land uses on the site or up gradient on the northern side of Manning Road. The lower concentrations recorded in the outlet drain water sampling are considered to be due to the dilution effects associated with the discharge of regional groundwater from the superficial formation to the surface within the wetland which discharges along the drain to the Canning River.

No measurements have been made of the ability of the wetland sediments to absorb nutrients and pollutants in the inflowing groundwater, as dilution described above is

considered to be the primary mechanism for water quality improvement through the wetland.

3.7.3 Potential Impacts

The redevelopment of the site is unlikely to significantly impact on the existing groundwater quality. The main potential changes as a result of the development are:

- the removal of contaminated soil within the site boundary which will (because of the relatively low level of contaminants present) should marginally improve water quality;
- the possibility of mobilising acidity from Potential Acid Sulfate Soils (PASS) identified in some areas of the site (refer to Section 3.11 for more detail); and
- the potential for addition of nutrients as a result of fertiliser addition in residences and areas of POS.

The potential receptors of any groundwater contamination include:

- the freshwater ecosystem within the proposed enhanced wetland and Clontarf Bay;
- the proposed residences should shallow groundwater bores be installed for irrigation (the likelihood of this is considered low as the proposed residential development consists of relatively small land parcels eg less than 500m^2); and
- the proposed POS assuming the shallow groundwater bores are installed for irrigation purposes.

3.7.4 Proposed Management

The following commitments are made in relation to the management of groundwater:

- monitoring of groundwater will continue to establish baseline water quality in the superficial aquifer beneath the site with the results being reported with the Site Soil Remediation and DNIWQM Plans that will be submitted for approval by relevant agencies;
- contaminated soils on the site will be remediated to the satisfaction of the DoE; and
- an Acid Sulfate Soil Management Plan will be developed prior to construction commencing to the satisfaction of the DoE and then implemented.

The management of nutrients and any further management commitments made on the basis of additional groundwater monitoring data will be incorporated within the DNIWQM Plan to be approved by the DoE and City of South Perth as a Condition of Subdivision.

3.8 Surface Water Quality

3.8.1 EPA Objective

To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

3.8.2 Existing Environment

Surface Hydrology

The surface hyrdology of the site has been investigated by JDA Hydrologists and included as Appendix 6 of this PER document. JDA examined the groundwater flownet associated with the project area and undertook site investigations on four occasions (10 and 13 November 2002, 20 February and 8 May 2003).

Eight groundwater monitoring bores were installed using a 75mm hand auger within the development area (Figure 9). The bores were located in two north-south transects through the area and included the wetland. A staff gauge was installed in the south-western corner of the wetland, at the point where the wetland flows through a 750mm diameter culvert into an open drain. The levels of all bores and the gauge were surveyed to mAHD. At the same time, open water levels were also surveyed at a number of points (Appendix 6).

Using 1m DOLA topographic contours, JDA found that approximately 12.2ha of the 18.5ha development site is estimated to drain to the wetland (including the wetland area itself) and 6.3ha is estimated to drain directly to the Canning River (Appendix 6).

JDA determined that the site lies within flow channel 2 of the Cloverdale area groundwater flownet with groundwater throughflow estimated at approximately 4,000m^3/d for this flow channel (Davidson, 1995). In relating this throughflow to the site, JDA calculated that the project area represents approximately 0.5km of the length of the flow channel corresponding to an expected throughflow of 200m^3/d or 2.4L/s (Appendix 6).

JDA also extrapolated that the development area receives surface drainage from external catchments including:

- Manning Road and Conlon Street catchment (approximately 6.9ha) that discharges into the north-western area of the wetland via piped drainage.

- Centenary Avenue catchment (approximately 26.0ha) that includes urban areas to the east of Centenary Avenue and north of Manning Road, discharging into the area via a piped drain under Centenary Avenue into the eastern region of the wetland.

- Two smaller catchments to the west (1.0ha) and south-east (1.5ha) that may discharge into the area from impervious areas as diffuse overland flow.

On the basis of this information, JDA estimates that the total upstream area draining into the East Clontarf development area is approximately 35.4ha of which 33.9ha drains directly into the wetland and is then discharged to the Canning River via the outlet drain constructed between the wetland and the river.

Wetland Hydrology

JDA's wetland investigation included identifying the source of wetland inflow and analysing the behaviour of wetland water levels under varying conditions.

During fieldwork in late 2002, the flow rate discharging from the western wetland to the Canning River was estimated by JDA to be in the order of 20 L/sec. In May 2003, using culvert hydraulics modelling software, JDA estimated the discharge through the culvert as 17L/s.

Calculations incorporating 35% rainfall runoff from the 46.1ha catchment during a 790mm/yr rainfall corresponds to 4L/s surface runoff, which is far less than the observed discharge rate. With the estimated groundwater throughflow in the Leederville aquifer being 0.1L/s neither of these two sources is likely to provide sufficient runoff as observed through the culvert.

JDA consider it likely that the inflow to the wetland sustaining the 20L/s discharge to the Canning River is discharge from the superficial formation. In order to determine the location of superficial groundwater discharge into the wetland, further field investigations were undertaken by JDA in early 2003. These investigations involved establishing seven 20m long transects along the northern bank of the wetland thereby allowing the extent of the seepage face for the wetland to be determined (Appendix 6).

The results of this investigation include:

- the groundwater inflow to the wetland is from a diffuse seepage face along the northern boundary;
- the extent of the wetland based on hydrological characteristics supports ATA Environmental's mapping as a more accurate representation of the extent of the wetland boundary when compared to WRC's Wetland Atlas (Hill, *et al*., 1996) and the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* wetland mapping;
- confirming the presence of a water table gradient across the wetland from east to west (see Figure 10);
- seasonal variations in water table within the wetland and the project area are small, in the order of 0.03m, compared to more typical seasonal groundwater variations of 1.0-1.5m on the Swan Coastal Plain;
- groundwater is estimated to contribute approximately 83% of wetland inflow; and

- peat is unlikely to be acting to create a perched water table due to the constant groundwater discharge associated with the wetland to the Canning River.

3.8.3 Potential Impacts

Potential impacts of the development on surface water quality include:

- altering the hydrology of the wetland and discharge through the drain outlet due to removal of peat from the eastern wetland;

- alteration to the fresh water flow volumes and/or quality in the wetland and to the stream and river;

- pollution of the wetland, stream and river ecosystem by sediment, nutrients and organochlorine and heavy metal compounds that may be released from the wetland sediment during earthworks associated with wetland modification and construction activities; and

- pollution of the wetland, stream and river ecosystem by acidic water as a result of acid sulfate soil reactions associated with the wetland modification and construction activities.

JDA Hydrologists concluded that the subdivision design would not significantly alter the water balance of the wetland (refer to Appendix 6).

3.8.4 Proposed Management

The outlet drain between the wetland and the river will be retained in the wetland reconstruction. The Paperbark/Flooded Gum wetland to be constructed in the vicinity of the outlet drain will not be connected to the drain.

3.9 Foreshore

3.9.1 EPA Objective

To maintain the integrity, ecological functions and environmental values of the foreshore environment.

3.9.2 Existing Environment

The East Clontarf site lies adjacent to the Canning River. The 1 in 100-year floodway level extends approximately 30m into the site from the river. The flood fringe extends only a short distance further inland than the floodway. The proposed development area lies outside of the area affected by the 1 in 100-year flood events.

The Foreshore Reserve vegetation on the site is a part of Bush Forever Site No. 333 (Canning River Foreshore, Salter Point to Wilson). The foreshore area is reserved for Parks and Recreation in the MRS and is linked to Bush Forever Sites No. 227 (to the west) and 224 (to the east).

The purpose of the Foreshore Reserve is generally to ensure protection and conservation of a watercourse and the ecosystems it supports. The conservation of the Foreshore Reserve enables a 'movement corridor' to be created allowing fauna to move freely along this length of the Canning River foreshore. Delineation of the Foreshore Reserve also takes into account the adjacent land use and expected pressure and type of use of the foreshore such as passive recreation and public appreciation and amenity. Protection of the integrity of the watercourse, including the attributes and functions, benefits to other users and values of the foreshore area such as recreational use and landscape amenity have been important determinants in the development of the proposed residential subdivision.

The currently defined Foreshore Reserve boundary under the MRS does not include all riparian vegetation. The extent of riparian vegetation that includes small salt marshes, reed beds and scattered Paperbark trees has been mapped as part of the investigations carried out for the proposed development. The foreshore area contains a narrow strip of sedge known as Sea Rush (*Juncus kraussii)* ranging in width from 10m to 30m wide. Samphire (*Halosarcia halocnemoides*) also occurs in patches along the foreshore.

3.9.3 Potential Environmental Impacts

Based on available WRC floodplain information, the proposed development area lies outside of the area affected by the 1 in 100-year flood events and therefore should not be at risk of flooding.

There are a number of potential indirect impacts on the foreshore environment that may occur as a result of the proposed development. These include:

- the introduction of weeds during construction activities; and

- an increased use of the area by both residents and visitors enabling uncontrolled access to the foreshore area resulting in trampling of vegetation and disturbance of fauna.

3.9.4 Proposed Management

All of the foreshore vegetation adjacent to the Canning River and contained within Bush Forever Site No. 333 will be protected within a conservation area. An additional 6000m^2 of POS that will abut the Bush Forever Site will be effectively added to the Foreshore Reserve and will act as a buffer between the proposed development and the Bush Forever Site.

A Foreshore Management Plan will be prepared and implemented with management strategies focussing on the following aspects:

- management of the foreshore area and development interface;

- rehabilitation of degraded areas in the foreshore area;

- provision and alignment of recreational facilities, including limiting access to the foreshore area;
- installation of signage; and
- management of drainage and nutrients from the proposed development.

The implementation of a revegetation program to improve degraded areas in the POS area will assist in the enhancement of the habitat for native fauna species, intercept and assimilate the potential movements of nutrients into the river and enhance the natural buffer zone between the proposed development and the foreshore reserve. Importantly, revegetation of degraded areas will provide a natural barrier to the movement of people beyond the proposed access path.

The objective of retaining and enhancing the existing native vegetation within the POS area and foreshore reserve will be achieved by controlling access to designated paths. A dual use path (DUP) will be constructed between the residential area and the Foreshore Reserve, and built within the reserve. The DUP will enable residents and visitors the opportunity to view the river foreshore and associated vegetation. The proposed location of the DUP is shown in Figure 3.

Development adjacent to the POS area is primarily residential. Construction activities in these areas will require some earthworking including the importing of fill to increase the base level to 2.5mAHD. TABEC, consulting engineers for the proponent, have provided indicative lot levels for the whole of the site. These are included as Figure 11.

Site surface recontouring activities will be contained within the designated development area. The interface between the development area and the POS area will be defined by terraced limestone walls and a dual use pathway/boardwalk (refer to Figures 3 and 4).

To ensure the construction activities associated with the proposed development do not extend into the foreshore or POS area, the limit of development will be clearly delineated with stakes and flagging tape prior to and during earth working activities on the site.

The implementation of a revegetation program to improve degraded areas in the POS area will provide a natural barrier to the movement of people beyond the proposed access paths. The areas requiring revegetation are located primarily in the eastern region of the POS area as shown in Figure 3. The surrounding native vegetation in this area is fairly limited in terms of species diversity therefore to encourage species richness only species known to occur over other parts of the river foreshore will be used in revegetation works.

There are currently no plans to fence the foreshore reserve and additional POS area. In areas adjacent to paths and access points the vegetation may need to be augmented to provide a natural barrier to prevent pedestrians from straying from the paths. Species common to the area (such as those listed in Table 5) should be relatively easy

to establish in the conditions and will provide a dense stand that should discourage divergence from paths.

To ensure the development and the POS area is fully integrated and utilised by prospective home owners and members of the public, BBQ facilities and a playground will be located in the eastern area adjoining the POS (Figure3). The siting of these facilities within close proximity to the drainage basin will ensure clearing of native vegetation is minimised and that shelter and shade will be provided by the stand of Marri trees present in this area.

Signage will be installed in the foreshore area to advise the public of revegetation works and the necessity to use designated paths.

In addition, public awareness of the value of the foreshore ecosystem will be promoted including the current issues affecting effective management of the foreshore area through the provision of signage. Within the foreshore area there are a number of forms this signage can take including:

- Directional – eg. to indicate location of paths and facilities and points of interest.

- Interpretative – eg. explanations of the natural environment, including descriptions of native vegetation, native fauna utilising the area, descriptions of work in progress and the reasons for prohibitive measures (such as fires, vehicle access and dog controls).

The development of the site will generate stormwater from hard surfaces such as roads and paths. The treatment of this stormwater has been designed to comply with the requirement of the Statement of Planning Policy No. 2 ie to 'maximise the consumption and retention of stormwater drainage on site'.

Stormwater generated from a portion of the proposed development will be collected in a basin to be constructed in the south-eastern area of the POS adjacent to the BBQ and playground facilities.

A secondary objective of the stormwater basin will be to act as a detention area for stormwater in which nutrients and other pollutants are concentrated. The resultant batters of the basin will be at a maximum slope of 1 in 6. One-year Average Recurrence Interval (ARI) events will be infiltrated where possible, consistent with the WRC's Interim Position Statement, February 2003.

Stormwater will enter the basin from a pipe outlet. The bank and base of the basin will be reinforced with limestone at the outlet point/s to prevent scouring and erosion should overflow occur.

The detailed design of the basin and scour protection measures will be prepared to the satisfaction of the City of South Perth.

No stormwater drainage will be directly discharged into the Foreshore Reserve from the proposed development.

3.10 Soil Quality

3.10.1 EPA Objective

To ensure the rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.

3.10.2 Existing Environment

Environmental geology mapping of the site shows that a large part of the site is considered to be part of the Canning River floodplain (Jordan, 1986). A wetland located in the centre of the site is identified as a marsh comprised of white to pale grey sand, with medium to coarse grain size of sub-angular to sub-rounded quartz. The sand has abundant shells and shell fragments.

Surrounding the wetland are Bassendean Sands which are described as white to pale grey sand at the surface and yellow at depth. The sand is of fine to medium-grain size, sub-angular to sub-rounded with minor heavy minerals of aeolian origin (Jordan, 1986). A geotechnical investigation presents information on the surface deposits over the Study Area and interprets the sand as Bassendean sand rather than river floodplain (Coffey, 2000).

Previous investigations completed at the site include:

- Report on Geotechnical studies, East Clontarf Manning, Coffey Geosciences Pty Ltd, October 2000.
- Environmental Assessment, East Clontarf, Manning, ATA Environmental January 2001.
- Preliminary Assessment – Asbestos Contamination East Clontarf, ATA Environmental May 2002.
- Remediation Report Asbestos Contamination East Clontarf, ATA Environmental September 2002.

Geotechnical Survey

A geotechnical assessment of the site was undertaken by Coffey Geosciences Pty. Ltd. (Coffey, 2000). Coffey divided the subsurface conditions in the East Clontarf site into five areas (Areas 1 to 5) based on field data together with engineering judgement (see Figure 8). The division was based on the presence of uncontrolled fill and peaty soils overlying natural soils in the site. A brief description of these areas is provided below.

Areas 1A, 1B and 1C, which represent most of the elevated parts of the site, are underlain by a natural soil profile. Uncontrolled fill and peaty soils were not encountered in this area at the locations tested. The subsurface conditions in Area 1A located at the south-eastern part of the East Clontarf site comprised medium dense sand overlying clayey sand, sandy clay and clay of the Guildford Formation. There is

a low hill on the northern part of Area 1A. This hill is likely to comprise sand, as can be seen from old excavation exposure of the side of the hill (Coffey, 2000).

Area 2A is a slightly elevated section between the wetland and the river. This area contains uncontrolled fill over natural medium dense sand and clayey sand, sandy clay and clay of the Guildford Formation. The fill materials encountered in test pits CTP23 and CTP24 contained traces of plastics, brick blocks, brick fragments and steel products. A large stockpile of building rubble was noted within the vicinity of CTP23 and CTP16 at the time of fieldwork. Uncontrolled fill sand was also encountered in test pit CTP12 overlying sand and coffee rock at 1.8m depth below ground level. Backhoe bucket refusal was recorded on Coffee Rock at 2.2m depth below ground surface (Coffey, 2000).

Area 2B included the community market garden that was located adjacent to Manning Road. It was anticipated that this area contained uncontrolled fill that may comprise soil with high organic content. This sub-area was not tested during the course of this investigation (Coffey, 2000).

Areas 3A, 3B, 3C and 3D are low-lying areas in or adjacent to the wetland and river foreshore reserve. These areas contain uncontrolled fill and peaty soils overlying natural soils. The natural soils were generally medium dense sand over clayey sand, sandy clay and clay of the Guildford Formation. The fill materials were generally sand, but test pits CTP3, CTP7, CTP10 and CTP25 contained traces of some brick blocks and fragments, concrete fragments, wood pieces, aluminium sheets, steel rods, plastics, steel strips, concrete slabs, concrete columns, tile bricks, concrete blocks, steel pipes, and asbestos cement sheets (Coffey, 2000).

Areas 4A and 4B mostly cover the swampy areas of the wetland and foreshore reserve. These areas contain peaty soils overlying natural soils comprising sand and clayey sand, sandy clay and clay of the Guildford Formation (Coffey, 2000).

Area 5 encompasses an area at the north-western corner of the East Clontarf site that is currently occupied by existing residential houses. Testing was not undertaken in this area. It was assumed that Area 5 overlies a deep natural sand profile (Coffey, 2000).

Soil Quality – Preliminary Investigation

In 2000, ATA Environmental undertook an environmental assessment of the site including a preliminary soil and groundwater contamination investigation in conjunction with the geotechnical investigations undertaken by Coffey Geosciences Pty Ltd (ATA Environmental, 2001). The purpose of the investigation was to identify potential soil contamination that may exist at the site due to historical land uses.

The soil investigation included the collection and subsequent analysis of judgemental soil samples from selected test pits excavated during geotechnical investigations. The preliminary soil investigation concentrated on the areas associated with the uncontrolled fill.

The potential for soil contamination was also noted within the market garden area and beneath the building pads associated with the residential dwellings of Area 5. However, due to occupation within the buildings at the time of sampling, it was decided to conduct further investigations of the building pads at a later date.

Soil samples soil samples were submitted to a NATA accredited laboratory and analysed for organochlorine pesticides, heavy metals, total petroleum hydrocarbons and asbestos.

All analytical results were compared to Ecological Investigation Levels (EILs) due to the proximity of the Canning River and the shallow groundwater table.

Only one of the soil samples analysed (EC CTP10 0 - 50cm) indicated contaminant concentrations above the EIL criteria. This sample contained 0.23mg/kg dieldrin, which is slightly above the EIL of 0.2mg/kg. Organochlorine pesticides were not detected in any other sample which suggest that the sample is representative of a localised hotspot.

Asbestos was not detected in any of the soil samples analysed. A section of fibrous cement piping was collected from within testpit CTP10 was submitted for asbestos laboratory analysis. Laboratory analysis confirmed that the piping contained chrysotile and amosite fibres (asbestiform minerals).

The geotechnical investigation identified imported fill material in Areas 2A, 3A, 3B, 3C, 3D. ATA Environmental recognised the potential for contamination within the imported fill material. In addition, pesticide contamination may exist within the market garden soil and beneath the pads of residential dwellings in Area 5.

Soil Quality - Detailed Site Investigation

As a result of the preliminary investigations, a Sampling and Analysis Plan was prepared to provide the scope of work for a Detailed Site Investigation (DSI). The DSI provided the basis for a Site Management Plan for soil excavation and dewatering during site redevelopment. The DSI was conducted in accordance with the DEP guidelines for Development of Sampling and Analysis Programs (DEP, 2001b).

The objectives of the detailed soil contamination investigation were to:

- further define the extent and characteristics of the uncontrolled fill material used in areas 2A, 3A, 3B and 3C;
- further define the characteristics of the soil in the market garden area (Area 2B); and
- to confirm that the soil contamination from the adjacent rubbish tip does not extend into the East Clontarf site.

A total of 349 samples were collected over a five day period and submitted and analyised by SGS Environmental Services. SGS holds National Association of

Testing Authorities (NATA) registration for the particular parameters and methodologies required to analyse the soil samples.

The location, areal extent, number of samples taken per location and analytical parameters analysed for per sample are shown in Figure 12.

Results were compared to the Ecological Investigation Levels (EILs) provided in the *Assessment Levels for Soil, Sediment and Water (Draft)* (DEP, 2001a) in view of the shallow depth to groundwater and proximity of the site to the Clontarf Bay.

The results indicate the soils on the site are generally free of contamination with the only significant elevations of contamination above EIL criteria being associated with uncontrolled fill that has been dumped on the site or where some landfill material from an adjacent former landfill site extends onto the East Clontarf site.

Soil assessment results are provided as follows:

- Table 6 presents the results for all samples where contaminant concentrations were recorded above EIL criteria; and

- Brief comments are presented on the contamination status of each of the areas of the site that were identified in the SAP as being at highest risk of contamination.

Market Garden Area

The concentrations of all analytes within samples collected from the market garden are either below the LOR or EIL assessment criteria. This area can therefore be regarded as free of contamination.

Landfill Investigation Area

The concentrations of all analytes within samples collected from the Landfill Investigation Area are either below the LOR or EIL assessment criteria except for chromium at TP139, depth interval 1.5m (Table 6). The chromium concentration at this location is equivalent to the EIL criterion and was detected in the natural underlying clays. The background concentration of chromium concentrations is commonly elevated in clays and this detection is considered to be a natural property of the soil.

Landfill material was evident as a thin lens in the 0-300mm profile of TP136. The material comprised yellow sands with trace fragments of plastic bags overlying the grey sands of the Bassendean Dune Formation. Analyte concentrations within soils sampled at this location were less than EIL assessment criteria.

Methane gas (the main component of concern in Landfill Gas) was not detected in any of the Landfill Investigation Area test pits.

Uncontrolled Fill Area

A total of 26 of the 94 sampling locations excavated within the areas identified by Coffey 2000 as comprising uncontrolled fill contained demolition rubble. This material occupies an area of approximately 17,000m^2 of the site.

The remaining area delineated by Coffey (2000) as uncontrolled fill comprises clean grey to brown, fine, sub rounded, well sorted sands and peaty soils overlying silty sand or sandy clay.

The uncontrolled fill material appears to be relatively uniform in contents across the site and comprised predominantly dark grey sand and the following:

(a) Bricks and brick fragments;
(b) Concrete blocks, slabs and rubble;
(c) Glass bottle fragments;
(d) Ceramic tile and fragments;
(e) Incinerated wood pieces;
(f) Metal sheets, rods and piping; and
(g) Asbestos cement sheeting fragments.

The thickness of the uncontrolled fill varies from 0.1 to 1.5m. The thickest sections of the fill are present at TP60 and TP53.

A number of samples within the area of uncontrolled fill indicated contaminant concentrations in excess of EIL criteria. The analytes that were detected in concentrations above EIL were metals (arsenic, cadmium, lead and zinc) and the organochlorine dieldrin. TPH, PAH and PCB concentrations in soils collected from all uncontrolled fill sampling locations were below the relevant EIL criteria.

Chrysotile and/or crocidolite asbestos was confirmed to be present in the uncontrolled fill material at sampling location and depth intervals TP34 0.3m, TP39 0.5m, TP73 0.5m and 76 0.2m. The scattered nature of the asbestos found suggests that the fibres have been released from the fragments of asbestos cement sheeting present in the uncontrolled fill.

TABLE 6
SAMPLING LOCATIONS WITH ANALYTE CONCETRATIONS ABOVE EIL CRITERION

Area	Sample Location and Depth Interval	Soil Description (See Appendix 4)	Analyte Detected Above EIL	Concentration (mg/kg)	EIL (MG/KG)	Vertically Defined	Horizontally Defined
Landfill	TP 139 1.5m	Mottled sandy clay	Chromium	**50**	50	No	No
2A	TP 90 1.5m	Mottled sandy clay	Chromium	**50**	50	No	No
2A	TP 113 0.5m	Mottled sandy clay	Chromium	**51**	50	No	No
3A	TP 46 0.5m	Uncontrolled Fill	Zinc	**610**	200	Yes	Yes
3A	TP 48 0.2m	Uncontrolled Fill	Lead	**460**	300	Yes	Yes
3A	TP 55 0.5m	Uncontrolled Fill	Arsenic	**22**	20	Yes	Yes
3A	TP 56 0.5m	Sand	Cadmium	**3.4**	3	Yes	Yes
3A	TP 60 0.5m	Uncontrolled Fill	Zinc	**230**	200	Yes	Yes
3A	TP 73 0.5m	Uncontrolled Fill	Zinc	**380**	200	Yes	Yes
3A	TP 75 1.0m Dup	Uncontrolled Fill	Dieldrin	**0.2**	0.2	Yes	Yes
3D	TP 120 0.5m	Uncontrolled Fill	Zinc	**200**	200	Yes	Yes
3D	TP 121 0.5m	Uncontrolled Fill	Zinc	**620**	200	Yes	Yes

3.10.3 Potential Impacts

The detected contaminants above EIL trigger a requirement for management action.

For environmental or health impacts to occur, it is necessary that both the concentration of the contaminant is sufficient to cause an impact on a receptor and an exposure pathway exists which brings the contaminant into contact with the receptor.

The nature of the contaminants detected in soils on the proposed East Clontarf development (predominantly metals and asbestos) is such that the predominant exposure pathways of concern are inhalation and ingestion.

3.10.4 Proposed Management

Areas of soil identified as contaminated in excess of EIL criteria will be excavated and the base and walls of the excavations validated in accordance with relevant DoE Guidelines for the Remediation of contaminated land (DEP, 2001, a, b and c).

The excavated soil will then be assessed to determine the appropriate management option. The currently preferred management option for excavated soils is disposal off-site but a final decision on the management of excavated contaminated soils will be made once analytical results are available for excavated soil. An alternative that may be considered is to screen the material to remove geotechnically unsuitable materials and then re-use the material as fill in appropriate areas on the site such as POS. Approval would be sought from the DoE and City of South Perth before re-using excavated soils in this manner.

A detailed remediation assessment report will be submitted to DoE on conclusion of remediation works that provides detailed information on:

- the remediation strategy implemented;
- the results of validation and stockpile sampling; and
- details of the management of all contaminated material.

3.11 Acid Sulfate Soils

3.11.1 EPA Objective

Plan and manage development that may potentially impact on ASS to avoid adverse effects on the natural and built environment and human activities and health.

3.11.2 Existing Environment

Assessment of the Site Geology

Acid sulfate soil (ASS) is the common name for soil containing iron sulfides or their oxidation products. When acid sulfate soils are exposed to air, the iron sulfides (commonly iron pyrite) oxidise and produce sulfuric acid and result in the release of soluble iron, sulfate, aluminium and other metals. This leachate has been responsible

for environmental damage, damage to infrastructure and buildings, and human health problems.

The following geomorphic or site description criteria are generally used to determine whether ASS is likely to be present:

a. land with elevation less than 5 metres AHD;
b. soil and sediment of recent geological age (Holocene);
c. marine or estuarine sediments and tidal lakes;
d. low-lying coastal wetlands or back swamp areas, waterlogged or scalded areas,
e. stranded beach ridges and adjacent swales, interdune swales or coastal sand dunes;
f. coastal alluvial valleys;
g. areas where the dominant vegetation is tolerant of salt, acid and/or waterlogging conditions eg. mangroves, saltcouch, swamp-tolerant reeds, rushes, paperbarks (*Melaleuca spp*.) and swamp oak (*Casuarina spp*.); and
h. areas identified in geological descriptions or in maps as:
i. bearing sulfide minerals;
j. coal deposits or marine shales/sediments (geological maps and accompanying descriptions may need to be checked); and
k. deep older estuarine sediments below ground surface of either Holocene or pre-Holocene age.

In the Perth area, specific examples of disturbances of acid sulfate soils include sediments disturbed during bridge construction at the Garrett Road and Guildford bridges on the Swan River; the Ozone Lakes development on the Swan River foreshore; disturbances in Stirling, Osborne Park, Bassendean, Guildford and Bayswater; and exposure of acid sulfate soils in wetlands eg Lake Gnangara.

As a result of information compiled for soil and groundwater quality assessments, it was concluded that the soils, geochemistry and topography of parts of the East Clontarf site are consistent with the potential occurrence of ASS. In particular the low-lying and peat affected areas of the site meet the following criteria from the list above (a, b, c, d, e,).

In particular, peat soils occupy an area of approximately 100,000m^2 on the site. The majority of this area is to remain undisturbed during the facilitation of the proposed bulk earthworks. An area of approximately 50,000m^2 will be disturbed either by dewatering practises or excavation works during development of the site.

As a result, it was concluded that the site should be investigated for the presence of ASS.

Site Investigations

A preliminary ASS investigation was conducted in accordance with the "Detailed Soil/Groundwater Contamination and Preliminary Acid Sulfate Soils Investigation, Sampling and Analysis Program (SAP)" prepared by ATA Environmental in December 2003. The DoE approved the SAP in March 2003.

The SAP undertaken in 2003 included an investigation methodology to be facilitated to assess the likelihood that ASS existed at the site.

The objectives of the preliminary ASS investigation were to:

- determine whether potential acid sulfate soils (PASS) exist within the peat soils to be disturbed during earthworks associated with the development at the site;
- determine whether PASS exist within areas to be influenced by the cone of depression attributed to the localised dewatering practises during earthworks associated with the development of the site;
- present a cross-sectional diagram showing the PASS materials within the site; and
- determine whether an Acid Sulfate Soil Management Plan (ASSMP) is required to be prepared and submitted to the DoE.

This investigation was conducted in accordance with:

- Draft Soil Management Guidelines. Queensland Acid Sulphate Soil Technical Manual. Department of Natural Resources and Mines (Dear *et al.,* 2002).
- Acid Sulphate Soils Manual 1998. Acid Sulphate Soils Management Advisory Committee. (Stone *et al.,* 1998).
- Draft DEWCP and EPA Guidance on Acid Sulfate Soils (2002).
- Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland (1998).

The Queensland (Dear *et al*., 2002) and New South Wales (Stone *et al.,* 1998) guidelines for development of sampling and analysis programs for acid sulphate soils assessments The outcomes of the field testing procedures were:

- the natural pH of soils on the site during the investigation did not vary greatly either vertically or laterally. All pH_F values were greater than pH 5;
- actual acid sulfate soils (AASS) was not detected at any of the ASS soil boring locations (ie pH >4); and
- four (4) of the ten (10) boring profiles exhibited PASS based on field pH. Eleven of 120 soil samples subjected to the field testing procedure exhibited PASS after field oxidation.

Based on TAA and sulfur trail percentages provided by S_p and S_{CR} results eight (8) of the ten (10) soil profiles exhibit soils that trigger one or more of the action criteria requiring a management plan to be formulated.

PASS is present in the silty sand or to a lesser extent, peaty soils. S_{CR}% ranged from <0.02 to 0.073 in the peat soils and <0.02 to 0.377 in the silty sands.

Of the eight (8) soil profiles which triggered the action criteria, sample EC ASS 7 shows potential acidity above 18mol H+/T although it does not exhibit detectable inorganic reduced sulfur forms (ie SCR <0.02%).

There was good correlation between field data and laboratory data although in some instances laboratory data indicated the presence of PASS when the field test result was negative. In these instances (EC ASS 8, EC ASS 10), S% was low and close to the action criteria of 0.03%. The EC ASS 5 profile showed SCR% of 0.325% whilst had a pHF_{OX} of >4. This is most likely attributed to insufficient time allowance for the reaction to occur during the field test (as time is limited in the field). All other depth intervals in this profile exhibited SCR percentages below the detectable range.

There is a good correlation between S_P and S_{CR} results, which indicates minimal organic sulfide interferences in the SPOCAS method.

Of the profiles subjected to SPOCAS analysis it appears that the soils of the site have limited self-neutralising capacity.

Table 7 provides a summary of the location and thickness of profiles that exhibit characteristics of ASS that trigger a management plan. It also provides the elevation (mAHD) of groundwater and elevation of PASS material of each profile. Figure 14 illustrates a cross-sectional representation of PASS.

TABLE 7
GROUNDWATER AND PASS ELEVATIONS OF PROFILES EXHIBITING ASS

Profile Description	Depth To Detected PASS Below Grade (m)	Approximate Depth To Groundwater (m)	Grade Elevation (mAHD)	Approximate Groundwater Elevation (mAHD)	PASS Elevation (mAHD)	Saturation Thickness above PASS (m)
EC ASS 2	2.00	1.2	1.63	0.43	-0.37	0.80
EC ASS 3	2.50	1.7	2.79	1.09	0.29	0.80
EC ASS 4	2.00	1.5	2.58	1.08	0.58	0.50
EC ASS 5	3.00	0.7	2.20	1.50	-0.80	2.30
EC ASS 6	0.75	0.1	1.99	1.89	1.24	0.65
EC ASS 8	0.5	0.1	2.82	2.72	2.32	0.40
EC ASS 10	0.5	0.3	2.42	2.10	1.92	0.18

Based on the data collected during the preliminary ASS investigation, the following conclusions have been made:

- no actual Acid Sulfate Soils (AASS) appear to be present on the site;
- soil profiles have been identified in some areas of the site that contain Potentially Acid Sulfate Soils (PASS) as a result of triggering either the oxidised pH criteria or the sulphur trail criteria; and

- a need therefore exists to develop an Acid Sulfate Soil Management Plan for the site.

3.11.3 Potential Impacts

Acid sulfate soils are not an environmental risk until exposed to oxygen through excavation or dewatering practices. When disturbed, these soils can rapidly produce sulfuric acid and mobilise heavy metals. The disturbance of these soils can significantly impact on the natural environment presenting serious potential risks to aquatic environments, compromise sub-surface infrastructure, affect construction materials and alter fill compaction levels.

These impacts can be prevented through early identification of the presence of ASS and the application of appropriate management practices during the construction period.

3.11.4 Proposed Management

An Acid Sulfate Soil Management Plan will be developed, prior to construction commencing, in accordance with the DoE's published guidelines (DEWCP, 2002).

Following approval by DoE, the plan will be implemented throughout the construction phase of the project.

The management practices finally adopted will be determined in conjunction with the engineering design of the subdivision. The general principles that will be applied include:

- The area of PASS soils to be disturbed by excavation of dewatering will be minimised as far as possible;

- Where ASS soils must be disturbed:

    - Earthworks will be completed as quickly as possible to minimise the time that the walls and base of excavations are exposed to atmosphere.

    - Un-neutralised ASS/PASS soils will be stored for only limited periods on site on bunded hardstand areas constructed from alkaline materials.

    - The quality of groundwater and dewatering effluents will be monitored regularly to ensure early detection of any alteration in water chemistry.

    - If necessary dewatering effluent will be treated to ensure appropriate water quality is maintained.

- Where excavated soils must be directed for off-site disposal, they will be directed to a site approved for acceptance and/or treatment of ASS by the DoE.

3.12 Noise

3.12.1 EPA Objective

To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

3.12.2 Existing Environment

The site is bound to the east by Centenary Avenue and to the north by Manning Road. Both these roads carry high traffic volumes and this may impact on the residents of the proposed development. There is existing low density housing to both the east and north-east of the subject land.

The potential noise impacts considered include construction noise on existing nearby residents and the potential for existing and future transport related noise on residences built within the subject land.

Noise received at the existing residences surrounding the site from construction equipment will need to comply with the requirements of the *Environmental Protection (Noise) Regulations* 1997 and specifically Regulation 13 "Construction sites". Where construction is undertaken during the day (0700 to 1900 hours) only, the occupier of the construction site must:

1. Carry out work in accordance with Section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites.
2. Use equipment that is the quietest reasonably available.
3. Prepare a noise management plan if required by the CEO of the local council.

Transport noise is specifically excluded from *the Environmental Protection (Noise) Regulation 1997* under Regulation 3(a). Main Roads Western Australia *have Noise Level Objectives* to satisfy at residences, which in the case of new residences is 63dB$L_{A10(18\ hour)}$. The EPA has a policy representing best practice, which is *EPA Statements for EIA No. 14 (Version 3) Road and Rail Transportation Noise (Draft 10/05/00*).

3.12.3 Potential Impacts

Noise Emissions from Local Roads

Future residences located adjacent to the northern and eastern boundaries of the development site will receive noise from vehicles travelling along Centenary and Manning Roads. Transport noise can impact on the health, welfare and amenity of future residents.

Herring Storer Acoustics has undertaken an assessment of the impact on existing and future ambient noise levels on the subject land. Calculations to the year 2021 have been undertaken.

Noise modelling undertaken indicates that predicted existing $L_{A10(18\ hour)}$ noise levels at the nearest proposed residences ranges from 59dB to 67dB. Based on the estimated increase in road traffic volumes, the corresponding increase in noise levels is 1dB (ie 60dB to 68dB in the year 2021) (Herring Storer Acoustics, 2003). This assessment is included in full as Appendix 8.

Noise Emissions from Construction Activities

With regard to construction activity, the nearest noise sensitive premises is located approximately 50m east and 150m north-east of the site boundaries. Noise can be generated at the site by the operation of construction equipment including mobile earthmoving equipment.

Construction noise may impact on the health, welfare and amenity of nearby existing residents.

3.12.4 Proposed Management

Noise modelling of road traffic has been undertaken to assess predicted noise levels received along the northern and eastern boundaries of the proposed residential development.

Noise Emissions from Local Roads

In relation to potential road noise experienced by prospective residents of the proposed development, abatement methods may need to be identified to minimise noise impacts. Noise reduction required by building construction can be achieved by incorporating any or all of the following measures:

- construction of noise barriers between the roadway and residential lots;
- specifying appropriate setbacks of proposed residences from existing roadways; or
- specification of construction methods and materials (in keeping with "quiet house design" principles).

The principal conclusion of the traffic noise assessment undertaken (Herring Storer Acoustics, 2003) was that at locations where the Noise Level Objective of $63dBL_{A10(18\ hour)}$ is exceeded, noise control measures in the form of a perimeter wall, should be constructed. Additionally, those lots immediately adjacent the two major roads should carry a notification on the title advising of the possible high noise levels from road traffic and residences should be designed accordingly (ie. "quiet house design").

Noise Emissions from Construction Activities

Besides on-site earthmoving activity noise, the bulk of the earth to be excavated and removed from the site will be via the Manning Road exit located to the northern side

of the site. As a result, noise impact on the existing residences to the east of Centenary Avenue will be minimal.
Noise impacts from construction activities is usually managed by selection of working hours and lower noise emitting equipment. Noise received at the existing residence from construction equipment will need to comply with the requirements of the *Environmental Protection (Noise) Regulations 1997*: Regulation 13 "Construction sites". To ensure compliance with this, Noise Management Procedures will be developed for the site as part of the overall CEMP.

Noise Management Procedures will be developed in consultation with the DoE and City of South Perth.

3.13 Dust

3.13.1 EPA Objective

Protect the surrounding land users such that dust and particulate emissions will not adversely impact on their welfare and amenity or cause health problems in accordance with EPA's Guidance Statement No. 18 Prevention of Air Quality Impacts from Land Development Sites.

3.13.2 Existing Environment

The majority of the site is covered with some form of vegetative cover that helps to act as a natural suppressant lessening the potential problem of dust for surrounding residences. The nearest residential premises is located approximately 50m to the east of the site along the eastern boundary of Centenary Avenue, with other residences being located approximately 150m to the north-east of Manning Road.

Annual figures derived for morning (0900 hours) and afternoon (1500 hours) wind rose data for the Jandakot Airport weather station and provided by the Bureau of Meteorology (2002) is included in Tables 8 and 9 below.

The 0900 hours wind rose show the dominance of the easterly (25%) and north-easterly (17%) winds typically in the range of 11-20km/hr (39%) and 21-30km/hr (28%).

Seasonal wind patterns indicate winds in the mornings are predominantly from the east in summer, autumn and spring, while north-easterly winds dominate in winter mornings (23% occurrent). South-easterly winds occur more frequently in summer (18% occurrence) while northerly winds occur 21% of the time in winter.

TABLE 8
WIND DIRECTION, PERCENTAGE OCCURRENCE AND SEASONAL DATA TO DUST SENSITIVE LOCATIONS – 0900 HOURS

Km/h	WIND DIRECTION								
	N	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**	**All**
1 – 10	3	5	6	3	2	1	1	1	**21**
11- 20	6	6	9	6	7	2	2	1	**39**
21 – 30	2	6	9	3	2	2	3	1	**28**
> 30	*	1	1	*	*	*	1	*	**5**
All	**11**	**17**	**25**	**12**	**12**	**6**	**7**	**3**	**100**

Source: Bureau of Meteorology (2002). Based on records from Jandakot Airport Weather Station and based on 4648 observations analysed.

The 1500 hours wind rose show the dominance of the south-westerly (30%) and westerly (28%) winds typically in the range of 11-20km/hr (31%) and 21-30km/hr (51%).

Seasonal wind patterns indicate winds in the afternoons are dominated by west to south-west winds in all seasons. Northerly and north-easterly winds are most common in winter afternoons (16% and 8% occurrence respectively), while easterly are most frequent in autumn (17% occurrence), and south-easterly winds are most frequent in summer and autumn (occurring 9% of the time in both seasons).

TABLE 9
WIND DIRECTION, PERCENTAGE OCCURRENCE AND SEASONAL DATA TO DUST SENSITIVE LOCATIONS – 1500 HOURS

Km/hr	WIND DIRECTION								
	N	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**	**All**
1 – 10	1	1	1	1	1	1	1	*	**7**
11- 20	2	3	5	4	4	5	7	2	**31**
21 – 30	2	1	4	2	2	21	16	3	**51**
> 30	1	*	*	*	*	3	3	2	**10**
All	**6**	**5**	**11**	**7**	**6**	**30**	**28**	**7**	**100**

Source: Bureau of Meteorology (2002). Based on records from Jandakot Airport Weather Station and based on 4081 observations analysed.

Dust may be created during construction due to vehicular movement on unsealed roads and ground disturbing construction activities. As the majority of the disturbed areas of the site will be landscaped and paved following construction, significant dust generation during operation is unlikely.

The EPA guidelines (EPA, 1996) contain an assessment chart to assist in the potential for adverse impacts as a result of dust and windborne material, and identifying the appropriate level of management for a site. The assessment chart determines the site classification based on the nature of the development site and the proximity to other land uses. The site classification indicates the level and type of management required to prevent dust problems from occurring and thereby protecting nearby land uses.

Common factors considered influencing the potential for airborne dust lift off and associated adverse impacts from development sites include:

- wind speed and direction;
- wind direction oscillation;
- area of land disturbed and exposed;
- soil dryness and compaction;
- the preventative measures implemented; and
- the proximity of nearby residents and land uses sensitive to dust impacts.

3.13.3 Potential Impacts

The subject land experiences moderate rainfall and seasonally strong winds with prominent diurnal cycles. Based on the viewed site conditions there is a relatively high potential for the generation of dust particularly during the summer should construction activities commence at the time. Land uses sensitive to impacts by dust are located within 150m of the site boundaries.

3.13.4 Proposed Management

The EPA guidelines indicate that areas of exposed disturbed land should be kept to a practical minimum and methods of dust suppression should be readily available on-site. The guidelines also indicate that the developer should also develop a contingency plan that details the measures to be implemented should impacts due to dust generation occur at the site.

Dust generated during construction will be minimised by the application of EPA guidelines and best practice in dust suppression (including watering of surfaces, minimisation of working surfaces at any one time and progressive rehabilitation of disturbed areas). Dust Management Procedures will be developed within the CEMP, in consultation with the DoE and City of South Perth.

3.14 Aboriginal Heritage

3.14.1 EPA Objective

To ensure changes to the biophysical environments resulting from the proposal do not affect historical and cultural associations within the area and comply with the requirements of relevant Aboriginal and heritage legislation.

3.14.2 Existing Environment

Consultation with local Aboriginal groups has been undertaken recently by McIntyre Dobson and Associates on behalf of the Christian Brothers.

The Clontarf Foreshore Management Plan (City of South Perth, 1993) included an investigation of the significance of the site for Aboriginal groups. However, this report was not conclusive, as Aboriginal representatives were not available for discussions at that time. It was recommended that the Nyungar people associated

with the area be given the opportunity to participate in the planning and management of the foreshore. The foreshore area may provide an opportunity for educational projects for the Clontarf Campus, including bird and plant identification, research, seed collection, plant propagation and rehabilitation.

As part of this project, Thomas O'Reilly on behalf of Macintyre Dobson and Associates undertook archaeological and ethnographic studies in 2000.
The Aboriginal Sites Register maintained by the DIA indicates two previously recorded ethnographic site, Canning River (S02550) and Clontarf East (S02304), in close proximity to the project area.

The Canning River site includes the entire length of the Canning River and associated creeks, tributaries and springs. Consultation and on site meetings with representatives of the local Aboriginal community confirmed that the Canning River is a site of major cultural and spiritual significance to traditional and contemporary Nyungars. The East Clontarf site was identified as part of a hunting, collecting and fishing ground of significance to the Nyungar people.

The Clontarf East site previously record in 1978 during the Swan Survey Project, was re-located and examined as part of O'Reilly's field survey in order to determine its current status. As a result of the field survey, it was established that the majority of the previously recorded site S02304 had been consumed by road work in the area, specifically the construction of Centenary Avenue and associated landscaping. No artefacts or archaeological material was observed in the remaining portion of site S02304.

A previously unrecorded archaeological site, referred to as Field Site 1, was located within the survey area by O'Reilly. This site was described as a small low-density artefact scatter (10 artefacts in total) and is located on a sand dune in the south-east corner of the site. The artefact assemblage recorded at this site is comprised of flakes (20%), flaked pieces (70%) and a single core (10%).

O'Reilly noted that Field Site 1 had been greatly disturbed in the past by recreational trail bike riders and four-wheel drive vehicles, resulting in numerous tracks being created across the dune. O'Reilly surmised that given the site's location in close proximity to reliable water sources, it was likely that this site was utilised as a camping ground or as a focus for hunting and foraging activities.

3.14.3 Potential Impacts

Thomas O'Reilly and Macintyre Dobson and Associates previously surveyed the project area for archaeological and ethnographic Aboriginal sites (Macintyre Dobson, 2000). The existing ethnographic site (SO2550) relates to the entire length of the Canning River. The river foreshore will be protected from the proposed development by the Bush Forever Site No. 333 and the additional 6000m^2 of Public Open Space being added to the existing Foreshore Reserve. The majority of archaeological site (S02304) has already been consumed by roadwork and associated landscaping with no artefacts or archaeological material being observed in the remaining portion of site S02304 located on-site. In order to undertake wetland rehabilitation and proposed earthworks for new Lot creation, Field Site 1 would be disturbed.

3.14.4 Proposed Management

The proponent has undertaken extensive consultation with representatives of the Clontarf Campus in relation to the proposed development and there are on-going negotiations and discussions taking place in relation to overall landscaping and enhancement of the wetland.
In respect to the previously recorded site S02304 and Field Site 1, the proponent, as required under section 18 of the *Aboriginal Heritage Act 1972*, will seek the consent of the Minister for Indigenous Affairs to proceed with activities that will disturb Aboriginal heritage sites.

The proponent will also undertake further archaeological investigations if required as part of the section 18 clearance. Such investigations may include, but not be limited to:

- surface recording, mapping and collection of archaeological material;
- archaeological excavation and/or sub-surface evaluation;
- recovery of samples for radiometric dating; and
- analysis of recovered material.

4. SUMMARY OF COMMITMENTS

This PER document provides information relating to the proposal to subdivide land wholly owned by the Trustees of the Christian Brothers in Western Australia Incorporated for the purposes of a residential estate. The document includes a description of the site, the characteristics of the proposal and identifies significant environmental issues.

Section 3 of this PER document identified the key environmental factors of significance that may be impacted both during the construction and the operational phase of the proposed residential development at East Clontarf, Waterford. In addition, the PER document also identifies how these impacts may be managed and specifies further studies or monitoring that will enable performance to be measured.

In accordance with the generic EPA guidelines for preparing a formal environmental review for the proposal, Table 10 presents a summary of the relevant environmental factors identified for this PER document including potential impact identified, proposed management and predicted outcome.

4.1 Construction Environmental Management Plan

The following CEMP will be implemented during construction and relates to construction-specific management requirements to maintain environmental quality.

The CEMP to be prepared and implemented for the site addresses each of the following issues: dewatering, wetland management, foreshore management, drainage irrigation nutrient and water quality management, noise, dust, soil contamination, acid sulfate soils and Aboriginal heritage.

Operational management during the period of the proposed subdivision will be identified in the various approved management plans discussed in Section 4.2.

4.1.1 Dewatering Program

Prior to commencing any dewatering, the proponent or their chosen contractor will apply for and obtain from the DoE a ‘Licence to Take Water’. All dewatering will be carried out in accordance with the conditions of the ‘Licence to Take Water’.

Should the dewatering activities require water to be discharged offsite, the proponent (or contractor) shall apply to the DoE for a ‘Disposal Licence’. Any discharge of water offsite shall be carried out in accordance with the ‘Disposal Licence’.

4.1.2 Groundwater Management Plan

Develop and implement a Groundwater Management Plan to the satisfaction of the DoE, that will include but not be limited to:

- nature and extent of groundwater contamination;

- groundwater flow characteristics; and
- groundwater contamination plume management.

4.1.3 Construction Noise Management Procedures

Noise Management Procedures will be developed and implemented to the satisfaction of the DoE and City of South Perth.

It is considered the following activities may cause complaints and as such measures will need to be taken to control such activities:

i) Starting of machinery before 0700hours;
ii) Working on Sundays and Public Holidays;
iii) Maintenance of machinery outside normal working hours; and
iv) Collection or delivery of plant outside normal working hours.

The only activity involving noise generation by machines proposed to take place outside the above nominated working hours will be dewatering using spears and mechanical pumps to lower groundwater. Dewatering is required to take place on a continuous 24-hour basis. It is therefore essential that pump engines, especially diesel, be appropriately muffled, located remote from residences and/or mounding, or other barrier, be provided to eliminate noise nuisance, especially outside of standard working hours.

4.1.4 Construction Dust Management Procedures

Construction Dust Management Procedures will be developed and implemented to the satisfaction of the DoE that will include, but not be limited to:

- watering of exposed surfaces;
- minimising working surfaces at any one time;
- wind fencing; and
- progressive stabilisation of disturbed areas (eg hydromulching).

4.1.5 Soil Remediation Procedures

Areas of soil identified as contaminated in excess of EIL criteria will be excavated and the base and walls of the excavations validated in accordance with relevant DoE Guidelines for the Remediation of Contaminated Land (DEP, 2001, a, b and c).

The excavated soil will then be assessed to determine the appropriate management option. The currently preferred management option for excavated soils is disposal off-site but a final decision on the management of excavated contaminated soils will be made once analytical results are available for excavated soil. An alternative that may be considered is to screen the material to remove geotechnically unsuitable materials and then re-use the material as fill in appropriate areas on the site such as POS. Approval would be sought from the DoE before re-using excavated soils in this manner.

A detailed remediation assessment report will be submitted to DoE on conclusion of remediation works that provides detailed information on:

- the remediation strategy implemented;
- the results of validation and stockpile sampling; and
- details of the management of all contaminated material.

4.1.6 Acid Sulfate Soil Management Plan

An Acid Sulfate Soil Management Plan will be developed, prior to construction commencing, in accordance with the published guidelines DEWCP (2002).

Following approval by DoE, the plan will be implemented throughout the construction phase of the project.

The management practices finally adopted will be determined in conjunction with the engineering design of the subdivision. The general principles that will be applied include:

- The area of PASS soils to be disturbed by excavation of dewatering will be minimised as far as possible;

- Where ASS soils must be disturbed:

    - Earthworks will be completed as quickly as possible to minimise the time that the walls and base of excavations are exposed to atmosphere.

    - Un-neutralised ASS/PASS soils will be stored for only limited periods on site on bunded hardstand areas constructed from alkaline materials.

    - The quality of groundwater and dewatering effluents will be monitored regularly to ensure early detection of any alteration in water chemistry.

    - If necessary dewatering effluent will be treated to ensure appropriate water quality is maintained.

- Where excavated soils must be directed for off-site disposal, they will be directed to a site approved for acceptance and/or treatment of ASS by the DoE.

4.1.7 Aboriginal Heritage

The proponent will apply for clearance under section 18 of the *Aboriginal Heritage Act 1972* to remove both previously recorded sites and any new sites that emerge as a result of earthmoving procedures located within the site that will be impacted by the proposed development.

The proponent will also undertake further archaeological investigations if required as part of the Section 18 clearance. Such investigations may include, but not be limited to:

- surface recording, mapping and collection of archaeological material;
- archaeological excavation and/or sub-surface evaluation;
- recovery of samples for radiometric dating; and
- analysis of recovered material.

4.2 Operational Management Plans

The following management plans will be developed and implemented for the whole-of-project and relate to ongoing management requirements to maintain environmental quality.

4.2.1 Wetland Management Plan

A Wetland Management Plan will be prepared and implemented to the satisfaction of the DoE, that will include, but not be limited to:

- Identification of existing wetland area to be retained;
- Avoiding direct and minimising indirect impacts on the wetland;
- Ensuring no net loss of wetland values and functions;
- Rehabilitation techniques to be employed;
- Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats;
- Mitigation strategies for loss of any vegetation will be investigated including both on-site and off-site options;
- Creation of a new Paperbark/Flooded Gum wetland area to be located adjacent to the existing wetland and the river foreshore and planted with tree, understorey sedge and shrub species common to the local riverine and wetland environment;
- Monitoring criteria to determine the success of the plan;
- Progress and compliance reporting; and
- Timing and implementation schedule.

4.2.2 Foreshore Management Plan

Develop and implement a Foreshore Management Plan to the satisfaction of the SRT, DPI and City of South Perth that will include, but not be limited to:

- Comprehensive weed eradication program;

- Revegetating and restoring foreshore POS adjoining conservation areas with appropriate indigenous flora of the Canning River;
- Increase the area contained within POS adjoining Bush Forever Site No. 333;
- Creation of habitat and wildlife corridors;
- Controlling vehicle and pedestrian access;
- Provision of public facilities;
- Soil and plant source material hygiene;
- Fire management including provision of fire hydrants;
- Provision of educational and interpretative materials within the area to raise awareness of JAMBA/CAMBA species that frequent the area;
- Encouraging community involvement and awareness promoting control of pets (eg cats and dogs);
- Monitoring criteria to determine the success of the revegetation and weed eradication program;
- Progress and compliance reporting; and
- Timing and implementation schedule.

4.2.3 Drainage, Nutrient, Irrigation and Water Quality Management Plan

Develop and implement a Drainage, Nutrient, Irrigation and Water Quality Management Plan to the satisfaction of the SRT and DoE, to include but not be limited to:

- Design and construct the detention/infiltration basin;
- Periodic monitoring of the infiltration basin (post-construction) to ensure continued function and maintenance as required;
- Maximising infiltration of uncontaminated stormwater at sources to recharge the groundwater system;
- Water conservation principles;
- Nutrient control;
- Prescribed fertilizer applications for areas of POS;
- Determination of flushing requirements, associated impacts and management options;

- Treating contaminated stormwater via gross pollutant and sediment traps;
- Directing treated stormwater into the Canning River along the south-eastern corner boundary of the site (as per DoE advice);
- Monitoring criteria to determine the success of the plan;
- Progress and compliance reporting; and
- Timing and implementation schedule.

TABLE 10

SUMMARY TABLE OF RELEVANT ENVIRONMENTAL FACTORS, POTENTIAL IMPACTS, PLANNED MANAGEMENT AND PREDICTED OUTCOMES FOR THE PROPOSED EAST CLONTARF RESIDENTIAL DEVELOPMENT

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
BIOPHYSICAL					
Vegetation	To maintain the abundance, diversity, geographic distribution and productivity of vegetation communities.	Much of the site has been cleared historically with only a few small remnant stands remaining. Vegetation surveys show 69 plant species (representing 25 families) occurring on-site with 47 of these being introduced species.	Development will involve clearing 1.57ha of native and exotic wetland vegetation.	Retention of small stands of dryland remnant vegetation. Areas of vegetation not proposed to be cleared will be flagged and specifically identified in site inductions. Develop and implement a Wetland Management Plan to the satisfaction of the DoE, that will include but not be limited to: • Identification of existing wetland area to be retained; • Avoiding direct and minimising indirect impacts on the wetland; • Ensuring no net loss of wetland values and functions; • Rehabilitation techniques to be employed; • Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats; • Mitigation strategies for loss of any vegetation will be investigated including both on-site and off-site options; • Creation of a new Paperbark/Flooded Gum wetland area to be located adjacent to the existing wetland and the river foreshore and planted with tree, understorey sedge and shrub species common to the local riverine and wetland environment; • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.	Based on the review of the available literature, results of the vegetation surveys undertaken and knowledge of the extent of the development and reasonable construction to be adopted, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to vegetation (predicted impact low with a high degree of confidence).
Significant Flora	To protect Declared Rare and Priority Flora consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect other flora of conservation significance.	No Declared Rare or Priority flora species were recorded on the site during the flora surveys.	No loss of, or disturbance to, any species of Declare Rare and Priority Flora.	Areas of vegetation not proposed to be cleared will be flagged and specifically identified in site inductions.	Based on the review of the available registers, the results of flora surveys undertaken and knowledge of the extent of the development and reasonable construction to be adopted, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to significant flora (predicted impact low with a high degree of confidence).
Fauna	To maintain the abundance, diversity, geographic distribution	Surveys undertaken recorded 31 species of herpetofauna, 112 species of avifauna and 13 species of mammals as potentially occurring	Habitat loss associated with vegetation/wetland clearing and/or modification.	River foreshore vegetation and fauna corridor to be maintained and habitat connection between river and wetland to be enhanced.	Based on the review of the available literature, the results of fauna surveys undertaken and knowledge of the extent of the development

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
	and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge.	within the site. The stands of Tree Lucerne (an introduced species) are thought to be a breeding habitat for the New Holland Honeyeater.	Rehabilitation and revegetation has the potential to create additional habitat and may strength the link between the wetland and Clontarf Bay.	Modification and rehabilitation of the wetland with local wetland and dryland species to maintain and enhance existing habitats. Develop and implement a Wetland Management Plan to the satisfaction of the DoE, that will include but not be limited to: • Identification of existing wetland area to be retained; • Avoiding direct and minimising indirect impacts on the wetland; • Ensuring no net loss of wetland values and functions; • Rehabilitation techniques to be employed; • Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats; • Mitigation strategies for loss of any vegetation will be investigated including both on-site and off-site options; • Creation of a new Paperbark/Flooded Gum wetland area to be located adjacent to the existing wetland and the river foreshore and planted with tree, understorey sedge and shrub species common to the local riverine and wetland environment; • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.	and habitat enhancement proposed, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to fauna (predicted impact low with a high degree of confidence).
Significant Fauna	Protect Specially Protected (Threatened) Fauna and Priority Fauna species and their habitats, consistent with provisions of the *Wildlife Conservation Act 1950*.	A search of DCLM's database identified the following species as possibly occurring in the vicinity of East Clontarf: ▪ Short-billed Black-Cockatoo or Carnaby's Cockatoo – Schedule 1; ▪ Peregrine Falcon – Schedule 4; and ▪ Southern Brown Bandicoot or Quenda - Priority 4. Three species listed on JAMBA/CAMBA international agreements relating to migratory birds were recorded during the surveys and a further three are listed as possible for the site. All of the species that were recorded were located in habitats associated with the Canning River.	No Specially Protected or Priority Fauna recorded within the site. Potential habitat impacts for several Significant Birds (as identified in Bush Forever) and species listed under JAMBA/CAMBA Agreements occur within or adjacent to the site.	Develop and implement a Foreshore Management Plan to the satisfaction of the SRT, DPI and City of South Perth, that will include, but not be limited to: • Comprehensive weed eradication program; • Revegetating and restoring foreshore POS adjoining conservation areas with appropriate indigenous flora of the Canning River; • Increase the area contained within POS adjoining Bush Forever Site No. 333; • Creation of habitat and wildlife corridors; • Controlling vehicle and pedestrian access; • Provision of public facilities; • Soil and plant source material hygiene; • Fire management including provision of fire hydrants; • Provision of educational and interpretative materials within the area to raise awareness of JAMBA/CAMBA species that frequent	Based on the review of the available registers, the results of fauna surveys undertaken and knowledge of the extent of the development and habitat enhancement proposed, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to significant fauna (predicted impact low with a high degree of confidence).

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
				the area; • Encouraging community involvement and awareness promoting control of pets (eg cats and dogs); • Water conservation principles; • Monitoring criteria to determine the success of the revegetation and weed eradication program; • Progress and compliance reporting; and • Timing and implementation schedule.	
Foreshore	To maintain the integrity, ecological functions and environmental values of the foreshore environment.	Vegetation surveys show 69 plant species (representing 25 families) occurring on-site with 47 of these being introduced species. Based on available WRC data, the proposed development area lies outside of the area affected by the 1 in 100-year flood events and therefore should not be at risk of flooding.	Potential indirect impacts include the introduction of further weeds during construction activities and an increased use of the area by both residents and visitors resulting in potential trampling of vegetation and disturbance of fauna.	The proposed development includes an additional setback (`6000m^2) resulting in an overall increase in foreshore area protecting on-site samphire vegetation. Develop and implement a Foreshore Management Plan to the satisfaction of the SRT, DPI and City of South Perth, that will include, but not be limited to: • Comprehensive weed eradication program; • Revegetating and restoring foreshore POS adjoining conservation areas with appropriate indigenous flora of the Canning River; • Increase the area contained within POS adjoining Bush Forever Site No. 333; • Creation of habitat and wildlife corridors; • Controlling vehicle and pedestrian access; • Provision of public facilities; • Soil and plant source material hygiene; • Fire management including provision of fire hydrants; • Provision of educational and interpretative materials within the area to raise awareness of JAMBA/CAMBA species that frequent the area; • Encouraging community involvement and awareness promoting control of pets (eg cats and dogs); • Water conservation principles; • Monitoring criteria to determine the success of the revegetation and weed eradication program; • Progress and compliance reporting; and • Timing and implementation schedule.	Based on the results of studies undertaken, knowledge of the extent of the development, wetland enhancement and other mitigation proposed, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to foreshores (predicted impact low with a high degree of confidence).
Wetlands	To maintain the integrity, ecological functions and environmental values of the wetlands environment.	A Resource Enhancement category EPP wetland is present in the impact area.	The proposed development will result in no net loss of wetland area and will achieve a net gain in wetland function, value and native vegetation.	The wetland will be revegetated using indigenous species of local provenance. Any proposed modifications to the wetland will ensure that the water balance, hydrological regime and flow rates will not be adversely altered.	Based on the currently degraded physical nature of the designated wetland area, the results of fauna surveys undertaken and knowledge of the extent of the development and wetland enhancement proposed, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to wetlands (predicted

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
				Develop and implement a Wetland Management Plan to the satisfaction of the DoE, that will include but not be limited to: • Identification of existing wetland area to be retained; • Avoiding direct and minimising indirect impacts on the wetland; • Ensuring no net loss of wetland values and functions; • Rehabilitation techniques to be employed; • Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats; • Mitigation strategies for loss of any vegetation will be investigated including both on-site and off-site options; • Creation of a new Paperbark/Flooded Gum wetland area to be located adjacent to the existing wetland and the river foreshore and planted with tree, understorey sedge and shrub species common to the local riverine and wetland environment; • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.	impact low with a high degree of confidence).
POLLUTION MANAGEMENT					
Surface Water Quality	To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	The site lies within flow channel 2 of the Cloverdale area groundwater flownet with groundwater throughflow estimated at approximately 4,000m^3/d. In relating this throughflow to the site, JDA calculated that the project area represents approximately 0.5km of the length of the flow channel corresponding to an expected throughflow of 200m^3/d or 2.4L/s. The development area receives surface drainage from external catchments including: - Manning Road and Conlon Street catchment (approximately 6.9ha) that discharges into the north-western area of the wetland via piped drainage. - Centenary Avenue catchment (approximately 26.0ha) that includes urban areas to the east of Centenary Avenue and north of Manning Road, discharging into the area via a piped drain under Centenary Avenue into the eastern region of the wetland. - Two smaller catchments to the west	Residential development and proposed wetland modifications may temporarily interrupt or alter current water balance, quality and flow rates within the wetland. Potential adverse nutrient export and drainage impacts on the wetland and adjacent river environment. Potential temporary impacts to surface water quality during construction phase.	Develop and implement a Drainage, Nutrient, Irrigation and Water Quality Management Plan (DNIWQMP) to the satisfaction of the SRT and DoE, to include but not be limited to: • Design and construct the detention/infiltration basin; • Periodic monitoring of the infiltration basin (post-construction) to ensure continued function and maintenance as required; • Maximising infiltration of uncontaminated stormwater at sources to recharge the groundwater system; • Water conservation principles; • Nutrient control; • Prescribed fertilizer applications for areas of POS; • Determination of flushing requirements, associated impacts and management options; • Treating contaminated stormwater via gross pollutant and sediment traps; • Directing treated stormwater into the Canning River along the south-eastern	Based on the results of hydrological studies undertaken, knowledge of the extent of the development, wetland enhancement and other mitigation measures proposed, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to surface water quality (predicted impact low with a high degree of confidence).

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
		(1.0ha) and south-east (1.5ha) that may discharge into the area from impervious areas as diffuse overland flow.		corner boundary of the site (as per DoE advice); • Monitoring criteria to determine the success of the plan; • Progress and compliance reporting; and • Timing and implementation schedule.	
Groundwater Quality	To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	The subject land received uncontrolled fill over an extended period of time. Aluminium concentration was above the freshwater aquatic ecosystem assessment criterion for the reported pH for samples collected from MW 1, MW2 and MW3. Total nitrogen concentrations of the samples collected from MW1 and MW3 were above the ANZECC and ARMCANZ (2000) lower river assessment criterion. Total phosphorus concentrations of samples collected from MW1, MW3 and MW4 were above the ANZECC and ARMCANZ (2000) lower river assessment criterion. Copper concentrations could not be assessed against the assessment criterion as the limit of reporting specified in the SAP was above the respective criterion. Copper concentrations were below 10ug/L in groundwater collected from all monitoring wells during the sampling event. Copper concentrations of samples collected from all monitoring wells were below the irrigation assessment criterion. Zinc concentration of the sample collected from MW4 was above the freshwater ecosystem criterion. Total nitrogen and ammoniacal nitrogen concentration of the sample collected from MW5 was above the ANZECC and ARMCANZ (2000) lower river assessment criterion. Cadmium concentration in sample collected from MW5 was above the freshwater aquatic ecosystem assessment criterion.	Potential unacceptable health and environmental impacts associated with the disturbance and development of contaminated groundwater on-site.	Develop and implement a Groundwater Management Plan as a component of the CEMP to the satisfaction of the WRC, that will include but not be limited to: ▪ Nature and extent of groundwater contamination; ▪ Groundwater flow characteristics; and ▪ Groundwater contamination plume management. Develop a Dewatering Program Plan as a component of the CEMP to the satisfaction of the DoE to determine the potential impacts of dewatering during the construction phase on the vegetation within the wetland areas, Canning River and groundwater quality. Prior to commencing any dewatering, the proponent or their chosen contractor will apply for and obtain from the DoE a 'Licence to Take Water'. All dewatering will be carried out in accordance with the conditions of the 'Licence to Take Water'. Should dewatering activities require water to be discharged offsite, the proponent (or contractor) shall apply to the DoE for a 'Disposal Licence'. Any discharge of water offsite shall be carried out in accordance with the 'Disposal Licence'.	Based on the currently degraded physical nature of the designated wetland area, the results of surveys undertaken and knowledge of the extent of the development and wetland enhancement proposed, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to groundwater quality (predicted impact low with a high degree of confidence).
Noise	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory	Noise assessments and modelling of traffic noise impacts undertaken. Existing noise levels arising from road traffic is high, with the potential to impacts on the amenity of future residents within the subject area both at present and into the future.	The nearest noise sensitive premises are located 50m east of the site. Noise can be generated at the site by the operation of construction equipment including mobile earthmoving equipment.	Construction noise received at existing residences opposite the proposed development will need to comply with the requirements of the *Environmental Protection (Noise) Regulations* 1997. To ensure noise emissions from construction	Based on the results of field studies and noise modelling undertaken, and commitments given towards mitigation it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to noise both currently and into the future (predicted impact low with a high

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
	requirements and acceptable standards.		Construction noise may impact on the health, welfare and amenity of nearby existing residences. Noise received at future residences located adjacent to the northern and eastern boundaries of the development site will receive noise from vehicles travelling along Manning Road and Centenary Avenue. Transport noise can impact on the health, welfare and amenity of future residents.	activities comply with the regulations Construction Noise Management Procedures will be developed and implemented within the CEMP and to the satisfaction of the DoE and the City of South Perth. In relation to road noise, any noise reduction required by building construction can be achieved, amongst others, by any or all of the following measures: • Construction of noise barriers between the roadway and residential lots; • Specification of construction methods and materials (in keeping with "quiet house design" principles); and • Appropriate setbacks from existing roadways.	degree of confidence).
Dust	Protect the surrounding land users such that dust and particulate emissions will not adversely impact on their welfare and amenity or cause health problems in accordance with EPA's Guidance Statement No. 18 Prevention of Air Quality Impacts from Land Development Sites.	The majority of the site is covered with some form of vegetative cover that currently helps to act as a natural suppressant lessening the potential problem of dust for surrounding residences. The nearest residential premises is located approximately 50m to the east of the site along the eastern boundary of Centenary Avenue, with other residences being located approximately 150m to the north-east of Manning Road.	The nearest dust sensitive premise is located approximately 50m east and 150m north-east of the site boundary. Dust may be generated at the site by the operation of construction equipment including mobile earthmoving equipment. Dust may impact on the health, welfare and amenity of nearby existing residents.	Dust will be controlled so as to comply with the requirements of the EPA's Guidance No. 18: *Prevention of Air Quality Impacts from Land Development Sites*. Construction Dust Management Procedures will be developed and implemented within the CEMP, to the satisfaction the DoE. These will include, but are not limited to: • Watering of exposed surfaces; • Minimising working surfaces at any one time; • Wind fencing; and • Progressive stabilisation of disturbed areas (eg hydromulching).	Based on the results of field visits undertaken, contemporary dust control measures to be adopted and commitments given, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to dust (predicted impact low with a high degree of confidence).
Soil Quality	To ensure that rehabilitation achieves an acceptable standard compatible with the intended landuse and consistent with appropriate criteria.	Prior use and deposited uncontrolled fill has impacted on soil quality within the subject land as follows: ***Former Market Garden Area*** The concentrations of all analytes within samples collected from the market garden are either below LOR or EIL assessment criteria. ***Landfill Investigation Area*** The concentrations of all analytes within samples collected from the Landfill Investigation Area are either below the LOR or EIL assessment criteria except for chromium at TP139, depth interval 1.5m. Methane gas was not detected in any of the Landfill Investigation Area test pits.	For environmental or health impacts to occur, it is necessary that both the concentration of the contaminant is sufficient to cause on impact on a receptor and an exposure pathway exists which brings the contaminant in contact with the receptor. The nature of the contaminants detected in soils on the subject land (predominantly metals and asbestos) is such that the predominant pathways of concern are inhalation and ingestion.	Areas of soil identified as contaminated in excess of EIL criteria will be excavated and the base and walls of the excavations validated in accordance with relevant DoE Guidelines for the Remediation of Contaminated Land (DEP, 2001, a, b and c). The excavated soil will then be assessed to determine the appropriate management option. The currently preferred management option for excavated soils is disposal off-site but a final decision on the management of excavated contaminated soils will be made once analytical results are available for excavated soil. An alternative that may be considered is to screen the material to remove geotechnically unsuitable materials and then re-use the material as fill in appropriate areas on the site such as POS.	Based on the results of studies undertaken, knowledge of the extent of the development and existing sources of contamination, remediation and other mitigation proposed, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to soil quality (predicted impact low with a high degree of confidence).

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
		Uncontrolled Fill Area A total of 26 of the 94 sampling locations excavated within the areas identified by Coffey 2000 as comprising uncontrolled fill contained demolition rubble. This material occupies an area of approximately 17,000m^2 of the site. The remaining area delineated by Coffey (2000) as uncontrolled fill comprises clean grey to brown, fine, sub rounded, well sorted sands and peaty soils overlying silty sand or sandy clay. The uncontrolled fill material is comprised predominantly of dark grey sand and the following: (a) Bricks and brick fragments; (b) Concrete blocks, slabs and rubble; (c) Glass bottle fragments; (d) Ceramic tile and fragments; (e) Incinerated wood pieces; (f) Metal sheets, rods and piping; and (g) Asbestos cement sheeting fragments. The thickness of the uncontrolled fill varies from 0.1 to 1.5m. The thickest sections of the fill are present at TP60 and TP53. Chrysotile and/or crocidolite asbestos fibres were confirmed to be present in some sample locations. The scattered nature of the asbestos found suggests that the fibres have been released from the fragments of cement sheeting present in the uncontrolled fill.		Approval will be sought from the DoE before re-using excavated soils in this manner. A detailed remediation assessment report will be submitted to DoE on conclusion of remediation works that provides detailed information on: • The remediation strategy implemented; • The results of validation and stockpile sampling; and Details of the management of all contaminated material.	
Acid Sulfate Soils	Plan and manage development that may potentially impact on ASS to avoid adverse effects on the natural and built environment and human activities and health.	The soils, geochemistry and site topography consistent with the potential occurrence of acid sulfate soils. A preliminary Acid Sulfate Soils investigation was conducted that indicated: • No actual Acid Sulfate Soils (AASS) appear to be present on the site; • Soil profiles have been identified in some areas of the site that contain Potentially Acid Sulfate Soils	Potential for ASS to be present within the site as a result of ground disturbance associated with proposed development.	Develop and implement an Acid Sulphate Soil Management Plan as a component of the CEMP and to the satisfaction of the DoE that will include but not be limited to: • The area of PASS soils to be disturbed by excavation or dewatering will be minimised as far as possible; • Where ASS must be disturbed: - Earthworks will be completed as quickly as possible to minimise the time that the walls and base of excavations are exposed to the atmosphere; - Un-neutralised ASS/PASS will be stored for only limited periods on on-site bunded hardstand areas constructed from alkaline materials; - The quality of groundwater and dewatering effluents will be monitored	Based on the results of field and laboratory studies undertaken, knowledge of the extent of the development and mitigation or procedural controls proposed, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to Acid Sulphate Soils (predicted impact low with a high degree of confidence).

Environmental Factor	EPA Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
				regularly to ensure early detection of any alteration in water chemistry; and - if necessary dewatering effluent will be treated to ensure appropriate water quality is maintained; and • Where excavated soils must be directed for off-site disposal, they will be directed to a site approved for acceptance and/or treatment of ASS by the DoE.	
SOCIAL					
Aboriginal Heritage	To ensure changes to the biophysical environment resulting from the proposal does not adversely affect historical and cultural associations within the area and comply with the requirements of relevant Aboriginal and heritage legislation.	The Aboriginal Sites Register maintained by the DIA indicates two previously recorded ethnographic sites, Canning River (S02550) and Clontarf East (S02304) in close proximity to the project area. As a result of a field survey no artefacts or archaeological material was observer in the remaining portion of site S02304. A new archaeological site, Field Site 1, a small low density artefact scatter was located on a sand dune in the south-east corner of the site.	Proposed modifications/clearing to wetland/adjacent land identified as having general significance.	Provisions of the *Aboriginal Heritage Act 1972* will be complied with. The proponent will apply for clearance under Section 18 of the Act to remove both previously recorded sites and any new sites that emerge as a result of earthmoving procedures located within the site that will be impacted by the proposed development. The proponent will also undertake further archaeological investigations if required as part of the Section 18 clearance. Such investigations may include, but not be limited to: • Surface recording, mapping and collection of archaeological material; • Archaeological excavation and/or sub-surface evaluation; • Recovery of samples for radiometric dating; and • Analysis of recovered material.	Based on a review of the available registers, measures to be adopted and commitments given, it is considered that the implementation of the project can be managed to meet the EPA's objectives in relation to Aboriginal heritage (predicted impact low with a high degree of confidence).

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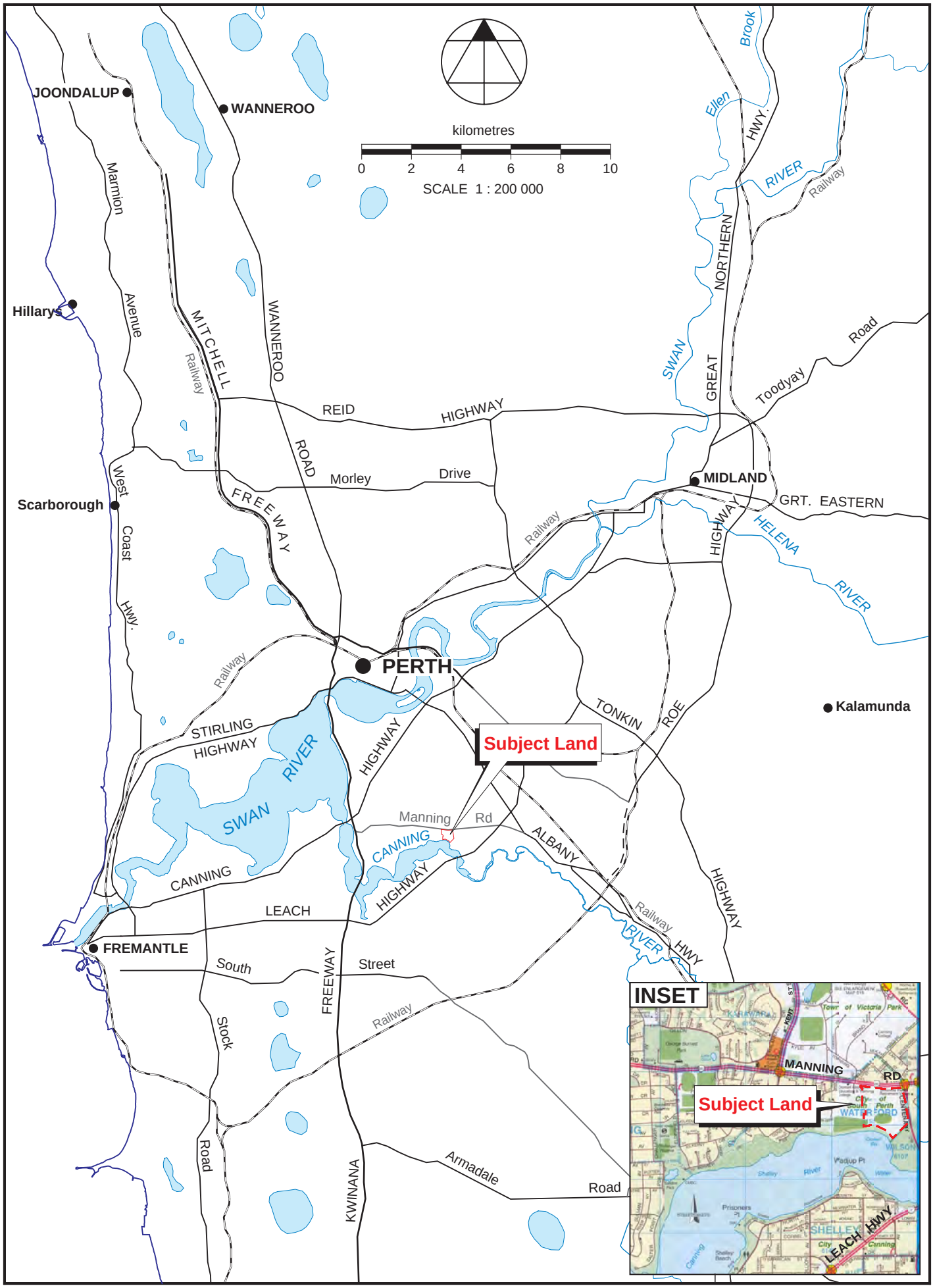
FIGURES



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ATA Environmental
environmental scientists

CLONTARF RESIDENTIAL SUBDIVISION, WATERFORD
PUBLIC ENVIRONMENTAL REVIEW

REGIONAL LOCATION

FIGURE 1

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DATUM: Not Spacially Correct
TCB-2003-002PER/23_91F2.dgn

GROVE OF EUCALYPTS

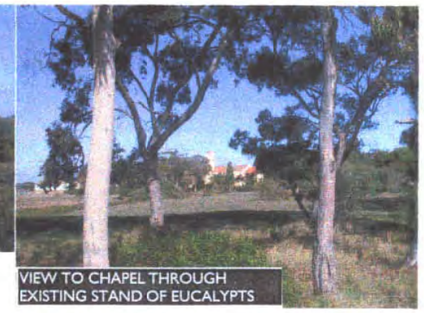
STORIC CHAPEL BUILDING
OCAL ELEMENT)

EXISTING PLAYING FIELDS ON CAMPUS

EXISTING EUCALYPTS ALONG MANNING ROAD

metres
0 50 100 150
APPROXIMATE SCALE

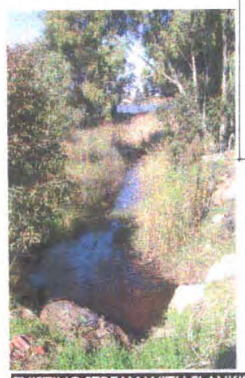
VIEW ACROSS WETLAND AREA TO CHAPEL ON CAMPUS
(BRACKEN FERN & BULRUSH INFESTATION IN FOREGROUND)



VIEW TO CHAPEL THROUGH EXISTING STAND OF EUCALYPTS

EXISTING GROVES OF EUCALYPTS AND WEED INFESTED AREAS

EXISTING STAND OF MARRI



EXISTING STREAM WITH FLANKING EUCALYPTS RUNNING INTO THE CANNING RIVER

WEED INFESTATION OF BRACKEN FERN AND BULRUSH

VIEWS TO THE CANNING RIVER AND FORESHORE LANDSCAPE (COMPRISING OF SEDGES AND WETLAND SPECIES)

EAST CLONTARF PROJECT

PREPARED FOR THE TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INCORPORATED

SITE ANALYSIS

LC-01

SOURCE: Plan E, July 2003

ATA Environmental
environmental scientists

CLONTARF RESIDENTIAL SUBDIVISION
WATERFORD
PUBLIC ENVIRONMENTAL REVIEW
SITE ANALYSIS
FIGURE 2

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DATUM: Not Spacially Correct

TCB-2003-002PER/23_91F3.dgn

GRASSED TERRACES

GRASSED TERRACES DOWN FROM CHAPEL TO WETLAND WALK

PUBLIC ARTWORK AT TERMINUS OF PEDESTRIAN WALK

EXISTING CHAPEL

VIEWING PAVILION

EXISTING SCHOENOPLECTUS VALIDUS SEDGELAND

BUSH TUCKER GARDENS WHICH RELATES THE LANDSCAPE TO THE ADJACENT ABORIGINAL CAMPUS AND EXISTING SITE HISTORY

WETLAND ENVIRONMENT

EUCALYPTUS SPECIES

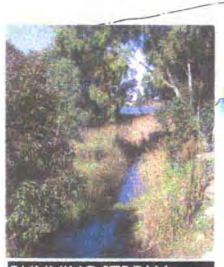
NEW PEDESTRIAN BRIDGE AND CULVERT

NATIVE MELALEUCA SPECIES WITH JUNCUS UNDERTOREY

TIMBER BOARDWALK MEANDERING THROUGH EXISTING VEGETATION

FLOODED GUMS ON SLIGHTLY HIGHER GROUND

RECREATION OF FLOODPLAIN VEGETATION WITH STANDS OF NATIVE PAPERBARKS AND EUCALYPTUS SPECIES IN JUNCUS



RUNNING STREAM

ENTRANCE INTO DEVELOPMENT SIGNAGE TO BE INCORPORATED ON ENTRY WALLS/ ARTWORK

NORTHERN PUBLIC OPEN SPACE INCLUDING PLAYGROUND AND PICNIC AREA

PAVILION OVERLOOKING LAKE AND ROOSTING ISLAND

BOARDWALK AND VIEWING DECKS OVERLOOKING THE WETLAND

REVEGETATED WETLAND

VIEW CORRIDOR

RL 1.7

RL 1.9

PICNIC AREA OVERLOOKING THE WETLAND LAKE AND SLAND

REVEGETATED WETLAND

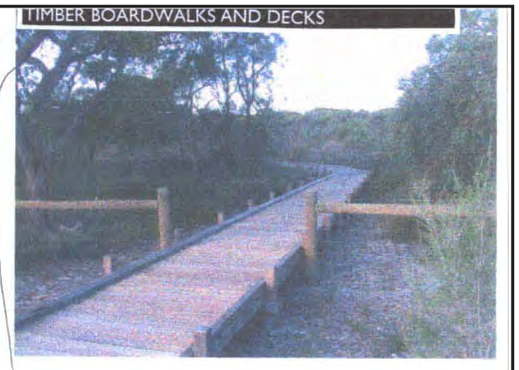
EXISTING FRESHWATER STREAM

EUCALYPTUS STREET TREES PROVIDING A STRONG CONNECTION WITH THE EXISTING WETLAND ENVIRONMENT

BBQ FACILITIES AND PLAYGROUND TO SOUTHERN PUBLIC OPEN SPACE TOGETHER WITH PUBLIC ART

EXISTING MARRI IN POS TO BE RETAINED

TIMBER BOARDWALKS AND DECKS



TIMBER BOARDWALKS MEANDERING THROUGH REVEGETATED WETLAND WITH TIMBER DECKS OFFERING VIEWS OUT ONTO THE WETLAND

VIEWING DECK WITH ARBORS ON EACH SIDE FRAMING THE VIEW TO EXISTING CHAPEL

ENTRY STATEMENT TO MARK ENTRANCE INTO DEVELOPMENT SIGNAGE TO BE INCORPORATED ON ENTRY WALLS/ ARTWORK

WETLAND PLANTS

SHADE STRUCTURE AND SEATING AREA LOCATED ON VIEW CORRIDOR

VIEW CORRIDORS THROUGHOUT THE DEVELOPMENT OPTIMISING EXISTING LANDMARKS AND FEATURES

MEANDERING PATH THROUGH PLANTED AND GRASSES AREAS.

PUBLIC ARTWORK

SEATING/ PICNIC AREAS

EAST CLONTARF PROJECT

PRELIMINARY SITE CONCEPT PLAN

PREPARED FOR THE TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INCORPORATED

SOURCE: PlanE, July 2003

metres

0 25 50 75 100

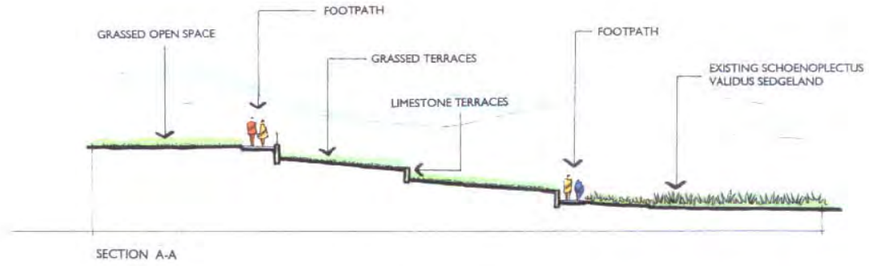
APPROXIMATE SCALE

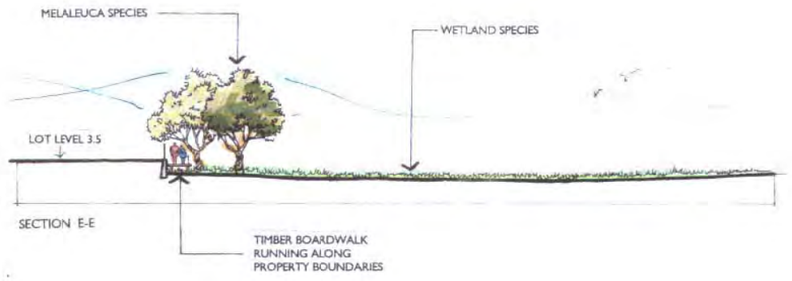
ATA Environmental
environmental scientists

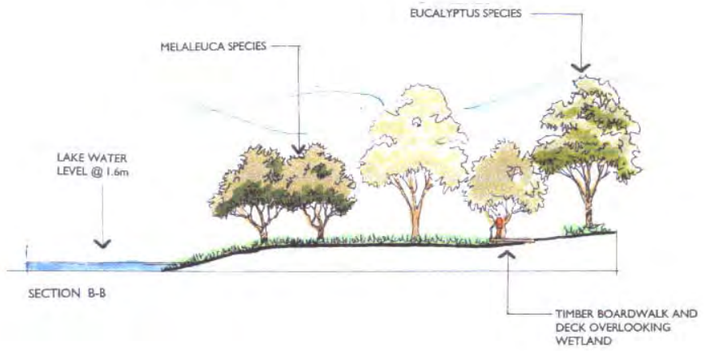
CLONTARF RESIDENTIAL SUBDIVISION
WATERFORD
PUBLIC ENVIRONMENTAL REVIEW

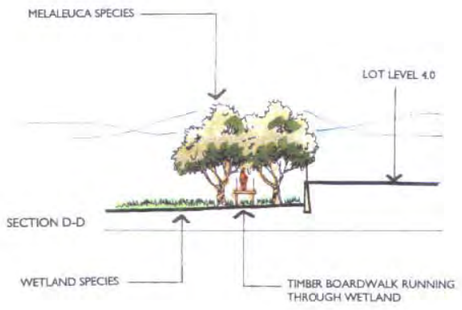
LANDSCAPE CONCEPT PLAN

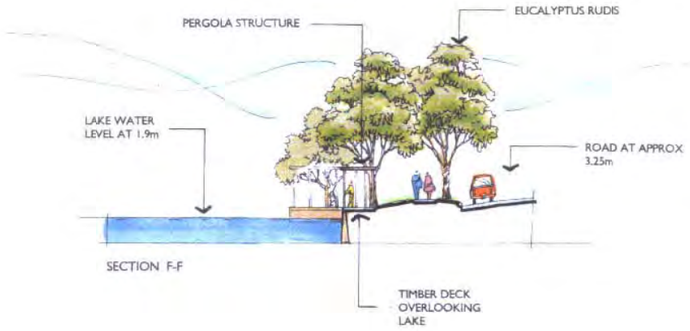
FIGURE 3

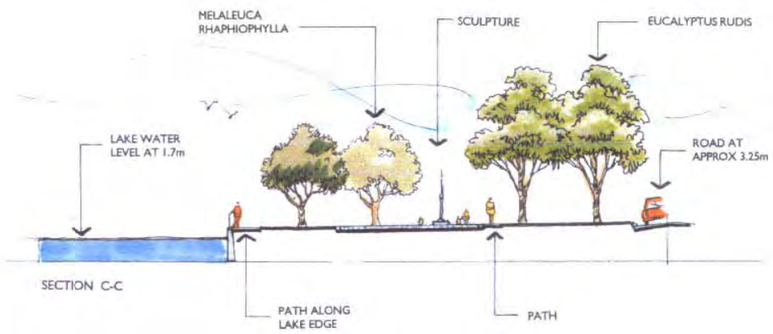


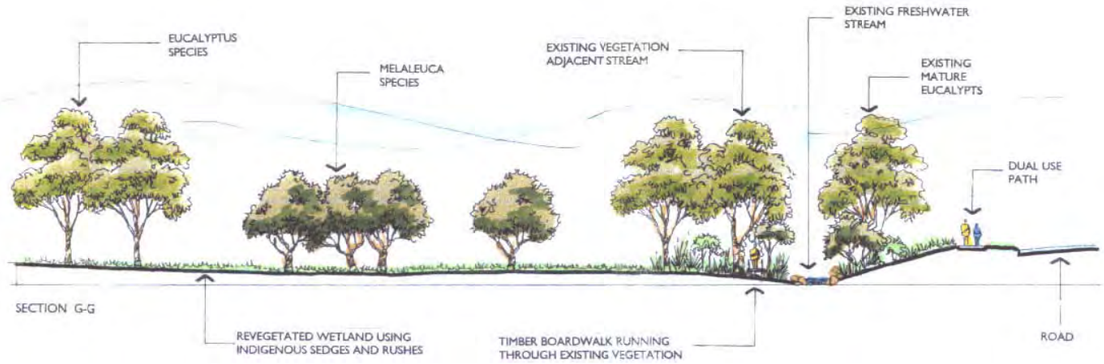












EAST CLONTARF PROJECT

LANDSCAPE CONCEPT SECTIONS

PREPARED FOR THE TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INCORPORATED

SOURCE: PlanE, July 2003

metres
0 5 10 15 20
APPROXIMATE SCALE

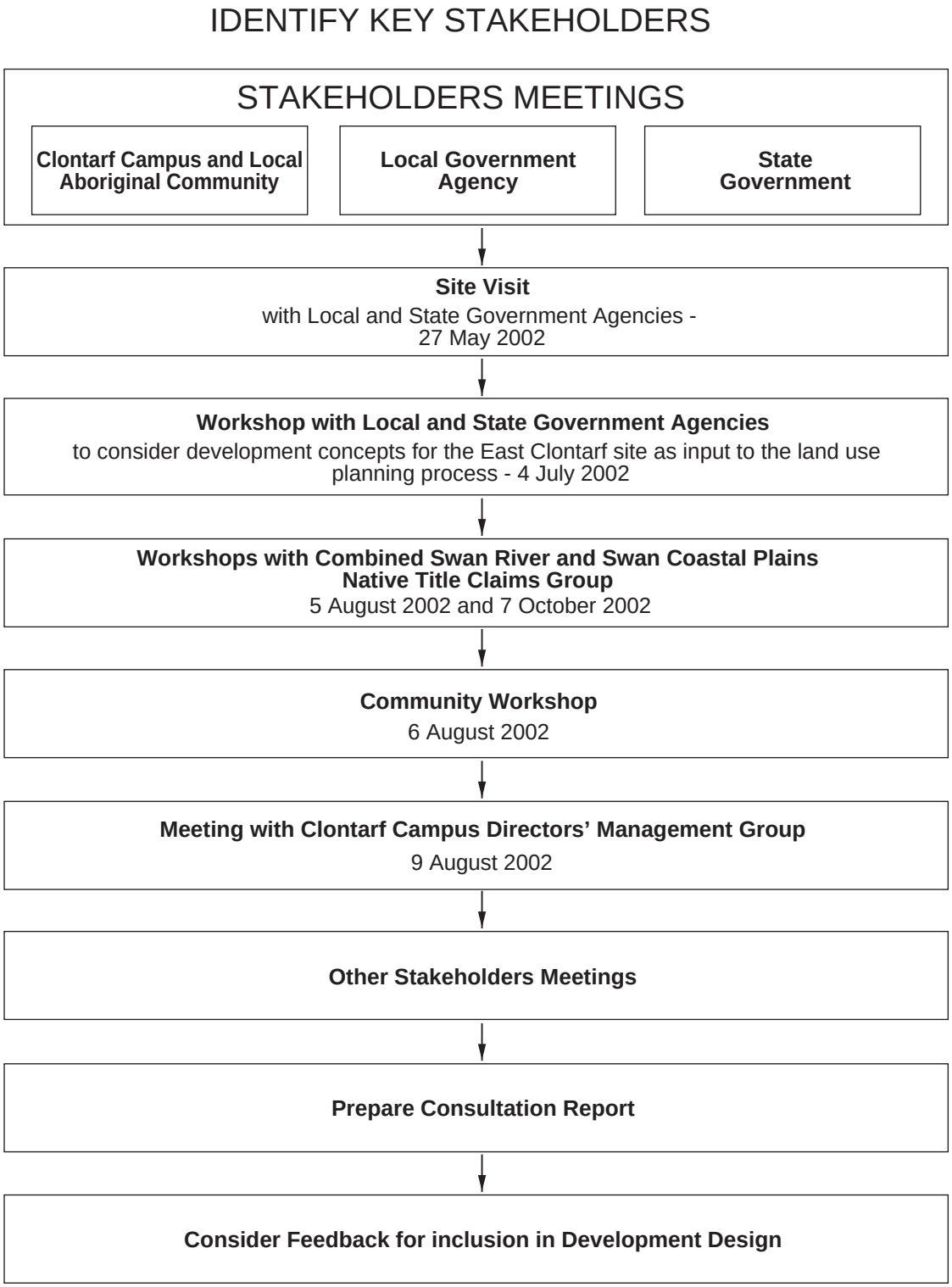
ATA Environmental
environmental scientists

CLONTARF RESIDENTAIL SUBDIVISION
WATERFORD
PUBLIC ENVIRONMENTAL REVIEW

LANDSCAPE CONCEPT CROSS-SECTIONS

FIGURE 4

CONSULTATION METHODOLOGY



SOURCE: Estille Pty Ltd, 2002

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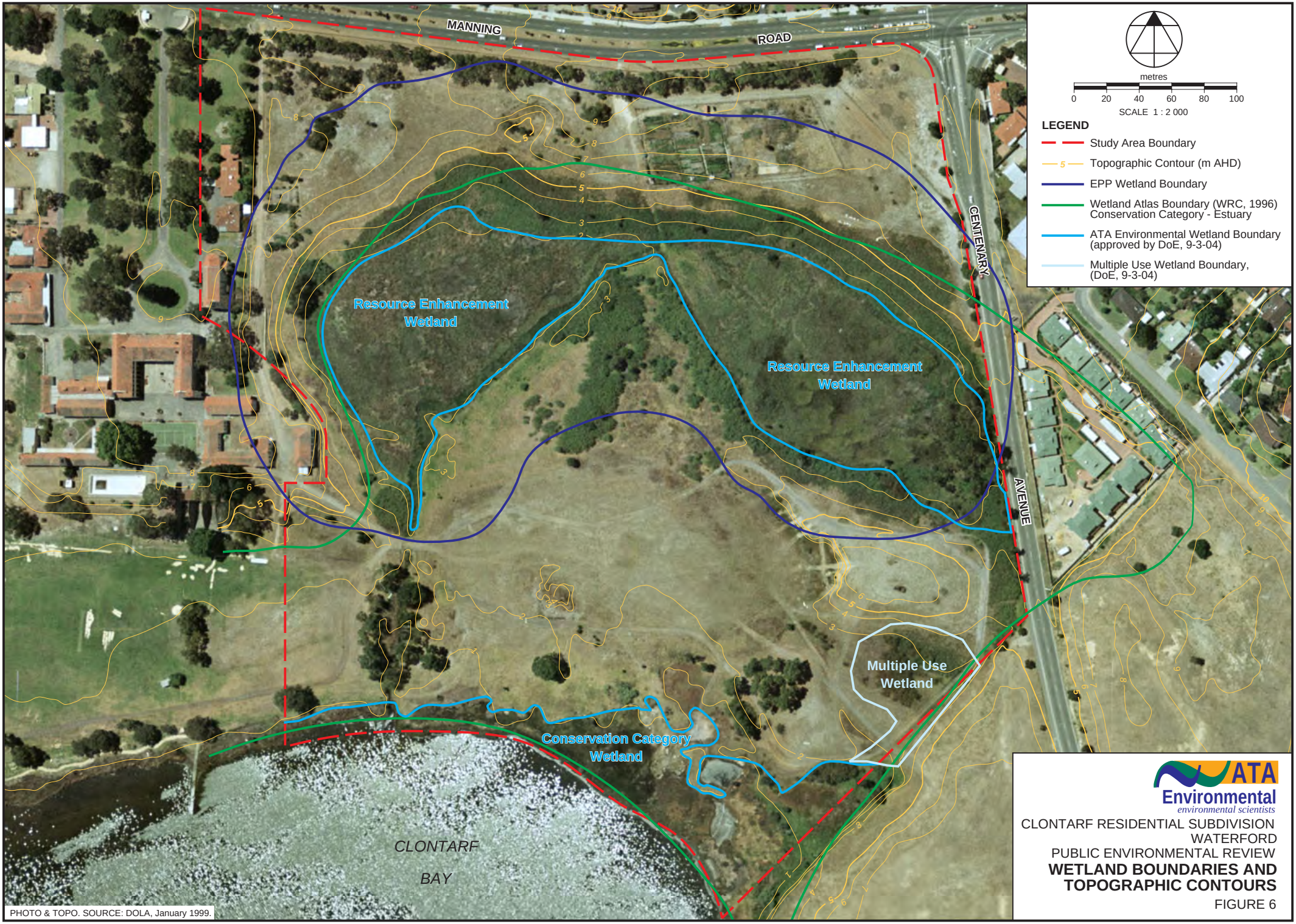
CLONTARF RESIDENTIAL SUBDIVISION, WATERFORD
PUBLIC ENVIRONMENTAL REVIEW

COMMUNITY CONSULTATION METHODOLOGY

FIGURE 5



PRINTED: Wed 02 Jun 04
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DATUM: AMG
TCB-2003-002PER/23_91F5.dgn

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WETLAND BOUNDARIES AND TOPOGRAPHIC CONTOURS

FIGURE 6

PRINTED: Wed 02 Jun 04

CHECKED: BvdW 12-11-03

DRAWN: TE 12-11-03

DATUM: AMG

TCB-2003-002PER/23_91f6.DGN

MANNING ROAD

CENTENARY AVENUE

Cleared

Cleared

metres

0 20 40 60 80 100

SCALE 1 : 2 000

LEGEND

- Study Area Boundary
- 5 Topographic Contour (m AHD)
- E Exotic *Eucalyptus* plantings
- Er *Eucalyptus rudis* (Flooded Gum)
- Et *Eucalyptus todtiana*
- Cc *Corymbia calophylla* (Marri)
- Vj *Viminaria juncea* Shrubland
- B Bracken Fern (*Pteridium esculentum*)
- Af *Astartea fascicularis* Closed Heath
- Cp *Cytissus proliferus* (Tree Lucerne)
- Sv *Schoenoplectus validus* Sedgeland
- T *Typha orientalis* (Bulrush) Sedgeland
- P *Paspalum* sp. Grassland
- Jp *Juncus pallidus* Sedgeland
- Jf *Jacksonia furcellata* Shrubland
- Jk *Juncus kraussii*
- Ll *Leptospermum laevigatum* (Victorian teatree)
- Al *Agonis linearifolia*
- Mr *Melaleuca raphiophylla* (Paperbark)
- K *Kikuyu* grass
- Ad *Arundo donax* (False Bamboo)
- B Bare salt flat
- Hh *Halosarcia halocnemoides* (Samphire)

PHOTO SOURCE: DOLA, January 1999.

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EAST CLONTARF PRELIMINARY ENVIRONMENTAL ASSESSMENT

VEGETATION

FIGURE 7

PRINTED: Wed 02 Jun 04

DRAWN: TE/GLM 11-5-04 CHECKED: PvdM 11-5-04

DATUM: AMG

TCB-2003-002PER/23_91F11.DGN

MANNING ROAD

CENTENARY AVENUE

AREA 1A

AREA 1B

AREA 1C

AREA 2A

AREA 2B

AREA 3A

AREA 3B

AREA 3C

AREA 3D

AREA 4A

AREA 4B

AREA 5

ECB1

ECB2

ECB3

ECB4

GROUPED HOUSING 3944m^

1.0347ha

2.8747ha

Foreshore Reserve

CLAUSE 42 FORESHORE RESERVE

CLONTARF

BAY

metres

0 20 40 60 80 100

SCALE 1 : 2 000

LEGEND

- Study Area Boundary
- Geotechnical Subarea Boundary
- 5 Topographic Contour, mAHD
- Revised Wetland Boundary
- Test Pit
- Monitoring Well
- ECB4 Water Monitoring Bore Location
- Proposed Soil Contamination Sampling Location (ATA)

SOURCES

PREVIOUS GEOTECHNICAL TESTING, CONTOURS: Coffey Geosciences Pty Ltd

DRAFT SUBDIVISION: DPS, 2003

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PUBLIC ENVIRONMENTAL REVIEW

GEOTECHNICAL SUBAREAS & SAMPLING LOCATIONS

FIGURE 8

TCB-2003-002PER/23_91F9.dgn DATUM: Not Spacially Correct DRAWN BY: TE 23-10-03 CHECKED BY: BvdW 23-10-03 PRINTED: Wed 02 Jun 04

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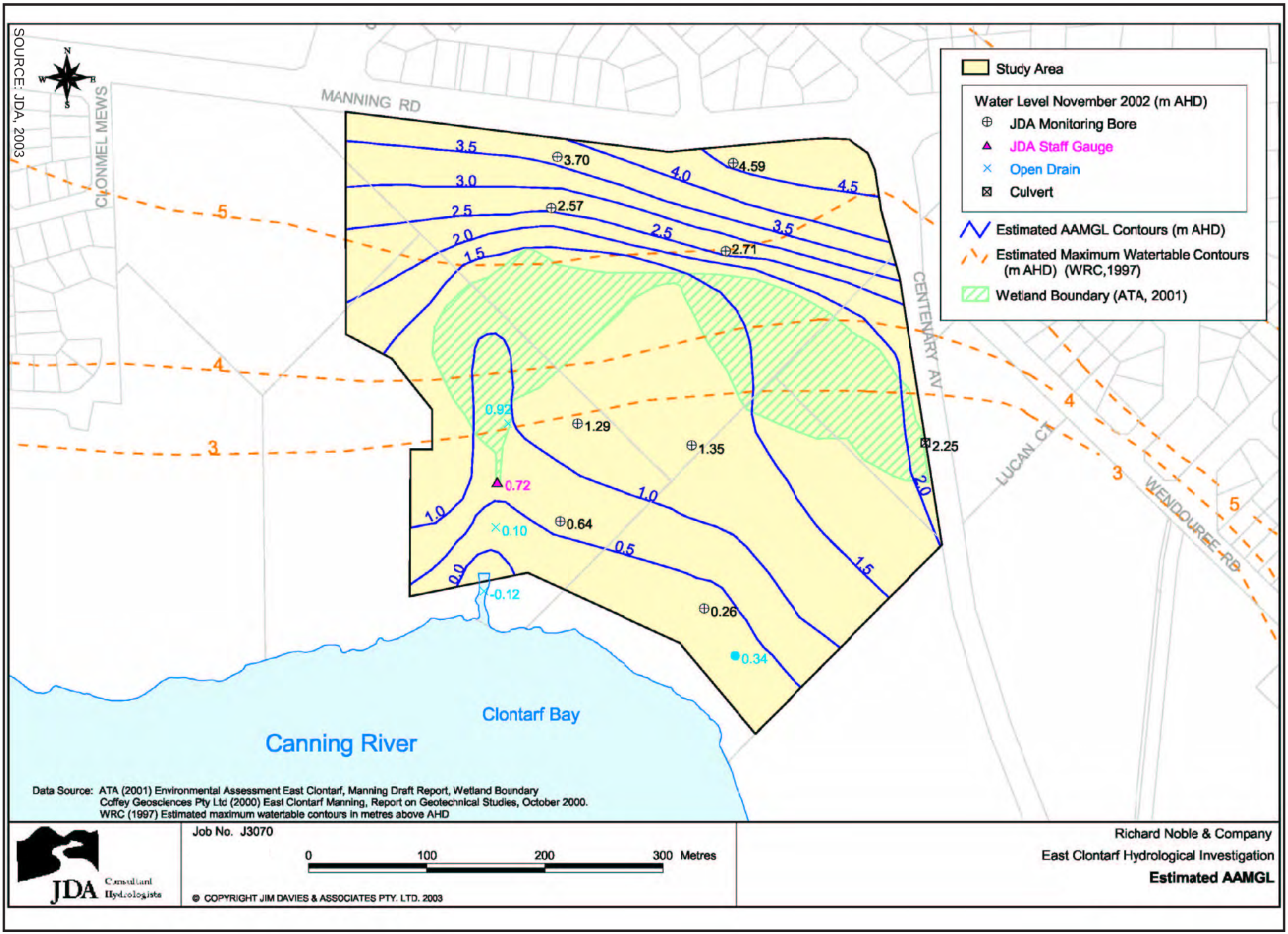
WATERFORD
PUBLIC ENVIRONMENTAL REVIEW
ESTIMATED AAMGL
FIGURE 9



TCB-2003-002PER/23_91F10.dgn DATUM: Not Spacially Correct DRAWN BY: TE 23-10-03 CHECKED BY: BvdW 23-10-03 PRINTED: Wed 02 Jun 04

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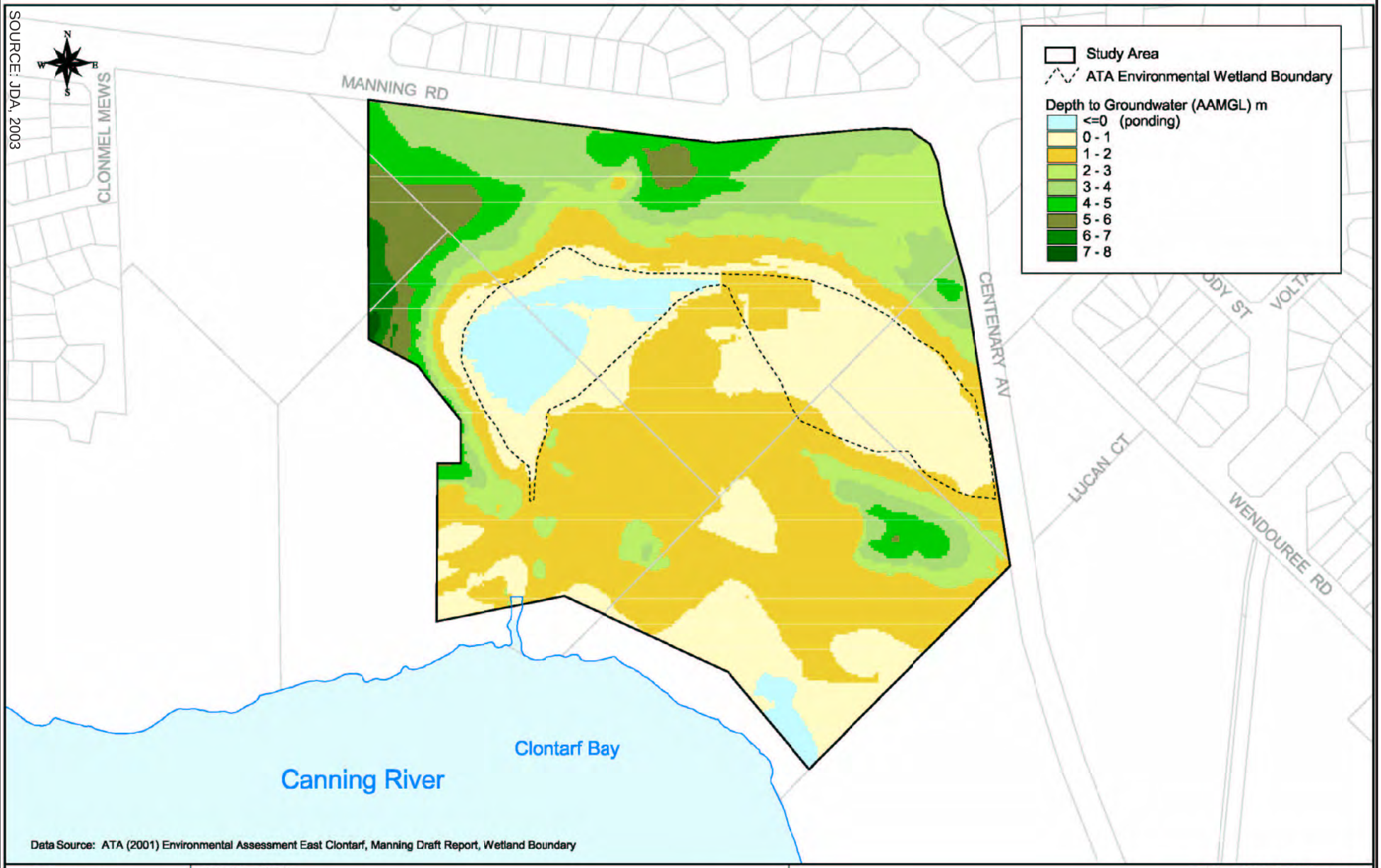
DEPTH TO GROUNDWATER (AAMGL)

FIGURE 10



JDA Consultant Hydrologists

Job No. J3070

0 100 200 300 Metres

Richard Noble & Company
East Clontarf Hydrological Investigation
Depth to Groundwater (AAMGL)

PRINTED: Wed 02 Jun 04

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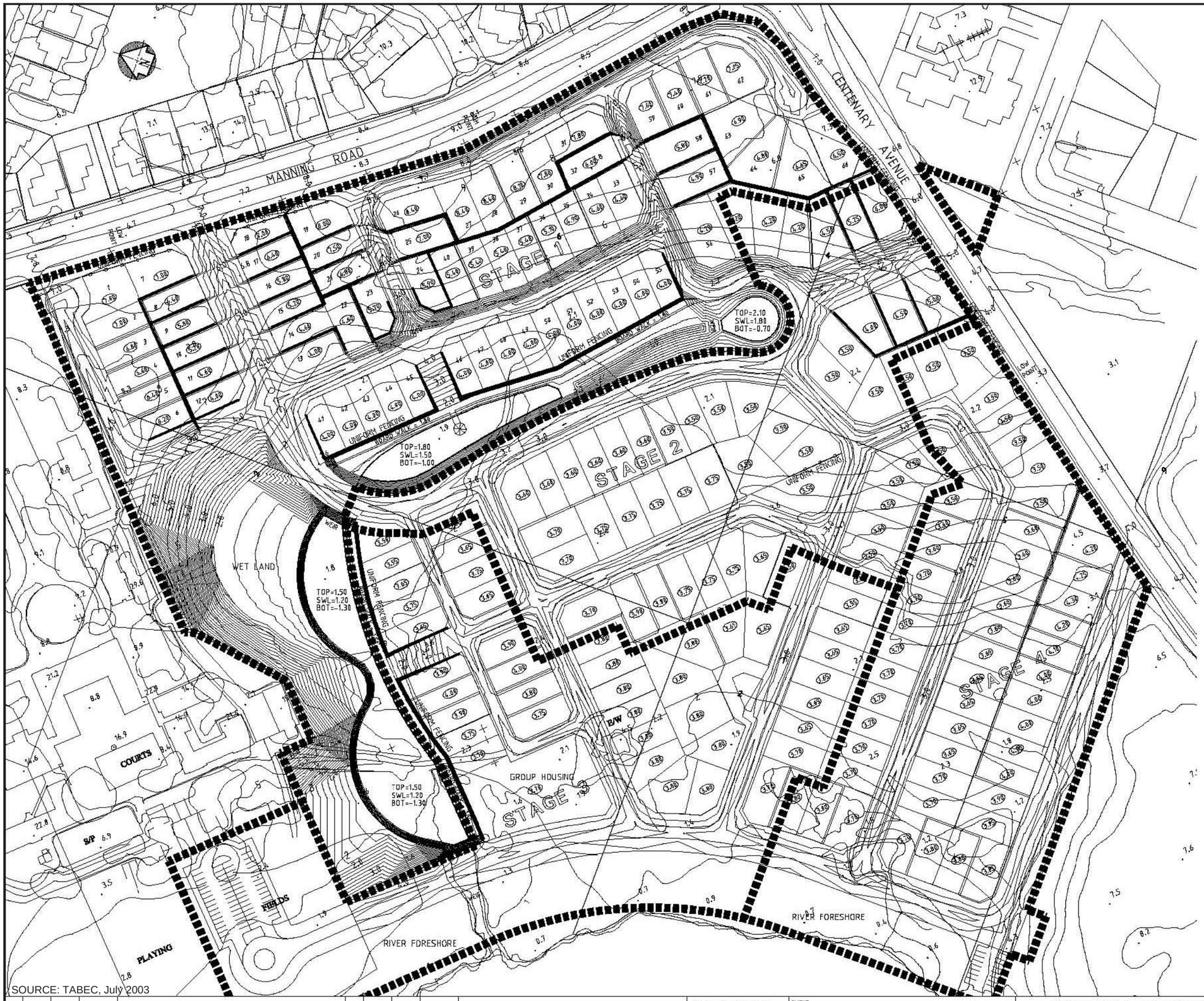
DATUM: Not Spacially Correct

TCB-2003-002PER/23_91F8.dgn



SOURCE: TABEC, July 2003

NOTES :

1. ALL FINISHED LEVELS ARE IN METRES TO AHD. HORIZONTAL DATUM : PERTH COASTAL GRID.
2. ALL DESIGN COORDINATES ARE IN PERTH COASTAL GRID.
3. ALL DIMENSIONS ARE IN METRES , WITH THE EXCEPTION OF SOME DETAIL DRAWINGS.
4. ANY DISCREPANCIES ARISING IN FIELD SETOUT OF THIS INFORMATION SHALL BE BROUGHT TO THE ATTENTION OF THE SUPERINTENDENT IMMEDIATELY.
5. EXISTING FEATURES AND LEVELS AS PROVIDED BY LICENSED SURVEYORS.
6. _____ ARE THE PROJECT SURVEYORS AND MUST BE USED IN CO-ORDINATING SETOUT OF THE ASSOCIATED WORKS.
7. ALL WASTE AND UNSUITABLE MATERIAL TO BE DISPOSED OF TO AN APPROVED TIPPING SITE. ALL FEES TO BE PAID BY CONTRACTOR.
8. CONTRACTOR TO LIMIT ACCESS TO ONLY THOSE AREAS WITHIN THE EARTHWORKS BOUNDARY.
9. BATTER TO EXISTING SURFACE AT 1:3 FROM BOUNDARY LIMITS UNLESS INDICATED OTHERWISE.
10. CONTRACTOR IS TO ALLOW FOR STABILISATION OF EARTHWORKED AREAS ONLY.
11. LOT PAD LEVEL FINISHES AT THE 6m BUILDING SETBACK LINE FROM FRONT OF LOT AND BATTERS TO LOT BOUNDARY LEVELS AS SHOWN.
12. UPON COMPLETION OF WALLS AND LOT LEVELLING A STAR PICKET FENCE COMPRISING OF PICKETS AT 5m INTERVALS & A 3 PLAIN WIRE FENCE (1.2m HIGH) IS TO BE INSTALLED AT THE TOP OF EACH WALL WHERE THE WALL EXCEEDS 1.2m IN HEIGHT. THE PICKETS ARE TO BE CAPPED WITH PLASTIC TOPS.
    SIGNS (800mm x 500mm) ARE TO BE INSTALLED WHERE THE WALLS EXCEED 0.6m HIGH (ONE SIGN TO FIVE LOTS). BLACK LETTERING ON A YELLOW BACKGROUND. WORDING AS FOLLOWS:

    DANGER
    DO NOT WALK ON OR NEAR THE RETAINING WALLS. YOU DO SO AT YOUR OWN RISK. RISK OF SERIOUS INJURY MAY OCCUR FOR WHICH THE OWNER, DEVELOPERS AND CONTRACTORS WILL NOT ACCEPT LIABILTY.

13. ALL RETAINING WALLS ARE OF TYPE 'B' UNLESS NOTED OTHERWISE ON THE PLAN. FOR RETAINING WALL DETAILS REFER STANDARD DWG. TABEC-STD-001.

LEGEND :

- 6.0 — PROPOSED FINISHED SURFACE CONTOUR (1.0m)
- 38.5 — EXISTING SURFACE CONTOUR (0.5m)
- 40.63 EXISTING SURFACE SPOT LEVEL
- PROPOSED LIMESTONE RETAINING WALL
- (3.50) FINISHED LOT PAD LEVEL

metres

0 20 40 60 80 100

APPROXIMATE SCALE

1:1000 0 20 40 60

No.	DATE	DRAWN	APPROVED	AMENDMENT
A	14-11-01	NJW		ISSUED FOR DISCUSSION.

CLIENT: RICHARD NOBLE & COMPANY

DESIGNED	CHECKED	APPROVED
NJW		
DRAWN	CHECKED	DATE
NJW		

TABEC
Trewin and Bittmead Engineering Consultants
TABEC Pty Ltd ACN 080 798 204
Level 1, 110-118 East Parade, East Perth WA 6004
Telephone 9226 4633, Fax 9226 4733
Email tabec@iinet.com.au

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PUBLIC ENVIRONMENTAL REVIEW
INDICATIVE LOT LEVELS
FIGURE 11

TCB-2003-002/23_91f12.dgn DATUM: MGA DRAWN BY: TE 22-12-03 CHECKED BY: BvdW 22-12-03 PRINTED: Wed 02 Jun 04

MANNING ROAD

Centenary Avenue

MW1 MW2 MW3

Area 2B

Area 3B

Area 3C

Area 3A

Area 2A

Area 3D

Lot 501

Lot 500

Lot 829

Pt Lot 83

Clontarf Aboriginal Education and Training College

MRS Boundary

Foreshore Reserve

Landfill Investigation Area

High Water Mark

Clontarf Bay

Canning River

metres

0 20 40 60 80 100

SCALE 1 : 2 000

AERIAL PHOTO SOURCE: DOLA, 7-8-03

CAD. SOURCE: PGS HOPE & Partners, 29-5-03

LEGEND

- Subject Land Boundary
- Cadastral Boundary
- MW5 Monitoring Well Location
- 36 Sample Location (colour indicates Area)
- Analytical concentration >EIL in profile
- Uncontrolled Fill Area
- Uncontrolled Fill Stockpile
- Uncontrolled Landfill Area

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CLONTARF RESIDENTIAL SUBDIVISION, WATERFORD PULIC ENVIRONMENTAL REVIEW

SOIL SAMPLING LOCATIONS

FIGURE 12

TCB-2003-002PER/23_91f13.dgn DATUM: MGA DRAWN BY: TE 23-10-03 CHECKED BY: BvdW 23-10-03 PRINTED: Wed 02 Jun 04

MANNING ROAD

Centenary Avenue

Lot 501

Lot 500

Clontarf Aboriginal Education and Training College

Lot 829

Pt Lot 83

MW3

A

A'

1

2

3

4

5

6

7

8

9

10

MRS Boundary

Foreshore Reserve

High Water Mark

High Water Mark

Clontarf Bay

Canning River

LEGEND

- Boundary of Subject Land
- Cadastral Boundary
- Section Line A - A' (see Figure 14)
- 10 Soil Boring Number (Prefix ECASS)
- Soil Boring Location, PASS in Profile
- Soil Boring Location, PASS Not Detected in Profile
- MW3 Monitoring Well Location and Identification

metres

0 20 40 60 80 100

SCALE 1 : 2 000

AERIAL PHOTO SOURCE: DOLA, 7-8-03

CAD. SOURCE: PGS HOPE & Partners, 29-5-03

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WATERFORD
PUBLIC ENVIRONMENTAL REVIEW

ACID SULFATE SOIL BORING LOCATIONS

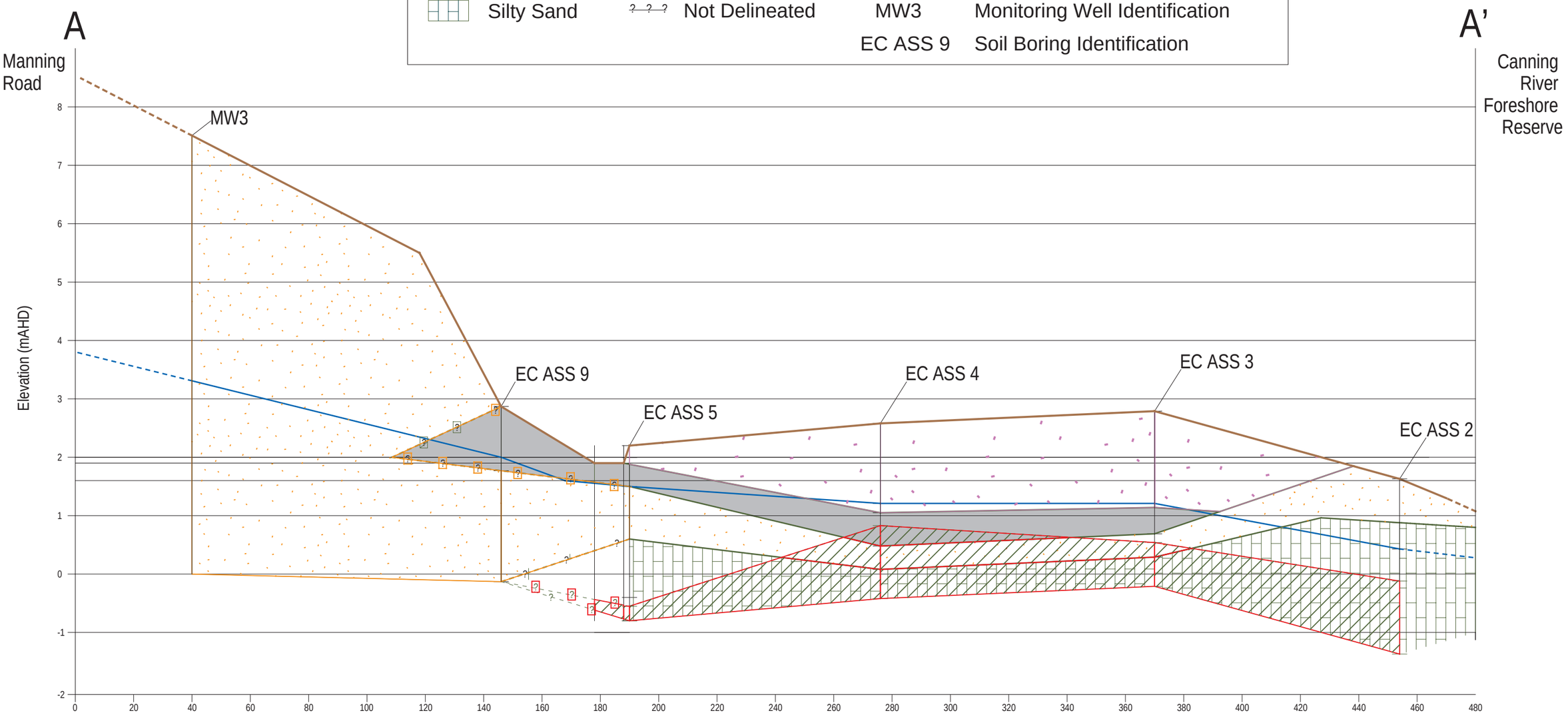
FIGURE 13

PRINTED: Wed 02 Jun 04

TCB-2003-002PER/23_91f14.dgn DATUM: Not Applicable DRAWN BY: TE 23-10-03 CHECKED BY: BvdW 23-10-03

LEGEND

- Sand
- Peat
- Silty Sand
- Fill
- PASS
- Not Delineated
- Ground Level
- Groundwater Level (JDA, 2003)
- MW3 — Monitoring Well Identification
- EC ASS 9 — Soil Boring Identification



PASS Cross Section
Manning Road to Canning River Foreshore Reserve

For location see Figure 13

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environmental scientists

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WATERFORD
PUBLIC ENVIRONMENTAL REVIEW

CROSS SECTION OF PASS MATERIAL

FIGURE 14

APPENDICES

APPENDIX 1

COMMUNITY CONSULTATION REPORT (ESTILL & ASSOCIATES PTY LTD, 2002)

APPENDIX 2

WETLAND REHABILITATION (QUILTY ENVIRONMENTAL, 2003)

APPENDIX 3

FLORA SPECIES LIST

APPENDIX 4

FAUNA REPORT

APPENDIX 5

SURFACE & GROUNDWATER SAMPLING RESULTS (2004)

APPENDIX 6

EAST CLONTARF HYDROLOGICAL INVESTIGATION (JDA CONSULTING HYDROLOGISTS, 2004)

APPENDIX 7

SUMMARY OF RESULTS OF GROUNDWATER INVESTIGATIONS

APPENDIX 8

NOISE LEVEL IMPACT ASSESSMENT – CLONTARF RESIDENTIAL SUBDIVISION, MANNING ROAD, WATERFORD (HERRING STORER ACOUSTICS, 2003)