

**WETLAND MANAGEMENT PLAN -
PROPONENT COMMITMENT NO. 3,
RETAINED WETLAND - CYGNIA COVE
ESTATE, WATERFORD**

Prepared for:

The Trustees of the Christian Brothers in WA
Incorporated
c/- Richard Noble and Company
Level 1, 189 Hay Street
SUBIACO WA 6008

Report Date: 4 August 2008
Project Ref: 2007/109, V4

Written/Submitted by:



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Reviewed/Approved by:



Dr Paul van der Moezel
Principal

4 August 2008

The Trustees of the Christian Brothers in WA Incorporated
c/- Richard Noble and Company
Level 1, 189 Hay Street
SUBIACO WA 6008

Attention: Alex Gregg

Dear Alex,

**RE: WETLAND MANAGEMENT PLAN - PROPONENT COMMITMENT NO. 3, RETAINED
WETLAND - CYGNIA COVE ESTATE, WATERFORD**

Enclosed is Version 4 of the Wetland Management Plan for portion of the retained wetland at the Cygnia Cove Estate, Waterford. This Management Plan has been prepared in accordance with the requirements of Proponent Commitment No. 3 contained in Ministerial Statement No. 692 taking into account comments received on Versions 1, 2 and 3 from the City of South Perth and the Department of Environment and Conservation.

Coffey Environments will submit copies of this plan to Juliet Cole at the Department of Environment Conservation, Alisa Krasnostein at the Department of Environment and Conservation (Wetlands Program) and Mark Taylor at the City of South Perth for approval.

Please contact the undersigned on (08) 6462 7900 or Paul.Zuvela@coffey.com if you have questions regarding the content of this report.

For and on behalf of Coffey Environments Pty Ltd



PAUL ZUVELA
Manager (Environmental Planning)

Addendum

2 EXISTING ENVIRONMENT

2.1 Climate

The area has a Mediterranean climate with mild wet winters and hot dry summers. The hottest months are January and February and rain falls primarily in the winter months. Long term average rainfall is approximately 860mm (based on Bureau of Meteorology's Perth Regional Station, 1880 to present). The annual average rainfall has decreased significantly since the mid-1970s.

Seasonal wind patterns consist of a moderate south-easterly wind flow during the mornings in summer, with a moderate south-westerly wind flow in the afternoon. The winter wind flow pattern reflects synoptic flow. For example, north-westerly winds would be expected following a cold front.

2.2 Topography

Topographic contours range from 0mAHD (Australian Height Datum) immediately adjacent to the Canning River across the subdivision area to 9mAHD near Manning Road (Figure 3). Much of the subdivision area is flat and less than 3mAHD, rising relatively steeply in the northern portion of the subdivision area. The retained wetland is below 2mAHD.

2.3 Geomorphology and Surface Geology

Environmental geology mapping for the subdivision area shows that a large part of the subdivision area is considered part of the Canning River floodplain (Jordan, 1986). A wetland in the centre of the subdivision area 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 contains abundant shells and shell fragments. The wetland is located in the Swan Estuary consanguineous suite (E.2) (Semenuik, 1988).

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 eolian origin (Jordan, 1986).

The soils of the retained wetland are predominantly peat and peaty sands extending from the surface to approximately 1m depth. The peaty soils overlie sand and silty sand at shallow depths. According to Coffey (2000), the approximate thickness of peat in the wetland area is 3m, decreasing in thickness towards the Canning River.

2.4 Soil Contamination and Acid Sulfate Soils

Previous investigations at the Cygnia Cove subdivision area have identified deposits of uncontrolled fill material in several areas, including areas to the south of the wetland and two areas on the northern margin of the wetlands (Figure 5). It is estimated that the uncontrolled fill covers approximately 2ha of the site and varies in thickness between 0.1m and 1.5m (ATA Environmental, 2003). Various contaminants have been recorded in the areas where uncontrolled fill occurs, including asbestos and heavy metals. There is limited contamination within the portion of the wetland that will be retained as part of the subdivision. Several remediation areas are located adjacent to the wetland boundary as depicted in Figure 5. Remediation of contaminated areas will be the first activity undertaken in the subdivision area. Remedial works will be implemented in accordance with the *Site Remediation and Validation Management Plan* (ATA Environmental, 2007) prepared to guide remedial works at the site.

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1 INTRODUCTION

1.1 Background

The Trustees of the Christian Brothers in WA Incorporated (the Proponent) propose to develop their land at Waterford for a residential subdivision to be known as Cygnia Cove Estate.

The subdivision is located approximately 8km southeast of the Perth Central Business District (Figure 1) and is bound by the Canning River to the south, Manning Road to the north, Centenary Avenue to the east, the Clontarf Campus to the west.

The development of Cygnia Cove (formerly known as East Clontarf) has been planned as part of the Proponent's strategy to generate funds for the on-going maintenance of the Clontarf Campus as well as other community services provided by The Christian Brothers in both Western Australia and South Australia.

The subdivision area has historically been used for farmland (grazing and market gardens), pine plantation and building infrastructure. The farm paddocks originally extended to the periphery of the wetlands and the swamp areas were fenced to prevent stock gaining access and becoming bogged in the mud. More recently, rubble in the form of brick fragments, concrete blocks, glass, ceramic tiles, metal sheets, rods and asbestos cement sheeting fragments had been dumped on the subdivision area.

The subdivision proposal was referred to the Environmental Protection Authority (EPA) for consideration under Section 38 of the *Environmental Protection Act 1986*. The EPA set a level of assessment as Public Environmental Review (PER). The subdivision proposal did not include a buffer between the proposed development and the portion of the wetland to be retained. It should be noted that a request to modify the proposal was submitted with the EPA in accordance with Section 45C of the *Environmental Protection Act 1986*. The modification to the subdivision plan resulted in the removal of a causeway that dissected a portion of the wetland to be retained resulting in a net reduction in the area of the wetland to be disturbed.

During the PER process for the development, the Proponent made a commitment to prepare and implement a Wetland Management Plan to the satisfaction of the Department of Environment (now Department of Environment and Conservation (DEC)) and the City of South Perth for the retained portion of the Resource Enhancement wetland.

1.2 Purpose and Scope

The Proponent has commissioned Coffey Environments (formerly ATA Environmental) to prepare a Wetland Management Plan for the portion of the wetland to be retained. Figure 2 shows the features of the retained wetland and its surrounding context. This Wetland Management Plan fulfils the Proponent's Environmental Management Commitment No. 3 contained in Ministerial Statement No. 692 (Appendix A) as outlined in Section 1.2.1.

The retained wetland is a Resource Enhancement Estuary-Peripheral wetland (consisting of wetlands UFI 13843 and UFI 13845). Resource Enhancement wetlands are those that have been partially modified but still support substantial ecological attributes and functions (Hill *et. al.*, 1996). It is the DEC's view that the management objectives for Resource Enhancement Wetlands should focus on opportunities to upgrade these wetlands for conservation. The EPA has also stated in *Bulletin 1156, East Clontarf Residential Development*, "although the wetland on the site was identified by the 1992

Environmental Protection (Swan Coastal Plain Lakes) Policy (EPP), it did not meet the minimum environmental quality criteria to support registration in the (now defunct) Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy and Regulations 2004" (Appendix B).

The following management objectives are central to this Wetland Management Plan:

- Ensure that the values, attributes and functions of the wetland and wetland buffer are rehabilitated, maintained and protected through appropriate management of the subdivision area.
- Implement restoration techniques to rehabilitate degraded areas.
- Minimise impacts on the wetland and offset impacts to ensure no net loss of function or values.
- Implement specific management and maintenance actions and schedules required to ensure the rehabilitation and maintenance of ecological function.
- Protect the community from nuisance mosquito and midge events.
- Ensure that the wetland management plan is publicly available to all stakeholders including future local residents, friends / interest groups and relevant government authorities.

1.2.1 Proponent Commitment

Through the PER process, the Proponent made a number of Environmental Management Commitments. Commitment No. 3 specifically related to wetland management with the objective being to minimise impacts on the wetland and to offset impacts to ensure no net loss of function or value. The Wetland Management Plan is to include:

1. Identification of existing wetland area to be retained;
2. Avoiding direct and minimising indirect impacts on the wetland;
3. Ensuring no net loss of wetland values and functions;
4. Rehabilitation techniques to be employed;
5. Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats;
6. Mitigation strategies for loss of any vegetation will be investigated, including both on-subdivision area and off-subdivision area options;
7. Creation of a new wetland area to be located adjacent to the retained wetland and the river foreshore suitable for Black Swan breeding habitat;
8. Adopt existing mosquito and midge management protocols currently utilised by the City of South Perth;
9. Monitoring criteria to determine success of the plan;
10. Progress and compliance reporting; and
11. Timing and implementation schedule.

It should be noted that a separate Wetland Management Plan for the proposed constructed wetland for Black Swan breeding habitat (Point 7 above) has been prepared separate to this Management Plan (refer to Coffey Environments, 2007a for details of the proposed constructed wetland).

1.2.2 Public Availability of Documents

Extensive community and stakeholder consultation was carried out during the PER process, which included the opportunity for the public to make submissions on the PER documentation.

All management plans prepared to meet the requirements for Ministerial Statement No.692 (Appendix A), including this plan, will be made publicly available in accordance with EPA requirements. Notification of the availability of all management plans will be advertised through relevant media outlets (e.g. local newspapers), and copies of all management plans being lodged with:

- DEC Library – 2 copies;
- City of South Perth library – 2 copies;
- City of South Perth – 2 copies; and
- JS Battye Library – 2 copies.

1.3 Plan of Subdivision

The Cygnia Cove development will include residential lots, group housing, Public Open Space (POS), drainage and roadways as shown in Figure 3 (refer to Figure 4 for proposed drainage design). The Western Australian Planning Commission (WAPC) approved the subdivision of the site subject to implementation of a number of conditions in January 2007 (WAPC reference number 121124).

2 EXISTING ENVIRONMENT

2.1 Climate

The area has a Mediterranean climate with mild wet winters and hot dry summers. The hottest months are January and February and rain falls primarily in the winter months. Long term average rainfall is approximately 860mm (based on Bureau of Meteorology's Perth Regional Station, 1880 to present). The annual average rainfall has decreased significantly since the mid-1970s.

Seasonal wind patterns consist of a moderate south-easterly wind flow during the mornings in summer, with a moderate south-westerly wind flow in the afternoon. The winter wind flow pattern reflects synoptic flow. For example, north-westerly winds would be expected following a cold front.

2.2 Topography

Topographic contours range from 0mAHD (Australian Height Datum) immediately adjacent to the Canning River across the subdivision area to 9mAHD near Manning Road (Figure 3). Much of the subdivision area is flat and less than 3mAHD, rising relatively steeply in the northern portion of the subdivision area. The retained wetland is below 2mAHD.

2.3 Geomorphology and Surface Geology

Environmental geology mapping for the subdivision area shows that a large part of the subdivision area is considered part of the Canning River floodplain (Jordan, 1986). A wetland in the centre of the subdivision area 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 contains abundant shells and shell fragments. This wetland consanguineous suite is the B3 Jandakot suite.

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 eolian origin (Jordan, 1986).

The soils of the retained wetland are predominantly peat and peaty sands extending from the surface to approximately 1m depth. The peaty soils overlie sand and silty sand at shallow depths. According to Coffey (2000), the approximate thickness of peat in the wetland area is 3m, decreasing in thickness towards the Canning River.

2.4 Soil Contamination and Acid Sulfate Soils

Previous investigations at the Cygnia Cove subdivision area have identified deposits of uncontrolled fill material in several areas, including areas to the south of the wetland and two areas on the northern margin of the wetlands (Figure 5). It is estimated that the uncontrolled fill covers approximately 2ha of the site and varies in thickness between 0.1m and 1.5m (ATA Environmental, 2003). Various contaminants have been recorded in the areas where uncontrolled fill occurs, including asbestos and heavy metals. There is limited contamination within the portion of the wetland that will be retained as part of the subdivision. Several remediation areas are located adjacent to the wetland boundary as depicted in Figure 5. Remediation of contaminated areas will be the first activity undertaken in the subdivision area. Remedial works will be implemented in accordance with the *Site Remediation and Validation Management Plan* (ATA Environmental, 2007) prepared to guide remedial works at the site.

In addition, a *Dust and Asbestos Management Plan* (Coffey Environments, 2008a) has been prepared for the management of dust and asbestos at the site during remedial works and subsequent bulk earthworks program.

An Acid Sulfate Soils (ASS) investigation has been completed for the Cygnia Cove development. This investigation identified that the retained wetland represents a high risk site in terms of ASS (Figure 6), which will require specific management where disturbance of peat material is required, or if dewatering activities are needed. An *ASS Management Plan* (Coffey Environments, 2008b) has been prepared for the subdivision area and will form an integral part of the earthworks necessary for the proposed works in and adjacent to the retained wetland (e.g. construction of an earth bund, boardwalk and a dual use path). Where the removal of peat is necessary, the peat material will be treated and disposed of appropriately in accordance with the *ASS Management Plan*. Where localised dewatering is needed, the period when dewatering is needed will be kept to a minimum, and dewatering effluent will be treated and infiltrated as described in the *ASS Management Plan* (Coffey Environments, 2008b).

2.5 Landscape and Landform Values

The foreshore area is the dominant landscape feature of the site. The *Swan River System Landscape Description* (SRT, 2007) describes the foreshore area as swampy and low-lying, with a sandy ridge behind the shore. SRT (2007) describes the attractive band of shorerush on the Clontarf foreshore, but makes reference to the non-conformity of the rubbish still at the site which detracts from the landscape value of the area.

The wetland itself is an important feature of the landscape, and the western half of this wetland will be retained within the subdivision, and rehabilitated as described in this Wetland Management Plan.

2.6 Hydrology

2.6.1 Surface Water

The DEC's Geomorphic Wetlands of the Swan Coastal Plain dataset, indicates that a kidney shaped wetland extends east-west across the northern portion of the subdivision area and covers an area of approximately 4ha. The wetland is located in the Swan Estuary consanguineous suite (E.2) (Semenuik, 1988). This indicates that the wetland is within the Bassendean Dune Geomorphic unit and is likely to have been originated by riverine processes. As discussed in Section 1.2, this wetland has been assigned a management category of Resource Enhancement and is an Estuary-Peripheral wetland. Resource Enhancement wetlands are partly modified but still support substantial functions and attributes (Hill *et. al.*, 1996). Management priorities for Resource Enhancement wetlands should aim at wetland restoration through the maintenance and enhancement of wetland functions and attributes (Hill *et. al.*, 1996).

Mapsheets 2034 in the EPA's *Environmental Protection (Swan Coastal Plain Wetlands) Policy* (EPP) shows the EPP wetland boundary extending into parts of the subdivision area as high as 9mAHD. A site survey was completed by ATA Environmental to confirm the extent of the wetland boundary. The survey found that the actual wetland boundary varied from that shown on Mapsheet 2034. The revised boundary roughly coincides with the 2mAHD contour level. The wetland boundary and management category assessment conducted by ATA Environmental was endorsed by the Wetlands Branch of the Department of Environment (now the DEC) and was reflected in the (now defunct) *Draft Environmental Protection (Swan Coastal Plains Wetlands) Policy and Regulations 2004*.

Historical photographs to 1948 indicate that 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.

JDA (2004) reported that approximately 12.2ha of the 18.5ha pre-development area is estimated to drain to the wetland (including the wetland area itself) and 6.3ha is estimated to drain directly to the Canning River (see Figure 7).

The subdivision area also receives surface drainage from external catchments as follows (and Figure 7):

- Manning Road and Conlon Street catchment of approximately 6.9ha which discharges into the north western area of the wetland via piped drainage. The extent of this catchment area is indicative only as it is based on topographic data.
- Centenary Avenue catchment (26.0ha), which includes urban areas to the east of Centenary Avenue and north of Manning Road. These areas discharge into the subdivision area via piped drainage under Centenary Avenue into the eastern region of the wetland.
- Two smaller catchments to the west (1.0ha) and south east (1.5ha), which may discharge into the subdivision area from impervious areas as diffused overland flow.

On this basis, JDA (2004) estimated that the total upstream area draining into the subdivision area is 35.4ha, of which 33.9ha drains into the retained wetland and is discharged to the Canning River through a 750mm diameter culvert from the wetland into an overgrown trapezoidal channel.

The total existing pre-development catchment of the wetland is therefore 46.1ha (JDA, 2004).

Surface water discharge from the wetland occurs predominantly via a constructed drainage channel connecting the south-west tip of the wetland with Clontarf Bay. The flow rate discharging from the wetland was estimated by JDA during fieldwork on 10 November and 31 December 2002 to be approximately 20 litres/sec. 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. Fieldwork completed by JDA in February 2007, measured the discharge flow rate from the wetland to be approximately 10 litres/sec. In April and May 2008, Coffey Environments measured the discharge flow rate from the wetland to be 22.46 litres/sec and 24.23 litres/sec respectively.

Assuming 35% rainfall run off from the 46.1ha catchment and 790mm/year rainfall, the estimated annual average runoff is approximately 127,000m³/year, corresponding to 4 litres/sec, which is far less than the observed discharge. It is therefore, considered unlikely that surface drainage is sustaining the observed discharge from the wetland to the Canning River.

A Drainage, Nutrient, Irrigation and Water Quality Management Plan (Coffey Environments, 2007b) has been prepared for the subdivision.

In 2004, ATA Environmental (now Coffey Environments) collected two surface water samples from the drainage channel located to the south of the retained wetland area. Surface water from the wetland flows through this drainage channel, prior to discharging to the Canning River. The surface water samples were analysed by a NATA Accredited laboratory for a range of parameters and the results indicated that the water quality is good. It should be noted that the proponent has committed to implementing a surface water monitoring program across the Cygnia Cove development area, with sampling of stormwater inputs into the site, as well as sampling downstream of the retained wetland

area and the proposed constructed wetland. Further details of this monitoring program are contained in the *Drainage, Nutrient, Irrigation and Water Quality Management Plan* (Coffey Environments, 2007b).

2.6.2 Groundwater

The subdivision area 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 25m 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 suggesting 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 salinity beneath the subdivision area 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 subdivision area, north of the wetland, is typical of that of the region beyond the subdivision area. 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 (see Figure 8). 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 or that they form a barrier to groundwater flow.

The *East Clontarf Hydrological Investigation* (JDA, 2004) identified that a major contributing source of the water in the wetland was groundwater from the superficial aquifer, entering the wetland through a diffuse seepage face along its northern boundary. The other major contributing source is stormwater runoff entering the site from stormwater drains. The permanency of surface water and the constant water levels in the wetland suggest that Davidson's (1995) assertion that the area is a zone of groundwater discharge from the Leederville Aquifer is accurate. This is reinforced with flow rate monitoring of surface water discharging from the wetland being higher than would be expected of the wetland was supplied primarily by surface water inputs (JDA, 2004).

The subdivision area is not located within an Underground Water Pollution Control Area.

Groundwater monitoring indicates that groundwater at the site is slightly degraded with respect to the Fresh Waters-Rivers criteria, although there is no evidence to suggest that contaminant concentrations are greater in down-gradient bores than in up-gradient bores. Accordingly, it is concluded that the uncontrolled fill present at the site does not appear to have had a negative impact on groundwater quality. A *Baseline Groundwater Monitoring and Management Plan* (Coffey Environments, 2008c) has been prepared for the subdivision area, as well as a *Drainage, Nutrient, Irrigation and Water Quality Management Plan* (Coffey Environments, 2007b).

2.7 Vegetation and Flora

2.7.1 Description

The wetland is completely covered in vegetation (native and non-native reeds and sedges), with no areas of open water (Figure 9). The portion of the wetland to be retained consists mostly of dense

Bulrush (*Typha orientalis**) and Lake Club-rush (*Schoenoplectus validus*) Sedgeland. The wetland area may have originally been dominated by Lake Club-rush (*Schoenoplectus validus*) sedgeland prior to disturbance. Adjacent to the western perimeter of the wetland is a stand of young Lemon-scented Gum (*Corymbia citriodora**) trees up to 8m tall (Figure 9).

The Bracken Fern (*Pteridium esculentum*) vegetation adjacent to the northern side of the wetland appears on aerial photographs to form part of the wetland (Figure 9) but on close inspection is shown to be located on sloping ground above the wetland.

Immediately adjacent to the south central side of the wetland are three large areas of Tree Lucerne (*Chamaecytisus palmensis**) up to 4m tall and some individual exotic Eucalypts (Figure 9). The Tree Lucerne is an exotic species that was planted to provide fodder for grazing animals many years ago.

The absence of native vegetation around the wetland has enabled weed species (Kikuyu (*Pennisetum clandestinum**), lupins (*Lupinus sp.**), etc.) to become established.

A list of plant species identified by Coffey Environments on the subdivision area is presented in Appendix C (non-native species have been marked with an asterisk). No Declared Rare or Priority flora species were recorded on the subdivision area during the flora surveys.

2.7.2 Vegetation Condition

The wetland vegetation and its immediate surrounds is of variable condition ranging from Completely Degraded to Very Good (Figure 10) according to the vegetation condition rating as developed by Keighery and used in Bush Forever (Government of Western Australia, 2000). Large areas are mapped as Completely Degraded or Degraded to Good due to the absence of native species and the dominance of introduced species.

2.8 Fauna

The following sections relating to fauna at the Cygnia Cove Estate site has been adapted from a fauna report prepared by Dr Mike Bamford. A copy of this report is provided as Appendix D of this Wetland Management Plan.

2.8.1 Habitats

Based on the existing vegetation and aerial photography the main fauna habitats on the subdivision area are considered to be the wetland dominated by Bulrush and other sedges that occupies about one third of the subdivision area, grassland surrounding the wetland and the Canning River including the adjoining foreshore.

Densely vegetated wetlands can provide sheltering, feeding, nesting and breeding areas for terrestrial and some aquatic birds. The main faunal groups considered likely to inhabit the management area are terrestrial and aquatic birds and amphibians and macro-invertebrates. However, the EPA's (2004) *Bulletin No. 1156 East Clontarf Residential Development: Trustees for the Christian Brothers of WA Inc. Report and Recommendations of the EPA*, states that while the area "does provide some habitat value, the wetland itself is not considered a significant habitat or refuge". Rehabilitation of this wetland as described in this Wetland Management Plan will improve habitat values of the portion of the wetland being retained.

2.8.2 Species

A brief fauna survey has been conducted between Clontarf and Mount Henry on the Canning River foreshore in autumn of 1993 (City of South Perth, 1993). The survey included areas of *Juncus kraussii*, which are typical of the foreshore vegetation found on the subdivision area. In areas representative of the subject subdivision area several species of skink, frogs, bush crickets and orb weave spiders were found. Black Swan (*Cygnus atratus*), Coot (*Fulica atra*) and Musk Duck (*Biziura lobata*) were identified on the river. It should be noted that Black Swans do not utilise the retained wetland area, rather they are typically found in Clontarf Bay and occasionally utilise the drainage channel leading up to the retained wetland area.

Additional information regarding the fauna of the subdivision area has been obtained through a series of subdivision area surveys undertaken at various times throughout the year. The surveys were undertaken by ATA Environmental in association with Bamford Consulting Ecologists. The results of this survey were documented in the PER document (ATA Environmental, 2004). The surveys were designed to determine the value of the habitats on the subdivision area for fauna.

Frogs

Six species of frogs were recorded during the surveys. One of these species, 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 quarry on the subdivision area and along the river. Within the wetland, records of frogs were restricted to the western portion, the drainage line extending to the river and within the drain that passes under Centenary Avenue.

Litoria moorei was recorded only within the marsh areas adjacent to the river although the habitat within the wetland also appears suitable for this species.

The low numbers of frogs calling from the majority of the wetland was unexpected. Conversely, the records of *Crinia georgiana* are unexpected as this species is patchily distributed on the coastal plain.

It is possible that frog diversity and abundance at the subdivision area has been adversely affected by past land uses and contamination. While the water within the wetland and drain is generally of good quality and the Bulrush provides a biofilter, past land use and contamination of the sediment and groundwater may be impacting on frogs within the wetland.

Reptiles

A small number of reptile species were recorded during the surveys. This can generally be attributed to the disturbed and highly modified nature of the habitats. The species found included the long necked tortoise (*Chelodina oblonga*), three species of skink lizards (*Acritoscincus (Bassiana) trilineatum*, *Cryptoblepharus plagiocephalus*, *Lerista elegans*) and two species of snakes (Tiger (*Notechis scutatus*) and Dugite (*Pseudoaja affinis*). All of the species are typical of the habitats 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 wetland from the river to lay eggs.

Birds

Six waterbird species were observed or heard within the wetland area on the subdivision area. The wetland on the subdivision area provides habitat for three species, the Spotless Crake (*Poizana tabuensis*), Clamorous Reed-Warbler (*Acrocephalus stentoreus*) and Little Grassbird (*Megalurus 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 (*Poizana pusilla*), could possibly occur in the wetland.

The wetland itself is not suitable for Black Swans due to the dense bulrush infestation and the absence of open water areas. However, the primary value of the wetland to the Swans is the continual supply of fresh water discharging from the wetland into Clontarf Bay. This flow will be maintained in the proposed development. The proponent has commissioned monthly flow rate monitoring for six months commencing in April 2008 (preliminary results contained in Section 2.6.1). Post-development flow rate monitoring will be undertaken as described in the Constructed Wetland Management Plan (Coffey Environments, 2007a)

Mammals

No native mammals were recorded during the subdivision area survey. The survey revealed that foxes, rabbits, feral or semi-domestic cats and at least one species of introduced rat occur within the subdivision area.

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. This record was not expected, as Gilgies are not known from other wetlands in South Perth.

2.8.3 Significant Species

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

Of possible relevance to the wetland area is the Southern Brown Bandicoot or Quenda (*Isoodon obesulus fusciventer*) which has been recorded nearby in Wilson. This species typically prefers low dense vegetation without too much water. However, due to the disturbed nature of the subdivision area, the presence of foxes and the permanent presence of surface water in the wetland, it is unlikely that populations of the Quenda persist in the wetland area. This species may however, colonise the area periodically from other habitats that adjoin the river in nearby localities provided 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 subdivision area. No evidence of this species was recorded during past subdivision area surveys, however the species may move along the river foreshore area.

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 subdivision area. All of the species that were recorded were located in habitats associated with the Canning River. A *Foreshore Management Plan* has been prepared to address this area (Coffey Environments, 2008d).

2.8.4 Conservation Significance

Main observations or findings of the vertebrate fauna surveys in relation to the significance of the habitats of the wetland area to fauna are as follows:

- 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, various frogs, and Long-necked Tortoise.
- The wetland could support a greater range of waterbirds if areas of open water were available.
- Dryland vegetation of the wetland such as bracken fern and some remnant dryland vegetation provide 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.
- Dryland vegetation of the subdivision area is severely degraded. These areas support few reptile species and open country birds such as Magpies that still rely on scattered mature trees. Trees within the subdivision area may be used for breeding by various birds, including some waterbirds such as ducks and herons.

The wetland supports a few species that are not found close to the river such as Reed-Warbler, Little Grassbird, and Spotless Crake. In addition, the single record of a Fairy-wren (*Malarus splendens*) indicates that the dryland vegetation have the potential to support a richer fauna than is currently present given the proposed rehabilitation and revegetation objectives contained within this Wetland Management Plan.

2.9 Heritage Values

The Clontarf campus site, neighbouring the development area, has a permanent entry on the Heritage Council of Western Australia's *Register of Heritage Places* (see Appendix E). The site contains a former orphanage, farm, and school which were built between 1901 and 1973.

2.9.1 Aboriginal Heritage Values

The Canning River is a recognised heritage site which 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 subdivision area was identified as part of a hunting, collecting and fishing ground of significance to the Nyungar people.

The Clontarf East site previously recorded in 1978 during the Swan Survey Project was re-located and examined as part of O'Reilly's field survey (MacIntyre, Dobson and O'Reilly, 2000) 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.

The proponent has been granted a Section 18 clearance by the Minister for Indigenous Affairs under the *Aboriginal Heritage Act 1972*. Under the Act, a Section 18 clearance is required where there is potential for an activity to disturb a registered Aboriginal Heritage site.

As part of the PER Aboriginal consultation process, Aboriginal representatives requested that the wetland is not modified into a landscaped water feature (ATA Environmental, 2004).

2.9.2 European Heritage Values

The Clontarf campus site was originally established by the Christian Brothers in 1901. Throughout its history, the wetland has been used as a source of domestic (drinking, cooking, washing) water and by the early 1920s, was part of a fully operational farm with orchards and vegetable gardens cultivated and tended by the boys. Irrigation was provided by channels diverted from the wetland. There was also a dairy, poultry yard, piggery and stock runs. As a result, Clontarf was nearly self-sufficient (Heritage Council of Western Australia, 2000).

Works to the farm were carried out in the period immediately after the second World War, with clearing and fencing as well as the building of a new dairy in 1951 (Heritage Council of Western Australia, 2000).

2.10 Retained Wetland Functions

Wetlands may have conservation significance depending on the functions they may serve. Typical wetland functions may include providing a habitat for native fauna and flora; providing a biologically productive and genetically diverse natural environment; maintaining ecological processes; providing a recreational aspect of the natural landscape; forming a part of the natural hydrology, surface and groundwater drainage system; and serving as a scientific resource.

The retained wetland at the subdivision area was once used as a water supply for the Clontarf Orphanage as irrigation and domestic consumption. Beside this past use, it does not appear to serve many significant functions other than it is a part of a drainage system to Canning River. The drainage channel into which this wetland discharges has been artificially created, although it is likely to have been a natural drainage discharge point prior to construction as a drain. The presence of reeds in the retained wetland contribute to maintaining water quality within the wetland and discharge to Canning River.

The natural wetland environment has been modified over time and does not provide a diverse natural environmental.

The wetland currently provides a low diversity of habitat, lacks open water, and therefore may be considered to have limited value for fauna with the following species potentially being present:

- 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; and

- Mosquito Fish.

The wetland does not currently appear to provide any recreational function, and due to the fact that it is privately owned, recreational pursuits would be considered trespass. Once developed, the wetland will provide some passive recreational benefits to the general public as it will be more accessible in POS.

There is no information suggesting that the wetland is currently a site for scientific or educational resource purposes. However, there is some potential educational value, depending on the success of the rehabilitation program as described in this Wetland Management Plan.

Implementation of this Management Plan will result in the improvement of the wetland's values, attributes and function.

3 WETLAND MANAGEMENT

3.1 Management Objectives

Resource Enhancement wetlands are those have been partially modified but still support substantial ecological attributes and functions (Hill *et. al.*, 1996). It is the DEC's view that the management objectives for Resource Enhancement wetlands should focus on opportunities to upgrade these wetlands for conservation.

The following wetland management objectives are designed to achieve an improvement in the retained wetland values:

- Ensure that the values, attributes and functions of the wetland and wetland buffer are rehabilitated, maintained and protected through appropriate management of the subdivision area.
- Implement restoration techniques to rehabilitate degraded areas.
- Minimise impacts on the wetland and offset impacts to ensure no net loss of function or values.
- Implement specific management and maintenance actions and schedules required to ensure the rehabilitation and maintenance of ecological function.
- Protect the community from nuisance mosquito and midge events.
- Ensure that the wetland management plan is made publicly available to all stakeholders including future local residents, friends / interest groups and relevant government authorities.

These objectives have been addressed in this Wetland Management Plan and are considered in further detail in the following sections.

3.2 Wetland Retention

Development of the Cygnia Cove Estate will result in the retention of 1.52ha of the retained wetland in Public Open Space with the balance (2.48ha) being drained and filled (see Figure 11). The area of wetland being retained will be rehabilitated (including dryland areas west of the retained wetland) in accordance with this Wetland Management Plan as part of the on-site mitigation strategy. Off-site mitigation strategies include the construction of a new wetland for the purposes of Black Swan breeding habitat, as well as the extension and rehabilitation of the foreshore reserve adjacent to the proposed development.

3.3 Constructed Wetland

As an off-set to the loss of a portion of the wetland, the proponent has committed to the creation of a constructed wetland suitable for Black Swan breeding habitat. Full details relating to the engineering design and environmental management of the constructed wetland have been addressed in a separate *Wetland Management Plan* (Coffey Environments, 2007a). It is intended that the constructed wetland will integrate with the retained wetland and function as a single system as depicted in Figure 12.

Water flowing from the retained wetland will be split at the junction of the existing drainage channel and the constructed wetland inlet using two weir structures positioned at the inlet and outlet zones of the constructed wetland. This will result in approximately 50% of the flows entering into the constructed wetland and the remaining 50% discharging directly into Clontarf Bay via the existing drainage channel.

Storm events will by-pass the wetland and discharge via the drainage channel to Clontarf Bay. The proposed wetland will discharge to the lower section of the drainage channel and then to Clontarf Bay, resulting in minimal loss of surface water flows. This design approach is consistent with the EPA's requirements as outlined on page 5 of the EPA's (2004) *Bulletin No. 1156 East Clontarf Residential Development: Trustees for the Christian Brothers of WA Inc. Report and Recommendations of the EPA*.

Water moving through the wetland will pass through densely vegetated areas as a method of pollutant removal prior to being discharged. The primary objective for the constructed wetland is to create Black Swan habitat and the wetland has not been designed as a stormwater treatment wetland. It is expected that the rehabilitation of the retained wetland will assist in the treatment of water entering the constructed wetland. It should be noted that the general approach to urban water management in the Cygnia Cove Estate is to infiltrate stormwater at source where possible. The management of stormwater in Cygnia Cove Estate will be in accordance with the Department of Water's (2004) *Stormwater Management Manual for Western Australia*.

3.4 Landscape Concept Plan

The proponent's consultant landscape architect (Plan E) has developed a Landscape Concept Master Plan for the retained wetland area and the proposed constructed wetland area (Figures 12 and 13). The Landscape Plan retains the core wetland area of the retained wetland as a closed sedgeland, maintaining this as an important landscape feature of the site. A 3.5m wide trafficable pathway is provided around the eastern and northern perimeter of the wetland area. A boardwalk crossing, constructed over an earth bund through the north eastern portion of the wetland will allow people to cross over the wetland area, potentially offering glimpses of bird life in the rehabilitated wetland area.

Between the northern boundary of the wetland and the development will be a batter landscaped with native species. Tree species will be planted in clumps to allow views of the wetland from the finished lots.

Along the western side of the wetland and connecting with the northern path, will be a path leading to a viewing terrace which will be constructed at the same level as the existing campus. The viewing terrace will contain a feature arbor structure overlooking the retained wetland.

The landscape plan provides for linkages between the retained wetland, the constructed wetland, and the foreshore reserve. A footbridge will be provided across the existing stream to provide an uninterrupted natural area from the north of the existing wetland all the way through to the foreshore reserve (Figure 12).

Contained within the dryland portions of the wetland buffer (outside the wetland area and to the west) will be a heritage walk trail with a Bush Tucker garden planted along this trail with interpretative signage. The western buffer will also be rehabilitated with native species.

The old gymnasium site will be redeveloped as an outdoor learning space and will include a shade structure. This learning space will be elevated and offer views across the wetland and Clontarf Bay to the east and southeast.

Infrastructure will be designed in consultation with and constructed to the satisfaction of the City of South Perth, and will be located outside the wetland boundary, with the exception of the proposed boardwalk which will be constructed through a portion of the wetland (over the earth bund).

3.5 Construction Management and Re-contouring

To ensure minimal damage to the portion of the wetland being retained, earthworks will be restricted to outer margins of the retained wetland area. Earthworks in the wetland area around its margins will be necessary for the removal of peat and replacement with clean fill to enable the construction of a boardwalk/trafficable path. Similarly construction in the north-east portion of the wetland will also be required to enable the construction of a small earth bund in the wetland area. During these earthworks, it may be necessary to install silt curtains to minimise the discharge of sediments to Clontarf Bay. Areas of the wetland disturbed during the construction process will be rehabilitated using native species as discussed in Section 3.11.

Development of the Cygnia Cove Estate will result in re-contouring of the existing landforms. It is proposed that batters will taper from the finished lot levels back towards the northern portion of the wetland to a level of 2mAHD (refer to Figure 13 for cross-sections and Figure 3 for design contours). Batters will be landscaped and revegetated using local species.

Earthworks will be conducted in accordance with the *Site Remediation and Validation Management Plan* (ATA Environmental, 2007), *Dust and Asbestos Management Plan* (Coffey Environments, 2008a) and the *Acid Sulfate Soils Management Plan* (Coffey Environments, 2008b).

Rubbish will be collected on a periodic basis during construction and disposed of to an approved landfill site.

All subdivision area works will be undertaken in accordance with the DEC's *Environmental Protection (Noise) Regulations 1997*. The Regulations specify assigned noise levels for premises receiving noise, according to the type of premises receiving the noise, the time of day and presence of commercial and industrial land use zonings, and major roads with 450m radius of the receiver.

A *Draft Construction and Environmental Management Plan* (CEMP) (Coffey Environments, 2008e) has been prepared and will be implemented by the proponent during construction stages in order to minimise environmental impacts arising from construction activities. The CEMP will be finalised once all other management plans required under Ministerial Statement No. 692 have been approved by the relevant regulators.

3.6 Access

The wetland POS area will be accessible to pedestrians via a dual use path (DUP) that will separate the wetland area from the adjacent lots. It is expected that the DUP system in Cygnia Cove Estate will link into the regional cycle network along the Canning River foreshore.

Vehicle access will be restricted to the trafficable path constructed around the eastern and northern portion of the wetland. Access will be limited to emergency service vehicles and maintenance vehicles. Frequent traffic is not expected.

Boardwalks are proposed in or around the wetland as depicted in Figure 12. The boardwalk proposed to go through the northeast part of the wetland will be constructed over a small earth bund that is required to be constructed as part of the stormwater management system.

3.7 Education

Although other opportunities for community involvement in implementing the Wetland Management Plan are limited, the retained wetland and its surrounding buffer offer an opportunity for public education

and appreciation. Figures 12 and 13 illustrate the proposed POS landscaping approach to be implemented at Cygnia Cove.

Interpretative signage will be erected along the DUP to inform the community of the environmental and heritage values of the area. This will particularly include signage along the heritage walk trail with particular reference to the historical significance of the subdivision area as well as information relating to the species contained in the Bush Tucker garden (further details in are included in Section 3.11.2).

In brief, the topics of the interpretative signage are proposed as follows (Appendix F contains more details):

- The wetland
- Site rehabilitation
- Architecture
- Social history
- The created wetland
- Black swans (2)
- The foreshore reserve
- Wetland fauna
- Water
- Creators of Clontarf
- Bush tucker and medicine
- Specific bush plants (6)
- Nyoongar life near wetlands
- Nyoongar life on rivers
- The old jetty
- Waterbirds
- Marris

On the western side of the wetland and contained in the buffer will be an elevated outdoor learning space with a shade structure and a viewing terrace (constructed at the existing campus level). Both of these areas will be accessed via the Cygnia Cove Estate path network. Both spaces are elevated and will provide views over the wetland area.

3.8 Drainage and Nutrient Management

The post-development drainage system at Cygnia Cove Estate is required to accommodate surface drainage from urban areas and sub-soil drains, while also preventing deterioration of wetlands, eutrophication of Clontarf Bay, control of peak flows into downstream water bodies and maintain pre-development drainage lines on subdivision area. The drainage design is detailed in Figure 4.

A *Drainage, Nutrient, Irrigation and Water Quality Management Plan* (DNIWQMP) (Coffey Environments, 2007b) has been prepared for the Cygnia Cove Estate and will be available to the public as described in Section 1.2.2 .

Water sensitive urban design principles will be applied throughout the development with preference for infiltration of stormwater at source where feasible. Sufficient separation between groundwater levels and buildings will occur where infiltration is to be employed. Infiltration will be used with consideration given to the City of South Perth's *Stormwater Drainage Management Plan*. It is anticipated that the retained wetland will not be used for primary drainage purposes. Drainage, if not infiltrated through soakwell pits in road reserves or in underground infiltration (Atlantis) cells, will be directed to one of two detention storage areas located in the southeast portion of the subdivision area or in the north-east portion of the retained wetland. It is anticipated that these detention storage areas will only receive stormwater from the development during large events. An earth bund will be constructed (beneath the

boardwalk shown in Figure 12) with several small pipes to permit water flow through the wetland. The earth bund will create a small weir (detention storage area 1) that is designed to retard stormwater flows into the wetland and enable the sedges present to filter the stormwater entering the wetland. It should be noted that stormwater generated from off-site is currently discharged into the wetland.

Emphasis will be placed on nutrient control at source as recommended in the Department of Water's (2004) *Stormwater Management Manual for Western Australia*. Source controls have been identified as a very cost effective and potentially significant means of addressing stormwater quality (Water and Rivers Commission, 2003). Turf areas will be kept to a minimum in order to reduce the requirement for fertiliser application and irrigation in keeping with best management practice. Slow release, low phosphorous fertilisers will be used preferentially on turf areas and animal manure soil conditioners will not be used. Regular maintenance of turf areas and the removal of cuttings from the subdivision area will assist the removal of potential nutrient inputs. It should be noted that majority of the landscaping in the subdivision will use native species to minimise water and nutrient requirements. Relatively small lot sizes throughout the estate are also likely to limit the amount of private gardens and lawns, thereby minimising nutrient inputs to the groundwater from fertiliser application.

The (DNIWQMP) (Coffey Environments, 2007b) has been prepared in accordance with Ministerial Statement No. 692. Ministerial Statement No. 692 states that the DNIWQMP is to be prepared prior to ground disturbance and the principal objective of the Plan is to address the following environmental quality objectives as described in *Riverplan – An Environmental Management Framework for the Swan and Canning Rivers* (SRT, 2004) to protect, restore, and maintain:

1. Ecosystem health;
2. Biological diversity;
3. Natural landscape;
4. Recreation; and
5. Water supply.

The following documents provided guidance in the preparation of the DNIWQMP:

- *Policy SRT/DE4 - Stormwater Disposal* (Swan River Trust, 1999);
- *City of South Perth Integrated Catchment Management Plan* (CoSP, 2004);
- *Stormwater Management Manual for Western Australia* (DoW, 2004);and
- *Water Quality Protection Note No. 33: Nutrient and Irrigation Management Plans* (DoW 2006).

A surface water monitoring program, as described in the DNIWQMP will be implemented by the proponent to monitor the quality of stormwater that is generated off-site but enters the site via a culvert located on Centenary Avenue, as well as monitoring the quality of surface water discharged from the retained wetland and the constructed wetland.

3.9 Mosquito and Midge Control

3.9.1 Background

Constructing residential areas in close proximity to water bodies increases the risk of exposure to nuisance insect events. Mosquitoes and midges can significantly reduce the amenity of areas and can, in the case of mosquitoes, pose health risks.

Mosquitoes become particular pests during the warmer summer months when the water temperatures increase, causing their breeding cycle to speed up and numbers to increase. Mosquitoes are considered to be a 'nuisance' when the number of mosquitoes caught at a single location in a single carbon dioxide baited insect trap exceeds 50 over a normal sampling period (12-18 hours) (EPA, 2000). If the species caught are ones that are known, or suspected to be vectors of mosquito-borne disease, and the mosquito population is in close proximity to a heavily populated area, then the mosquitoes present a potential health risk and will require control.

Problems with mosquitoes and midges are typically associated with wetlands with poor water quality and high nutrient loads. Nutrient loads within the retained wetland should not be significantly increased as a result of the development as the emphasis will be on at source nutrient controls and the drainage system will encourage infiltration where possible.

3.9.2 Mosquito and Midge Control Objectives

The objectives of the mosquito and midge control program are to:

- Reduce residents exposure to disease carrying mosquitoes and nuisance midges;
- Minimise the use of chemicals for the control of mosquitoes;
- Control mosquitoes and midges using the most cost effective and environmentally safe methods available; and
- Educate the community about midges, mosquitoes, mosquito borne diseases and mosquito prevention.

3.9.3 Proposed Control Program

Mosquito numbers vary between seasons and years. While it is not possible to eliminate all mosquitoes, it is important to take measures to reduce the risk of people being bitten by infected mosquitoes (EPA, 2000).

A monitoring program will be established for the Cygnia Cove Estate that will involve:

- A 12 month baseline sampling period has commenced to determine the species of mosquitoes and midges present; and
- On-going monitoring of mosquito and midge population numbers by the proponent with ultimate responsibility for management to be adopted by the City of South Perth.

Mosquitoes become an increasing pest during summer months. At the same time, humans engage in more outdoor activities during the hotter months and therefore become exposed to mosquitoes in greater frequency. For this reason it is recommended that the intensity of the monitoring program increase during the warmer months (October to March) and reduced during cooler months. During the

October to March period, it is recommended that monitoring of mosquito and midge populations be taken on a fortnightly basis and during cooler months on a monthly basis. Depending on the results, the requirement for further monitoring should be assessed and if appropriate, the monitoring program be revised. The results should also be used to formulate appropriate control strategies where necessary. Control strategies could involve physical, chemical, biological or cultural methods.

To be effective, a mosquito and midge control programme must utilise an integrated approach to management employing a combination of physical, biological, chemical and cultural control methods and targeting both larvae and adult mosquitoes and midges. These might include:

- Physical – Physical modification or removal of source to prevent breeding through techniques such as runnelling;
- Chemical – Application of larvicides and adulticides, including fogging and residual surface adulticides;
- Biological – Introduction of appropriate mosquito predators; and
- Cultural – Encouragement of public to implement personal preventative measures through the provision of signage in POS areas advising people about the risk posed by mosquitoes.

A Mosquito Management Plan will be prepared by the proponent. It is recommended that the City of South Perth keep records of complaints from Cygnia Cove Estate relating to mosquito and midges. It should be noted that the responsibility for monitoring and implementation of control strategies will be the responsibility of the proponent for a two year period and will be undertaken in keeping with the City of South Perth's current mosquito management protocols. Thereafter the City of South Perth will assume responsibility for the control of mosquitoes and midges.

3.10 Weed Management

3.10.1 Initial Management

The wetland area (including the adjacent buffer) has historically been exposed to ongoing sources of weed infestation. Ideally, small infestations of major weeds would be targeted to prevent massive infestation as it is often more effective to control the source of weed invasion before major infestation occurs. This approach is more suitable for the maintenance period after the wetland has been rehabilitated. Weeds within the subdivision area are extensive both in distribution and density. Therefore, prior to rehabilitation commencing, it is proposed that a weed assessment be carried out by a suitably qualified weed contractor prior to undertaking weed control at the site. The dryland wetland buffer area is then proposed to be scalped to remove existing weeds. Slashing and spraying may be effective, although it is probable that repeated effort will be required to control the weeds (refer to Section 3.10.2 for further details).

In and around the wetland, herbicide use will be in accordance with recommendations contained in the *Water Note No. 22 – Herbicide Use in Wetlands* (Water and Rivers Commission, 2001).

There are three prominent weed species presently in or immediately surrounding the retained wetland, these are:

- Bulrush (*Typha orientalis*);
- Paspalum (*Paspalum dilatatum*); and

- Kikuyu (*Pennisetum clandestinum*).

The management of weed species in the wetland area will be undertaken using a three-step process:

1. A suitably qualified and experienced weed manager will assess the wetland for the presence and location of weed species;
2. The appropriate weed management measures will be implemented; and
3. The weed management contractor will report to proponent's consultant landscape architect every six months on the status of weeds in the wetland, in particular on the success (or failure) of any control methods used and the requirement for additional weed control.

The rehabilitation timeline and responsibility for implementation are detailed in Sections 3.14 and 3.15.

Bulrush

Bulrush is a tall rigid reed that grows to 4.5m tall with flat strap-like leaves to 2m long and a thick cylindrical stem. Eradication of bulrush is difficult because of the large seed production and the hard to kill rhizomatous root system. Removal methods include cultivation, mowing, physical removal, burning and herbicides. Most of these removal techniques are considered inappropriate at the Clontarf wetland. Cultivation, mowing and physical removal may result in the discharge of sediment to Clontarf Bay and the potential oxidation of high risk acid sulfate soils. The risk of discharging sediment to Clontarf Bay if physical removal was implemented, could be reduced by starting removal from the eastern end of the wetland and progressively moving west. The rate of removal would need to be slow and a monitoring program in place. Silt curtains could also be installed to reduce the amount of sediment discharged to Clontarf Bay. Burning is not considered an appropriate control method as continuous groundwater inflow ensures that the wetland area is permanently wet.

The proponent, in conjunction with Coffey Environments has implemented a trial to spray the *Typha* with Round-Up Bi-active ®. Initial results indicate that the trial has been highly successful, killing the areas of *Typha* treated. Further treatment will be required due to the rhizomatous nature of *Typha*.

Further control of *Typha* in less accessible areas of the wetland cannot be achieved with blanket spraying, and Biodiversafety (the weed contractor that successfully completed the trial spray program) has proposed that their Boomwing device is used to treat those less accessible areas. Biodiversafety advises that on other sites with similar rates of *Typha* infestation, this method of eradication has been 98% effective in eliminating *Typha*. Biodiversafety have recommended that this treatment be used and propose a follow-up application be applied when the *Typha* is showing signs of dying back.

Where practicable, areas of native sedgeland will be identified prior to spraying commencing to avoid mortality of native species during weed control. A reduction in the density of *Typha* will greatly assist with the regeneration of native rushes and sedges. Revegetation of the batter around the wetland will include planting shade trees and shrubs to assist in natural regeneration.

Kikuyu

Kikuyu is a mat-forming grass, spreading by rhizomes (underground runners). Leaves are bright green, folded in bud, flat and about 1cm wide when mature. Kikuyu seldom flowers or seeds. It is cultivated for pastures, lawns and playing fields due to its robustness and is a common weed throughout the Perth metropolitan area.

Kikuyu can be controlled through mechanical methods such as digging. However, it is important that all rhizomes are removed for effective control. Kikuyu is easy to control with herbicides. On-site Kikuyu will require on-going weed control, until the native plants are sufficiently established to out-compete the grass. During vegetation establishment, a grass-specific herbicide can be used to remove it from among native grasses, with minimal damage to the natives.

Paspalum

Paspalum is a tufted perennial grass that can generally grow up to 150cm tall. However, when cut with a mower, the plant will grow prostrate with only the flowering heads being produced just above mowing height. It is dormant during winter months and will grow vigorously in locations where it receives adequate moisture during summer. Paspalum will also respond vigorously to high levels of soil nitrogen in these conditions. Paspalum flowers and produces seed in late summer. The seed is sticky and is readily transported on shoes, clothing or machinery (e.g. lawn mowers).

Paspalum should be treated during the period of active growth, late spring to early autumn with a herbicide such as glyphosate.

Removal of Exotic Shrubs and Trees

In addition to Bulrush, Paspalum and Kikuyu, there are a number of tree and shrub species around the wetland that should be removed and replaced with local species. The introduced species include Lemon-scented Gum, Japanese Pepper, Tree Lucerne, Bamboo and Castor Oil Plant.

The Japanese pepper, bamboo and castor oil can be cut and the stump dug out and thereafter controlled by the slashing and herbicide application.

The Lemon-scented Gum trees will be retained as they provide habitat for bird species. However, it is intended that these trees will be removed as native tree species are established to replace the Lemon-scented gums.

The Tree Lucerne currently provides habitat for birds (such as the New Holland Honeyeater). Therefore, mature stands of the Tree Lucerne should only be removed as native shrubs and trees are established to replace it. However, in the short term, the focus should be on the removal by slashing and spraying young seedlings that germinate around the existing bushes.

Well composted mulch can be spread in landscaped dryland areas that have been treated for weeds to prevent their re-establishment.

3.10.2 Follow-up Weed Treatment

Maintenance spraying or brush-cutting will be required to ensure effective control of weeds likely to germinate after disturbance to the subdivision area. To prevent excessive weed growth, the timing of subsequent applications will need to be assessed monthly during autumn and winter and then on a bi-monthly basis through spring and summer.

Weed Monitoring

Monitoring for regeneration of any other broadleaf weed species will occur on a bimonthly basis and any new germinants will be controlled with spot spraying through backpack application.

3.11 Revegetation

The wetland is densely vegetated with Bulrush (*Typha orientalis**) and other rushes and sedges.

All rehabilitation works for the wetland will be conducted in accordance with EPA *Guidance Statement No.6 Rehabilitation of Terrestrial Ecosystems* (EPA 2006) where practicable.

Where possible plant species used in revegetation works will be of local provenance, defined as propagated from plant in the immediate geographic area from areas that closely match the physical environment and the plant community types of the area to be planted. The City of South Perth has made an opportunity to collect seed from local reserves available, subject to normal seed collection restrictions. In acknowledgement that sourcing sufficient plant stock, particularly wetland species, can be difficult, tubestock from species that would be expected to be found in the retained wetland in this locality may be sourced from available nursery stock.

Figure 14 outlines the planting zones for the rehabilitation works for the retained wetland area.

3.11.1 Plantings for Wetland and Fringing Areas

Different plant species have differing tolerances to ground water levels and as a result, may prefer inundated and lower slope environments over slightly drier areas. *Schoenoplectus validus*, *Juncus pallidus*, *Baumea juncea* and *B. articulata* are recommended for planting within the wetter areas located in close proximity to the wetland's edge. *Juncus pallidus* and *Baumea* species are able to tolerate seasonal inundation, as well as being able to survive dry periods over summer. It is anticipated that only small areas of the wetland margin may be planted with wetland species as disturbance of the wetland may result in mobilisation of sediments into Clontarf Bay. If revegetation in the wetland is required, the preferred species for revegetation of the wetland are listed in Table 1.

Table 1 also contains native species considered suitable for revegetating fringing areas of the wetland. The revegetation of the fringing areas will include clumped plantings of tree species. Tree guards will be erected around each plant to protect them from introduced vertebrate pests, pets and people. Monitoring of planted tubestock survival rates will commence during spring then monthly during the first summer (i.e. December, January, and February), and bi-annually during the following year. It is recommended that the dryland plants are hand watered weekly to fortnightly during the summer months and then fortnightly to monthly during the cooler months to reduce plant deaths at least during their first year following planting.

The proponent will salvage native plants for the rehabilitation works from the eastern portion of the wetland that is to be filled. If practical, a holding bay will be established in the wetland area to be retained to store the salvaged plants until they are needed for rehabilitation. The ability to establish the holding bay may be governed by the staging of the excavation of the eastern side of the wetland.

TABLE 1
RECOMMENDED REVEGETATION SPECIES FOR WETLAND AND FRINGING AREAS (EW3)¹

Scientific name	Common name	Form	Height	Planting	Density	Estimated number
<i>Carex appressa</i>	Tall sedge	Sedge	1.5	Tubestock	500cts	1050
<i>Carex fascicularis</i>	Tassel sedge	Sedge	1	Tubestock	500cts	1050
<i>Baumea juncea</i>	Bare twig rush	Sedge	1	Tubestock	500cts	1600
<i>Baumea rubiginosa</i>	River twig rush	Sedge	1	Tubestock	500cts	1050
<i>Juncus kraussii</i>	Shore rush	Sedge	1.2	Tubestock	500cts	1600
<i>Juncus pallidus</i>	Pale rush	Sedge	1.5	Tubestock	500cts	1050
<i>Schoenoplectus validus</i>	Lake club rush	Sedge	2.5	Tubestock	500cts	1600
<i>Banksia littoralis</i>	Swamp banksia	Tree	10	45Lt-100Lt bag	As shown	12
<i>Casuarina obesa</i>	Swamp sheoak	Tree	10	45Lt-100Lt bag	As shown	12
<i>Eucalyptus rudis</i>	Flooded gum	Tree	15	45Lt-100Lt bag	As shown	12
<i>Melaleuca pressiana</i>	Modong	Tree	10	45Lt-100Lt bag	As shown	12
<i>Melaleuca raphiophylla</i>	Swamp paperbark	Tree	8	45Lt-100Lt bag	As shown	12

3.11.2 Dryland Plantings

The degraded wetland buffer on the western boundary will be revegetated with native species (Table 2) with a particular emphasis on Bush Tucker species. A Bush Tucker garden will be planted closest to the path network in the wetland buffer area as part of a heritage walk trail. The Bush Tucker garden will

¹ Refer to Figure 14 for definition of EW3.

relate the landscape to the Aboriginal Campus and serve an education function. A list of possible Bush Tucker species is provided in Table 3. Signage will be installed along the walk trail educating visitors about the significance of the area and particular species to the Aborigines.

Table 2 contains a list of species suitable for revegetating degraded dryland areas west of the retained wetland. These species will predominantly be planted on the western side of the wetland and will be augmented with the Bush Tucker garden. The paucity of native species on subdivision area limits the availability of tube stock of local provenance. The final species selection will be subject to availability from NIASA accredited nurseries with an aim of sourcing dieback free seedling stock. The transplanting of plants from the areas to be cleared will also be considered if practical. However, it should be noted that access into the wetland areas is difficult due to the presence of peat and dense vegetative cover.

TABLE 2
RECOMMENDED SPECIES FOR DRYLAND REVEGETATION (EW2)²

Scientific name	Common name	Form	Height	Planting	Density	Estimated number
<i>Acacia lasiocarpa</i>	Dune Moses	Shrub	1.5	Tubestock	700cts	200
<i>Acacia saligna</i>	Coojong	Shrub	6	Tubestock	1000cts	50
<i>Adenanthos cygnorum</i>	Woolly bush	Shrub	3	Tubestock	700cts	100
<i>Allocasuarina humilis</i>	Dwarf sheoak	Shrub	1.5	Tubestock	600cts	200
<i>Anigozanthos manglesii</i>	Mangles kangaroo paw	Shrub	0.5	Tubestock	300cts	1600
<i>Bossiaea eriocarpa</i>	Common brown pea	Shrub	1	Tubestock	500cts	800
<i>Conospermum stoechadis</i>	Common smokebush	Shrub	2	Tubestock	500cts	800
<i>Conostylis aculeata</i>	Prickly conostylis	Herb	0.5	Tubestock	300cts	1030
<i>Conostylis candicans</i>	Grey cottonhead	Herb	0.5	Tubestock	300cts	1600

² Refer to Figure 14 for definition of EW2.

Scientific name	Common name	Form	Height	Planting	Density	Estimated number
<i>Banksia sessilis</i>	Parrot bush	Shrub	4	Tubestock	600cts	100
<i>Gompholobium tomentosum</i>	Yellow pea	Herb	1	Tubestock	600cts	700
<i>Hakea prostrata</i>	Harsh hakea	Shrub	3	Tubestock	600cts	130
<i>Hardenbergia comptoniana</i>	Native wisteria	Creeper	0.5	Tubestock	800cts	25
<i>Hemiandra pungens</i>	Snakebush	Shrub	0.5	Tubestock	500cts	130
<i>Hibbertia racemosa</i>	Stalked guinea flower	Herb	0.3	Tubestock	600cts	400
<i>Hovea pungens</i>	Devil's pins	Herb	0.5	Tubestock	450cts	700
<i>Hovea trisperma</i>	Common hovea	Shrub	0.5	Tubestock	450cts	700
<i>Jacksonia furcellata</i>	Grey stinkwood	Shrub	4	Tubestock	800cts	70
<i>Jacksonia sternbergiana</i>	Green stinkwood	Shrub	4	Tubestock	800cts	25
<i>Kennedia prostrata</i>	Scarlet postman	Creeper		Tubestock	800cts	50
<i>Olearis axillaris</i>	Coastal daisy bush	Herb	1.5	Tubestock	500cts	500
<i>Patersonia occidentalis</i>	Western Patersonia	Shrub	0.5	Tubestock	400cts	800
<i>Philotheca spicata</i>	Pepper and salt	Shrub	1.2	Tubestock	500cts	400
<i>Banksia attenuata</i>	Candle banksia	Tree	8	45Lt-100Lt bag	As shown	5
<i>Banksia grandis</i>	Bull banksia	Tree	8	45Lt-100Lt bag	As shown	5
<i>Banksia ilicifolia</i>	Swamp banksia	Tree	10	45Lt-100Lt bag	As shown	5

Scientific name	Common name	Form	Height	Planting	Density	Estimated number
<i>Banksia menziesii</i>	Firewood banksia	Tree	10	45Lt-100Lt bag	As shown	5
<i>Corymbia calophylla</i>	Marri	Tree	35	45Lt-100Lt bag	As shown	10
<i>Eucalyptus marginata</i>	Jarrah	Tree	30	45Lt-100Lt bag	As shown	10
<i>Macrozamia riedlei</i>	Zamia	Shrub	2	Transplant	As shown	3
<i>Nuytsia floribunda</i>	Christmas tree	Tree	8	Transplant	As shown	4
<i>Xanthorrhoea preissii</i>	Grass tree	Shrub	3	Transplant	As shown	3

TABLE 3
RECOMMENDED SPECIES FOR BUSH TUCKER GARDEN (EW1)³

Scientific Name	Common Name	Form	Height	Planting	Density	Estimated number
<i>Acacia cyclops</i>	Coastal wattle	Shrub	3	Tubestock	800cts	250
<i>Acacia pulchella</i>	Prickly Moses	Shrub	2	Tubestock	700cts	250
<i>Acacia saligna</i>	Coojong	Shrub	6	Tubestock	1000cts	150
<i>Boronia alata</i>	Winged boronia	Shrub	3	Tubestock	700cts	250
<i>Banksia nivea</i>	Couch honeypot	Shrub		Tubestock	500cts	400
<i>Banksia sessilis</i>	Parrot bush	Shrub	4	Tubestock	500cts	300
<i>Eremophila glabra</i>	Tar bush	Herb	0.5	Tubestock	500cts	600
<i>Ficinia nodosa</i>	Knotted clubrush	Sedge		Tubestock	400cts	1550

³ Refer to Figure 14 for definition of EW1.

Scientific Name	Common Name	Form	Height	Planting	Density	Estimated number
<i>Grevillea crithmifolia</i>		Shrub	1	Tubestock	600cts	600
<i>Grevillea thelmanniana</i>	Spidernet grevillea	Shrub	1	Tubestock	600cts	600
<i>Hemiandra pungens</i>	Snakebush	Herb	0.5	Tubestock	500cts	600
<i>Juncus krausii</i>	Sea rush	Sedge	2	Tubestock	300cts	1250
<i>Kennedia prostrata</i>	Scarlet postman	Creeper		Tubestock	500cts	350
<i>Billardia (Sollya) heterophylla</i>	Australian bluebell	Shrub		Tubestock	500cts	290
<i>Agonis flexuosa</i>	Peppermint	Tree	12	13Lt-100Lt bag	N/a	1
<i>Allocasuarina humilis</i>	Dwarf sheoak	Shrub	1.5	13Lt-100Lt bag	N/a	3
<i>Banksia attenuata</i>	Candle banksia	Tree	8	13Lt-100Lt bag	N/a	1
<i>Banksia grandis</i>	Bull banksia	Tree	8	13Lt-100Lt bag	N/a	1
<i>Banksia menziesii</i>	Firewood banksia	Tree	10	13Lt-100Lt bag	N/a	1
<i>Callitris preissii</i>	Rottnest Cyprus	Shrub	6	13Lt-100Lt bag	N/a	3
<i>Eucalyptus decipiens</i>	Limestone marlock	Tree	6	13Lt-100Lt bag	N/a	1
<i>Eucalyptus foecunda</i>	Fremantle mallee	Shrub	3	13Lt-100Lt bag	N/a	1
<i>Macrozamia riedlei</i>	Zamia	Shrub	2	Transplant	N/a	1
<i>Melaleuca lanceolata</i>	Rottenest tea tree	Shrub	3	13Lt-100Lt bag	N/a	1

Scientific Name	Common Name	Form	Height	Planting	Density	Estimated number
<i>Nuytsia floribunda</i>	Christmas tree	Tree	8	Transplant	N/a	1
<i>Santalum acuminatum</i>	Quandong	Shrub	5	13Lt-100Lt bag	N/a	5
<i>Xanthorrhoea preissii</i>	Grass tree	Shrub	3	Transplant	N/a	3

Individual species will be planted irregularly to reflect the distribution found in natural areas. Tubestock will preferably be planted during winter to allow maximum root growth and plant establishment before summer. Artificial irrigation will be utilised at least in the initial summer season following planting. Tree guards will be erected around each plant to protect them from introduced vertebrate pests, pets and people. Monitoring of planted tubestock survival rates will commence during spring then monthly during the first summer (i.e. December, January, and February), and bi-annually during the following year will be undertaken. It is recommended that the dryland plants are watered weekly to fortnightly during the summer months and then fortnightly to monthly during the cooler months to reduce plant deaths at least during their first year following planting.

Prior to the City of South Perth assuming responsibility for the management of the wetland area, the proponent will need to demonstrate that the 'completion criteria' for the rehabilitation works (refer to Section 3.14.2) have been achieved. An annual progress report detailing the rehabilitation work undertaken during the relevant reporting period will be submitted to the City of South Perth for the duration of the implementation and proponent's maintenance period.

3.12 Fauna Management

The management strategies outlined in this Wetland Management Plan will maintain or enhance the faunal values of the retained wetland. The rehabilitation of degraded areas with native species should encourage fauna species that may not currently be present in the area. The re-introduction of native plant species during revegetation works will provide new habitat for fauna species (in particular birds).

It is known that Black Swans visit the drainage channel south of the wetland to access freshwater. They are not known to access the core wetland area due to the absence of open water sections. However, of importance to Black Swans is the feeling of security from potential predators including dogs. For this reason it is important to install signage along paths to raise awareness about the importance of dog control.

3.13 Fire Management

A Preliminary Fire Management report has been prepared to assess the proposed development and in particular the proposed management of the POS areas.

The report specifically examines the potential fire hazard and fire management principles including fuel loadings, hazard separation, building protection zones, boundary treatment for POS, water supply, site access and adjoining land uses.

The report notes that the rehabilitated wetland area would not normally pose a major fire risk as it does not dry out during the summer months. However as the wetland is densely vegetated with Bulrush (*Typha orientalis*) and the removal and replacement of the Bulrushes in the wetland area will be challenging due to the shallow nature of water in the wetland, the wetland has the potential to become a fire hazard requiring a separation zone to any dwellings. The proposed landscaping works include revegetating of the wetland perimeter and fringing areas and the construction of limestone walls provide the opportunity to remove bulrushes from the areas closest to any dwellings.

The annual maintenance program will need to include inspecting the wetland area in early spring to assess the potential fuel loadings with an opportunity for appropriate remedial action (i.e. spraying and/or removal of bulrushes from fringe areas) before the start of the fire season.

It will also be important to provide an appropriate access around the perimeter of the site, which will also separate the wetland from dwellings.

This access will comprise of DUPs of 3.5m width so that they can accommodate Council service and emergency vehicles. Typically the "service" vehicle would be a 4WD utility vehicle or a light truck and need access for maintenance and litter collection. The fire fighting vehicle would normally be a "fast attack" unit which arrives at the scene before the larger urban tanker units. A "fast attack" unit is typically a "LandCruiser" type utility with a minimum 500L "slip on" fire fighting appliance.

There will be water reticulation (Figure 15) to locations within the POS areas. This also provides the potential to install additional strategically placed fire hydrants to provide coverage particularly to the rear of the lots which back or front directly onto the POS.

In relation to the wetland public open space the report recommends that:

- An annual inspection of the wetland area be conducted in early spring to assess the potential fuel loadings with an opportunity for appropriate remedial action (ie spraying and/or removal of bulrushes from fringe areas) before the start of the fire season.
- All lots within the estate and all parts of each lot must be situated within 120m of a fire hydrant in accordance with the Water Corporation's design specifications. This should also include the adjoining area of POS where the lots are backing onto it.
- Any fire hydrants located in landscaped areas must be protected to ensure that the landscaping does not obscure the location of the hydrants (i.e. by ground mulches, low shrubs etc). This also applies to the road verges within the subdivision and private landowners must not obstruct the visibility of hydrant locations.
- Where lots are backing onto or fronting areas of POS, the DUP system must be capable of providing access for emergency vehicles.
- The DUP on the western boundary of the property must be capable of providing access for emergency vehicles.
- The existing fire management system for the campus (i.e. fire hydrants, water mains, access and emergency evacuation plans) should be reviewed to acknowledge the proposed development of the adjoining POS areas.

3.14 Schedule of Works and Maintenance

Table 4 outlines the proposed timeline for the rehabilitation works. Earthworks are proposed to commence in October 2008. It is proposed that weed control, focussing initially on the *Typha* eradication program (trial commenced in summer 2007) will be undertaken in October/November 2008 to reduce weed density in the wetland area. Areas outside of the wetland will have weed control implemented following completion of earthworks. Wetland planting will commence in autumn 2009 and dryland plantings will commence in winter 2009.

TABLE 4
REHABILITATION TIMELINE

Expected Start	Activity	Anticipated Completion
November 2007	Undertake trial spraying of Bulrush.	December 2007
October 2008	Spraying of bulrush.	December 2008
March 2009	Planting/translocation of wetland species.	July 2010
March - May 2009	Scalp existing weeds to reduce weed density.	June 2009
June to July 2009	Monthly spraying during autumn and winter. Bimonthly spot spraying to control spring and summer weed germination.	September 2010 for developer, then the City of South Perth at the commencement of management handover.
Following adequate winter rains, May/June 2009	Planting of dryland species on upper fringes.	To be completed 1 to 2 months after commencement of planting.
October 2009	Maintenance planting of wetland species.	November 2009
November 2009	Monthly watering of dryland species.	February 2010
Following adequate autumn rains, May 2010	Maintenance planting of dryland species 10%.	To be completed 1 to 2 months after commencement of planting.

It should be noted that the above timeline may be altered according to progress of planting and the availability of suitable stock from nurseries. In this case, the annual reporting period may be adjusted to reflect the modified rehabilitation program.

3.15 Allocation of Responsibilities

The developer will be responsible for the implementation of the recommendations in this management plan, except where identified, for a period of two years (refer to Table 5) to satisfaction of the City of South Perth. The trigger point for the commencement of the two year maintenance period will be from the transfer of titles for POS areas to the City of South Perth.

On completion of all rehabilitation and maintenance requirements by the proponent, the City of South Perth will assume responsibility for the on-going management and maintenance of the retained wetland area.

TABLE 5
RESPONSIBILITY FOR PROPOSED MANAGEMENT

Strategy	Specification	Timing	Responsibility
Drainage Maintenance	Removal of debris from drainage infrastructure	On-going post construction	Developer for an initial two year period, thereafter the City of South Perth
	Street sweeping to reduce particulate build-up on road surface and gutters	Monthly, post construction	Developer for an initial two year period, thereafter the City of South Perth
	Maintenance of the stormwater network	On-going post construction	Developer for an initial two year period, thereafter the City of South Perth
	Mowing of grass in the grassed area and appropriate disposal of clippings	On-going, monthly	Developer for an initial two year period, thereafter the City of South Perth
	Manual litter collections	On-going during and after construction	Developer for an initial two year period, thereafter the City of South Perth
Public Open Space Facilities	Construct a DUP around the retained wetland as depicted in Figure 12	Once only, during construction	Developer
	Construct boardwalks at the locations shown in Figure 12	Once only, during construction	Developer

Strategy	Specification	Timing	Responsibility
	Install interpretative signage highlighting the importance of wetland conservation and how residents can assist with protecting their local natural environment in two locations along the DUP	Once only, during construction	Developer
Weed Control	Scalp and mulch wetland buffer areas prior to planting	Once only, during construction	Developer
	A suitably qualified and experienced weed manager will assess the wetland for the presence of weed species; The weed management measures will be implemented; and The weed management contractor will report to the proponent's consultant landscape architect on the status of weeds in the wetland, in particular on the success (or failure) of any control methods used and the requirement for additional weed control.	Every 6 months	Developer
	Monitoring for preventive weed control measures to be undertaken bimonthly	Bimonthly, during and after construction	Developer for an initial two year period, thereafter the City of South Perth
Revegetation	Implement planting in rehabilitation areas in the wetland POS area	Autumn and winter 2008 and 2009	Developer

Strategy	Specification	Timing	Responsibility
	If practicable, a holding bay will be established in the wetland area to be retained to store plants salvaged from the area of wetland to be filled until they are needed for rehabilitation. The ability to establish the holding bay may be governed by the staging of the excavation of the eastern side of the wetland.	Prior to revegetation	Developer
	Install plant protective measures as required (i.e. tree guards)	Post revegetation	Developer
	Monitoring for rehabilitation success once initially during Spring, then monthly during the first summer (i.e. December, January, and February), and bi-annually during the following years until plants are well established for water stress and individually hand watered if necessary.	Once during spring, monthly during first summer and then bi-annually	Developer for an initial two year period, thereafter the City of South Perth
General Maintenance and Monitoring	Inspect areas where management strategies have been implemented. Assess if further works or general repairs are required.	Monthly	Developer (unless identified otherwise) for initial two year period, thereafter the City of South Perth
Mosquito and midge management	A Mosquito and Midge Management Plan will be prepared	Prior to construction	Developer

Strategy	Specification	Timing	Responsibility
Fire management	Wetland fuel loads will be visually inspected and dry plant material removed	Annual in early Spring	Developer for the life of the project and then the City of South Perth
Reporting	Prepare an annual report on implementation and rehabilitation progress	Annually, reporting periods being Oct. 2008 – Sept. 2009 and Oct. 2009 – Sept. 2010	Developer to submit annual report to the City of South Perth

3.16 Monitoring, Completion Criteria and Reporting

The implementation of management strategies detailed in this Plan will be an on-going process, which should be flexible in responding to changes in the natural environment, the recreational use of the environment and community values. Monitoring procedures will assist in the adaptive management of the wetlands, as well as informing the progress of management.

The program of monitoring the success of the strategies is essential for the purposes of reviewing and updating the Plan by the City of South Perth. This will ensure that the objectives of the Plan are achieved and that any changes or new developments in management techniques can be incorporated.

3.16.1 Performance Monitoring

The proponent will implement monitoring procedures to assess the success of management strategies addressing rehabilitation works, weed control activities and water quality during the two year management period. This will allow the identification of area requiring augmentation or remedial works to be identified early and appropriately planned. In addition, the monitoring will ensure that an adequate representation of species and plant diversity is achieved.

3.16.2 Rehabilitation Completion Criteria and Reporting

Prior to the City of South Perth assuming responsibility for the management of the wetland area, the proponent will need to demonstrate that the completion criteria for the rehabilitation works have been achieved.

The completion criteria for the Wetland Management Plan are:

- 80% survival of stated plant numbers within each zone;
- A maximum of five weeds per m² with a maximum of 5% cover (excluding core wetland area which is dominated by Bulrush);
- No bulbous, noxious (such as Pampas Grass) or woody weeds and rhizomatous grass species in the rehabilitation area;
- Attempts to control *Typha* in the wetland area have been implemented;
- Fencing and other infrastructure maintained in good condition; and
- Completion of all other commitments as specified in the Wetland Management Plan to the satisfaction of the City of South Perth.

An annual progress report detailing rehabilitation work undertaken will be submitted to the City of South Perth. The reporting periods will be October 2008 to September 2009 and October 2009 to September 2010.

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5 DISCLAIMER

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Figures

**Wetland Management Plan - Proponent Commitment No. 3, Retained Wetland -
Cygnia Cove Estate, Waterford**

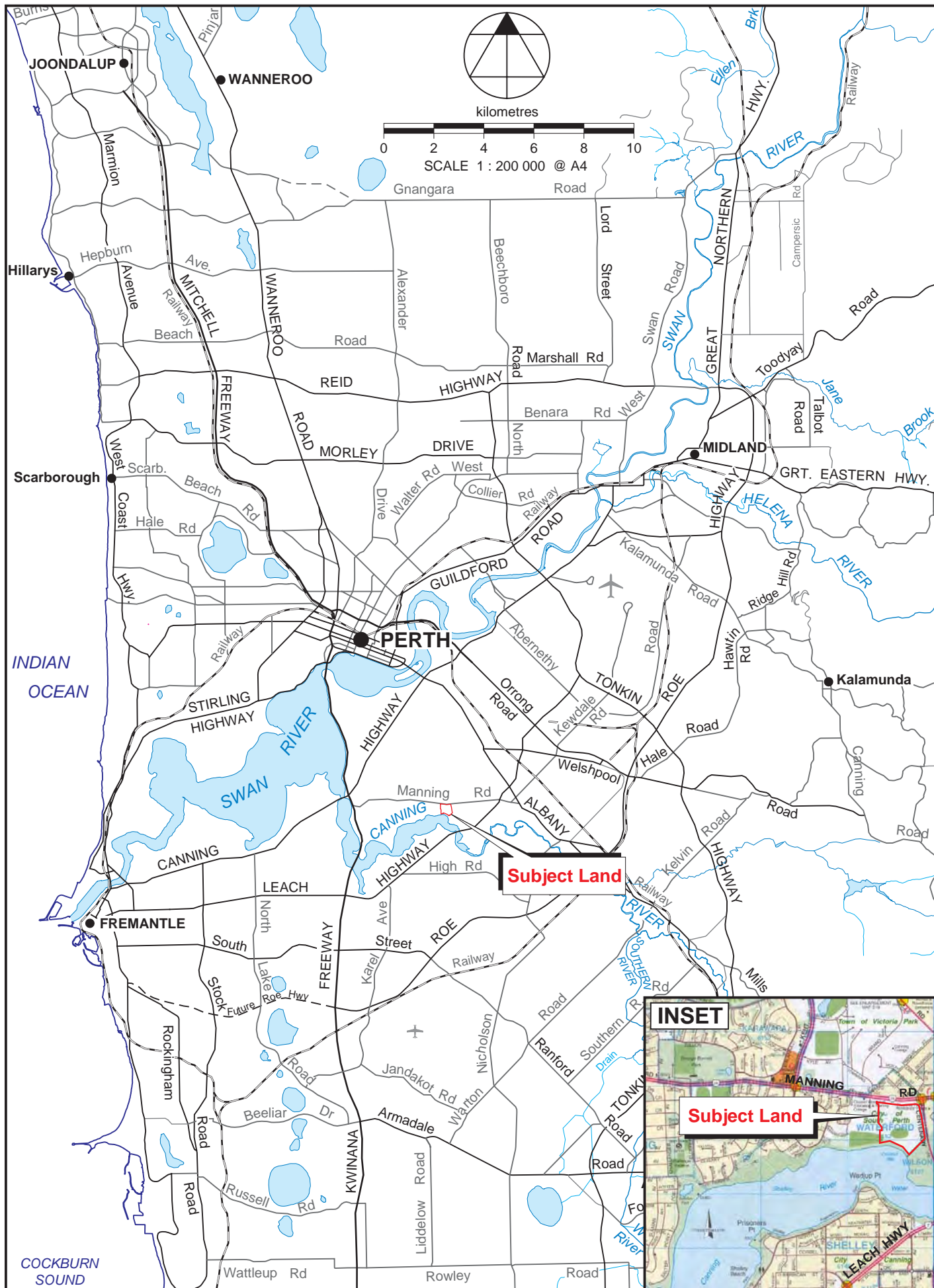
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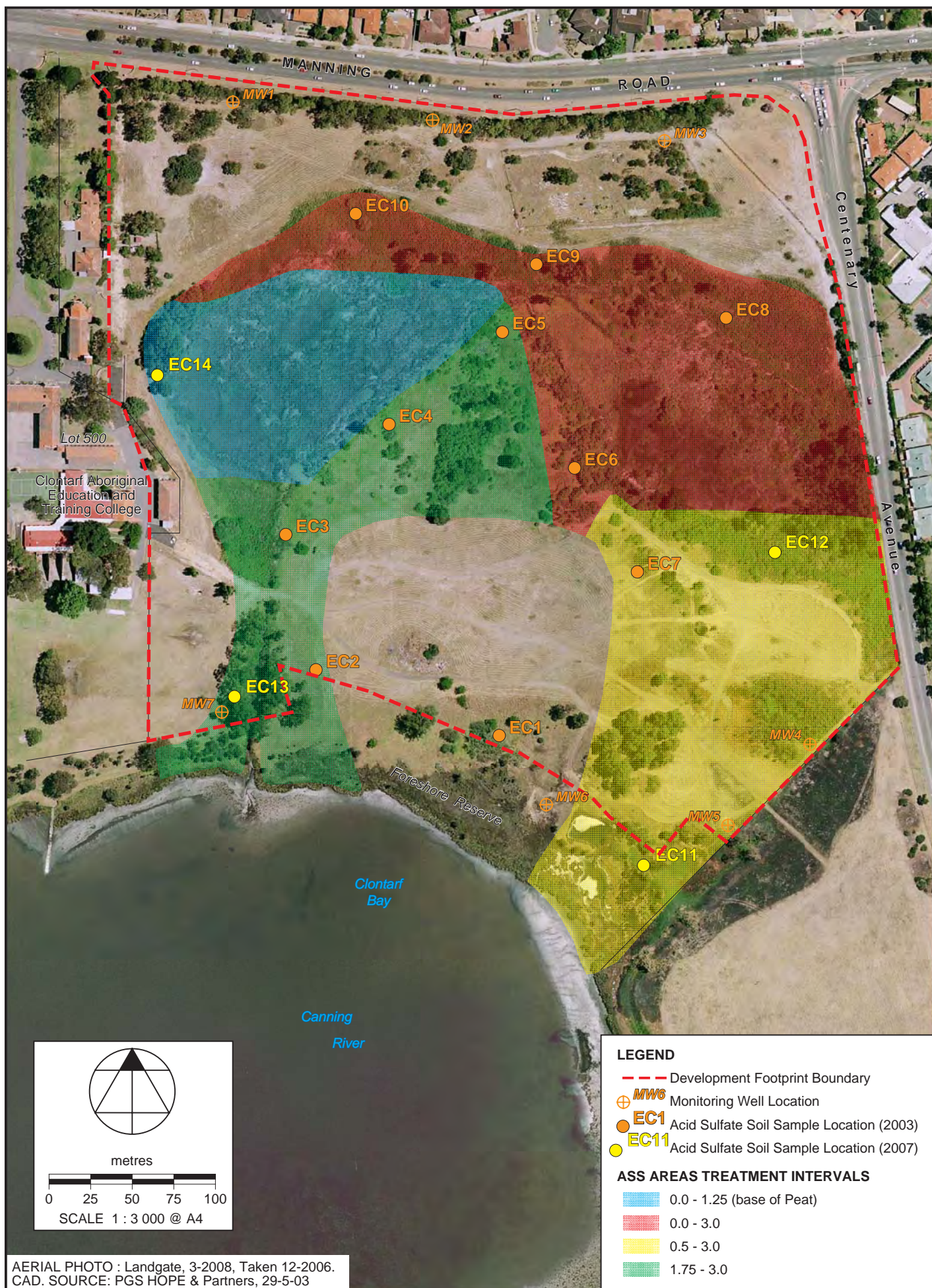












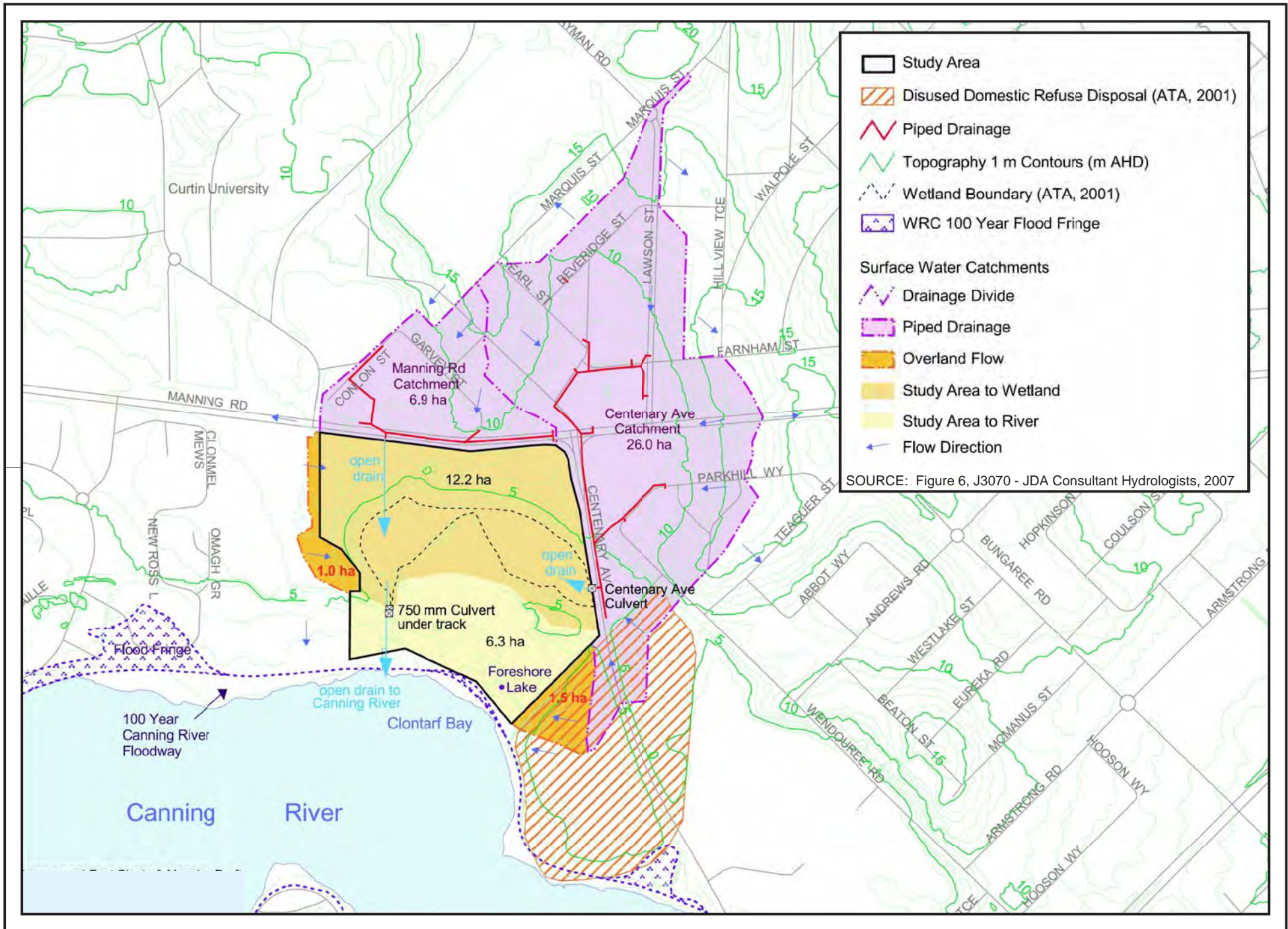
LEGEND

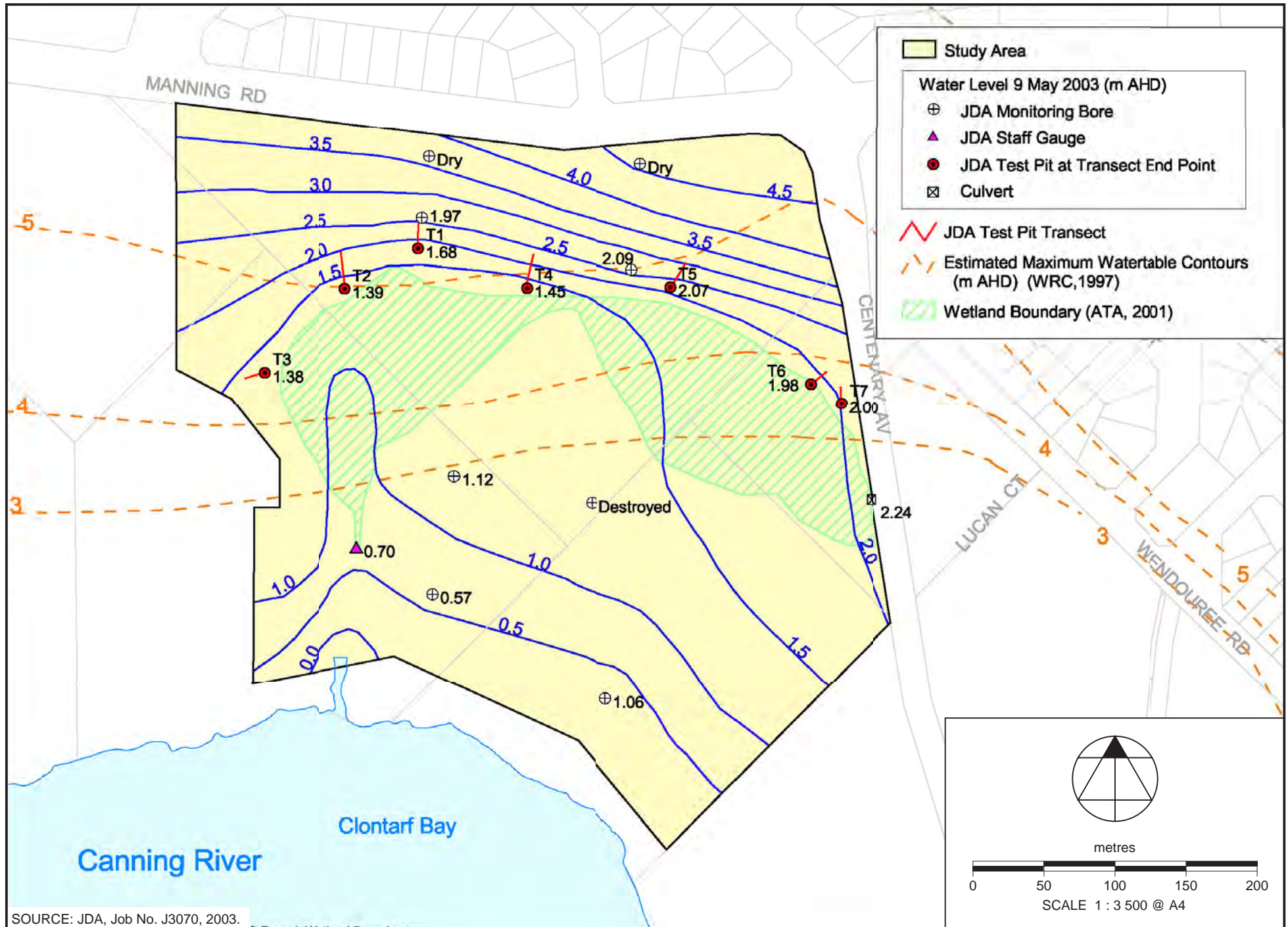
- Development Footprint Boundary
- ⊕ **MW6** Monitoring Well Location
- **EC1** Acid Sulfate Soil Sample Location (2003)
- **EC11** Acid Sulfate Soil Sample Location (2007)

ASS AREAS TREATMENT INTERVALS

- 0.0 - 1.25 (base of Peat)
- 0.0 - 3.0
- 0.5 - 3.0
- 1.75 - 3.0

AERIAL PHOTO : Landgate, 3-2008, Taken 12-2006.
CAD. SOURCE: PGS HOPE & Partners, 29-5-03









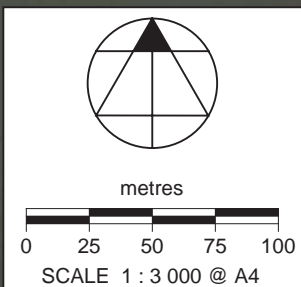
LEGEND

- Development Area Boundary
- Topographic Contour (m AHD)

- Wetland Management Plan Boundary

VEGETATION CONDITION

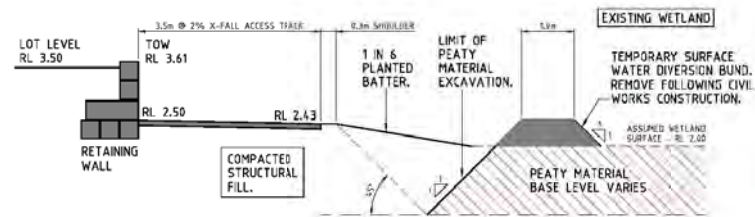
- | | |
|--|--|
| <p>P Pristine - N/A</p> <p>Ex Excellent - N/A</p> <p>VG Very Good - Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.</p> <p>G Good - Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.</p> | <p>D Degraded - Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.</p> <p>CD Completely Degraded - The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.</p> <p>C Cleared - No native vegetation remaining.</p> |
|--|--|



AERIAL PHOTO : Landgate, 3-2008, Taken 12-2006.

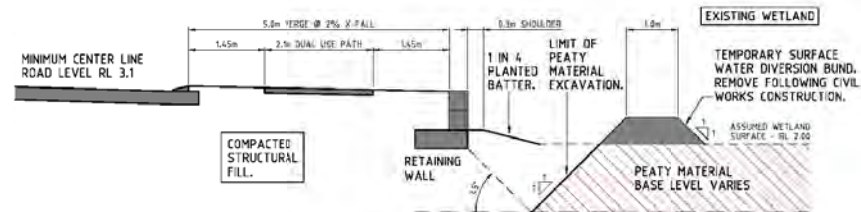






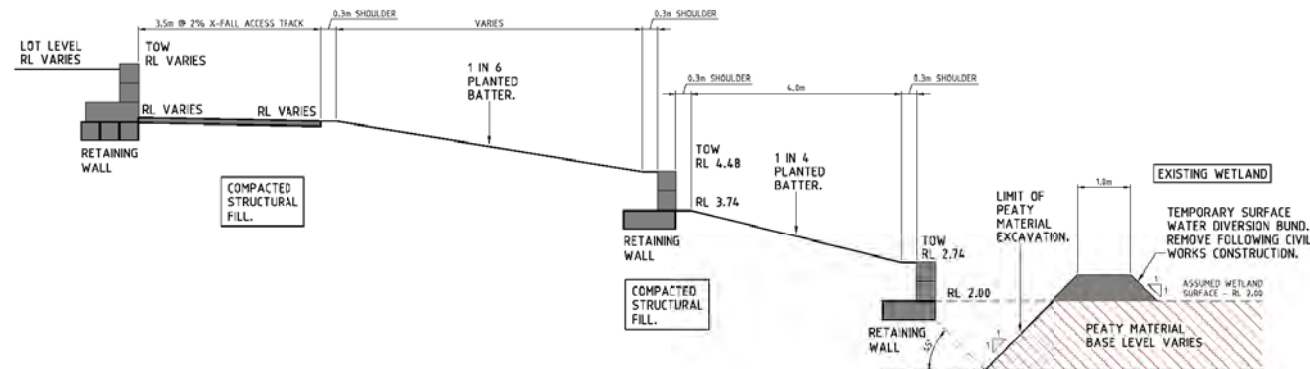
SOUTH EASTERN WETLAND INTERFACE

SECTION A



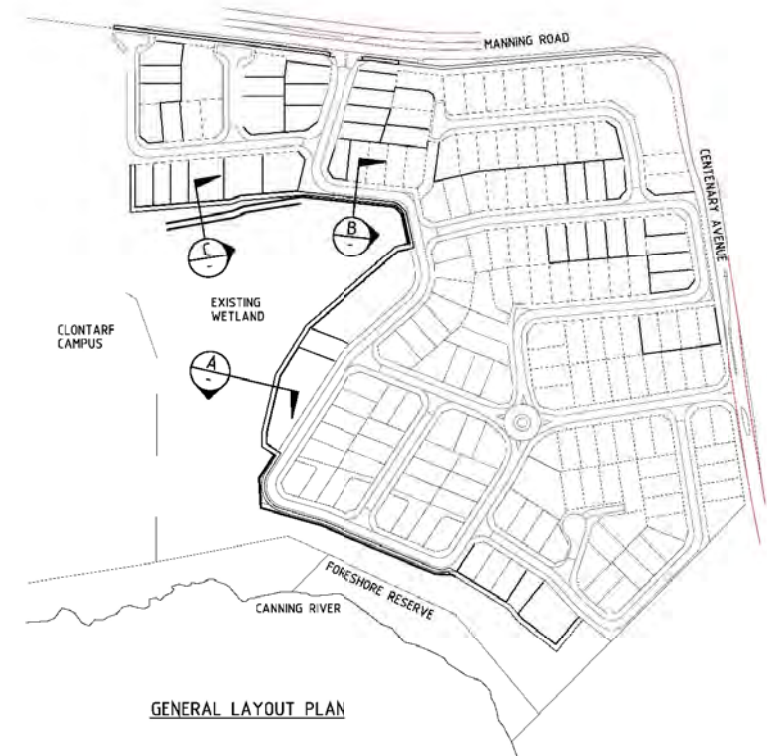
EASTERN WETLAND INTERFACE

SECTION B



NORTHERN WETLAND INTERFACE

SECTION C



GENERAL LAYOUT PLAN

PLANTING ZONE LEGEND**EXISTING WETLAND**

- EW1 Bushucker Garden
- EW2 Dry Revegetation
- EW3 Lower Embankment Re-vegetation/ submerged

CONSTRUCTED WETLAND

- CW1 Dry Revegetation
- CW2 Upper Embankment Revegetation
- CW3 Lower Embankment Infill
- CW4 Lower Embankment Revegetation/ Submerged

FORESHORE RESERVE

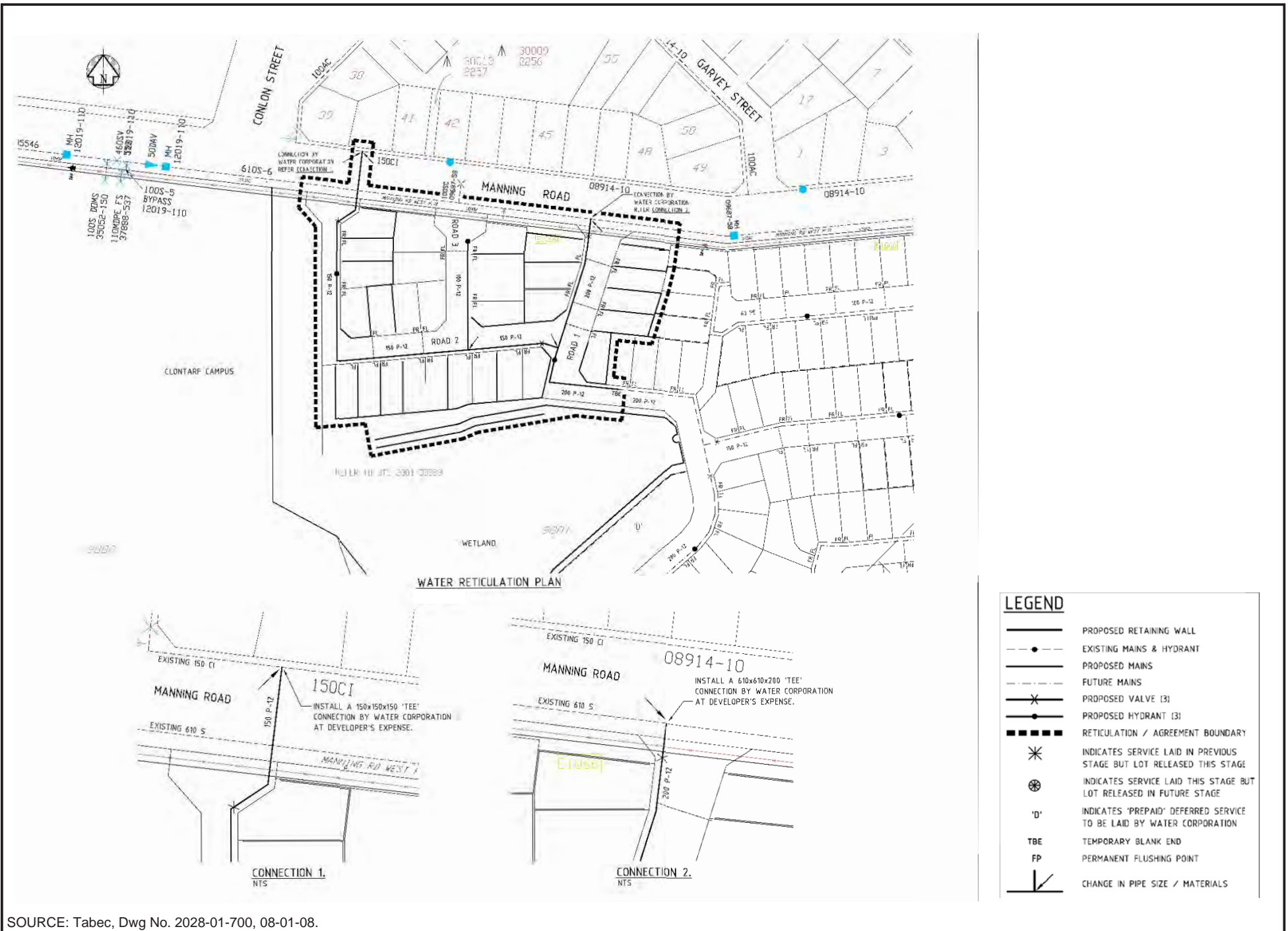
- FSR1 Foreshore Infill
- FSR2 Woodland Vegetation
- FSR3 Samphire Revegetation
- FSR4 Stream Revegetation

STREETSCAPE

- SS1 Median Strip Planting
- SS2 Verge Planting



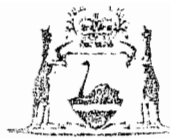
SOURCE: PLAN E, Job No. 02132-01, October 2007 Rev E



Appendix A

Ministerial Statement No. 692

**Wetland Management Plan - Proponent Commitment No. 3, Retained Wetland -
Cygnia Cove Estate, Waterford**



GOVERNMENT OF WESTERN AUSTRALIA

MINISTER FOR THE ENVIRONMENT; SCIENCE

Statement No.

000692

**STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED
(PURSUANT TO THE PROVISIONS OF THE
ENVIRONMENTAL PROTECTION ACT 1986)**

**EAST CLONTARF RESIDENTIAL DEVELOPMENT
WATERFORD, CITY OF SOUTH PERTH**

Proposal: The residential development of the East Clontarf site, Waterford, as documented in schedule 1 of this statement.

Proponent: Trustees for The Christian Brothers in Western Australia Inc

Proponent Address: c/- Richard Noble and Associates, PO Box 7071 Cloisters' Square, PERTH WA 6850.

Assessment Number: 1467

Report of the Environmental Protection Authority: Bulletin 1156

The proposal referred to above may be implemented by the proponent subject to the following conditions and procedures:

1 Implementation

- 1-1 The proponent shall implement the proposal as documented in schedule 1 of this statement subject to the conditions and procedures of this statement.

2 Proponent Commitments

- 2-1 The proponent shall implement the environmental management commitments documented in schedule 2 of this statement.

Published on

11 OCT 2005

3 Proponent Nomination and Contact Details

- 3-1 The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the *Environmental Protection Act 1986* is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person as the proponent for the proposal.
- 3-2 If the proponent wishes to relinquish the nomination, the proponent shall apply for the transfer of proponent and provide a letter with a copy of this statement endorsed by the proposed replacement proponent that the proposal will be carried out in accordance with this statement. Contact details and appropriate documentation on the capability of the proposed replacement proponent to carry out the proposal shall also be provided.
- 3-3 The nominated proponent shall notify the Department of Environment of any change of contact name and address within 60 days of such change.

4 Commencement and Time Limit of Approval

- 4-1 The proponent shall substantially commence the proposal within five years of the date of this statement or the approval granted in this statement shall lapse and be void.

Note: The Minister for the Environment will determine any dispute as to whether the proposal has been substantially commenced.

- 4-2 The proponent shall make application for any extension of approval for the substantial commencement of the proposal beyond five years from the date of this statement to the Minister for the Environment, prior to the expiration of the five-year period referred to in condition 4-1.

The application shall demonstrate that:

- 1. the environmental factors of the proposal have not changed significantly;
- 2. new, significant, environmental issues have not arisen; and
- 3. all relevant government authorities have been consulted.

Note: The Minister for the Environment may consider the grant of an extension of the time limit of approval not exceeding five years for the substantial commencement of the proposal.

5 Compliance Audit and Performance Review

- 5-1 The proponent shall prepare an audit program and submit compliance reports to the Department of Environment which address:

1. the status of implementation of the proposal as defined in schedule 1 of this statement;
2. evidence of compliance with the conditions and commitments; and
3. the performance of the environmental management plans and programs.

Note: Under sections 48(1) and 47(2) of the *Environmental Protection Act 1986*, the Chief Executive Officer of the Department of Environment is empowered to monitor the compliance of the proponent with the statement and should directly receive the compliance documentation, including environmental management plans, related to the conditions, procedures and commitments contained in this statement.

6 Wetland

- 6-1 Within 12 months following subdivision/development approval, the proponent shall substantially commence construction of an approximately 1.9-hectare wetland shown in Figure 1 of schedule 1 as Public Open Space, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

This wetland shall include the following:

1. Black Swan breeding habitat;
 2. revegetation with local indigenous species;
 3. landform recontouring;
 4. establishment and maintenance of wetland connection to Clontarf Bay and the Canning River;
 5. weed control measures;
 6. water quality and quantity monitoring; and
 7. contingency measures to maintain or improve water quality of water flowing into Clontarf Bay and the Canning River.
- 6-2 Prior to commencement of construction of the wetland required by condition 6-1, the proponent shall prepare a Wetland Management Plan which includes identification of species to be used in revegetation works on site, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.
- 6-3 The proponent shall implement the Wetland Management Plan required by condition 6-2.
- 6-4 The proponent shall make the Wetland Management Plan required by condition 6-2 publicly available.

7 Water Quality

- 7-1 Prior to ground-disturbing activity, the proponent shall prepare a Drainage, Nutrient, Irrigation and Water Quality Management Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

This Plan shall address the following environmental quality objectives as described in *Riverplan – An Environmental Management Framework for the Swan and Canning Rivers (August 2004)* to protect, restore and maintain:

1. ecosystem health;
 2. biological diversity;
 3. natural landscape;
 4. recreation; and
 5. water supply.
- 7-2 The proponent shall implement the Drainage, Nutrient, Irrigation and Water Quality Management Plan required by condition 7-1.
- 7-3 The proponent shall make the Drainage, Nutrient, Irrigation and Water Quality Management Plan required by condition 7-1 publicly available.
- 7-4 Prior to ground-disturbing activity, the proponent shall prepare an Ecotoxological Testing Plan to monitor the benthic habitat at the wetland discharge point into Clontarf Bay, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.
- 7-5 The proponent shall implement the Ecotoxological Testing Plan required by condition 7-4.
- 7-6 The proponent shall make the Ecotoxological Testing Plan required by condition 7-4 publicly available.

8 Site Contamination

- 8-1 Prior to ground-disturbing activity, the proponent shall prepare a Site (Soil and Groundwater) Contamination Investigation, Remediation and Validation Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority with the concurrence of the Department of Health.

This Plan shall be prepared in general accordance with the Department of Environment *Contaminated Sites Management Series of Guidelines*, and shall include:

1. an Acid Sulfate Soil Management Plan; and
 2. an Asbestos Management Plan.
- 8-2 The proponent shall implement the Site (Soil and Groundwater) Contamination Investigation, Remediation and Validation Plan required by condition 8-1.
- 8-3 The proponent shall make the Site (Soil and Groundwater) Contamination Investigation, Remediation and Validation Plan required by condition 8-1 publicly available.

Procedures

- 1 Where a condition states “to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority”, the Environmental Protection Authority will provide that advice to the Department of Environment for the preparation of written notice to the proponent.
- 2 The Environmental Protection Authority may seek advice from other agencies or organisations, as required, in order to provide its advice to the Department of Environment.
- 3 Where a condition lists advisory bodies, it is expected that the proponent will obtain the advice of those listed as part of its compliance reporting to the Department of Environment.

Notes

- 1 The Minister for the Environment will determine any dispute between the proponent and the Environmental Protection Authority or the Department of Environment over the fulfilment of the requirements of the conditions.

Dr Judy Edwards MLA
MINISTER FOR THE ENVIRONMENT; SCIENCE

11 OCT 2005

The Proposal (Assessment No. 1467)

The proposal is for:

- the residential development of the 18-hectare East Clontarf site bounded by Manning Road, Centenary Avenue, the Clontarf Aboriginal Campus and the Canning River, creating up to 200 lots, as shown in Figure 1;
- the filling and draining of approximately 2.1 hectares of Resource Enhancement wetland identified in the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* and the *Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy 2004*;
- the creation of an approximately 1.9-hectare wetland and associated upland vegetation adjacent to the existing wetland and Canning River;
- increasing the river foreshore area by approximately 8350 square metres;
- investigation into soil and groundwater contamination, and remediation as required;
- installation of two additional monitoring bores to perform additional ground and surface water monitoring; and
- provision of road frontage along both the wetland and the river foreshore, but not including the western section of Public Open Space which is to be a revegetated dryland buffer.

Table 1 – Key Proposal Characteristics

Element	Description
Proposal	Creation of up to 200 residential allotments
Area of disturbance	Approximately 16 hectares
Major components – <ul style="list-style-type: none"> • Wetland modification • Dewatering • Disturbance to site hydrology • Remediation of site contamination • Additional foreshore reserve • Potential acid sulfate disturbance • Created wetland • Noise and dust creation 	<p>Draining and filling of approximately 2.1 hectares of Resource Enhancement wetland as depicted on schedule 1.</p> <p>Creation of not less than 1.9 hectares (approximately) of wetland.</p> <p>Provision of 8350 square metres of additional foreshore reserve.</p> <p>Hydrological maintenance – water quality and quantity.</p> <p>Remediation of on-site contamination.</p>

Figure (attached).

Figure 1 - Residential Development Plan

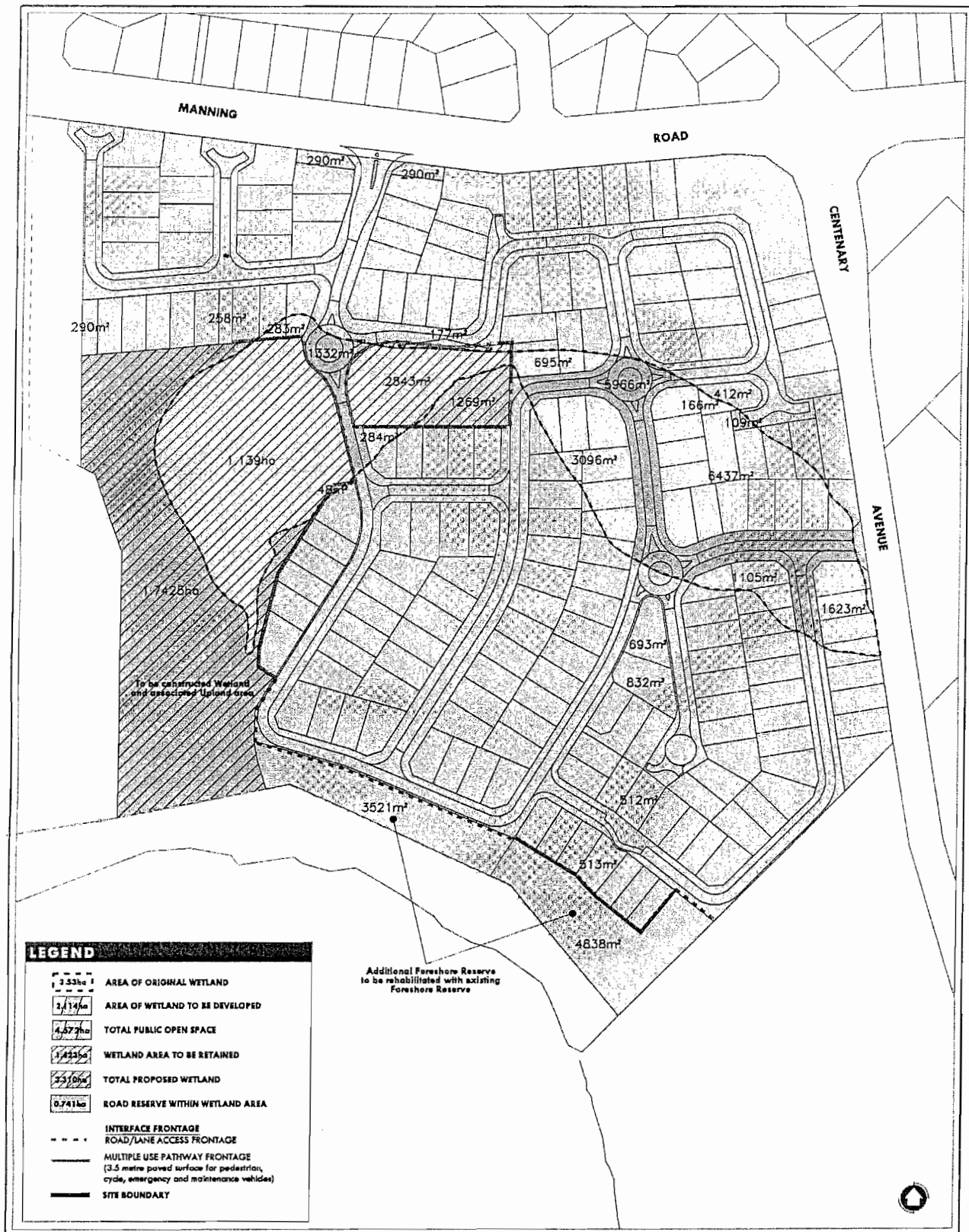


Figure 1 - Residential Development Plan

Note: The area for residential development is within the "site boundary", but excludes "Public Open Space", the "Wetland Area", and the "Area of Proposed Rehabilitated Wetland" indicated above.

Schedule 2

Proponent's Environmental Management Commitments

(September 2005)

**East Clontarf Residential Development
Waterford, City of South Perth**

(Assessment No. 1467)

Trustees for
The Christian Brothers in Western Australia Inc

Proponent's Environmental Management Commitments – September 2005

EAST CLONTARF RESIDENTIAL DEVELOPMENT, WATERFORD (Assessment No. 1467)

Note: The term “commitment” as used in this schedule includes the entire row of the table and its six separate parts as follows:

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

No.	Topic	Objective	Action	Timing	Advice
1.	Construction Management	<p>To protect the remnant wetland vegetation identified for protection within <i>Bush Forever</i> adjoining the development from potential impacts associated with construction.</p> <p>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.</p>	<p>Prepare and implement a Construction Environmental Management Plan (CEMP) to the satisfaction of the DoE and the Cities of South Perth and Canning, which addresses:</p> <ol style="list-style-type: none"> 1. Dewatering Program; 2. Detailed Remediation Assessment of Contaminated Soils; 3. Acid Sulfate Soils Management Plan; 4. Construction Noise Management Procedures; and 5. Construction Dust Management Procedures. 	<p>Prepared and approved prior to construction.</p> <p>Implemented during construction.</p> <p>Audits to be completed during construction works and post-construction.</p>	<p>City of South Perth</p> <p>City of Canning</p>

No.	Topic	Objective	Action	Timing	Advice
2.	Foreshore Management	<p>To protect the conservation values identified for protection within the development adjacent to the Canning River foreshore.</p> <p>To mitigate proposed clearing within the development and enhance linkages and habitat value.</p>	<p>Prepare and implement a detailed Foreshore Management Plan to the satisfaction of the DPI, the SRT and the City of South Perth, which will include:</p> <ol style="list-style-type: none"> 1. Comprehensive weed eradication program; 2. Revegetating and restoring foreshore POS adjoining conservation areas with appropriate indigenous flora of the Canning River; 3. Increase the area contained within POS adjoining Bush Forever Site No. 333; 4. Creation of habitat and wildlife corridors; 5. Controlling vehicle and pedestrian access; 6. Construction of a dog-proof fence along the existing Foreshore Reserve, if considered appropriate; 7. Provision of public facilities; 8. Soil and plant source material hygiene; 9. Fire management including provision of fire hydrants; 10. Provision of educational and interpretative materials within the area to raise awareness of JAMBA/CAMBA species which frequent the area; 11. Encouraging community involvement and awareness by promoting control of pets (eg cats and dogs); 12. Water conservation principles; 13. Monitoring re-establishment or native and exotic plant species for a period of not less than 2 years followed by review; 14. Monitoring criteria to determine the success of the revegetation and weed eradication program; 15. Progress and compliance reporting; and 16. Timing and implementation schedule. 	<p>Preparation prior to construction.</p> <p>Implementation to be as determined in schedule within the Foreshore Management Plan.</p>	<p>CALM SRT City of South Perth</p>
3.	Wetland Management	To minimise impacts on wetlands and to offset any wetland impacts to ensure no net loss of function or value.	<p>Prepare and implement a Wetland Management Plan to the satisfaction of the DoE and the City of South Perth which will include:</p> <ol style="list-style-type: none"> 1. Identification of existing wetland area to be retained; 2. Avoiding direct and minimising indirect impacts on the wetland; 3. Ensuring no net loss of wetland values and functions; 4. Rehabilitation techniques to be employed; 	<p>Preparation prior to construction.</p> <p>Implementation to be as determined in schedule within the Wetland Management Plan.</p>	City of South Perth

No.	Topic	Objective	Action	Timing	Advice
			<ol style="list-style-type: none"> 5. Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats; 6. Mitigation strategies for loss of any vegetation will be investigated, including both on-site and off-site options; 7. Creation of a new wetland area to be located adjacent to the existing wetland and the river foreshore suitable for Black Swan breeding habitat; 8. adopt existing mosquito and midge management protocols currently utilised by the City of South Perth; 9. Monitoring criteria to determine the success of the plan; 10. Progress and compliance reporting; and 11. Timing and implementation schedule. 		
4.	Groundwater Management	<p>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.</p> <p>To determine the potential impacts of dewatering during the construction phase on the vegetation within the wetland areas, Canning River and groundwater quality.</p>	<p>(1) Prepare and implement a Groundwater Management Plan as a component of the CEMP to the satisfaction of the DoE, SRT and Water Corporation which will include:</p> <ol style="list-style-type: none"> 1. Determining the nature and extent of groundwater contamination; 2. Installation of 2 additional monitoring bores; 3. Quarterly sampling of both additional and existing monitoring bores for a 12-month period; 4. Groundwater flow characteristics; and 5. Groundwater contamination plume management. <p>(2) Develop a Dewatering Program as a component of the CEMP to the satisfaction of the DoE.</p>	<p>Preparation of Groundwater Management Plan and Dewatering Program prior to construction.</p> <p>Implementation as per Plan/Program.</p> <p>Construction works to be timed and staged to minimise the volume of dewatering required.</p>	SRT Water Corporation

No.	Topic	Objective	Action	Timing	Advice
5.	Drainage, Nutrient, Irrigation and Water Quality Management	<p>To maintain acceptable water quality within the wetland and the Canning River in keeping with the Riverplan framework of management and best practice in urban stormwater management.</p> <p>To ensure that no road surface run-off directly enters the wetland.</p> <p>To ensure that there is provision for contaminant spillage entrapment.</p>	<p>Prepare and implement a Drainage, Nutrient, Irrigation and Water Quality Management Plan (DNIWQMP) to the satisfaction of the DoE, the SRT and the City of South Perth, which will include:</p> <ol style="list-style-type: none"> 1. Design and construction of the detention/infiltration basin; 2. Periodic monitoring of the infiltration basin (post-construction) to ensure continued function and maintenance as required; 3. Quarterly sampling of surface water body for a 12-month period; 4. Maximising infiltration of uncontaminated stormwater at sources to recharge the groundwater system; 5. Water conservation principles; 6. Nutrient control; 7. Prescribed fertilizer applications for areas of POS; 8. Determination of flushing requirements, associated impacts and management options; 9. Treating contaminated stormwater via gross pollutant and sediment traps; 10. Directing treated stormwater into the Canning River along the south-eastern corner boundary of the site (as per DoE advice); 11. Monitoring criteria to determine the success of the plan; 12. Develop and implement contingency measures to be implemented in the event that monitoring criteria are exceeded; 13. Progress and compliance reporting; and 14. Timing and implementation schedule. 	<p>Preparation prior to construction.</p> <p>Implementation to be as determined within the DNIWQM Plan.</p>	SRT City of South Perth
6.	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.	<p>(1) Prepare and implement a Site Remediation (Contaminated Soils) Management Plan as a component of the CEMP to the satisfaction of the DoE.</p> <p>(2) Areas of soil identified as contaminated in excess of EIL or HIL criteria will be excavated (if directed by DoE) and the base and walls of the excavations validated in accordance with relevant DoE Guidelines for the Remediation of Contaminated Land.</p>	Preparation and implementation prior to site works in areas identified in the DSI as potentially contaminated.	DoH Worksafe City of South Perth City of Canning

No.	Topic	Objective	Action	Timing	Advice
			<p>(3) The excavated soil will then be assessed to determine the appropriate management option. A final decision on the management of excavated contaminated soils will be made once analytical results are available for excavated soil.</p> <p>(4) 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.</p> <p>(5) A remediation assessment report will be submitted to DoE on conclusion of remediation works which provides detailed information on:</p> <ol style="list-style-type: none"> 1. The remediation strategy implemented; 2. The results of validation and stockpile sampling; and 3. Details of the management of all contaminated material. <p>(6) Where areas have been identified as potentially affected by asbestos cement sheeting, prepare a specific Health and Safety Plan.</p> <p>This plan will be prepared as an appendix to the overall Site Remediation Management Plan.</p>	Before works commence	
7.	Water Conservation Principles	To conserve water.	<p>Water conservation measures will be applied within the development. These include:</p> <ol style="list-style-type: none"> 1. Promoting the use of plant species which have low water and fertiliser requirements; 2. Utilising local native plant varieties in landscaping; 3. Promoting landscape treatments sympathetic to climatic conditions and prevailing site conditions – soil types, topography, environment, wetlands etc.; 4. 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; 5. Irrigating POS areas at appropriate times so as to reduce evaporative loss and minimise transpiration losses; and 6. Ensuring that the irrigation regime applied to areas of POS is responsive to prevailing weather conditions. 	To be considered within preparation of the Foreshore Management Plan, Groundwater Management Plan and the DNIWQMP (Commitments 3 and 9).	SRT City of South Perth

No.	Topic	Objective	Action	Timing	Advice
8.	Noise	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring that the noise levels meet statutory requirements and acceptable standards.	<p>Noise Management Procedures will be prepared for the site as part of the overall CEMP (see commitment 1).</p> <p>Measures to minimise noise levels received by proposed residences within the development from existing roadways will include:</p> <ol style="list-style-type: none"> 1. Construction of noise barriers between the roadway and residential lots; 2. Specifying appropriate setbacks of proposed residences from existing roadways; and 3. Specification of construction methods and materials (in keeping with “quiet house design” principles). 	<p>Prepared and approved prior to construction. Implemented during construction.</p> <p>Audits completed during construction works and post-construction.</p>	City of South Perth City of Canning
9.	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.	<p>(1) Dust generated during construction will be minimised by the application of EPA guidelines and best practice in dust suppression.</p> <p>(2) Dust Management Procedures will be prepared for the site as part of the overall CEMP (see commitment 1).</p> <p>Measures to minimise dust levels will include:</p> <ol style="list-style-type: none"> 1. Watering of exposed surfaces; 2. Minimising working surfaces at any one time; and 3. Progressive rehabilitation of disturbed areas. 	<p>Prepared and approved prior to construction. Implemented during construction.</p> <p>Audits to be completed during construction works and post-construction.</p>	City of South Perth City of Canning
10.	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.	<p>Prepare and implement an Acid Sulfate Soil Management Plan as a component of the CEMP (see commitment 1) to the satisfaction of the DoE, which will include:</p> <ol style="list-style-type: none"> 1. The area of PASS soils to be disturbed by excavation or dewatering will be minimised as far as possible; 2. Where ASS must be disturbed: <ul style="list-style-type: none"> • Earthworks will be completed as quickly as possible to minimise the time that the walls and base of excavations are exposed to the atmosphere; 	<p>Prepared prior to commencement of any earthworks or dewatering in areas identified as having potential for Acid Sulfate Soils.</p> <p>To be implemented during construction.</p>	SRT

No.	Topic	Objective	Action	Timing	Advice
			<ul style="list-style-type: none"> • 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 that appropriate water quality is maintained; and <p>3. 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.</p>		
11.	Archaeological Investigations	To fulfil the requirements stipulated on the Section 18 clearance of the <i>Aboriginal Heritage Act 1972</i> .	<p>(1) Apply for clearance under Section 18 of the <i>Aboriginal Heritage Act 1972</i> to remove both previously recorded sites and any new sites that emerge as a result of earthmoving procedures located within the site which will be impacted by the development.</p> <p>(2) Also undertake further archaeological investigations if required as part of the Section 18 clearance. Such investigations may include:</p> <ol style="list-style-type: none"> 1. Surface recording, mapping and collection of archaeological material; 2. Archaeological excavation and/or sub-surface evaluation; 3. Recovery of samples for radiometric dating; and 4. Analysis of recovered material. 	Site Heritage Protocol will be prepared prior to commencement of construction and implemented during construction, with any statutory processes followed as per the requirements of the <i>Aboriginal Heritage Act 1972</i> .	DIA

Abbreviations:

ASS - Acid sulfate soils
 CAMBA – China-Australia Migratory Birds Agreement
 CALM - Department of Conservation and Land Management
 DIA - Department of Indigenous Affairs
 DoE - Department of Environment
 DoH - Department of Health

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Abbreviations continued:

DPI – Department for Planning & Infrastructure
DSI – Detailed site investigation
EIL – Ecological Investigation Levels
HIL – Health Investigation Levels
JAMBA - Japan-Australia Migratory Birds Agreement
PASS – Potential acid sulfate soils
POS – Public Open Space
SRT - Swan River Trust

Appendix B

Wetlands EPP Evaluation

**Wetland Management Plan - Proponent Commitment No. 3, Retained Wetland -
Cygnia Cove Estate, Waterford**

Wetlands EPP evaluation

Criteria	Evaluation
<p>The wetland is recognised internationally, nationally or regionally as provided in regulation 5 of the regulations.</p> <p>5. International, national or regional recognition of wetlands</p> <p>(1) For the purposes of the policy, a wetland is recognised internationally if the wetland is an important feeding, breeding or resting site for birds listed under either or both of the following agreements —</p> <p>(a) the China-Australia Migratory Bird Agreement (CAMBA), being the Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and Their Environment 1986, Australian Treaty Series No. 22, Department of Foreign Affairs and Trade, AGPS, Canberra, 1988;</p> <p>(b) the Japan-Australia Migratory Bird Agreement (JAMBA), being the Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in danger of extinction and Their Environment 1974, Australian Treaty Series No. 6, Department of Foreign Affairs, AGPS, Canberra, 1981.</p>	<p>Although recognised, the 3 species identified during surveys were all recorded in habitats associated with the Canning River Foreshore and further information collected does indicate that the 3 species would prefer the river/foreshore habitat rather than the dense vegetation of the wetland.</p>

Criteria	Evaluation
<p>(2) For the purposes of the policy, a wetland is recognised internationally, nationally or regionally if it is recognised in one or more of the following publications —</p> <p>(a) A Directory of Important Wetlands in Australia, 2nd edition, Australian Nature Conservation Agency, Canberra, 1996;</p>	No
<p>(b) Conservation Reserves for Western Australia, Vols 1-6, Environmental Protection Authority, Perth, 1976;</p>	No
<p>(c) L. Pen, A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton-Walpole Region, Water Resource Allocation and Planning Series, report no. WRAP 7, Water and Rivers Commission, Perth, 1997;</p>	No
<p>(f) the United Nations Educational, Scientific and Cultural Organisation Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971, Australian Treaty Series No. 48, Department of Foreign Affairs, AGPS, Canberra, 1975</p>	No
<p>(e) Perth's Bush Forever, Government of Western Australia, Perth, 2000;</p>	No
<p>(f) the United Nations Educational, Scientific and Cultural Organisation Convention on</p>	No

Criteria	Evaluation
<p>Wetlands of International Importance Especially as Waterfowl Habitat 1971, Australian Treaty Series No. 48, Department of Foreign Affairs, AGPS, Canberra, 1975</p>	
<p>The wetland has at least one of the significant natural attributes referred to in regulation 6 of the regulations.</p> <p>6. Significant natural attributes of wetlands. For the purposes of the policy, a wetland has a significant natural attribute if —</p> <p>(a) it supports protected flora as defined in section 6(1) of the Wildlife Conservation Act 1950;</p>	<p>No</p>
<p>(b) it supports fauna specified in a notice in operation under section 14(2)(ba) of the Wildlife Conservation Act 1950 as fauna that is likely to become extinct, or is rare, or otherwise in need of special protection;</p>	<p>No</p>
<p>(c) it supports vegetation in “good, very good, excellent or pristine condition” as described by B J Keighery in Bushland Plant Survey. A Guide to Plant Community Survey for the Community, Wildflower Society of WA (Inc), Nedlands, Western Australia, 1994;</p>	<p>No – the vegetation on site is predominantly weed species. This factor applies to native vegetation.</p>

Criteria	Evaluation
<p>(d) it supports an ecological community listed as “threatened” in Category 1, 2, 3 or 4 as described by V J English and J Blyth in —</p> <p>(i) “Identifying and Conserving Threatened Ecological Communities in the South West Botanical Province”, (Project N702) published in Final Report to Environment Australia, Department of Conservation and Land Management, Como, Western Australia, 1997; or</p> <p>(ii) “Development and application of procedures to identify and conserve threatened ecological communities in the South West Botanical Province of Western Australia”, published in Pacific Conservation Biology No. 5, 1999, at pp. 124-38, Surrey, Beatty and Sons, New South Wales, 1999;</p>	<p>No</p>
<p>(e) it is a wetland of a natural wetland type that is part of a natural wetland group of which fewer than 30% of wetlands of that type in that group are represented in the conservation estate on the Swan coastal plain, according to the wetland type and geomorphic classification system in Hill, AL, Semeniuk, CA, Semeniuk, V and Del Marco, A, Wetlands of the Swan coastal plain, Volume 1: Wetland Mapping, Classification and Evaluation — Main Report and Volume 2: Wetland Mapping, Classification and Evaluation — Wetland Atlas, Water and Rivers Commission and Department of Environmental Protection, Perth, Western Australia, 1996;</p>	<p>Data not available but preliminary information suggests that there is more than 30% remaining.</p>
<p>(f) it is a significant habitat or refuge for native or migratory fauna; or</p>	<p>While it does provide some habitat value, the wetlands itself is not considered a</p>

Criteria	Evaluation
	significant habitat or refuge.
(g) it supports a concentration of a species of native or migratory fauna.	No
<p><i>The wetland has at least 2 of the environmental values listed in regulation 7 of the regulations.</i></p> <p>7. Other environmental values of wetlands. For the purposes of clause 6(c) of the policy, the following environmental values are listed —</p> <p>(a) the wetland is a significant site of pollen records, unusual sediments (as indicators of historical change), unusual geomorphology or hydrology for the scientific community;</p>	No
(b) the wetland is a public resource for water-based and land-based recreation;	No
(c) the wetland is a significant archaeological or historical heritage site;	No
(d) the wetland is an Aboriginal site as defined in section 4 of the Aboriginal Heritage Act 1972;	Yes – but clearance has been received
(e) the wetland is a significant field study site for educational purposes.	No

Appendix C

East Clontarf Flora List

**Wetland Management Plan - Proponent Commitment No. 3, Retained Wetland -
Cygnia Cove Estate, Waterford**

APPENDIX C
EAST CLONTARF FLORA LIST

FERNS

DENNSTAEDTIACEAE

Pteridium esculentum

MONOCOTYLEDONS

ARACEAE

**Zantedeschia aethiopica*

CYPERACEAE

Baumea articulata

Isolepis cernua

Bolboschoenus caldwellii

Lepidosperma longitudinale

IRIDACEAE

**Chasmanthe floribunda*

**Homeria flaccida*

JUNCAEAE

Juncus pallidus

Juncus krausii

SCHEUZERIACEAE

Triglochin mucronata

POACEAE

**Avena fatua*

**Arundo donax*

**Briza maxima*

**Cortaderia selloana*

**Cynodon dactylon*

**Ehrharta calycina*

**Eragrostis curvula*

**Lolium perenne*

**Poa annua*

**Sporobolus virginicus*

**Pennisetum clandestinum*

RESTIONACEAE

Leptocarpus diffusus

TYPHACEAE

**Typha orientalis*

DICOTYLEDONS

ASTERACEAE

**Arctotheca calendula*

**Conyza bonariensis*

Cotula coronopifolia

**Hypochaeris glabra*

**Hypochaeris radicata*

**Sonchus oleraceus*

Senecio lautus ssp. maritimus

**Ursinia anthemoides*

BRASSICACEAE

**Raphanus raphanistrum*

**Rorippa nasturtium - aquaticum*

CHENOPODIACEAE

Enchylaena tomentosum

Halosarcia halocnemoides

**Rumex acetosella*

CASUARINACEAE

Casuarina obesa

EUPHORBIACEAE

**Euphorbia terracina*

FUMARIACEAE

**Fumaria capreolata*

GERANIACEAE

**Pelargonium capitatum*

**Erodium moschatum*

LYTHRACEAE

**Lythrum sp.*

MIMOSACEAE

Acacia stenoptera

MENYANTHACEAE

Villarsia albiflora

MYRTACEAE

Astartea fascicularis

Corymbia calophylla

**Eucalyptus citriodora*

**Eucalyptus camaldulensis*

**Eucalyptus robusta*

Eucalyptus rudis

Melaleuca raphiophylla

OROBANCHACEAE

**Orobanche minor*

OXALIDACEAE

**Oxalis pes-caprae*

PAPILIONACEAE

Jacksonia furcellata

* *Chamaecytisus palmensis*

**Lotus sp.*

**Lupinus cosentinii*

**Lupinus mutabilis*

**Medicago polymorpha*

**Trifolium arvense*

**Trifolium campestre*

**Trifolium glomeratum*

**Vicia sativa*

Viminaria juncea

SOLANACEAE

**Solanum nigrum*

**Solanum americanum*

POLYPOGONACEAE

**Persicaria decipiens*

**Polypogon sp.*

Appendix D Fauna Report

**Wetland Management Plan - Proponent Commitment No. 3, Retained Wetland -
Cygnia Cove Estate, Waterford**

APPENDIX E VERTEBRATE FAUNA

EAST CLONTARF, MANNING

1. HABITATS

Based on the existing vegetation and aerial photography the main habitats of the site are the large wetland dominated by Bulrush (*Typha orientalis*) and other sedges that occupies about one third of the site, grassland surrounding the wetland and the Canning River including the adjoining foreshore. The site also supports scattered individual or small stands of exotic and locally occurring trees.

The wetland is limited in its value to fauna due to the lack of open water sections, which thereby restricts its use by many species of waterfowl. The main faunal groups considered likely to inhabit the site are terrestrial and aquatic birds and amphibians.

2. SPECIES

A brief fauna survey was conducted between Clontarf and Mount Henry on the Canning River foreshore in autumn of 1993 (City of South Perth, 1993). The survey included areas of *Juncus* sp., which are typical of the foreshore vegetation found on the East Clontarf site. In areas representative of the subject site several species of skink, frogs, bush crickets and orb weave spiders were found. Black Swan, Coot and Musk Duck were identified on the river.

Additional information regarding the fauna of the East Clontarf site has been obtained through a series of site surveys undertaken at various times throughout the year. The surveys were designed to determine the value of the habitats at the site for fauna. The surveys were undertaken by ATA Environmental in association with Bamford Consulting Ecologists.

Site surveys were conducted on five occasions between May and December 2000. Site visits occurred on 8 and 16 May, 21 August, 31 October and 21 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 species recorded during the survey is presented in Appendix 1. A summary of the results is outlined in the following sections.

2.1 Frogs

Six species of frogs were recorded during the surveys. One of these species, 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 quarry 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 pit area south of the wetland towards the eastern side of the property. This sand pit and wheel ruts provide ideal breeding habitat for the Moaning Frog and Quacking Frog.

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

The low numbers of frogs calling from the majority of the wetland was unexpected. Conversely, the records of *Crinia georgiana* are unexpected as this species is patchily distributed on the coastal plain.

It is possible that frog diversity and abundance at the site has been adversely affected by past land uses and contamination. While the water within the wetland and drains visually appears to be of high quality and the Bulrush provides a biofilter, past land use and contamination of the sediment and groundwater may be impacting on frogs within the wetland.

2.2 Reptiles

Few reptiles were recorded during the surveys. This can generally be attributed to the disturbed and highly modified nature of the habitats. All of the species are typical of the habitats 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.

2.3 Birds

Fifty-two bird species were recorded during the on site visits. Eighteen waterbird species were recorded on the river, while only six waterbird species were observed or heard within the wetland area on the site. The observation of a pair of Pacific Black Ducks with 9 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, the Spotless Crake, Clamorous Reed-Warbler and Little Grassbird, 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, 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, either Splendid or Variegated (*Malurus lamberti*) Fairy-wren, in rushes on the southern edge of the wetland area. The presence of the Fairy-wren at the site was unexpected. It may represent dispersal from more suitable areas upstream but indicates some potential for the site to support this species.

2.4 Mammals

No native mammals were recorded during the site survey. The survey revealed that foxes, rabbits, feral or semi-domestic cats and at least one species of introduced rat 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 presumed to have been killed by foxes were located on the site.

2.5 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. This record was not expected, as Gilgies are not known from other wetlands in South Perth.

3. SIGNIFICANT SPECIES

Department of Conservation and Land Management maintains a database of Specially Protected and Priority Fauna species. A search of the database (conducted in March 2000) 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 CALM 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 (*Calyptrorhynchus 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 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 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.

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

4. CONSERVATION SIGNIFICANCE

Main observations or findings of the vertebrate fauna surveys in relation to the significance of the habitats of East Clontarf to fauna 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 areas 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, various frogs, and Long-necked Tortoise.
- The wetland could support a greater range of waterbirds if areas of open water were available.
- 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.

- Upland vegetation of the site is severely degraded. These areas support few reptile species and open country birds such as Magpies that still rely on scattered mature trees. Trees within the site may be used for breeding by various birds, including some waterbirds such as ducks and herons.
- Discussions with Ted Cockett (Curtin University) indicate that the area around Clontarf had a lot of native vegetation in the 1950s and 1960s and that the vertebrate fauna was previously much more extensive.

Observations from the surveys conducted clearly suggest that the river and fringing foreshore vegetation are important for fauna, whereas the existing wetlands and uplands are of limited value. The wetland however, supports a few species not present close to the river such as Reed-Warbler, Little Grassbird, and Spotless Crake. In addition, the single record of a fairy-wren indicates that the upland and wetland fringing vegetation have the potential to support a richer fauna than is currently present.

5. RECOMMENDATIONS

Modification of the site could potentially enhance the number of species and abundance of species if alterations included the following:

- Creation of freshwater lakes, partly vegetated with sedges, immediately behind the river foreshore, possibly through the diversion of the existing drainage line. This would create wetland habitat close to the river and potentially improve breeding sites for water birds such as the Black Swan, and would assist with filtering water flowing into the river.
- Retention of remnant native upland vegetation, such as the patch of Marri near the river and groves of Flooded Gums. Other eucalypts and exotic trees also provide valuable roosting and nesting sites for many species of birds.
- Compensation of any loss of wetland due to development by habitat creation within the remaining wetland area. Wetlands smaller than the existing wetland could be designed to support increased numbers and diversity of waterbirds. For example, creating some open water in the wetlands and retaining dense rush beds around most of the fringe of the open water, and on one or more islands, and planting dense vegetation along the edge of rush beds would create a mosaic of valuable habitat.
- Native riparian species, especially small trees such as *Agonis linearifolia*, could be used to create aesthetic corridors of vegetation along narrow waterways.
- Planting of some dense shrubs around the wetland and along the margins of the river foreshore would be valuable for birds such as the fairy-wrens, and would enhance the wildlife corridor along the Canning River foreshore.

- Use of native vegetation in public areas, on road verges and even encouraged in private gardens would benefit wildlife.
- Provision of an appropriate width buffer along the river foreshore to minimise disturbance of wildlife, especially waterbirds on the river, from any development and future residents. Dogs should be excluded from the foreshore area and residents should be encouraged to keep cats indoors, particularly at night.
- Water quality within the wetland should be ascertained and any major threats to maintaining good quality of water, such as sediment or groundwater contamination, should be addressed and appropriately managed to minimise impacts.

APPENDIX 1

VERTEBRATE FAUNA RECORDED OR EXPECTED TO OCCUR

VERTEBRATE FAUNA RECORDED OR EXPECTED TO OCCUR

For the purposes of this species list, the East Clontarf site is considered to include the freshwater wetland, upland areas around the wetland, and the adjacent river and foreshore. The habitat and fauna with all these areas would potentially be affected by development of the site.

Species were recorded on the site during:

- May (08 May 2000 and 16 May 2000)
- August (21 August 2000)
- October (31 October 2000)
- December (21 December 2000)

KEY:

- ✓: Species recorded at the site
- *: Species expected on the site
- +: Species that may be present

Species present during a particular survey date are indicated as

- R: On the river
- U: In upland habitats
- W: Within the wetlands

- “nearby” species recorded nearby but not on the site
- “report” species reported by people spoken to during the survey
- “fly” species recorded as flying over the site

- (S1 - 4) Specially Protected species (Schedules 1 – 4)
- (P1 - 4) species listed as Priority taxa (Priority 1 - 4)
- (I) introduced species

Totals provided in parentheses () indicate number of species expected or possible (including those that were recorded) at the site.

Note: a number of bird species have been excluded from this list as they would only occur at the site as vagrants.

VERTEBRATE FAUNA RECORDED OR EXPECTED TO OCCUR

	Overall	May	Aug	Oct	Dec
Amphibians					
Myobatrachidae (ground frogs)					
Quacking Frog <i>Crinia georgiana</i>	✓		W	W	
Glauert's Froglet <i>Crinia (Ranidella) glauerti</i>	✓	W	W	W	W
Sandplain Froglet <i>Crinia (Ranidella) insignifera</i>	✓	W	W		
Moaning Frog <i>Heleioporus eyrei</i>	✓	W			
Pobblebonk <i>Limnodynastes dorsalis</i>	✓		nearby		
Turtle Frog <i>Myobatrachus gouldii</i>	+				
Guenther's Toadlet <i>Pseudophryne guentheri</i>	+				
Hylidae (tree frogs)					
Slender Tree Frog <i>Litoria adelaidensis</i>	*				
Motorbike Frog <i>Litoria moorei</i>	✓		W		
Sub-Total	6 (9)	3	5	2	1
Reptiles					
Chelidae (side-neck tortoises)					
Long-necked Tortoise <i>Chelodina oblonga</i>	✓	W			W
Gekkonidae (geckoes)					
Spiny-tailed Gecko <i>Diplodactylus spinigerus</i>	*				
Marbled Gecko <i>Phyllodactylus marmoratus</i>	*				
Pygopodidae (legless lizards)					
Sandplain Worm Lizard <i>Aprasia repens</i>	*				
Burton's Legless Lizard <i>Lialis burtonis</i>	+				
Common Scalefoot <i>Pygopus lepidopodus</i>	+				
Agamidae (dragon lizards)					
Western Bearded Dragon <i>Pogona minor</i>	+				
Sandhill Dragon <i>Tympanocryptis adelaidensis</i>	+				
Varanidae (monitors or goannas)					
Gould's Sand Goanna <i>Varanus gouldii</i>	+				
Scincidae (skink lizards)					
<i>Acritoscincus (Bassiana) trilineatum</i>	✓		WU	WU	WU
Fence Skink <i>Cryptoblepharus plagiocephalus</i>	✓	U			
<i>Ctenotus fallens</i>	+				
King's Skink <i>Egernia kingii</i>	+				
<i>Hemiergis quadrilineata</i>	*				
<i>Lerista elegans</i>	✓				U
<i>Lerista praepedita</i>	*				
Dwarf Skink <i>Menetia greyii</i>	*				
<i>Morethia lineocellata</i>	+				
Dusky Morethia <i>Morethia obscura</i>	+				
Western Bluetongue <i>Tiliqua occipitalis</i>	+				
Bobtail <i>Tiliqua rugosa</i>	*				
Elapidae (front-fanged snakes)					
Tiger Snake <i>Notechis scutatus</i>	✓		WU	WU	
Dugite <i>Pseudonaja affinis</i>	✓		report		U
Sub-Total	6 (23)	2	3	2	4
Birds					
Anatidae (ducks, geese and swans)					
Black Swan <i>Cygnus atratus</i>	✓	R			R
Australian Shelduck <i>Tadorna tadornoides</i>	✓	R	R		
Pacific Black Duck <i>Anas superciliosus</i>	✓	R	R	RW	

		Overall	May	Aug	Oct	Dec
Grey Teal	<i>Anas gibberifrons</i>	✓		R	R	
Chestnut Teal	<i>Anas castanea</i>	+				
Australasian Shoveler	<i>Anas rhynchotis</i>	✓		R		
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>	+				
Hardhead (White-eyed Duck)	<i>Aythya australis</i>	+				
Australian Wood Duck	<i>Chenonetta jubata</i>	+				
Musk Duck	<i>Biziura lobata</i>	✓	R			R
Blue-billed Duck	<i>Oxyura australis</i>	*				
Podicepsidae (grebes)						
Hoary-headed Grebe	<i>Poliocephalus poliocephalus</i>	+				
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>	+				
Anhingidae (darters)						
Darter	<i>Anhinga melanogaster</i>	✓	R		R	R
Phalacrocoracidae (cormorants)						
Great Cormorant	<i>Phalacrocorax carbo</i>	✓	R		R	R
Pied Cormorant	<i>Phalacrocorax varius</i>	✓	R			
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	✓	R	R		
Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>	✓	R	R	R	R
Pelecanoididae (pelicans)						
Australian Pelican	<i>Pelecanus conspicillatus</i>	✓	R	R	R	R
Ardeidae (herons and egrets)						
White-faced Heron	<i>Egretta novaehollandiae</i>	✓	R	R	W	UR
Little Egret	<i>Egretta garzetta</i>	+				
White-necked Heron	<i>Ardea pacifica</i>	+				
Great Egret	<i>Egretta alba</i>	✓	R	R		
Nankeen Night Heron	<i>Nycticorax caledonicus</i>	*				
Plataleidae (ibis and spoonbills)						
Australian White Ibis	<i>Threskiornis molucca</i>	✓	fly	W	RW	
Straw-necked Ibis	<i>Threskiornis spinicollis</i>	*				
Yellow-billed Spoonbill	<i>Platalea flavipes</i>	✓	R			
Accipitridae (kites, hawks and eagles)						
Osprey	<i>Pandion haliaetus</i>	*				
Black-shouldered Kite	<i>Elanus notatus</i>	✓		U	U	U
Whistling Kite	<i>Haliastur sphenurus</i>	*				
White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	+				
Swamp Harrier	<i>Circus approximans</i>	*				
Brown Goshawk	<i>Accipiter fasciatus</i>	*				
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>	✓		U		U
Wedge-tailed Eagle	<i>Aquila audax</i>	+				
Little Eagle	<i>Hieraetus morphnoides</i>	+				
Falconidae (falcons)						
Peregrine Falcon	<i>Falco peregrinus</i> (S4)	+				
Australian Hobby	<i>Falco longipennis</i>	✓		U		
Brown Falcon	<i>Falco berigora</i>	*				
Nankeen Kestrel	<i>Falco cenchroides</i>	*				
Rallidae (crakes and rails)						
Buff-banded Rail	<i>Rallus philippensis</i>	*				
Baillon's Crake	<i>Porzana pusilla</i>	*				
Australian Spotted Crake	<i>Porzana fluminea</i>	*				
Spotless Crake	<i>Porzana tabuensis</i>	✓		W		
Dusky Moorhen	<i>Gallinula tenebrosa</i>	+				
Purple Swamphen	<i>Porphyrio porphyrio</i>	*				
Eurasian Coot	<i>Fulica atra</i>	✓				R

		Overall	May	Aug	Oct	Dec
Scolopacidae (sandpipers)						
Common Greenshank	<i>Tringa nebularia</i>	✓			R	
Wood Sandpiper	<i>Tringa glareola</i>	+				
Common Sandpiper	<i>Tringa hypoleucos</i>	✓			R	
Recurvirostridae (stilts and avocets)						
Black-winged Stilt	<i>Himantopus himantopus</i>	✓	R		R	R
Red-necked Avocet	<i>Recurvirostra novaehollandiae</i>	*				
Charadriidae (lapwings and plovers)						
Grey Plover	<i>Pluvialis squatarola</i>	+				
Red-capped Plover	<i>Charadrius ruficapillus</i>	*				
Black-fronted Dotterel	<i>Elseya melanops</i>	+				
Banded Lapwing	<i>Vanellus tricolor</i>	+				
Laridae (gulls and terns)						
Silver Gull	<i>Larus novaehollandiae</i>	✓	R	R	R	
Caspian Tern	<i>Hydroprogne caspia</i>	✓	R	R		
Crested Tern	<i>Sterna bergii</i>	✓	R		R	
Whiskered Tern	<i>Chlidonias hybrida</i>	+				
Columbidae (pigeons and doves)						
Rock Dove (feral pigeon)	<i>Columba livia</i> (I)	✓	U			
Spotted Turtle-Dove	<i>Streptopelia chinensis</i> (I)	✓	U			U
Laughing Turtle-Dove	<i>Streptopelia senegalensis</i> (I)	✓	U		U	
Cacatuidae (cockatoos)						
Short-billed Black-Cockatoo	<i>Calyptorhynchus latirostris</i> (S1)	*				
Galah	<i>Cacatua roseicapilla</i>	✓		U	U	U
Long-billed Corella	<i>Cacatua tenuirostris</i> (I)	✓	U			
Western Corella	<i>Cacatua pastinator</i>	*				
Little Corella	<i>Cacatua sanguinea</i>	*				
Psittacidae (lorikeets and parrots)						
Rainbow Lorikeet	<i>Trichoglossus haematodus</i> (I)	✓		U	U	fly
Purple-crowned Lorikeet	<i>Glossopsitta porphyrocephala</i>	+				
Red-capped Parrot	<i>Purpureicephalus spurius</i>	✓			U	
Australian Ringneck	<i>Barnardius zonarius</i>	*				
Cuculidae (cuckoos)						
Pallid Cuckoo	<i>Cuculus pallidus</i>	+				
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalis</i>	+				
Shining Bronze-Cuckoo	<i>Chrysococcyx lucidus</i>	+				
Strigidae (hawk-owls)						
Southern Boobook Owl	<i>Ninox novaeseelandiae</i>	*				
Tytonidae (barn owls)						
Barn Owl	<i>Tyto alba</i>	*				
Podargidae (frogmouths)						
Tawny Frogmouth	<i>Podargus strigoides</i>	+				
Apodidae (swifts)						
Fork-tailed Swift	<i>Apus pacificus</i>	+				
Halcyonidae (forest kingfishers)						
Laughing Kookaburra	<i>Dacelo novaeguineae</i> (I)	*				
Sacred Kingfisher	<i>Todiramphus sanctus</i>	*				
Meropidae (bee-eaters)						
Rainbow Bee-eater	<i>Merops ornatus</i>	*				
Maluridae (fairy-wrens)						
fairy-wren ? splendid	<i>Malurus splendens</i>	✓				WU
Pardalotidae (pardalotes)						
Spotted Pardalote	<i>Pardalotus punctatus</i>	*				

		Overall	May	Aug	Oct	Dec
Striated Pardalote	<i>Pardalotus striatus</i>	✓	U	U	U	
Western Gerygone	<i>Gerygone fusca</i>	✓			U	
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>	*				
Meliphagidae (honeyeaters)						
Red Wattlebird	<i>Anthochaera carunculata</i>	✓	U		U	U
Western Wattlebird	<i>Anthochaera lunulata</i>	*				
Singing Honeyeater	<i>Lichenostomus virescens</i>	✓	U	U	U	U
Brown Honeyeater	<i>Lichmera indistincta</i>	✓	WU	WU	WU	WU
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	*				
White-cheeked Honeyeater	<i>Phylidonyris nigra</i>	*				
White-fronted Chat	<i>Epthianura albifrons</i>	*				
Pachycephalidae (whistlers)						
Rufous Whistler	<i>Pachycephala rufiventris</i>	*				
Dicruridae (flycatchers)						
Magpie-lark	<i>Grallina cyanoleuca</i>	✓	U	U	U	U
Grey Fantail	<i>Rhipidura fuliginosa</i>	*				
Willie Wagtail	<i>Rhipidura leucophrys</i>	✓	U	U	U	U
Campephagidae (cuckoo-shrikes)						
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	✓		U	U	U
White-winged Triller	<i>Lalage sueurii</i>	*				
Artamidae (woodswallows)						
Black-faced Woodswallow	<i>Artamus cinereus</i>	*				
Grey Butcherbird	<i>Cracticus torquatus</i>	✓		U		
Australian Magpie	<i>Gymnorhina tibicen</i>	✓	U	U	U	U
Corvidae (ravens and crows)						
Australian Raven	<i>Corvus coronoides</i>	✓	U	U	U	U
Motacillidae (pipits and true wagtails)						
Richard's Pipit	<i>Anthus novaeseelandiae</i>	✓	U		U	U
Dicaeidae (flower-peckers)						
Mistletoebird	<i>Dicaeum hirundinaceum</i>	*				
Hirundinidae (swallows)						
White-backed Swallow	<i>Cheramoeca leucosternus</i>	*				
Welcome Swallow	<i>Hirundo neoxena</i>	✓	U	U	U	
Tree Martin	<i>Hirundo nigricans</i>	✓	U		U	
Fairy Martin	<i>Hirundo ariel</i>	*				
Sylviidae (Old World warblers)						
Clamorous Reed-Warbler	<i>Acrocephalus stentoreus</i>	✓	W	W	W	W
Little Grassbird	<i>Megalurus grammurus</i>	✓		W		W
Zosteropidae (white-eyes)						
Silvereye	<i>Zosterops lateralis</i>	✓		WU	WU	WU
Sub-Total		52 (113)	34	31	33	27
Mammals						
Peramelidae (bandicoots)						
Quenda or Southern Brown Bandicoot	<i>Isodon obesulus</i> (P4)	*				
Phalangeridae (possums)						
Brush-tailed Possum	<i>Trichosurus vulpecula</i>	*				
Mollosidae (moustiff bats)						
White-striped Bat	<i>Nyctinomus (Tadarida) australis</i>	*				
Vespertilionidae (vesper bats)						
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	+				
	<i>Vespadalus (Eptesicus) regulus</i>	+				
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>	+				

		Overall	May	Aug	Oct	Dec
Muridae (rats and mice)						
Rakali or Water Rat	<i>Hydromys chrysogaster</i> (P4)	*				
House Mouse	<i>Mus musculus</i> (I)	*				
Black Rat	<i>Rattus rattus</i> (I)	✓	W			
Brown Rat	<i>Rattus norvegicus</i> (I)	*				
Leporidae (rabbits and hares)						
Rabbit	<i>Oryctolagus cuniculus</i> (I)	✓				U
Canidae (foxes and dogs)						
European Red Fox	<i>Vulpes vulpes</i> (I)	✓	U	U		U
Felidae (cats)						
Feral Cat	<i>Felis catus</i> (I)	✓	U			
Sub-Total		4 (13)	2	1	-	2
TOTAL		67 (158)	41	40	37	34

Note. Fish have not been included in the species list. The introduced Mosquito Fish *Gambusia holbrooki* is present in the wetland.

Appendix E Register of Heritage Places – Permanent Entry

**Wetland Management Plan - Proponent Commitment No. 3, Retained Wetland -
Cygnia Cove Estate, Waterford**



REGISTER OF HERITAGE PLACES

Permanent Entry

1. **DATA BASE No.** 02401
2. **NAME** *Clontarf* (1901, 1935-1941, 1957, 1973, 1974/5, 1985, 1999)
FORMER NAME St Joseph's Boys' Orphanage, Clontarf Boys Town, Clontarf Campus
3. **LOCATION** 295 Manning Road, Waterford
4. **DESCRIPTION OF PLACE INCLUDED IN THIS ENTRY**
5. Those portions of:
 Canning Location 57 and Canning Location 87, being part of the land comprised in Certificate of Title Volume 2145 Folio 827 and
 Canning Location 58, being part of the land comprised in Certificate of Title Volume 2145 Folio 828 and
 Canning Location 65, being part of the land comprised in Certificate of Title Volume 1731 Folio 307 as together are defined in Heritage Council of Western Australia survey drawing No. 2401 prepared by Steffanoni Ewing & Cruickshank Pty Ltd.
5. **LOCAL GOVERNMENT AREA** City of South Perth
6. **OWNER** Trustees of the Christian Brothers in Western Australia Inc
7. **HERITAGE LISTINGS**
 - Register of Heritage Places: Interim Entry 15/12/2000
 Permanent Entry 14/12/2001
 - National Trust Classification: -----
 - Town Planning Scheme: TPS No. 5
 - Municipal Inventory: Adopted 28/12/1996
 - Register of the National Estate: -----
8. **CONSERVATION ORDER**

9. **HERITAGE AGREEMENT**

10. **STATEMENT OF SIGNIFICANCE**
Clontarf, a large site containing buildings of a former orphanage, farm and school dating from 1901 to 1973 in a variety of styles, some later buildings, 'Brother Keaney's Gardens', sports grounds, swimming pool, gardens and wetlands, has cultural heritage significance for the following reasons:

the place is important for its schooling of day boys and boarders, residential care education and supervision of orphans, vagrants, children from suffering families, child migrants and Aboriginal children from 1901 to the 1980s. It represents memories and associations for those in whose lives it played an important role and is a tangible reminder of the institutionalisation, abuse and exploitation suffered by some boys at the hands of those charged with their care;

the buildings constructed in the period 1935-41 (including the clocktower) are examples of the technical achievements of the Christian Brothers and the children who worked under their supervision;

the elegant proportions and fine interior detailing of the Inter-War Romanesque style chapel is of aesthetic value and demonstrates the level of technical excellence achieved by the boys and Brothers through the progressive construction process on the site;

the main building is a fine example of Victorian Romanesque style by Architect Michael Cavanagh, constructed in local limestone with soft red brick detailing;

the chapel is associated with architect Marie Jackson;

is valued by the Christian Brothers as a demonstration of the organisation's philanthropic educational basis;

is valued by the Aboriginal community of Perth and Western Australia as a place of education and self-determination integral to the formation of their modern culture;

is of aesthetic value for its formal entry statements, driveway, mature trees, rose gardens, expansive lawns, wetlands and homogenous group of pale walled, terracotta roofed buildings; and,

the site has landmark qualities and contributes to the community's sense of place.

The transportable building on the western side of the driveway has not been included in the assessment due to its temporary nature.

The pool, sports grounds, hand ball courts and basket ball court are significant in demonstrating recreational activities provided for the boys however they are not notable technical or aesthetic achievements.

The former matron's residence, the library, the workshop, the current Brothers' residence and grave are of low cultural heritage significance. The new Abmusic building and new building being constructed for Marr Mooditj are significant structures for the organisations and Aboriginal community however it is too early to assess their cultural heritage significance.

The towers and concrete verandah structure at the rear of the main building are intrusive, as are the garden beds at the front of the building.

Appendix F

Interpretive Panel List

**Wetland Management Plan - Proponent Commitment No. 3, Retained Wetland -
Cygnia Cove Estate, Waterford**

POSSIBLE INTERPRETIVE PANEL TOPICS AND LOCATIONS – CYGNIA COVE

Interpretive material falls broadly into two categories: Major Nodes (4 of) each of which deal with one of the key aspects / areas of the site, and Trailside Stories – which are more specific to a particular location. Major nodes could/should have seating and shade.

MAJOR NODES

MAP #	LOCATION	PANEL	TOPIC	SIZE
A	North end of boardwalk across the wetland	Primary focus of this site is the retained “natural” wetland & remediation of contaminated site (overall)		
		1	<i>The wetland – overall story: what, why, how, historical uses etc – including role as a “filter” of contaminants</i>	900 x 400
		2	<i>Remediation of contaminated site (big picture, whole site); removal of rubble & exotic weeds</i>	900 x 400
B	On proposed viewing deck on east side of wetland	Primary focus is Clontarf – the views, buildings & social history		
		3	<i>The beautiful buildings of Clontarf – architecture, what, when, how, who built them etc</i>	900 x 400
		4	<i>The social history of Clontarf – transition of uses, including a time-line & the 1988 hard-over to indigenous community</i>	900 x 400
C	At the stream crossing, where the wetland “loop” meets the riverside path	Primary focus is the created wetland – the swan habitat		
		5	<i>The created wetland – what, when, why and how it came about + existing stream (orig source of water for Clontarf)</i>	900 x 400
		6	<i>Black swans – their ecology & social habits, with particular reference to their breeding cycle & how they pair up</i>	900 x 400

D	On the riverside path where the “marri POS” adjoins foreshore	Primary focus of panels at this site is the foreshore reserve and who is responsible for its management		
		7	<i>The foreshore reserve – its history, its health, its current situation & its vegetation (inc general overview of birdlife, if space permits)</i>	900 x 400
		8	<i>A broad social history of the Canning River, with particular focus on this section</i>	900 x 400

TRAILSIDE STORIES

MAP #	LOCATION	PANEL	TOPIC	SIZE
e	<i>North side retained wetland</i>	9	<i>Wetland critters – frogs, fish, snakes</i>	600 x 350
f	<i>East end of retained wetland</i>	10	<i>Where does the water come from? (Inc possible Noongar concepts)</i>	600 x 350
g	<i>West side wetland, by Chapel</i>	11	<i>The men who created Clontarf – focus on Chapel</i>	600 x 350
h	<i>Bush tucker trail</i>	12	<i>Bush tucker / bush medicine plants – general overview re usage</i>	600 x 350
		13 – 18	<i>Simple species-specific signs: names & usage only (6 of)</i>	200 x 150
h-g	<i>Bush tucker trail / west side</i>	19	<i>General overview of Noongar life near wetlands & on coastal plain</i>	600 x 350
h-g	<i>Bush tucker trail / west side</i>	20	<i>General overview of Noongar life along Canning River / all rivers</i>	600 x 350
i	<i>West side created wetland</i>	21	<i>Black swan info: repeat some of sign #6 (+ behaviour messages)</i>	600 x 350
j	<i>Foreshore pathway, west part</i>	22	<i>The old jetty – what, when, why etc; riverboats – then / now</i>	600 x 350
k	<i>Foreshore pathway, central</i>	23	<i>Waterbirds of the river (not swans)</i>	600 x 350
l	<i>In main grove of marri trees</i>	24	<i>Marri – what, how to recognise, key features etc</i>	600 x 350

LANDSCAPE ARCHITECTS
ENVIRONMENTAL CONSULTANTS