ALKIMOS WASTEWATER TREATMENT PLANT WASTEWATER DISPOSAL STRATEGY AND PROPOSED OCEAN OUTLET

SCOPE OF PUBLIC ENVIRONMENTAL REVIEW

FINAL - FOR EPA CONSULTATION

MAY 2005

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TABLES

FIGURES

ABBREVIATIONS

AWWTP	Alkimos Wastewater Treatment Plant
BPPH	Benthic Primary Producer Habitat
CEE	Consulting Environmental Engineers
Corporation	Water Corporation (Western Australia)
CSIRO	Commonwealth Scientific & Industrial Research Organisation
DIN	dissolved inorganic nitrogen
DoE	Department of Environment (Western Australia)
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority (Western Australia)
EQMF	Environmental Quality Management Framework
FCT	floristic community type
ha	hectare
IDEA	Intermittent Decant Extended Aeration
kL/d	kilolitres per day (thousand litres per day)
m	metre
m^3	cubic metre
µg/L	micrograms per litre
mg/L	milligrams per litre (thousandths of a gram per litre)
ML/d	Megalitres per day (million litres per day)
MRS	Metropolitan Region Scheme
OU	odour units
OU/s	odour units per second
PCWS	Perth Coastal Waters Study
PER	Public Environmental Review
PLOOM	Perth Long-term Ocean Outlet Monitoring Programme
S	second
TKN	total Kjeldahl nitrogen
TN	total nitrogen
TWW	Treated Wastewater
WAPC	Western Australian Planning Commission
WSD	Water Supply Development
WTP	water treatment plant
WWTP	wastewater treatment plant

1. INTRODUCTION

1.1 PROPOSAL REFERRAL

The Water Corporation (the Corporation) on 15 July 2004 referred to the Environmental Protection Authority (EPA) an amended proposal (Water Corporation 2004) to establish the Alkimos Wastewater Treatment Plant (AWWTP), including a treated wastewater management strategy incorporating groundwater recharge through infiltration, and an ocean outfall.

The EPA determined to assess the proposal at the level of Public Environmental Review (PER), advertised on 19 July 2004. As the next stage in the process of assessment, the EPA required that the Corporation prepare and submit this Environmental Scoping document.

On 12 January 2005, the Corporation formally requested that the EPA consent to modifying the referred proposal by removing from consideration one alternative WWTP location, known as Site B1, as the site was no longer a viable option.

This document presents the environmental issues requiring studies in the course of the Public Environmental Review. They have been divided into *Relevant Environmental Factors* (those that require detailed assessment and study due to their potential environmental significance), and *Other Factors* (those that are not considered relevant for detailed formal assessment and control due to their relative insignificance in the context of the overall urban development in the north-western corridor, or due to being appropriately managed through other policies, instruments and statutory requirements). These factors will, however be addressed within the PER to the extent that their relative significance will be explained and relevant management processes to be implemented will be identified.

The Water Corporation will ensure that all studies are undertaken in a manner that would enable the EPA to assess the effects of various stages in the proposed development of the AWWTP.

1.2 PROPOSAL PROPONENT

The Water Corporation (ABN 28 003 434 917) is the proponent for the proposal. Contact details for the proponent are:

Water Corporation
PO Box 100
LEEDERVILLE WA 6902

Nominated Contacts:

Project Management – Mr Mike Bluck, Project Manager AWWTP.

Environmental – Mr Andrew Baker, Principal Consultant, Environmental Approvals.

1.3 PROPOSAL BACKGROUND

The Water Corporation is responsible for the collection, treatment and disposal of wastewater from the northern corridor.

In the 1970s the Corporation identified the need for a wastewater treatment plant (WWTP) north of the Beenyup WWTP, to service the planned continued residential growth in Perth's North West Metropolitan Corridor. Currently, projected growth in the Alkimos wastewater catchment indicates that approximately 60ML/d of wastewater will require treatment at the AWWTP by 2040. Ultimately, plant inflows could grow to 140 - 160ML/d.

A major consideration for the Corporation in siting the new wastewater scheme is the pre-eminence placed on providing a gravity system. Such a system avoids the pumping of wastewater to the treatment plant, with the associated high energy demands in perpetuity and the emergency overflow issues associated with failure of the system pumps. Examination of a range of options also indicated that incorporation of an ocean outfall is critical to the secure long-term wastewater planning for the northern corridor.

Following evaluation of options, the Corporation in 1987 acquired Lot 101 (known as Site A in this Scoping Document) from the Urban Land Council. **Figure 1-1** in Appendix A shows the Alkimos Lot 101 WWTP location. That site is currently recognised within the Metropolitan Region Scheme (MRS) as Public Purposes (WSD) Reservation.

Subsequently LandCorp and other interested parties expressed a preference for the AWWTP to be relocated further inland, out of the Alkimos-Eglinton Structure Plan area, in order to accommodate a residential and commercial node on the coast. The Alkimos-Eglinton Liaison Group, chaired by the then Ministry for Planning, concluded that the AWWTP should remain within the Structure Plan area.

LandCorp in June 1998 negotiated with the Corporation an "in-principle agreement" that the proposed AWWTP site be relocated 600 metres (m) to the east of Site A, to a location then known as Site B (now referred to as Site B_{west}), and that the amenity buffer surrounding the WWTP be reduced to 300 m, in order to allow greater urban development between the WWTP and the coast. After further negotiation, the "in-principle agreement" was formalised in June 2001 with a binding agreement.

The odour buffer was subsequently expanded to 600 m to meet new EPA criteria. This led to adoption of Site B_{east}, some 150 m further east. Site B_{east} is hereafter referred to as Site B. The location of Sites A and B are shown on **Figure 1-2** in Appendix A.

It should be noted that no commercial agreement has yet been reached between the Corporation and the developer to relocate to Site B. Should the agreement conditions upon which the move to Site B is predicated not be met, or if environmental approval is not secured, the Corporation proposes to revert to developing Site A.

To give effect within the Metropolitan Region Scheme to the AWWTP Site B location, and other planning changes, the Western Australian Planning Commission has initiated Metropolitan Region Scheme Amendment No. 1029/33. As a matter of perspective, it is noted that the AWWTP terrestrial facilities will disturb an area probably less than 50 ha, compared with the 1,332 ha of residential development and 232 ha of other development land uses within the Alkimos-Eglinton regional area that the AWWTP services (LandCorp 2003).

The Corporation now proposes to construct Stage 1 of the AWWTP along with associated treated wastewater management facilities (i.e. groundwater recharge and ocean outlet). Although growth in wastewater flow in the North West Corridor has been difficult to predict, it is anticipated that AWWTP Stage 1 will service the area for the next 10 - 15 years.

Amplification in capacity will be implemented as required. The full capacity for amplifications forms part of the proposal.

Although not part of this proposal, it is noted that the Corporation will also be developing a water treatment plant (WTP) in the Alkimos area. One option, the co-location of the WTP within the AWWTP buffer has considerable merit. The proposal for the WTP will be subject to separate referral to the EPA as planning progresses.

This scoping document presents the key relevant factors the Corporation considers require evaluation by the Environmental Protection Authority, to assist it in determining the acceptability of the proposed Alkimos WWTP development.

1.4 PROPOSAL TIMING

Precise timing of development of the AWWTP is subject to further definition. However, additional lead-time is necessary for the extensive earthworks at Site B compared to Site A, and therefore progressing planning and environmental approval is critical to meeting growing demand, within the Alkimos catchment, for wastewater management. The Corporation provides the following preliminary timetable (Table 1-1) for the project.

Table 1.1 AWWTP Project timetable Site A and B

EVENT	TIMING
Referral to the EPA	**15 July 2004**
Pre-PER environmental investigations	**continuing to June 2005**
Submission to EPA of draft Scoping Document	**February 2005**
Agreement with EPA of final scope of PER	**March 2005**
Stakeholder Consultation	**ongoing**
Submit draft PER to EPA	**August 2005**
Finalise PER to EPA satisfaction	**October 2005**
PER document released for public comment	**November 2005**
Public comment period	**8 weeks**
Response to public comment	**February 2006**
EPA Report and Recommendations	**May 2006**
Approval by Minister for the Environment	**July 2006**
Finalise construction tender documents	**2006 - 2007**
Commence site civil works	**2007 - 2008**
Commence WWTP and outlet construction (depends on site)	**2008 - 2009**
Commissioning of WWTP and ocean outlet (depends on site)	**2009 - 2010**

Note: Stated dates based on anticipated project schedule for Alkimos WWTP Scheme, as at February 2005.

1.5 STAKEHOLDER CONSULTATION

A stakeholder communication plan has been developed, recognising that the AWWTP is proposed to be sited at a location currently remote from development, but in the path of urbanisation over the next decade. The Corporation is seeking to keep stakeholders informed of its plans and address any concerns and opportunities.

To date most consultation has been with:

- Planning authorities (Department of Planning and Infrastructure);
- Owners seeking to develop the surrounding land (LandCorp and Eglinton Estates);
- City of Wanneroo (officers and elected members); and
- The local Member of the Legislative Assembly, Dianne Guise.

The Corporation has also:

- Actively participated in Department of Planning and Infrastructure planning forums at which regional developers have been present, such as the Alkimos Eglinton District Structure Planning Workshop in August 2004;
- Conducted an information forum for community and environmental groups, to which 46 invitations were circulated, and following which emails were sent offering further presentations and information;
- Developed and distributed a 10-page project overview brochure, including at the above forum; and
- Maintained, on its web site, general information regarding the proposal, the above brochure and the document and maps referring the proposal to the EPA.

To date, most interaction has been with the surrounding land developers, particularly LandCorp. The Corporation has gone to extreme lengths to cooperate with the developers to achieve what the developers perceive as a better planning outcome, including the potential relocation of the AWWTP inland 750m from the site previously identified and purchased by the Corporation.

The Corporation has undertaken conceptual structure planning to establish that the AWWTP is compatible with and contributes to its regional setting. The Corporation has had particular regard to considering opportunities to contribute to regional conservation, recreation, education and amenities in the buffer zone use planning.

As more project and environmental information becomes available during the PER development phase, consultation will be extended to other identified stakeholders, such as the Conservation Council to which an invitation for a briefing has already been extended.

1.6 METROPOLITAN REGION SCHEME AMENDMENT

The Western Australian Planning Commission is pursuing an amendment to the Alkimos-Eglinton Metropolitan Region Scheme (MRS) which has been referred to the EPA under s.48 of the *Environmental Protection Act 1986*. One significant element of the amendment is the relocation of the area designated Public Purposes for the AWWTP (including an odour amenity buffer zone), from the location designated in the current MRS, referred to in this Scoping Document as Site A, to that referred to as Site B (refer to **Figure 1-2**).

A number of environmental issues differentiate Sites A and B for the purpose of WWTP development, and the Corporation believes those matters are best considered by the EPA and the acceptability of their impact be determined, as part of the s.48 MRS amendment proposal, in particular the:

- Extent of excavation necessary at Site B to a level permitting a gravity solution (i.e. gravity inflow and outflow), with the resultant encroachment into the surrounding parabolic dune system and associated ridge vegetation and fauna habitat;
- Necessity to dispose of the approximately 3,000,000 m^3 of spoil excavated from Site B, onto surrounding areas currently supporting native vegetation and providing fauna habitat, some of which is to be zoned for development; and
- Potential exacerbation of the WWTP odour impact resulting from odour ponding in and subsequently flushing from the pit created for the WWTP at Site B, necessitating additional buffer provision and/or emission control at source (which is already intended to be best practice for Australia).

2. PROPOSED ALKIMOS WASTEWATER TREATMENT PLANT

2.1 REQUIREMENT FOR THE ALKIMOS WWTP

The Corporation is required to service development in the North West Corridor under a State Government Cabinet Agreement 1989. The sustainable benefits of well-managed sewerage services are the protection of public water supplies, public health, and the environment.

Alkimos is one of five major wastewater catchments for the Perth metropolitan area. The planned AWWTP catchment boundary (refer to **Figure 1-1** in Appendix A) captures five development zones: Yanchep, Alkimos, Mindarie, Swan Valley and Bullsbrook.

Currently, Alkimos and Mindarie development zones are directed south to Beenyup WWTP, which serves Perth's rapidly developing northern suburbs extending along the coast from Quinns Rock to Scarborough. The capacity of the plant is currently 112.5 ML/day but is expected to eventually reach 150 ML/day.

The Yanchep development zone is served by two WWTPs, one in Two Rocks and the other in Yanchep. The Two Rocks WWTP has a capacity of 132 kL/day and is a packaged plant with extended aeration and infiltration. Yanchep WWTP is a 600 kL/day Intermittent Decant Extended Aeration (IDEA) plant, which infiltrates along the coast. The Yanchep WWTP is expected to reach its capacity in 2010.

There has been unprecedented development growth in the North West Corridor over the past 6 years, and wastewater flows from the catchment have increased at a rate of 7% over the past two years. If the growth in the North West Corridor continues at the current rate, the existing conveyance system will exceed its design capacity within 2 years and the Beenyup WWTP will reach its design capacity within 4 to 6 years. The new Alkimos WWTP and conveyance system is required to overcome this situation. Enhancement of existing conveyance systems to Beenyup WWTP and advancement of expansion at Beenyup WWTP will be necessary in the interim.

The Corporation estimates that the Alkimos development zones will produce a total wastewater flow of approximately 30 ML/d by 2025, 60 ML/d by 2040 and a longer-term flow of 140 to 160 ML/d. This is comparable to the projected long term capacity at Beenyup WWTP (150 ML/d) and the current installed capacity at Woodman Point WWTP (160 ML/d).

These future flows are in excess of the capacity of Beenyup WWTP. Therefore, the Alkimos WWTP will be required to handle these flows, and will be a long-term solution that will be able to service the wastewater catchment well into the future.

2.2 ALKIMOS WWTP SITE SELECTION

2.2.1 Background to Selection of the Alkimos Site

In the 1970s the Corporation identified the need for a wastewater treatment plant, north of the Beenyup WWTP, to service the planned continued residential growth in Perth's North West Corridor.

Currently, projected growth in the Alkimos wastewater catchment indicates that approximately 70ML/d of wastewater will require treatment at the AWWTP by 2040 and, ultimately, plant inflows could grow to 140 – 160 ML/d. This necessitates providing an area large enough to accommodate a plant of that capacity.

The Water Corporation is committed to achieving the target from the State Water Strategy of recycling 20% of treated wastewater by 2012. The broader strategy is to maximising reuse where viable in accordance with the objectives of WASTWATER 2040. In the Alkimos region various options for treated wastewater re-use are technically possible. Such options include tertiary treatment for potable re-use, as well as aquifer storage and recovery; horticulture irrigation and industrial reuse. Provision of an ocean outlet is critical to the secure wastewater planning for the northern corridor especially when in winter when flows are highest, however the Corporation will maximise and undertake any viable opportunities for re-use as they emerge in the future.

Re-use of some of this water, for example in irrigated horticulture, would allow higher quality water to be retained for high value uses, and has the potential to allow for the development of new sources to be postponed. Water re-use may also be used to create a number of environmental benefits, such as providing water for the maintenance of groundwater ecosystems including wetlands and caves.

One of the key opportunities for water re-use in Western Australia is through managed aquifer recharge (MAR). This is the infiltration or injection of water into a groundwater aquifer. Such projects may be proposed for a range of reasons including improvements in the recharge water quality, environmental benefits and as a means of water storage.

Following evaluation of several different siting options, the Corporation selected Alkimos Lot 101 (known in this Scoping Document as Site A) as the preferred site for this WWTP, and in 1987 finalised acquisition of the site from the Urban Land Council. **Figure 1-1** in Appendix A shows the location of the Alkimos Lot 101.

One of the primary drivers for selection of the location of Alkimos Lot 101 as the site for the WWTP was to employ the natural level of the land to achieve gravity flow into the treatment plant from its catchment and out of the treatment plant to the ocean. A gravity system minimises energy needs (equivalent of supplying power for up to 3000 households if pumping were required), and therefore minimises greenhouse gas emissions and operating costs. A gravity system also minimises septicity and odours. In addition, a gravity system is the least likely to result in overflows as it is immune to power failures and pressure main bursts. In the case even of a lengthy power failure and the WWTP operating in a passive mode, the gravity system would still achieve at least primary treatment of wastewater being discharged.

Another important driver for the selection of the Alkimos Lot 101 site was that it provided the best available site for the construction of the ocean outlet. The coastline of the North West Corridor is particularly difficult to locate an ocean outlet. To successfully launch, lay and operate an outlet pipe in an acceptable manner requires:

- A suitable launching site;
- An acceptably graded sea bed;
- Minimal rocky areas;
- Minimal environmentally sensitive habitat; and
- An outlet route that terminates at a distance and depth that provides the desired environmental outcomes, such as flushing.

A third attribute of siting the WWTP at Lot 101 was the extensive separation it provided between the plant and potentially sensitive land uses (e.g. residences) that would eventually develop beyond the Lot boundary.

In recent years there has been increasing pressure from LandCorp and other interested parties for the WWTP to be relocated further inland. The main argument advanced has been that the coastal Lot 101, owned by the Corporation for the WWTP, would be more suited to urban development.

Consequently in 1996/97 LandCorp proposed to relocate the site for the AWWTP out of the Alkimos-Eglinton Structure Plan area, to instead accommodate residential development and a commercial node on the coast. The resolution of issues within the Structure Plan area was facilitated by the Alkimos-Eglinton Liaison Group, chaired by the then Ministry for Planning. This Group's conclusion was that the AWWTP should continue to be located within the Structure Plan area.

LandCorp in June 1998 negotiated with the Corporation an "in-principle agreement" that the proposed AWWTP site be relocated 600 metres to the east of Site A, to a location known as Site B, and that the amenity buffer surrounding the WWTP be reduced to 300 m, in order to allow greater urban development between the WWTP and the coast.

Having identified the merit of Site A as a WWTP site prior to its acquisition, the Corporation agreement to relocate was made conditional upon the considerable additional costs arising from the WWTP relocation and increased odour control (due to the smaller buffer) being funded by the land developers benefiting from the relocation of the WWTP site.

After further negotiation, the "in principle agreement" was formalised on 29 June 2001 with the signing by the Water Corporation, LandCorp and Eglinton Estates (the principal landowners within the structure plan area) of the Alkimos-Eglinton Relocation, Construction and Development Agreement. This agreement identified the alternative site as acceptable to all parties at the time of signing, and is binding on the parties. Subsequent to the settlement of the agreement, a number of issues have resulted in the parties considering further options. These include:

1. Revision of the EPA's odour management criteria (necessitating a larger buffer size than anticipated, 600 m in lieu of 300 m), requiring that previous planning work be reviewed and revised;
2. The Alkimos-Eglinton Metropolitan Region Scheme (MRS) plan amendment was publicly advertised on 26 September 2003. The location of the future AWWTP is a significant element of that amendment; and
3. Consideration of several other possible sites for the best development planning outcome, including consideration of buffer size.

As a consequence of the requirement to provide a larger odour amenity buffer and the desire to still accommodate an urban coastal node to the west, the AWWTP location being investigated as Site B was slipped east approximately a further 150 m. To differentiate, the earlier site is referred to as Site B_{west} and the current site as Site B_{east} or, for convenience, Site B. It is Site B_{east} that has been proposed in the MRS Amendment No. 1029/33. The notional locations of Sites A and B are shown on **Figure 1-2** in Appendix A.

2.2.2 Site Selection Principles

The Corporation maintains that whether the AWWTP is finally located at Site B or at Site A, the following site selection principles apply:

1. A gravity solution (i.e. gravity inflow and outflow at the WWTP), thereby minimizing energy consumption from pumping, and maximizing confidence in "fail-safe" treatment and disposal when the collection and treatment system experiences power failure;
2. Provision of secure routes for main sewers and tunnel portal locations;
3. Protecting as far as practicable the local flora associations, fauna habitat and identified conservation values;
4. Protecting as far as practicable the unique landforms and geoheritage values of the area;
5. Maximising the opportunities for alternate disposal/re-use of treated wastewater;
6. Implementation of the project in a staged manner commensurate with the service demands of development in the area;
7. Provision of an ocean outlet for disposal of surplus treated wastewater and as a fail-safe in the event of power loss to the treatment plant. The ocean outlet will also be necessary to provide a final disposal option for reject water from any possible future re-use options;
8. Provision of a secure route for the onshore ocean outfall pipeline;
9. Optimising odour emission control on all major WWTP process units such that no unacceptable impact occurs to surrounding odour sensitive land uses;
10. Provision of a sustainable buffer zone separating the WWTP from sensitive land uses and encompassing appropriate compatible land uses, secured by land purchase and compatible land zonings;
11. Land developers covering the full costs if the WWTP development is to be relocated from Site A to Site B; and
12. Social acceptability and regulatory approval for the preferred solution.

2.2.3 Gravity Solution

It is emphasised that a fundamental consideration for the Corporation in siting the new wastewater plant remains the pre-eminence placed on providing a gravity system. Such a system avoids the pumping of wastewater with the associated high energy demands in perpetuity and the emergency overflow issues associated with failure of the main-sewer system pumps. Specifically:

1. Raw wastewater is planned to be delivered to the WWTP by a system of gravity main sewers flowing from the north (Yanchep Main Sewer) and from the south (Quinns Main Sewer);
2. Sufficient hydraulic gradient will be achieved to allow all wastewater to flow through the WWTP under all conditions. During power failures under gravity flows the wastewater passing through the WWTP will continue to receive basic secondary treatment for up to 24 hours and thereafter at least primary treatment;
3. Treated wastewater not required for re-use, would flow by gravity to the ocean via an ocean outlet, thus significantly reducing the likelihood of overflows in the upstream system;
4. Significant greenhouse gas efficiency in the overall scheme; and
5. Reduced risk of failure (with the resultant spills) in the overall scheme due to failure of pressure mains, electrical faults and pump failures.

An aspect of developing the AWWTP that has become better defined as project planning has progressed is the extensive excavation necessary during site preparation of Site B in order to achieve the gravity solution. In order to develop a WWTP fulfilling the Corporation's site selection principles, it will be necessary to excavate Site B to a level of around 10 m AHD, thereby encroaching into the fringing dune structure and creating within the surrounding landform, a major pit approximately 3,000,000 m^3 in volume. Investigations are continuing to determine the likely nature of the material that would have to be excavated and options for its disposal. Further, excavation at Site B will delay commencement of WWTP construction and

commissioning by around one year compared to the schedule achievable at Site A. A further issue currently being investigated is the implication on the dispersion of odour, under 'ponding' conditions, of siting the AWWTP in a pit.

Based on assessment to date, the Corporation considers that consistent with the Alkimos-Eglinton Relocation, Construction and Development Agreement Site B (the site subject to the MRS amendment process and agreement with the land developers) can be made to fulfil the principles, albeit with probable additional constraints due to greater construction and operational complexity, that must be offset with a substantial financial contribution by the land developers benefiting from the re-siting and Site A (the original site, as per the existing MRS) best fulfils its site selection principles. Thus Site A remains included as one of the options in the Water Corporation's proposal, to be developed should technical, financial and/or environmental constraints at Site B prove prohibitive for development on that site.

2.3 WASTEWATER TREATMENT PLANT TYPE AND STAGING

The level wastewater treatment and the method of treated wastewater management is determined having regard to public health, environmental and economic criteria (economic – as the Corporation has an obligation to provide wastewater treatment, at a financial cost the community can afford).

To position the Corporation for future reuse opportunities, it is proposed to base treatment at Alkimos on the "activated sludge" process. This will be an advanced secondary treatment process similar to that recently constructed at Woodman Point. The Corporation presently achieves a high degree of nitrogen removal using this process.

It should be noted that energy recovery is also an important factor in the long-term development of the AWWTP. This generally requires a primary treatment step in the process train to recover 'raw sludge' for anaerobic digestion and recovery of biogas. This in turn removes some of the carbon source that enables full denitrification to occur in the secondary process. Based on current treatment processes, staging of the AWWTP and expected nitrogen output is summarised in **Table 2-1**.

The AWWTP is proposed to be developed on one of two sites, either:

- Site A – (Lot 101) purchased by the Water Corporation for this purpose in 1987 and as zoned for this use in the current Metropolitan Region Scheme (MRS); or
- Site B – the site subject to the Alkimos-Eglinton Relocation, Construction and Development Agreement currently the proposed within the Modified MRS Amendment 1029/33 of December 2004.

As previously described, development of the AWWTP will be staged in modules, ahead of demand forecast to be placed upon it. An indicative schedule of plant capacity is provided in **Table 2-1**. The ultimate plant capacity incorporates the following processes and conceptual locations illustrated for Site B in **Figure 2-1**, although it must be recognised that wastewater treatment technology and potentially the site layout are likely to evolve over the life of this facility as it develops:

- Sewer inlet, screening and grit removal tanks at the eastern end of the site;
- Primary sedimentation tanks;
- Sequencing batch reactors;
- Sludge thickening;
- Sludge digesters, with a gas recovery and combustion building;
- Digested sludge storage tanks;

- A sludge dewatering building, wherein sludge is dewatered using centrifuges (as at the Subiaco, Beenyup and Woodman Point treatment plants);
- Treated water balancing lagoons;
- Infiltration pond(s);
- Outlet flume, in the west of the site.
- Provision for a water reclamation plant;
- Provision for a product-water tank(s); and
- Odour control extraction and scrubbing plant, with discharge vent stack;

All odorous processes will be enclosed to contain odorous gas. Gas will be scrubbed before discharge to atmosphere through a vent stack, expected to be above 50m in height.

Beyond the immediate WWTP boundary, the Corporation will establish and maintain:

- On-shore ocean outlet pipeline, extending from the WWTP outlet flume to the ocean outlet launching site (refer to **Figure 2-2**);
- Ocean outlet assembly area and launching site (refer to **Figure 2-2**);
- Ocean outlet pipeline(s) (refer to **Figure 2-2**);
- Treated wastewater recharge infiltration ponds and pressure mains (refer to **Figure 2-3**); and
- An odour amenity protection buffer of size sufficient to protect odour sensitive land-uses beyond its boundary (refer to **Figure 1-2**).

Main sewer development does not constitute an element of the proposal referred to the EPA and will be managed in the same manner as currently employed to service the expanding urban front.

Table 2.1 Notional AWWTP Development Stages

<table>
<tr><th rowspan="2">Notional Project Stage</th><th rowspan="2">Indicative Timing</th><th rowspan="2">Installed Capacity (ML/d of inflow)</th><th colspan="2">Treated wastewater Total N</th><th rowspan="2">Additional treatment to reclaim water for reuse</th></tr>
<tr><th>with energy recovery</th><th>without energy recovery</th></tr>
<tr><td>1</td><td>2009</td><td>10</td><td rowspan="3">Not applicable due to scale.</td><td rowspan="5"><10 mg/L (annual mean).</td><td rowspan="5">Phosphorous reduction and disinfection to suit disposal/reuse application.</td></tr>
<tr><td>2</td><td>2020</td><td>20</td></tr>
<tr><td>3</td><td>2030</td><td>40</td></tr>
<tr><td>4</td><td>2040</td><td>60</td><td>May not be applicable due to scale.</td></tr>
<tr><td>5</td><td>2050</td><td>80</td><td rowspan="2">15-20 mg/L (annual mean).</td></tr>
<tr><td>6</td><td>Long term</td><td>160</td></tr>
</table>

Both Sites A and B enable the fundamental design requirement to maximize the gravity solution for the wastewater conveyancing and treatment system, however each presents site specific constraints such as - possible environmental, health and social impacts, technical viability and timing for delivery of services in the face of increasing demand in the northern corridor. These are identified below, and form the key *Relevant Factors* to be addressed in the PER to be prepared for the EPA. Subsequent chapters present a summary of the current state of knowledge regarding the key *Relevant Factors*, and the further studies the Corporation intends to undertake to elucidate the issues, environmental risk and mitigation strategies.

2.4 KEY RELEVANT ENVIRONMENTAL FACTORS

The Corporation, having considered the EPA's *'Guide to EIA Environmental Principles, Factors and Objectives'* believes that the following environmental factors are relevant to the EPA's assessment of the AWWTP and are therefore proposed be addressed in the PER.

Table 2.2 Summary Table of Environmental Factors Relevant to Assessment of the AWWTP Project Proposal

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Principles of Environmental Protection						
Precaution Equity Conservation Valuation and Waste minimisation	Lot 101, within Sites A and B, the outlet launching area and the associated buffer areas	The Water Corporation is charged with providing an efficient, effective and safe, centralised wastewater treatment facility in order to eliminate the requirement for individual urban household disposal systems, with their attendant adverse impacts on the environment and public health. The accepted social value of this function is reflected in the mandate placed upon the Corporation to provide the wastewater collection, treatment and disposal service. The Water Corporation, in planning and implementing the proposed wastewater treatment strategy, will adopt the principles of environmental protection enunciated in section 4A of the *Environmental Protection Act 1986* and expanded upon in EPA Position Statement No. 7	Flora and fauna impacts, odour, energy use and associated greenhouse gas implications, disturbance of geo-heritage values, security (fail safe) and efficiency of the system, impacts to the groundwater and marine environment.	To assess the viability or preferred option of the AWWTP in terms of environmental acceptability of the proposed treated wastewater recharge within the AWWTP buffer or the use of the proposed ocean outlet. A number of studies have been completed or will be completed. These studies include: • Flora/Vegetation; • Stygofauna; • Infiltration study; • Suite of marine studies; • Odour mitigation studies; • Geotechnical studies; • Aboriginal heritage studies; and • Review of geo-heritage issues as they apply to landform and flora and fauna.	Providing a gravity solution, to minimise energy use (and GHG emissions) and environmental impacts from system failures; Conservation of flora, fauna and geo-heritage values to the maximum extent possible; Explore the prospects for medium and long-term options for water reclamation and re-use beyond the groundwater recharge and ocean discharge proposed as part of this project; Establish an ocean outlet as an element of the treatment system to handle treated wastewater disposal and re-use concentrate into the future; Applying best practice design principles to treatment technologies to minimise odour impacts and establish a buffer zone surrounding the AWWTP; and Identifying uses for the bio-solids produced at the AWWTP.	The principles of environmental protection underlie the Corporation's approach to fulfilling its obligation to provide the proposed wastewater treatment service at the AWWTP. The principles are particularly relevant to explaining the selection of waste treatment technology, location and rationale for certain project elements, such as the merit of treated wastewater recharge to groundwater and the necessity for an ocean outlet. The Water Corporation will take cognisance of the principles in the assessment of all relevant environmental factors.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Biophysical						
Flora and Vegetation (terrestrial)	Lot 101, within Sites A and B, the outlet launching area and the associated buffer areas	The Water Corporation seeks to maintain the abundance, diversity, geographic distribution and productivity of flora and vegetation communities at species and ecosystem levels, through the avoidance or management of adverse impacts and improvement in knowledge. In particular, the Corporation recognises the opportunity for and intends to identify, investigate the values of and propose a strategy to conserve the flora values of the AWWTP buffer zone and linkages to surrounding areas.	Development of the AWWTP at Site A or B, with the associated recharge ponds, ocean outlet launch facility and connecting terrestrial pipelines and roads will necessitate disturbing in perpetuity up to approximately 47 ha of land across the Quindalup and Spearwood geomorphic land units (Roberts Day 2004). These geomorphic units provide flora habitat documented as supporting significant species and communities in the region (ATA Environmental 2003; Weston 2004).	The Corporation has engaged Syrinx Environmental, collaborating with Dr Arthur Weston, to conduct a flora and vegetation survey of the AWWTP sites; Their associated odour buffer zonse and the proposed spoil locations. Due to the recent bush fire in the region identifying plant species can be difficult, Arthur Weston may have identified a possible Declared Rare Flora (DRF) and threatened Ecological Communities (FCT26a). Arthur Weston will conduct additional surveys to positively identify and confirm any DRF and threatened Ecological Communities (FCT26a) which will be presented in his final report ready for the PER.	The Corporation will endeavour to manage its land to minimise the necessary project impact on flora and vegetation and maximise the conservation and ecological linkage opportunities. The Corporation will integrate conservation values into its management planning for buffer zone land it will control.	Conservation of flora and vegetation values and habitat and geo-heritage linkages are considered a key Relevant Environmental Factors for assessment in the PER.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Fauna (terrestrial)	Lot 101, within Sites A and B, the outlet launching area and the associated buffer areas.	The Water Corporation seeks to maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. In particular, the Corporation recognises the opportunity for and intends to identify, investigate the values of and propose a strategy to conserve the fauna habitat values of the AWWTP buffer zone and linkages to surrounding areas.	Development of the AWWTP at Site A or B, associated odour buffer zone, spoil locations with the associated infiltration ponds, ocean outlet launch facility and connecting terrestrial pipelines and roads will necessitate disturbing in perpetuity up to approximately 47 ha of land across the Quindalup and Spearwood geomorphic land units (Roberts Day 2004). These geomorphic units provide fauna habitat documented as potentially supporting significant species and communities in the region (ATA Environmental 2003; Thompson 2004).	Bamford Consulting Ecologists, have been engaged to investigate and advise the Corporation on the terrestrial fauna values and fauna impact issues related to the proposal. A site inspection, literature review and desktop survey has been conducted. Bamford's final report and associated maps will be available in the PER.	The Corporation recognises the potential to minimise the necessary project impact on fauna and habitat, and to contribute to regional protection of fauna through its management planning for buffer zone land it will control. The Corporation is currently investigating potential conservation flora and fauna linkages along the northern ridge of the dune system and possibly along the fore dunes if Site A is the chosen location for the WWTP. The Corporation is also proposing to conserve bush areas of banksia woodland and the Dryandra sessilis thickets that are known to be feeding grounds for Carnaby's Cockatoo, a protected fauna species.	Conservation of fauna habitat and their linkages to geo-heritage values are considered a key Relevant Environmental Factor for assessment in the PER.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Geophysical						
Geo-heritage	The coastal dune formations within Lot 101, Sites A and B, the outlet launching area and the associated buffer areas	The Water Corporation seeks to maintain the integrity, ecological functions and environmental values of the landform, in particular the Alkimos coastal dune formations.	The coastal dune formations in the Alkimos area have been identified as having national and world geo-heritage significance (Semeniuk 2004) such that it was recommended by the Geological Society of Western Australia (with support from the Geological Sites Committee and the CSIRO) that the Alkimos Dune System be nominated as a Geological Monument, reserved as open space and that future use of the land should not involve activities that will disturb the land surface (Lemmon, Gee, Morgan and Elkington, 1979). The WWTP at Site A or B, the ocean outlet assembly and launch facility, infiltration ponds, site excavation spoil disposal, and the associated infrastructure have the potential to adversely impact on the dune system landform. The AWWTP odour amenity buffer encompasses a substantial area of dunes, presenting the opportunity through informed and sensitive land use planning to provide for partial preservation of the Alkimos dune system. The Corporation will seek to maximise the preservation of dune landform geo-heritage values, by the appropriate siting and construction of AWWTP.	Semeniuk V & C, Research Group (2004). Assessment of the Alkimos coastal area: Stage 1 – the onshore areas, August 2004. Report to Syrinx Environmental P/L for the Water Corporation, 25 August 2004. Semeniuk V & C, Research Group (2004). A description of the coastal and marine zones of the Alkimos area, October 2004. Report to Syrinx Environmental P/L for the Water Corporation, October 2004. No further studies are planned.	The Corporation will consult with the EPA and other parties as to the significance placed upon protection of the Alkimos coastal dune system and how best to harmonise the AWWTP development into the landform so as to protect geo-heritage values to the greatest extent practical. The Corporation is well advanced with regional and buffer zone development concept plans, having regard to the dune structure and opportunities to incorporate its protection into the buffer land-use development plan. Reflecting the integrated nature of geo-heritage being more than just the underlying landform, the Corporation is having regard to protection of the flora, vegetation and fauna associated with the Alkimos dune systems.	The conservation of the geo-heritage coastal dune formations (either in part or in total) is considered a key Relevant Environmental Factor for assessment in the PER.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Marine Environment						
Marine Impact Zone	Area surrounding the proposed ocean outlet and near shore TWW groundwater infiltration into the marine environment.	Using the hydrodynamic modelling, ecological data and scientific knowledge about cause and effect pathways to make informed predictions about the potential ecological consequences of the proposed ocean discharge of TWW (both from proposed outlet and groundwater discharge to the near shore) to underpin development of an EQMF, predict ecological impacts and delineate zones of ecological protection.	Elevated nutrients and hence increased productivity of the benthic habitat, algae and phytoplankton within the vicinity of the affected areas. Possible loss of marine habitat due to the construction of the ocean outlet depending upon option taken (i.e. tunnelling). Adverse impact on water quality and the long term “health” of benthic habitats. Possible breaches in the social values identified for the coastal waters in the Alkimos region.	No additional investigations besides those already proposed in this scoping document (including the hydrodynamic modelling, benthic habitat mapping and infauna survey, sediment survey, water quality characterisation and phytoplankton surveys).	The synthesis of the technical studies, to provide a coherent conceptual model of the relationships between the observed physical processes (wind, waves, currents, temperature), the physical environment (bathymetry and seabed characteristics) and the ecological characteristics (benthic habitat, water quality, marine flora and fauna) in the Alkimos Region is key to this proposal. This information, in conjunction with the existing information on the impacts of the discharge of treated wastewater on the coastal environment from studies undertaken as part of the Perth Coastal Waters Study (PCWS), the Perth Long-Term Ocean Outlet Monitoring (PLOOM) Programme and the Bunbury Ocean Outfall Monitoring Programme, will be used to enable informed predictions to be made about the potential consequences of the proposed ocean discharge of treated wastewater on the ecological (ecosystem health including water quality and the long-term 'health' of benthic habitat) and social values identified for the coastal waters in the Alkimos region and hence delineation of Zones of Low and High ecological Protection.	Understanding, management and monitoring of the marine environment and delineation of marine impact zones are considered key Relevant Environmental Factors for assessment in the PER

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Marine Environment						
Marine Ecosystem (Phytoplankton)	Marine survey area	To maintain the abundance, diversity, geographic distribution and productivity of through the avoidance or management of adverse impacts and improvement in knowledge. To collect data to underpin predictions about the ecological responses to TWW discharge, as well as the informing development of an appropriate monitoring and management programme consistent with the EQMF. To ensure phytoplankton survey methods are consistent with those in the Manual of Standard Operating Procedures (SOP) that supports the SEP for Cockburn Sound (EPA Report 21, Jan 2005). To clarify how results of the phytoplankton surveys, including data interpretation, would inform evaluation of the environmental quality consequences of the proposed ocean discharge of TWW.	Nutrients discharged by the AWWTP marine outlet may potentially produce changes in the phytoplankton species composition and abundance, which may in turn have implications for the marine food chain. Whilst this is not considered by the Corporation to be a likely significant impact, based upon operational experience at other outlets, the Corporation accepts that demonstration of such is necessary. If there were to be any environmental quality consequences from the proposed ocean discharge of TWW, the results of the phytoplankton survey, combined with the Coastal Water Study and PLOOM program would provide extensive data to provide information any environmental consequences	Oceanica Consulting has been appointed to perform a phytoplankton survey to a scope of work specified in their report 427/6 of December 2004, which has been provided to the EPA with the original scoping document. No further studies are needed as Oceanica will be completing the field sampling and the lab analysis will be conducted by Dalcon Environment. Both scopes are consistent with SOP that supports the SEP for Cockburn Sound (EPA Report 21, Jan 2005).	The Corporation will develop an 'Environmental Quality Management Framework' for the Alkimos WWTP Ocean Outlet and TWW ground water discharge from the infiltration ponds into the marine environment. With both options data on phytoplankton species composition and abundance will be used to: 1)Determine if there are differences between sites that may be attributable to the effects of the treated wastewater discharge; and 2) Determine if potentially harmful phytoplankton species are present in the marine receiving environment at concentrations which exceed the Western Australian Shellfish Quality Assurance Program (WASQAP) Guidelines.	No problems are foreseen associated with phytoplankton (such as toxic blooms, species diversity, abundance) due to ocean discharge or infiltration of TWW. Sampling, analysis and interpretation will quickly detect any emerging issues and management control processes will be quickly implemented to resolve the issue. The management will be in accordance with 1) Manual of Standard Operating Procedures (SOP) 2) An approved monitoring and management programme consistent with EQMF 3) Coastal Water Study and PLOOM program 4) 'Environmental Quality Management Framework' Management and monitoring of the marine environment are considered key Relevant Environmental Factors for assessment in the PER

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Marine Studies						
Hydrodynamic modelling	Ocean Outfall and marine environment	1) To provide concept design that meets environmental requirements i.e. Protects Environmental Values (EV's) and Environmental Quality Objectives EQO's) that have been set for the area in the vicinity of the proposed WWTP. 2) To emphasise that flushing time alone is not adequate to met the EPA's assessment of environmental acceptability. 3) To ensure that modelled statistical outputs will be compatible with the environmental quality guidelines. 4) To predict transport of conservative and non-conservative tracers in the environment through hydrodynamic modelling. 5) To provide adequate data to represent near surface currents. 6) To predict the maximum extent of a zone required to achieve the number of dilutions required to meet 99% species protection EQG. 7) To provide justification for selecting the median exceedance contours for 500 and 1000 fold dilution. 8) To provide rigorous justification for the selected bacterial die-off rate as it will strongly influence the	Lack of rigour in the input into the hydrodynamic modelling resulting in incorrect predictions resulting in ecological, toxological and human health issues within the near and off-shore marine environment.	1). Hydrodynamic modelling to examine different diffuser designs to see whether (EV's) and EQO's) have been met. 2) Hydrodynamic flushing studies will assist in the interpretation of ecological, toxicological and human health criteria, to meet the EPA draft guidelines. 3) Establish the boundaries at which ecological, toxological and human health criteria will be met based on current EPA draft guidelines. 4) Hydrodynamic modelling using the near field model (CORMIX Model) and the far field model (EFDC Model) have the capability to predict the transport of conservative and non conservative tracers in the environment. 5) Two new current meters will be deployed at 2 sites to record near bottom currents: one at a depth of 1-3m above the sea bed and one near the surface 3m below the surface. . One of the meters will be deployed south of the proposed outlet, offshore from Eglington Rocks and the other at the seaward end of the proposed outlet. Both will be deployed in late Autumn to Winter. 6) Hydrodynamic modelling will aim to predict the maximum extent of a zone required to achieve the number of dilutions to meet the 99% species protection.	Hydrodynamic modelling will meet environmental requirements (EV's and EQO'S) and be compatible with the quality environmental guidelines. All additional investigations will be reported on and referenced within the PER The ecological data that has been examined for the Perth Coastal Water Study, the Beenyup WWTP project and the proposed Alkimos projectwill be addressed in the PER for ecological consideration. The current meters will provide sufficient data for the hydrodynamic modelling.	Understanding and monitoring of the marine hydrodynamic environment are considered fundamental to all other marine studies and are thus key Relevant Environmental Factors for assessment in the PER

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Hydrodynamic modelling	Ocean Outfall and marine environment	outcome of the bacterial dispersion model. 9) To describe how the Corporation will model the buoyant water influx and any cumulative effects. 10) To address the potential for ecological interaction between the Beenyup outlets and the proposed Alkimos outlet. 11) To refer to contemporary data for background concentrations of toxicants in seawater of Perth.		7) Hydrodynamic modelling will be used to assess the approximate distance over which dissolved inorganic nitrogen is reduced to background levels. 8) A comprehensive literature review will be conducted because the dispersion and dilution are too great in the natural environment to enable it to be done empirically. 9) Hydrodynamic modelling will address buoyant water influx and any cumulative effects. 10) Existing data from Technical Series 117, Perth Coastal Water Study, the Beenyup WWTP project and the proposed Alkimos project will be examined to consider ecological interactions.		

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Marine Studies						
Marine benthic habitat survey, bathymetric survey and the ocean outlet pipe	Marine Survey Area, Ocean Outlet Pipe including the associated dune and beach excavation	The objectives of the Benthic Habitat Mapping component and the bathymetric survey of the Alkimos marines studies are to: 1) Determine the distribution of seagrasses, reef, and bare sand in the area surrounding the proposed outlet; 2)Record the nature, abundance and distribution of flora and fauna associated within these habitats; 3) Preliminary assessment of the feasibility and impact of alternative outlet pipeline routes and construction methods. It will also be used in developing the outlet dispersion modelling. To maintain the integrity, ecological functions and environmental values of the seabed and the marine habitat. To spatially define an appropriate management unit(s) of the order of 50km^2. To provide estimations of the cumulative direct and indirect losses of each Benthic Primary Producer Habitat (BPPH) type that have occurred since European settlement due to historical human activities and the additional loss due to this proposal within the management unit. To identify and spatially	If the outlet pipeline is established by conventional construction methods, the outlet pipeline will necessitate some disturbance and, potentially, temporary or permanent modification of the benthic habitat, as a result of: 1) Excavation and burial across the beach and dune, with subsequent rehabilitation, ; 2) Excavation to an adequate depth and burial across the surf zone, so that the pipeline does not interfere with coastal processes; and 3) Potential for underwater blasting, if reef needed to be trenched. 4) Potential for underwater drilling beneath the seabed to reduce disturbance to the benthic habit.	Oceanica Consulting has been appointed to perform benthic habitat mapping to a scope of work specified in their report 427/7 of January 2005, which will be provided to the EPA with this scoping document. The final report will be available in the PER. A bathymetric survey shall be conducted during autumn 2005. Appoint a reputable marine consultant to complete a scope of work to carry out sediment quality sampling and analyses consistent with the SOP Manual and detection limits for all analytes including silver that will be sufficiently low to enable data to be compared to ANZECC/ARMCANZ (2000) guideline values. This report will be presented in the PER. Appoint a reputable marine consultant to prepare a draft scope of works to sample shoreline sediments, where the groundwater discharges into the marine environment. This will be done in a two stage approach, firstly involving the identification of the area where the groundwater is likely to discharge, and secondly, once the discharge area has been identified, to undertake a survey which will involve collection of samples at appropriate sites (as per the DoE SOP Manual and as per the Offshore Sediment Survey Scope) and then analysis	Blasting is not the preferred construction technique and the contractor will be discouraged from using blasting, which will be used only as a last resort. If blasting is necessary, an underwater blasting procedure will be developed to the requirements of the EPA and CALM such that any impacts on marine biota are minimised. Blasting activities would be monitored by CALM. Which ever the construction method chosen by the Water Corporation the management of construction activities will be detailed in a construction EMP. The management of the proposed benthic habitat mapping studies will spatially define an appropriate management unit(s) of the order of 50km^2, however according to Oceanica the 50 km^2 size is irrelevant as the management unit versus disturbed area of the pipeline footprint is small i.e. disturbance of a very small part of the 50km^2 will occur. The PER will provide calculations of the cumulative losses of each BPPH type that have occurred since European settlement due to historical human activities and the additional loss due to this proposal within the management unit in accordance	The Water Corporation will justify its preferred methods for pipeline installation in the PER after it has considered all options to avoid and minimise loss of benthic habitat. If the Corporation decides to construct and utilise an ocean outlet the EPA can be reassured that this decision has arisen through a lengthy and detailed investigation of options based on a hierarchical risk based approach which has reuse as the preferred option. .Marine benthic habitat and bathymetric surveying relating to the construction and operation of the ocean outlet pipe are considered key Relevant Environmental Factors for assessment in the PER

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Marine benthic habitat survey, bathymetric survey and the ocean outlet pipe	Marine Survey Area, Ocean Outlet Pipe including the associated dune and beach excavation	define the extent of benthic habitats within a zone likely to be influenced by the proposed outfall. To provide benthic habitat data to inform predictions about likely ecological consequences of TWW discharge. To undertake sediment quality sampling and analyses which will be consistent with the SOP Manual with detection limits for all analytes sufficiently low to enable data to be compared against the ANZECC/ARMCANZ (2000) guideline values. To take sediment samples in the marine environment near the shoreline to inform impact prediction.		of sediment samples for contaminants. This report will also be presented in the PER.	with the Environmental Protection Act 1986 under the Guidance for the Assessment of Environmental Factors No. 29.	
Sediment Survey	Shore line, Near shore line and offshore line	To characterise the sediments (grain size, nutrients, total organic carbon, organic matter and carbonate) and measure the concentrations of metals, pesticides and herbicides at sites in the vicinity of the proposed Ocean Outlet.	Data will be used to assist with the assessment of the potential effects of the treated wastewater discharge on the marine environment once the AWWTP ocean Outlet is operational.	Development of an appropriate monitoring program.	The Environmental Quality Management Framework for the Alkimos WWTP Ocean Outlet.	Understanding, management and monitoring of the marine environment are considered key Relevant Environmental Factors for assessment in the PER

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Marine Studies						
Water Quality (Marine)	Marine Ocean Outlet Dispersion Zone and surrounding marine environment including TWW leaching into the marine environment from infiltration ponds.	To undertake regular field measurements to characterise the water quality of the marine waters around the proposed WWTP Ocean Outlet. It is recognised that the ANZECC/ARMCANZ (2000) 99% species protection guideline values need to be applied throughout the high protection zone. To identify that currently all social EV's are protected and a high level of protection is afforded to ecosystem health in the vicinity of the outfall. To provide data to underpin interpretation of the ecological consequences of the proposal in the context of the EV's (and social EV's) and EQO's which have been established by the EPA . To provide quantitative data that will assist in the development of an EQMF for the outfall, including informing the development of environmental quality criteria for the area. To analyse spatial variation in water quality data including a longshore component. To include information about how modelling and baseline surveys will inform	Establishment of a treated wastewater ocean outlet is an essential element of the AWWTP, although the regularity, frequency and volume of use will be dependent upon the terrestrial water recycling options employed in the short, medium and long-term. It is also proposed that treated wastewater be infiltrated into terrestrial basins adjacent to the AWWTP, seeping into the underlying groundwater. The groundwater bearing infiltrate will subsequently discharge into the marine environment. The discharge to the marine environment of treated wastewater, whether directly from the outlet diffuser or via groundwater infiltration, will change marine water quality within the respective mixing zones, with the potential to impact on marine biota, the ecosystem and suitability of the marine waters for human use.	Besides the ongoing monitoring of water quality at Alkimos the Water Corporation believes that the potential environmental impacts at Alkimos can also be readily assessed and compared with the considerable body of research undertaken at existing WWTP and outlets. The combination of these two approaches should provide more than ample data to be able to assess the effect of treated waste water on water quality around the proposed AWWTP Ocean Outlet. The relationships, comparisons and inferences made to the Bunbury WWTP will be addressed with consideration to the difference in relative discharge quantities. Water quality studies to characterise water quality for other periods of the year other than summer will be conducted (i.e. winter). Calculation of the spatial extent of low, medium and high protection zones via modelling plumes, water quality tests and benthic surveys.	Comparison of the water quality parameters with the appropriate ANZECC/ARMCANZ (2000) Guidelines for fresh and Marine Water Quality and the Revised Environmental Quality Criteria Reference Document (Cockburn Sound), Environmental Protection Authority 2004) Ensure the development of an EQMF utilising quantitative data to underpin the development of a draft Environmental Quality Criteria (EQC) for waters adjacent to the proposed Alkimos Ocean Outlet. Identify the environmental values that are to be protected in the waters inshore and offshore of the WWTP and the spatial designation of the environmental values i.e. low, medium and high protection zones, which will be used to underpin the interpretation of the ecological consequences of the proposal.	Understanding, management and monitoring of the marine water quality are considered key Relevant Environmental Factors for assessment in the PER

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
		identification of reference and potential impact sites.				
Hydrology						
Water quality (ground)	Infiltration Ponds located within the immediate environs to the west of Sites A and B; Intersection with unconfined aquifers, water courses etc.	To maintain the quality of the groundwater so that existing and potential health (P3 PDWSA) and environmental values, including ecosystem function of the near-shore marine environment are protected.	The Corporation proposes to initially infiltrate the treated wastewater in swales in the dunes adjacent to the proposed site, (refer to Figure 2-3). The ponds will generally be sited at lower locations across the site, approximately 500m from the ocean. As far as practical, they will be spread in a north-south direction to minimise groundwater mounding. Infiltrated treated wastewater (TWW) may be transported to the marine environment, particularly given karstic nature of the hydrology beneath the proposed site giving rise to potential cumulative effects of discharging in the marine environment. The Corporation is aware of potential bacterial concentrations of TWW that may be released into the marine environment. There is the possibility of potential cumulative ecological consequences of discharging TWW to the marine environment via groundwater discharge. .	Hydrological investigations at the proposed Alkimos WWTP site were conducted by Rockwater Pty Ltd. The report investigated and reported to the Corporation on the potential for and consequences of treated wastewater infiltration into the soils. Field trials established the infiltration capability and numerical groundwater modelling was used to predict the impact on groundwater. No additional hydro-geological investigations are planned Oceanica has been appointed to undertake waster quality characterisation (including microbiological indicators) at shore, near-shore and off-shore sites prior to construction and operation. Worley Parsons are undertaking hydrodynamic near field (CORMIX) and far field modelling (EFDC) to model impacts from discharges on coastal regions and baroclinic mixing and exchange processes to enable predictions of potential cumulative ecological impacts.	The AWWTP is proposed to be located within the present western margin of a proclaimed P3 Public Drinking Water Supply Area (PDWSA). Negotiations with the DoE are under way to re-locate the PDWSA boundary east, so as to exclude the proposed area of recharge from the policy area. The treated wastewater will be pumped to the infiltration basins on rotation, to allow for basin resting and maintenance. Information from existing studies – specifically the Rockwater report will be incorporated into the PER. Geotechnical investigations to identify the location of karstic limestone, water flow rates through the rock and the potential for passage to the marine environment will be undertaken. Results from hydrodynamic modelling, in combination with groundwater modelling and background water quality data,and equilibrium modelling to establish potential near-shore nutrient and chlorophyll levels arising from elevated groundwater nutrient concentrations for various infiltration scenarios. Evaluation of potential bacterial concentrations released into the ground and	The Water Corporation will address the PER guidelines outlined by the EPA and implement management options or additional investigations where there is insufficient evidence to support the outcomes of the environmental objectives during the commissioning, construction and operation of the proposed. Potential impact from the infiltration of treated wastewater on the P3 PWSA and the near-shore marine environment are considered key Relevant Environmental Factors for assessment in the PER

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Water quality (ground)	Infiltration Ponds located within the immediate environs to the west of Sites A and B; Intersection with unconfined aquifers, water courses etc.				marine environment via and assessment of possible impacts on recreational amenity. Evaluation of potential cumulative ecological consequences of discharging TWW to the marine environment via groundwater discharge in the context of existing conditions. Assess compliance with EPA's nutrient related water quality guidelines.	

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Social Surroundings						
Pollution Management						
Air quality (odour)	Odour buffer zone	The Water Corporation seeks to ensure that odour 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. Specifically, by: a) Ensuring that the siting and design of the AWWTP is chosen to minimise the odour impacts from the plant on surrounding residential and recreational land-uses as far as practicable, using best practice odour emission control design and operation. b) Ensuring the provision of an adequate odour amenity buffer zone and permitting only compatible land-uses within the buffer, through Water Corporation ownership and control of the buffer.	Wastewater arriving at the AWWTP will be odorous. Uncontrolled, this could lead to a high rate of emission of odours from the treatment plant. Odours emitted from the AWWTP, unmanaged, would have the potential to adversely impact on the amenity of occupants and users of land surrounding the plant.	1) Borgas M. (2004a). Alkimos Ponding Study (Draft). CSIRO Atmospheric Research, 2) Borgas M. (2004b). Alkimos Emissions and Dispersion Study: Discussion Document (Draft). CSIRO Atmospheric Research, 3) Borgas M. (2005). Alkimos Emissions and Dispersion Estimates. Prepared by CSIRO Atmospheric Research for Consulting Environmental Engineers,. 4) Consulting Environmental Engineers (2002). Report on Buffer Zone for Proposed Future Alkimos Wastewater Treatment Plant. 5) Consulting Environmental Engineers (2003). Report on Buffer Zone for Proposed Future Alkimos Wastewater Treatment Plant, Version 2. 6) Consulting Environmental Engineers (2004). Report on Buffer Zone for Proposed Future Alkimos Wastewater Treatment Plant, Version 7. 7) Environodour Australia Pty Ltd (2004). Odour Intensity Study. Report to the Western Australia Water Corporation.	The AWWTP will incorporate best practice odour control with extensive covers over all primary and secondary treatment tanks, to contain and permit extraction of odorous gas and odour control to sludge processing facilities. The extracted gas will be treated in chemical and/or biological scrubbing systems and the treated gas released via a stack(s) suitably sized for the purpose, probably over 50m in height. During detailed design, the number and location of scrubbers, soil bed filters and discharge stacks will be determined, but the air from within buildings and beneath covers from the process areas will be collected and treated to reduce odours to the extent feasible.	Extent and distribution of odour and the resultant size and shape of an amenity buffer is likely to be greater than originally envisaged, and therefore are considered key Relevant Environmental Factors for assessment in the PER

3. PRINCIPLES OF ENVIRONMENTAL PROTECTION

3.1 OBJECTIVE

The Water Corporation, in planning and implementing the proposed wastewater treatment strategy, will adopt the principles of environmental protection enunciated in section 4A of the *Environmental Protection Act 1986* and expanded upon in EPA Position Statement No. 7, specifically:

- The precautionary principle;
- The principle of intergenerational equity;
- The principle of the conservation of biological diversity and ecological integrity;
- Principles relating to improved valuation, pricing and incentive mechanisms; and
- The principles of waste minimisation.

3.2 ASPECTS AND POTENTIAL IMPACTS

Establishment and non-establishment, or delayed establishment, of the proposed AWWTP will have impacts on the principles of environmental protection.

The very establishment of the AWWTP is based upon the Corporation providing an efficient, effective and safe, centralised wastewater treatment facility in order to eliminate the requirement for individual urban household disposal systems, with their attendant adverse impacts on the environment and public health. The accepted social value of this function is reflected in the mandate placed upon the Corporation to provide the wastewater collection, treatment and disposal service.

It is proposed that the principles of environmental protection provide the framework for specifically addressing:

1. The case for establishment of a single, centralised wastewater treatment facility in the Alkimos region;
2. The imperative for site selection based upon a gravity solution;
3. Groundwater recharge as the preferred method of short to medium-term treated wastewater management, subject to ongoing studies establishing environmental acceptability;
4. The requirement for and role of an ocean outlet(s) as a necessary and environmentally responsible element of the treatment system;
5. Adoption of a conservative amenity buffer zone surrounding the AWWTP;
6. Uses for the bio-solids produced at the AWWTP; and
7. The Corporation's role in and the prospects for, medium and longer-term options for treated wastewater recycling, beyond on-site groundwater recharge proposed as part of this project.

Principles of environmental protection will also be addressed as relevant to other specific factors discussed in subsequent sections.

3.3 GUIDANCES TO ASSESSMENT OF ENVIRONMENTAL FACTORS

The EPA has issued several policies to which the Corporation will have regard in investigating and reporting on aspects of the proposed AWWTP relating to the principles of environmental protection:

- *Towards Sustainability. Position Statement No. 6, August 2004.* (EPA 2004e)
- *Principles of Environmental Protection. Position Statement No. 7, August 2004.* (EPA 2004f)

The Corporation's PER will approach and evaluate alternatives including the preferred option against the criteria outlined in WASTE WATER 2040, namely:

- Health;
- Environmental;
- Technical;
- Social; and
- Financial.

Alternatives will also be evaluated against key policy initiatives including:

- State Sustainability Strategy;
- Perth's Coastal Water Environmental Values and Objectives (EPA 2000); and
- EPA Guidance Statement No. 29 for Benthic Primary Producer Habitat protection for Western Australia's Marine Environment.

3.4 CURRENT STATE OF KNOWLEDGE

The Alkimos Wastewater System Catchment Boundary extends from Two Rocks, south to Burns Beach and east to Bullsbrook and Middle Swan. Numerous studies have been conducted over the years for the Corporation and other stakeholders, investigating WWTP locations, from north of Two Rocks to Neerabup in the south. Based upon those studies, the Corporation concluded that the location selected at Alkimos, Site A, is the best option from a WWTP operator's perspective, but has agreed to locate slightly further east, at Site B, based upon the argument by the local land developers that the location is a better land planning option, that is affordable and can still fulfil the Corporation's technical requirements. The Corporation has worked to develop concepts for integrating the necessary buffer land with the surrounding land uses.

It should be noted that no commercial agreement has yet been reached between the Corporation and the developer to relocate to Site B. Should technical or financial constraints at Site B be prohibitive for development at that site, or if environmental approval cannot be secured, the Corporation proposes to revert to developing Site A.

An account of the site selection history will be presented in the PER to demonstrate why Site A and B have been selected as the options for development.

A gravity solution (inflow and outflow), as achievable at both proposed sites, is an environmentally superior arrangement as it eliminates main sewer pumping. Two major benefits of locating the WWTP so as to accept gravity flow, are the pumping energy saved in perpetuity and the elimination of pump station overflow risk in the event of pump failure and pressure main bursts. The PER will address the environmental protection principles behind this decision on AWWTP siting.

The Corporation is actively pursuing investigations and also striving to realise wastewater recycling, in support of the State Water Strategy target of recycling 20% of treated wastewater sources by 2012. Current examples of major metropolitan water reuse are the Kwinana Water Reclamation Project which has just been commissioned and the McGillivray Oval Irrigation Project trial.

The Corporation is planning the AWWTP such that wastewater can be recovered and reused as opportunities become viable. At present five recycling options are being considered, one potentially of immediate application and three with varying degrees of difficulty and probability, and are therefore, not part of this proposal:

1. Groundwater recharge within the AWWTP buffer to enhance future groundwater recovery up-gradient. It is believed feasible to use up to 20 ML/day in this manner, without significant environmental impact. Investigations for the Corporation by Rockwater (2004) have identified locations in proximity to the WWTP with the capacity to successfully infiltrate the target quantities without unacceptably impacting the quality of local groundwater or the marine environment where the groundwater emerges. Negotiations with the Department of Environment (DoE) are underway to relocate eastward the western boundary of the Public Drinking Water Supply Area currently extending beneath the proposed infiltration area.
2. Supply to horticulturalists at Carabooda. The current groundwater allocation of the area is 9.8GL/y, and this could be met with the use of recycled water, but demand is seasonal, being highest in summer, whilst AWWTP production will be highest in winter. Other issues include applying recycled water in a Public Drinking Water Supply Area.
3. Additional wastewater treatment, conveyance and recharge at the Gnangara Groundwater Mound for later extraction as potable water. This recycling option has attractions, but also many as yet unresolved issues, one being the disposal of the waste generated by the supplementary treatment prior to recharge.
4. Supply recycled water to Carabooda/Yanchep area to sustain groundwater dependent ecosystems. This could be done in conjunction with options 2 and 3 described above. Provisional estimates from the DoE are that up to 15 GL/y of recycled water could be needed to meet horticultural and environmental needs in the area. The Corporation is working closely with the DoE to better understand the opportunities for use of recycled water to balance the competing needs from the Gnangara Mound allowing for drying climate trends.
5. Non-potable scheme water supply. Although this practice is used in other countries, social acceptance in Perth may be some time away.

Maximisation of the water reuse potential of the AWWTP, through identification of viable reuse options for the treated effluent, and implementing those identified options in a socially and environmentally acceptable manner will be an ongoing objective for the project throughout its life. However, it is likely that only the first option listed above will be sufficiently developed to be addressed in the PER as a component of this proposal.

The currently identified treated wastewater recycling option in which the Corporation has reasonable confidence in the medium-term is infiltration recharge within the AWWTP buffer. This is currently thought to have the capacity to infiltrate up to, approximately 20 ML/day meeting the need of the plant to around the year 2030. As most of this water requires pumping to available recharge ponds, buffer storage capacity is required within the AWWTP to hold treated wastewater produced during periods of pump outage, and there are clearly practical and financial limits on that capacity. Additionally, higher levels of treatment required for alternative water recycling options generate waste streams not suitable for infiltration. An ocean outlet provides:

1. A secure disposal option, regardless of power supply, as it is a gravity fed pipeline. This provides a robust, gravity wastewater treatment and disposal system under all circumstances, as a back-up to infiltration in the early years and to dispose of water beyond the capacity for local infiltration, if alternative recycling uses have not been realised.
2. An established facility to dispose of waste streams (e.g. reverse osmosis saline reject) from supplementary wastewater treatment to generate water of a quality suitable for future recycling applications. The Corporation recognises that such uses would have to be demonstrated to have acceptable impact on the environmental performance of the outlet and may require further formal assessment. Initial screening could be performed under the licence for the AWWTP and referred to the EPA if thought to potentially have a significant incremental impact.

The PER will present the case establishing the need and prudence for providing for an ocean outlet at the AWWTP.

3.5 PROPOSED STUDIES

The Corporation will develop an account in the PER demonstrating how the AWWTP scheme, as proposed, reflects the 'Principles of Environmental Protection' cited in the *Environmental Protection Act* 1986 and by the EPA in its various guides to environmental impact assessment.

To confirm the environmental acceptability of the proposed treated wastewater recharge within the AWWTP buffer, further investigations are being conducted into the impacts on flora, fauna and the marine environment. These studies are described later in this document.

Environmental considerations of the establishment and operation of the ocean outlet pipeline and diffuser are addressed later in this document in relation to specific factors upon which it potentially impacts.

4. FLORA AND VEGETATION (TERRESTRIAL)

4.1 OBJECTIVE

The Water Corporation seeks to maintain the abundance, diversity, geographic distribution and productivity of flora and vegetation communities at species and ecosystem levels, through the avoidance or management of adverse impacts and improvement in knowledge.

In particular, the Corporation recognises the opportunity for and intends to identify, investigate the values of and propose a strategy to conserve the flora values of the AWWTP buffer zone and linkages to surrounding areas.

4.2 ASPECTS AND POTENTIAL IMPACTS

Development of the AWWTP at Site A or B, with the associated recharge ponds, ocean outlet launch facility and connecting terrestrial pipelines and roads will necessitate disturbing in perpetuity up to approximately 47 ha of land across the Quindalup and Spearwood geomorphic land units (Roberts Day 2004). These geomorphic units provide flora habitat documented as supporting significant species and communities in the region (ATA Environmental 2003; Weston 2004).

The requirement to maintain an odour amenity management buffer zone surrounding the AWWTP, and options for management of the land within that buffer under the control of the Corporation, provides the opportunity to protect significant habitat, species and communities, should such be identified within the project area. Potential conservation linkages and synergies also exist with the block of Bush Forever site 397 to the north of the AWWTP buffer zone, although this block is proposed by Metropolitan Region Scheme Amendment 1029/33 to be rezoned urban (WAPC 2003).

Preparation of the WWTP site B development will necessitate relocation of excavated material and placement within receival areas. In the case of Site B this will, by virtue of the quantities involved, be beyond the Corporation's landholding.

Establishment of a treated wastewater ocean outlet is an essential element of the WWTP. Construction of the outlet pipeline by conventional means will necessitate a land-based facility and associated disturbance.

4.3 GUIDANCES TO ASSESSMENT OF ENVIRONMENTAL FACTOR

The EPA has issued guidance to which the Corporation will have regard in investigating and reporting on aspects of the proposed AWWTP potentially impacting on the environment.

No.51 - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, June 2004 (EPA 2004a).

4.4 CURRENT STATE OF KNOWLEDGE

The Quindalup and Spearwood landform units support, respectively, Quindalup and Cottesloe vegetation complexes. The vegetation condition varies extremely between excellent and degraded, stock grazing having taken place historically. More recent change has also resulted from a major, intense fire across Sites A, B and their respective buffer zones (Weston 2004), since the surveys reported by ATA Environmental in 2003.

As reported by Weston (2004), the Swan Coastal Plain Spearwood Dunes support six floristic community types (FCT) of which one, FCT26a – Melaleuca hueglii – M. acerose (now M. systena) shrublands on Limestone ridges, has been listed on the Department of Conservation and Land Management's database of Threatened Ecological Communities (TEC). Weston (2004) established two areas within the AWWTP northern buffer zone that may on closer examination be established to be FCT26a, but equally may not.

Weston (2004) concludes that no Declared Rare Flora (DRF) or Priority 1 or 2 flora are likely to be in the area studied in 2004. However, Weston noted that ATA Environmental (2003) recorded Priority 3 species and that other flora of significance likely to occur in the area have been noted in Bush Forever (Government of WA 2000) and Trudgen and Keighery (1990).

As a matter of perspective, it is noted that the AWWTP terrestrial facilities will disturb an area probably less than 50 ha, compared with the 1,332 ha of residential development and 232 ha of other development land uses within the Alkimos-Eglinton regional area that the AWWTP services (LandCorp 2003).

4.5 PROPOSED STUDIES

The Corporation has engaged Syrinx Environmental, collaborating with Dr Arthur Weston, to conduct a flora and vegetation evaluation of the proposed AWWTP scheme, with the objective of:

Providing accurate descriptions of flora, floristic community types and vegetation units of the study area, and estimates of the type and size of the areas to be impacted, based upon desktop analyses and field surveys;
Documenting the health of the vegetation units, and compare it to the health of vegetation remaining in the surrounding area,
Assessing the impact of recent fires in the area on density, presence or absence of species and on any difficulties that this presents during the field survey (eg identification of species), commenting specifically on significant vegetation that could reasonably be expected to recover to a healthy state over time;
Providing comment on flora species that could reasonably be expected to be present and were not discovered during the flora survey;
Assessing impacts on flora as a result of the proposed works;
Determining the presence of Declared Rare Flora (DRF), endangered and priority species, Threatened Ecological Communities (TEC) and other significant vegetation units, and map areas of particular conservation significance to be avoided;
Providing a vegetation map of the area showing any DRF, TEC and other significant vegetation;
Conducting the evaluation in accordance with best-practice flora surveys, and to meet the requirements of the EPA's Guidance Note No. 51 for the Assessment of Environmental Factors for *'Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia'*, including setting up and sampling 10 m by 10 m quadrats;
Conducting the surveys with sufficient precision and density to enable the identification of the preferred location(s) of the WWTP site from an ecological perspective;
Identifying any requirements that the Corporation must comply with under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* and the State's *Wildlife Conservation Act 1950*.

The project is to have two stages and two sections. The stages are (1)-spring to early summer (late November – early December 2004) and (2) mid to late summer 2005. The sections are (1) footprint section and (2) areas that will not be extensively disturbed.

Stage 1, for which the field work is complete and reporting is imminent, was a Level 1 Survey, comprising background research or 'desktop' study and reconnaissance survey, along with an initial stage of a Level 2 Survey: establishing plots, undertaking the first sampling of them and searching for rare and otherwise significant flora.

The Stage 2 of a Level 2 survey, to be commenced in mid-February, will comprise more detailed survey and enough comprehensive survey to fill in gaps in the knowledge needed to place the remnant vegetation and flora of the survey areas in a regional context, especially in relation to Bush Forever sites and the recent ATA Environmental survey of areas subject to MRS amendment. Subsequent sampling of plots, analysis of plot data and searching for later-flowering significant flora will be undertaken during Stage 2.

5. FAUNA (TERRESTRIAL)

5.1 OBJECTIVE

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

In particular, the Corporation recognises the opportunity for and intends to identify, investigate the values of and propose a strategy to conserve the fauna habitat values of the AWWTP buffer zone and linkages to surrounding areas.

5.2 ASPECTS AND POTENTIAL IMPACTS

Development of the AWWTP at Site A or B, with the associated infiltration ponds, ocean outlet launch facility and connecting terrestrial pipelines and roads will necessitate disturbing in perpetuity up to approximately 47 ha of land across the Quindalup and Spearwood geomorphic land units (Roberts Day 2004). These geomorphic units provide fauna habitat documented as potentially supporting significant species and communities in the region (ATA Environmental 2003; Thompson 2004).

The requirement to maintain an odour amenity management buffer zone surrounding the AWWTP, and options for management of the land within that buffer under the control of the Corporation, provides the opportunity to protect significant habitat, species and communities, should such be identified within the buffer area. Potential conservation linkages and synergies also exist with the block of Bush Forever site 397 to the north of the AWWTP buffer zone, although this block is proposed by Metropolitan Region Scheme Amendment 1029/33 to be rezoned urban.

Preparation of the WWTP site for development will necessitate relocation of excavated material and placement within alternative receival areas. In the case of Site B, this will by virtue of the quantities involved, be beyond the Corporation's landholding.

Operation of the treated wastewater infiltration basins will impact on the groundwater quality in their immediate vicinity, with decreasing influence down-gradient of the ponds. The nature of the hydrogeology in this region may be such as to support subterranean fauna which could potentially be adversely impacted.

Establishment of a treated wastewater ocean outlet is an essential element of the WWTP. Construction of the outlet pipeline by conventional means will necessitate a land-based facility and associated disturbance.

5.3 GUIDANCES TO ASSESSMENT OF ENVIRONMENTAL FACTOR

The EPA has issued guidance to which the Corporation will have regard in investigating and reporting on aspects of the proposed AWWTP potentially impacting on the environment.

No.54 – Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia, December 2003 (EPA 2003).

No.56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, June 2004 (EPA 2004b).

5.4 CURRENT STATE OF KNOWLEDGE

ATA Environmental (2003), Thompson (2004) and Roberts Day (2004) provide accounts of terrestrial fauna in the Alkimos-Eglinton region, developed as part of the Metropolitan Region Planning Scheme Amendment No. 1029/33. A substantial number of earlier studies, including physical surveys, also exist, as identified by Thompson and ATA. These works identify the potential for the occurrence in the vicinity of Alkimos of significant and protected fauna species, such as Carnaby's Cockatoo, Peregrine Falcon, Carpet Python, Western Brown Bandicoot and the Brush Wallaby.

The Corporation recognises the potential for subterranean fauna to be present in the limestone sediments in the vicinity of the proposed AWWTP and are known from the Yanchep area to the north. No knowledge specific to the Alkimos area exists.

The proposal to infiltrate treated wastewater will impact the quality of the underlying groundwater, but the potential to impact subterranean fauna is not yet understood. Treated wastewater is intended not to exceed 10 mg/L nitrogen. Rockwater (Rockwater 2004) cite background nutrient levels in the area as about 1 mg/L nitrate and less than 0.03 mg/L phosphorous.

5.5 PROPOSED STUDIES

5.5.1 Terrestrial Fauna

Bamford Consulting Ecologists, have been engaged to investigate and advise the Corporation on the terrestrial fauna values and fauna impact issues related to the proposal. A site inspection and literature review has been conducted to collect information on:

Habitat type/s present within the study area;
Vertebrate fauna species that either may occur or were recorded in the study area;
Threatened fauna species that may occur in the study area; and
Possible impacts of development upon fauna species.

This information is to be used to make recommendations on how to minimise the impacts of the development on fauna species. A report of this work is anticipated to be available around the time this Scoping Document is submitted in draft.

The investigation is intended to be consistent with a Level 1 assessment under the EPA Guidance Statement No. 56 'Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia' (EPA 2004b).

In their proposal to conduct the study, Bamford Consulting Ecologists expressed the view that this level of survey conducted by them should be acceptable to the EPA in view of the wealth of relevant fauna information available.

Available references include publications that provide information on general patterns of distribution of frogs (Tyler et al. 2000), reptiles (Storr et al. 1983, 1986, 1990 and 1999, Bush et al. 1995), birds (Johnstone and Storr 1998), and mammals (Strahan 1995).

In addition, specimen records of frogs, reptiles and mammals held by the WA Museum were obtained for the region bounded by 31.57^{o} to 31.67^{o} S, and 115.65^{o} to 115.75^{o} E. Birds Australia's Atlas database was searched for the same area.

A fauna assessment from Burn's Beach (Bamford 1998) was used to provide additional data on species occurrences and distributions from a local context.

The Department of Environment and Heritage database of species listed under the Environment Protection and Biodiversity Conservation (EPBC) Act, and the WA Department of Conservation and Land Management (CALM) threatened and priority fauna database, have been interrogated for the coastal plain north of Perth, within the last three months.

5.5.2 Subterranean Fauna

The Corporation intends using in-house expertise to investigate potential impact on subterranean fauna, in particular stygofauna. The study, whilst not yet designed in detail, will be staged with progression from one stage to the next being contingent upon the findings of the prior stage:

1. Desktop study of previous surveys and knowledge of stygofauna in the area of the project, including consultation with:
   - CALM;
   - WA Museum; and
   - Tertiary Institutions;
2. Assess the likelihood of the proposal significantly adversely impacting stygofauna, were such to be present;
3. If stygofauna are likely to be present, identify bores in the area of suitable specification to permit stygofauna sampling; and
4. Design and implement a stygofauna pilot survey, to:
   - Establish the presence/absence and identify any stygofauna within the relevant impact zone a control zone beyond the zone of influence;
   - Attempt to determine the conservation status of any stygofauna found;
   - Analyse the findings and identify management issues; and
   - Report the results of the survey, to CALM and in the PER.

Development and progressive implementation / termination of the above program would be performed in consultation with the EPA.

6. MARINE ECOSYSTEM

6.1 OBJECTIVE

The Water Corporation's objective of the proposal it to be compatible with the environmental quality management framework (EQMF), while noting that a mixing zone(s) will be proposed in the vicinity of the diffuser with a lower level of ecological protection. The Corporation also seeks to maintain the abundance, diversity, geographic distribution and productivity of marine fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

The Water Corporation proposal is being designed and operated to achieve the following EQOs established in Perth's Coastal Waters (EPA 2000).

EQO1	Maintenance of ecosystem integrity
EQO2	Maintenance of aquatic life for human consumption
EQO3	Maintenance of primary contact recreation values
EQO4	Maintenance of secondary contact recreation values
EQO5	Maintenance of of aesthetic values
EQO6	Maintenance of industrial water supply values

The Water Corporation will utilise hydrodynamic, baseline surveys and benthic habitat mapping to identify suitable reference sites and monitoring sites.

6.2 ASPECTS AND POTENTIAL IMPACTS

Nutrients discharged by the AWWTP marine outlet may potentially produce changes in the phytoplankton species composition and abundance, which may in turn have implications for the marine food chain.

Whilst this is not considered by the Corporation to be a likely impact, based upon operational experience at other outlets, the Corporation accepts that demonstration of such is necessary.

6.3 GUIDANCES TO ASSESSMENT OF ENVIRONMENTAL FACTOR

The EPA has issued guidance to which the Corporation will have regard in investigating and reporting on aspects of the proposed AWWTP potentially impacting on the environment.

Environmental Quality Criteria Reference Document for Cockburn Sound (2003 - 2004), Environmental Protection Authority Report 20, January 2005.

6.4 CURRENT STATE OF KNOWLEDGE

Oceanica Consulting has provided the Corporation a review of marine issues, associated with the management of the Corporation's WWTP outlets, that should be considered in planning at Alkimos. The following information is drawn from the Oceanica advice.

Perth's coastal waters are characterised by very low nutrient levels and high clarity. The low nutrient levels are due to the warm, nutrient poor Leeuwin Current and the lack of significant terrestrial inputs from a dry, geologically ancient land mass.

The Perth Coastal Waters Study (Lord and Hillman, 1995) undertook water quality surveys in the region from Yanchep to Tims Thicket and west to the 100 m depth contour at 127 sites in winter (1993) and at 75 sites in summer (early 1994).

Background nutrient concentrations for nearshore (less than 25 m depth) and offshore (greater than 25 m depth) waters in northern (North Mole to Yanchep) and southern (Tims Thicket to North Mole) coastal areas are shown in Table 11-1. In summer there was a distinct increase in total nitrogen (TN), total Kjeldahl nitrogen (TKN) and dissolved inorganic nitrogen (DIN) from south to north.

Phytoplankton biomass, measured as chlorophyll a concentration, was higher nearshore in summer and winter for northern waters and higher nearshore in winter in southern waters. Offshore median background chlorophyll a values were less than 0.3 micrograms per litre (µg/L).

The Perth Long-Term Ocean Outlet Monitoring Programme (PLOOM) measures the influence of the discharge by the Corporation of treated wastewater on Perth's coastal waters through both investigative and compliance monitoring components.

The findings of the PLOOM programme are reported to the EPA annually. The major findings of the PLOOM programme from 1995 to 2003 in relation to phytoplankton can be summarised as follows (refer DALSE 2004a):

There are small increases in phytoplankton biomass (measured as water column chlorophyll a concentration) immediately north of each outlet, attributed to the outlet, but concentrations are below national (ANZECC/ARMCANZ, 2000) guidelines for nearshore waters.

Oceanica identified the key environmental issue associated with the proposed Alkimos outlet to be the potential for nutrient enrichment and the consequential impacts. Oceanica recommended that a programme of phytoplankton monitoring (species and biomass) be conducted to address the seasonal variations in chlorophyll a and its relationship to water quality conditions, and seasonal variations in phytoplankton species composition and abundance.

6.5 PROPOSED STUDIES

Oceanica Consulting has been appointed to perform a phytoplankton survey to a scope of work specified in their report 427/6 of December 2004, which will be provided to the EPA with this scoping document.

The phytoplankton survey data will be used to provide information on the seasonal variation in phytoplankton species composition and abundance, and their relationship with water quality. The data will be used to underpin the development of an appropriate monitoring programme and the 'Environmental Quality Management Framework' for the Alkimos WWTP Ocean Outlet. Once the ocean outlet is operational, data on phytoplankton species composition and abundance will be used to:

Determine if there are differences between sites that may be attributable to the effects of the treated wastewater discharge; and

Determine if potentially harmful phytoplankton species are present in the marine receiving environment at concentrations which exceed the Western Australian Shellfish Quality Assurance Program (WASQAP) Guidelines.

The key study tasks will be:

1. Phytoplankton Survey: Phytoplankton samples will be collected from each of the 6 near-shore (≈9.5-12.5 m) and 6 offshore (≈14-15.5 m) sites at monthly intervals over the period December 2004-April 2005.
2. Analysis for Potentially Harmful Species: Establish whether potentially harmful phytoplankton species are present in the marine waters at concentrations that exceed the WASQAP Guidelines.
3. Phytoplankton Community Analysis: Analysis of phytoplankton species composition and abundance data to assess differences between sites and between sampling dates.

4. Preparation of a Phytoplankton Survey Report: providing details on the field methods, analytical techniques, results and a detailed description and interpretation of the phytoplankton communities over the study period. The survey results will be presented graphically to assist with interpretation. All the data collected during the survey will be tabulated and presented in the report.
5. Design a Baseline Phytoplankton Monitoring Programme: Design a Baseline Phytoplankton Monitoring Programme to provide appropriate baseline phytoplankton data prior to the construction and operation of the proposed WWTP and ocean outlet.

Baseline monitoring will be implemented prior to construction of the outlet.

7. LAND (TERRESTRIAL)

7.1 OBJECTIVE

The Water Corporation seeks to maintain the integrity, ecological functions and environmental values of the landform, in particular the Alkimos coastal dune formations.

7.2 ASPECTS AND POTENTIAL IMPACTS

The coastal dune formations in the Alkimos area have been identified as having national and world geoheritage significance (Semeniuk 2004). Such is the significance that it was recommended by the Geological Society of Western Australia (with support from the Geological Sites Committee and the CSIRO) that the Alkimos Dune System be nominated as a Geological Monument, reserved as open space and that future use of the land should not involve activities that will disturb the land surface (Lemmon, Gee, Morgan and Elkington, 1979).

Establishment of the WWTP at Site A or B, the ocean outlet assembly and launch facility, treated wastewater infiltration ponds, site excavation spoil disposal, plus the necessary connecting pipelines and roads have the potential to adversely impact on the dune system landform. Conversely, the AWWTP odour amenity buffer encompasses a substantial area of dunes, presenting the potential through informed and sensitive land use planning to provide for partial preservation of the Alkimos dune system. The Corporation will seek to maximise the preservation of dune landform geoheritage values, by the appropriate siting and construction of AWWTP facilities.

7.3 CURRENT STATE OF KNOWLEDGE

The Swan Coastal Plain between Geographe Bay and Dongara is the product of a complex set of conditions and processes described by Semeniuk (2004) as unique in the world. The location of the proposed AWWTP is within the more northerly Whitfords-Lancelin Coastal Sector, described by Semeniuk as representing the final stage in the series of coastal landforms, a sequence of more recent parabolic dunes perched on an older limestone plateau. The dunes were formed by progressive erosion of the cuspate foreland, the resultant sand driven inland by strong south-westerly winds, which have moderated over geological time scales.

Semeniuk (2004) states that the Alkimos cuspate foreland coastal system represents a significant geoheritage feature, as it:

1. Has a low amplitude coastal projection centred on a nearshore reef (the coastal projection being the penultimate stage of erosion of a cuspate foreland);
2. Exhibits perched dunes;
3. Exhibits an excellent sequence of nested parabolic dunes; and
4. Exhibits a gradient where an west-east oriented large parabolic dune has encroached over Spearwood Dune terrain, with a variety of ecological contacts.

Semeniuk (2004) asserts that the Alkimos coastal area is a feature worthy of consideration for preservation in its entirety, as a feature of geoheritage significance. It represents an ensemble of inter-related coastal landforms, from nearshore reef to low amplitude cuspate foreland to perched dunes and the nested parabolic dunes that transgress the Spearwood Dunes.

Semeniuk (2004) identifies that, were the AWWTP with its associated buffer zone to be placed at Site A, the buffer zone would encompass about one-third of the total coastal complex identified as of geoheritage value and therefore have the potential to incorporate geoheritage

conservation as a management objective. Semeniuk observes that Site B will preserve less of the various near-coastal dune complexes.

7.4 PROPOSED STUDIES

No further scientific studies are proposed in regard to characterising the landform geoheritage values. The Corporation will consult with the EPA and other parties as to the significance placed upon protection of the Alkimos coastal dune system and how best to harmonise the necessary AWWTP development into the landform so as to protect geoheritage values to the extent practical.

The Corporation is well advanced with regional and buffer zone development concept plans, having regard to the dune structure and opportunities to incorporate its protection into the buffer land-use development plan. Reflecting the integrated nature of geoheritage being more than just the underlying landform, the Corporation is having regard to protection of the flora, vegetation and fauna associated with the Alkimos dune systems.

8. LAND (MARINE) AND BENTHIC HABITAT

8.1 OBJECTIVE

The Corporation seeks to maintain the integrity, ecological functions and environmental values of the seabed and coast.

8.2 ASPECTS AND POTENTIAL IMPACTS

Establishment and operation of a treated wastewater ocean outlet is an essential element of the WWTP.

If the outlet pipeline is established by conventional construction methods, the outlet pipeline will necessitate some disturbance and, potentially, temporary or permanent modification of the benthic habitat, as a result of:

Excavation and burial across the beach and dune, with subsequent rehabilitation;
Excavation to an adequate depth and burial across the surf zone, so that the pipeline does not interfere with coastal processes; and
Potential for underwater blasting, if reef needed to be trenched.

Recognising these impacts, the Corporation is actively investigating the availability, feasibility, cost and benefit of various alternatives to establishing the outlet pipeline in the manner previously employed in Western Australia. These include options such as:

Boring or tunnelling beneath the beach dunes for some distance, possibly to the beyond the surf zone, thus avoiding excavation;
Boring beneath emergent reefs, thus avoiding the need for blasting; and
Boring the entire length of the outfall.

Each of these options will have environmental benefits, as well as unique potential impacts requiring identification and consideration. The Corporation believes that the potential benefits from continuing to consider alternative options for outlet construction outweigh the current uncertainty that this creates for the project planning and environmental assessment process.

Discharge of treated wastewater carries with it low levels of materials, such as metals, that might precipitate or settle onto the sediments around the outlet diffuser, causing enrichment in those species. The Corporation's experience with the operation of its outlets at Bunbury (Oceanica 2004), Sepia Depression and Swanbourne (DALSE 2004) is that no sediment contamination has been detectable. However, the Corporation recognises this concern by others and therefore identifies such a potential impact as one for consideration.

8.3 GUIDANCES TO ASSESSMENT OF ENVIRONMENTAL FACTOR

The EPA has issued guidance to which the Corporation will have regard in investigating and reporting on aspects of the proposed AWWTP potentially impacting on the environment.

No.29 – Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment, June 2004 (EPA 2004c).

8.4 CURRENT STATE OF KNOWLEDGE

An account of the benthic habitat of the Perth nearshore waters has been provided to the Corporation by Oceanica Consulting Pty Ltd (Oceanica 2004), which is reproduced below.

The shallow (<20 m deep) nearshore waters off Perth contain a variety of habitats, varying from meadow-forming seagrasses that are dominant in the more sheltered sandy areas, to limestone reefs and platforms supporting a variety of algal communities in the more exposed coastal waters (Lord and Hillman 1995). The low nutrient environment and high water clarity, mean that seagrasses are a common feature and may be found in the depth range ~1 m to ~15 m.

Examination of aerial imagery of the region from Ocean Reef to Yanchep suggests that the benthic habitat is likely to be similar, with low relief reef, high reef (dominated by macro algae) and mobile sand beds and seagrasses which are adapted to the higher energy areas of the coast, such as *Posidonia coriacea* which grows as clumps rather than continuous meadows.

The Ocean Reef area consists of limestone platform and high relief reef, scattered seagrass meadows and sand patches. It was found that the dominant feature of the region was its dynamic nature, with physical processes driving the large-volume movement of sand (DALSE 2004a) and therefore the area of seagrass, reef and sand at any one time. For example, large areas of limestone platform were found to be repeatedly buried and exposed as sandy sediments were transported through the area (Alex Wiley & Associates 2001).

Of Perth's three ocean outlets, the sea state and bottom conditions at Ocean Reef are probably most similar to those at Alkimos. The results from five metals and pesticides surveys at Ocean Reef outlet over the past 12 years have shown either non-detectable or very low levels of contaminants in the vicinity of the Ocean Reef outlet; with no evident long-term increases in metal or pesticide concentrations. The results from the summer 2003/04 survey at Ocean Reef are summarised below (for detailed results refer to DAL Science & Engineering 2004b):

Sediments at Ocean Reef comprised clean fine to coarse sands, and contained a very low silt content.

Metal (As, Ag, Cd, Co, Cu, Cr, Hg, Ni, Pb, Se, and Zn), organochlorine pesticide, organophosphate pesticide, triazine herbicide concentrations in the sediments at Ocean Reef were all well below the interim sediment quality guidelines-low (ANZECC/ARMCANZ 2000); indicating there is negligible risk of metal or pesticide contamination affording biological disturbance to organisms inhabiting these sediments.

The Corporation's experience with the operation of its outlets at Bunbury (Oceanica 2004), Sepia Depression and Swanbourne (DALSE 2004) is that sediment contamination is not an issue.

There is limited site specific information available to describe the marine environment at Alkimos. A brief reconnaissance study was undertaken by DA Lord & Associates (1997) to examine the characteristics of the coast between Burns Beach and Yanchep to determine whether the Alkimos beach area opposite Lot 101 had features that made it significantly more valuable for community recreation than any other area. Relevant findings from this study were:

The foredunes (i.e. dunes along the beach front) in front of Lot 101 are low, and do not present any special environmental features to distinguish them from the remainder of the foredunes along this part of the coast. The foredunes along this part of the coast are heavily affected by uncontrolled vehicle access.

The beaches along this part of the coast are reasonably wide (on average 60 metres), and the coast relatively straight. A small headland dune is located just south of Lot 101. Swimming is safe along this entire coast. Beach orientation is to the south-west, and during the summer, little protection is provided from the seabreeze.

The main attraction to this part of the coast is a series of offshore reefs and limestone platforms, which are located within one to two kilometres from the shore. These provide a dampening effect on wave energy, and also generate sites for recreation (snorkelling, diving, fishing and surfing). These reefs and platforms are most prominent over an approximately four km of coastline, located evenly north and south of Lot 101.

The section of coastline between Burns Beach and Yanchep has the same types of habitat (beaches, shallow water sandy areas, seagrasses, limestone platforms, and reef) that exist further south in the Marmion Marine Park. However, limestone reef and platform habitat is not nearly as widespread as in the Marmion Marine Park.

From this it can be concluded that there were no features of the beach in front of Lot 101 that made it significantly more valuable for community recreation than other areas between Burns Beach and Yanchep.

8.5 PROPOSED STUDIES

8.5.1 Bathymetric Survey

The Corporation has sourced the most recent existing bathymetric data for the Alkimos area for use in preliminary assessment of the feasibility and impact of alternative outlet pipeline routes and construction methods. It will also be used in developing the outlet dispersion modelling.

A new marine geophysical investigation will be conducted in the second quarter of 2005 to confirm bathymetric conditions in refined target areas, to confirm the bathymetry, establish sediment conditions and also to confirm the hydrodynamic modelling of effluent dispersal in the ocean.

Bathymetric information also assists in identifying key ecological elements (e.g. reef habitat).

8.5.2 Benthic Habitat Mapping

Oceanica Consulting has been appointed to perform benthic habitat mapping to a scope of work specified in their report 427/7 of January 2005, which will be provided to the EPA with this scoping document. It is anticipated, following review of a historic habitat study within the area (DA Lord & Associates, 1997), that the benthic habitats in the area will consist of sand, seagrass, limestone platform and limestone pavement reef.

The study objective is to produce a detailed habitat map of the marine area in the vicinity of the proposed ocean outlet, to:
Determine the distribution of seagrasses, reef, and bare sand in the area surrounding the proposed outlet; and
Record the nature, abundance and distribution of flora and fauna associated with these habitats.

The habitat map will be prepared using rectified aerial photography, supplemented by ground truth observations undertaken by towed underwater video and by spot dives.

The key study tasks are:

1. Mapping of benthic habitats (vegetated and unvegetated habitats) from the Perth Metropolitan Aerial Photography 2004 digital imagery.
2. Ground-truthing of the benthic habitats using towed video to determine the distribution of sand, seagrass and reef habitats.
3. More detailed ground-truthing of the benthic habitats using diving, including the collection of seagrass specimens and sediment in-fauna core samples for subsequent analysis.
4. Analysis of the benthic infauna community data, using the statistical package PRIMER, which enables multivariate analysis of species composition and abundance data.
5. Produce a report, detailing the methods used and results obtained from the habitat mapping work, including a habitat map.

The habitat map is required largely for environmental purposes; however, the habitat map will provide supplementary information for the selection of the outlet route.

8.5.3 Marine Sediment Contamination Monitoring

A single sediment quality survey for heavy metals, herbicides and pesticides will be conducted to determine background contamination levels at the same offshore and inshore locations as surveyed for water quality.

Monitoring will be resumed, as part of comprehensive marine monitoring, on commissioning of the outlet.

9. AIR QUALITY - ODOUR

9.1 OBJECTIVE

The Water Corporation seeks to ensure that odour 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. Specifically, by:

a) Ensuring that the siting and design of the AWWTP is chosen to minimise the odour impacts from the plant on surrounding residential and recreational land-uses as far as practicable, using best practice odour emission control design and operation.

b) Ensuring the provision of an adequate odour amenity buffer zone and permitting only compatible land-uses within the buffer, through Water Corporation ownership and control of the buffer.

9.2 ASPECTS AND POTENTIAL IMPACTS

Every sewage treatment plant receives odorous wastewater and releases odour at times (Consulting Environmental Engineers (CEE) 2004).

The Alkimos region will constitute a large urban catchment to the north and northeast of Perth, thus wastewater will travel in the sewers for hours before it reaches the treatment plant. Biological activity in sewage decomposes the organic constituents, generating odorous gas.

Hence, it is known that the wastewater arriving at the AWWTP will be odorous. Uncontrolled, this could lead to a high rate of emission of odours from the treatment plant. Odours emitted from the AWWTP, unmanaged, would have the potential to adversely impact on the amenity of occupants and users of land surrounding the plant.

Best management practice is to be adopted (CEE 2004) to minimise the emission of odours and their impact on the community, involving the following measures:

1. Design of the collection system to minimise odour generation prior to arrival at the plant (gravity sewers);
2. Design and operation of treatment plant to minimise odour release;
3. Collection and scrubbing of odorous gases liberated within the plant enclosures; and
4. Provision of a public amenity buffer zone appropriate to the particular site and plant.

The AWWTP will incorporate best practice odour control with extensive covers over all primary and secondary treatment tanks, to contain and permit extraction of odorous gas and odour control to sludge processing facilities. The extracted gas will be treated in chemical and/or biological scrubbing systems and the treated gas released via a stack(s) suitably sized for the purpose, probably over 50m in height. During detailed design, the number and location of scrubbers, soil bed filters and discharge stacks will be determined, but the air from within buildings and beneath covers from the process areas will be collected and treated to reduce odours to the extent feasible.

The currently predicted odour emission at ground level is 27,000 OU/s, the sum of residual odour leakage from the covered tanks as a result of minor leaks, pressure variations under the covers due to wind effects, inspections to enable plant operations and maintenance activities (CEE 2004). This represents a very high level of odour containment, and is a lower release of odour than expected from the smaller Subiaco WWTP after the $22 million upgrade to control odour (CEE 2004).

The predicted total odour emission rate from the ultimate plant is estimated to be 62,000 OU/s. To provide a perspective, the expected odour emission rate from low level sources at the 160 ML/d AWWTP is expected to be only 25 per cent of the present odour emission rate from the existing 60 ML/d Subiaco WWTP or only 20 per cent of the present odour emission rate from the existing 110 ML/d Woodman Point WWTP with covers on the preliminary and primary treatment tanks (CEE 2004).

9.3 GUIDANCES TO ASSESSMENT OF ENVIRONMENTAL FACTOR

The EPA has issued a Guidance to which the Corporation will have regard in investigating and reporting on the odour aspects of the proposed AWWTP potentially impacting on the environment:

No.47 – Assessment of Odour Impacts from New Proposals, March 2002.

The Corporation will also have regard to the DoE guideline:

'Odour Methodology Guideline', Department of Environmental Protection, Perth, Western Australia, March 2002.

9.4 CURRENT STATE OF KNOWLEDGE

Lot 101, purchased by the Corporation in 1987, is approximately 160ha in area, extending about 1,260 m from north to south and 1,300 m from east to west. The treatment facility was, conceptually, to be constructed on an area of 260 m by 300 m (Site A) in the centre of the lot providing within Lot 101 a buffer 500 m wide around the treatment plant. The Metropolitan Region Scheme (MRS) adopted in 1994 provided additional land around the perimeter of the plant for the buffer zone, extending 1,000 m to the north and tapering down to 600 m in the south.

The currently proposed MRS amendment has the AWWTP site at (Site B), zoned *Public Purposes*, 750m east of its original planned location. The proposed MRS provides a 600m buffer around the primary / secondary treatment area of the plant, consisting of an inner zone of 450m radius and a further 150 m wide strip zoned *Urban Deferred*.

Site B for the treatment plant is within a dune valley at higher elevation than Site A. In order for sewage to flow into the plant by gravity, it is necessary that a flat area within the valley be formed by excavation to a base level of 10 m AHD. Thus the plant will be surrounded by sand dunes with elevations of 30 to 40 m AHD, that is, about 20 to 30 m higher than the treatment plant. The plant therefore sits within a deep basin.

Following consultation with CSIRO, the Corporation developed an extensive meteorological monitoring program for the revised plant site, including establishment of three monitoring stations to provide comprehensive local meteorological data representative of the dune valley and crest conditions (two commissioned in March 2002 and the third in May 2003). The on-site meteorological monitoring will continue until a total of three years of continuous data is obtained.

In January 2004, CEE provided the Corporation with an assessment of the necessary buffer zone based on the accumulated on-site meteorological measurements, having regard to the conceptual plant layout and experience of odour management issues around other large treatment plants in the Perth region. This report used on-site meteorological information for odour modelling, to update a preliminary assessment of the June 2002 report, thus providing a more accurate assessment of odour buffer requirements.

From the studies at Subiaco, Woodman Point and Beenyup WWTPs, the Corporation has concluded that 5 OU (99.9%, 60-minute) is the odour level that represents the boundary of odour complaints or concerns, and corresponds to a 'distinct odour'.

The CEE 2004 report recommends, for interim planning purposes, a 600m wide buffer zone, possibly reducing to 450m to the south, based upon an acceptability criterion of 5OU at the 99.9^{th} percentile frequency for a 1-hour averaging period. This recommendation is subject to the confirmation of the "distinct" level of odour (assumed for the purpose of the CEE 2004 report to be 5OU) and testing the outcome of the upgrades at the Subiaco and Beenyup WWTPs. This work is expected to be completed in June 2005. The Corporation has assumed a uniform 600m buffer until it has the results of final modelling.

During odour management investigations conducted to date, awareness has arisen that the siting of the AWWTP within a deep basin at Site B creates conditions under which odour may pond and accumulate in the basin during low wind, atmospheric inversion conditions. The accumulated odour-laden air would then be flushed from the basin when wind speeds increased and/or the inversion broke up. The concern was that such conditions and the potential odour impact may not be adequately reflected by the normal dispersion modelling upon which the buffer zone dimension was to be established.

CSIRO has been engaged to investigate the extent of potential odour ponding at Alkimos and to advise on the implications for providing an appropriate buffer zone. CSIRO has advised (Borgas 2004a) that odour ponding is a real phenomenon at Alkimos and that in worst cases, odorous air could accumulate for extended periods and a large volume source flush from the site in a very short period, thus being more severe than assumed in the existing dispersion modelling. The implications of this were further investigated and CSIRO's conclusions (Borgas 2004b; Borgas 2005) are that in low entrainment conditions, pond concentrations and volumes could grow far greater than previously assumed for normal conditions. CSIRO predicted significant detectable odour and possible nuisance downwind beyond the previously modelled buffer zone. That work is being peer reviewed and evaluated and the significance of the final results will be considered by the Corporation in determining the final buffer dimensions.

CEE (pers comm. 14/11/04) has provided preliminary advice on the CSIRO study:

> *"The results show that ponding is a concern, and is likely to increase the extent of the buffer zone to the west of the plant by about 100 to 200m."*

When the monitoring and analysis is fully completed and investigations into the performance of covers over the Beenyup and Subiaco WWTPs have been completed, a final recommendation on

the appropriate buffer zone for the Alkimos plant can be established. After this work is completed, anticipated to be in mid-2005, the buffer can be adjusted to its final shape, allowing the final zoning plan to be defined.

The Water Corporation will have regard to the odour predictions in determining the nature and location of compatible land use options to be considered within the buffer. It is the Corporation's intention that the buffer not be a sterile area, but be of social benefit.

9.5 PROPOSED INVESTIGATIONS

Prior to finalising the PER for public review and EPA assessment, the Corporation will:

1. Receive the final advice from the CSIRO regarding the nature and implications for buffer provision, of odour ponding conditions at AWWTP Site B; and
2. Complete investigations by CEE and receive a revised report and recommendations of its investigations regarding:
    - Odour emissions inventories for various stages of the AWWTP development;
    - Updated available meteorological data;
    - Examination and confirmation of the appropriate 'distinct' odour level to be adopted for planning the AWWTP buffer;
    - Selection of the most appropriate odour dispersion model for the AWWTP situation;
    - Odour contours predicted for the AWWTP for the emissions and meteorological data files;
    - Influence of odour ponding phenomenon;
    - Interpretation of odour model outputs to establish adequate and prudent buffer zone dimensions for both sites and compatible buffer land-uses; and
    - Comparison between alternative sites and plant layouts.

10. WATER QUALITY (GROUNDWATER)

10.1 OBJECTIVE

The Water Corporation seeks to ensure that the infiltration of treated wastewater to ground does not adversely affect environment values or the health, welfare and amenity of people and land uses, by meeting statutory requirements and acceptable standards.

10.2 ASPECTS AND POTENTIAL IMPACTS

The requirement for treatment of wastewater in the North West Corridor will be incremental, with the AWWTP established in stages ahead of forecast demand. The initial capacity will most likely be approximately 10ML/d.

The Corporation proposes, subject to confirming environmental acceptability, to initially infiltrate the treated wastewater in swales in the dunes adjacent to the proposed site, within the Corporation controlled buffer zone (refer to Figure 2-3). The ponds will generally be sited at lower locations across the site, approximately 500m from the ocean. As far as practical, they will be spread in a north-south direction to minimise groundwater mounding. The treated wastewater will be pumped to the basins on rotation, to allow for basin resting and maintenance.

The feasibility of infiltrating up to 20ML/d has been established (Rockwater 2004). Recharge of such flows as can be accommodated in proximity to the AWWTP is considered the most environmentally sound option for use / disposal of the treated water, as it provides a resource, enhancing future upstream water abstraction.

The Corporation has identified the impact that infiltration of treated wastewater will have on the underlying groundwater quality, and the requirement to establish and demonstrate acceptability of that proposal. The AWWTP is proposed to be located within the present western margin of a proclaimed P3 Public Drinking Water Supply Area (PDWSA). Negotiations with the DoE are progressing to re-locate the PDWSA boundary east, so as to exclude the proposed area of recharge.

The treated wastewater will filter down through the sand into the groundwater and then join the groundwater flowing to the ocean at, or west of, the shoreline. It is recognised that this may potentially impact on subterranean fauna, should such be present, and upon the marine shoreline. These potential impacts are dealt with under other factors.

Infiltrated treated wastewater may be transported to the marine environment, particularly given karstic nature of the hydrology beneath the proposed site creating potential cumulative effects on the marine environment.

The Corporation does not foresee phosphorus being a problem as Tamala Limestone has a high adsorptive capacity, and elevated phosphorus are rarely seen in groundwater (Rockwater, 2004).

The Corporation is aware of potential bacterial concentrations in TWW that may be released into the marine environment and Oceanica has been appointed to undertake waster quality characterisation (including microbiological indicators) at shore, near-shore and off-shore sites prior to construction and operation. It is also noted that infiltrated wastewater would take a minimum of 4 months to reach the coastline, suggesting high virus and bacteria removal (OCEANICA PTY LTD: Memorandum 2004).

There is the possibility of potential cumulative ecological consequences of discharging TWW to the marine environment via groundwater discharge; however hydrodynamic near field modelling (CORMIX) and far field modelling (EFDC) being conducted by Worley Parsons have a demonstrated history of modelling impacts of discharges on coastal regions and an ability to model baroclinic mixing and exchange processes to enable predictions to be made about any potential cumulative ecological consequences associated with TWW infiltration.

10.3 CURRENT STATE OF KNOWLEDGE

The proposed recharge ponds are situated within the Safety Bay Sand of the Quidalup Dune System, approximately 600m inland from the coast. The Safety Bay Sand, consisting of fine to medium grained quartz sand and shell fragments, overlies calcareous sand and limestone of the Tamala Limestone, the formations together comprising the Superficial aquifer (Rockwater 2004).

Rockwater Pty Ltd investigated and reported to the Corporation on the potential for and consequences of treated wastewater infiltration into the soils. Field trials established the infiltration capability and numerical groundwater modelling was used to predict the impact on groundwater.

Rockwater reported the Safety Bay Sand at Alkimos to be generally unsaturated, the water table being deeper, within the Tamala Limestone, 5 – 10 m below ground level at the sites investigated. The Tamala Limestone was described as karstic in nature and having high permeability, groundwater flowing westward to discharge to the ocean. Groundwater salinity was said to grade from 500 mg/L TDS below the AWWTP site to 1,000 mg/L near the coast. Citing Davison 1995, Rockwater stated that nutrient concentrations were low, nitrate around 1 mg/L and phosphorous less than 0.03 mg/L.

Infiltration tests identified variable, moderate to high permeability in the study area. Phosphorous Retention Indices ranged from 2.1 mL/g to 130 mL/g.

Groundwater flow and solute transport modelling was carried out to:

Determine changes to groundwater levels;
Calculate nitrogen loads in groundwater discharging to the ocean;
Predict the fate of phosphorous; and
Establish whether the infiltrated wastewater could flow back to the planned Eglinton groundwater production bores.

Modelling predicted:

Groundwater rise of between 0.1 to 0.6 m, depending upon infiltration rates (up to 20 ML/d) and rate of concurrent groundwater abstraction;
Nitrogen-enriched groundwater would intersect the coast over a 1.5 km to 2 km section, at concentrations between 0.6 to 3 mg/L, contributing a load between 5 and 39 kg/d after 13 years of infiltration;
Phosphorous would not reach the coast for 28 years under worst case conditions, and after 100 years of operation, concentrations at the coast would be 7 to 8 mg/L, noting that actual concentrations would be much smaller; and
No possibility of groundwater beneath the infiltration ponds being drawn back towards the Eglinton bores.

10.4 PROPOSED INVESTIGATIONS

No additional hydrogeological investigations are planned, as part of the PER, for the purpose of predicting impact on the groundwater. The requirement for additional future investigation will be determined when the precise location and nature of infiltration is defined.

11. WATER QUALITY (MARINE)

11.1 OBJECTIVE

The objective of the proposal by the Water Corporation for the AWWTP is to be compatible with the Water Quality Management Framework (EPA 2005) and its Environmental Quality Objectives outlined in Perth's Coastal Waters; Environmental Values and Objectives (EPA 2000).

They are as listed:

- Maintenance of ecosystem integrity;
- Maintenance of aquatic life for human consumption,
- Maintenance of primary contact recreation values
- Maintenance of secondary contact recreation values
- Maintenance of aesthetic values
- Maintenance of industrial water supply values

The Water Corporation's specific objectives are to ensure:

- That wastewater discharges do not adversely affect marine environment values or the health, welfare and amenity of people and water uses, by meeting statutory requirements and acceptable standards; and
- The maintenance of the abundance, diversity, geographic distribution and productivity of marine flora and fauna, at species and ecosystem levels, through the avoidance or management of adverse impacts and improvement in knowledge.

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11.2 ASPECTS AND POTENTIAL IMPACTS

Establishment of a treated wastewater ocean outlet is an essential element of the AWWTP, although the regularity, frequency and volume of use will be dependent upon the terrestrial water recycling options employed in the short, medium and long-term. It is also proposed that treated wastewater be infiltrated into terrestrial basins adjacent to the AWWTP, seeping into the underlying groundwater. The groundwater bearing infiltrate will subsequently discharge into the marine environment.

The discharge to the marine environment of treated wastewater, whether directly from the outlet diffuser or via groundwater infiltration, will change marine water quality within the respective mixing zones, with the potential to impact on marine biota, the ecosystem and suitability of the marine waters for human use.

The Water Corporation believes that the potential environmental impacts at Alkimos can be readily assessed by comparison with the considerable body of research undertaken at existing WWTP and outlets.

11.3 GUIDANCES TO ASSESSMENT OF ENVIRONMENTAL FACTOR

The EPA has issued guidance to which the Corporation will have regard in investigating and reporting on aspects of the proposed AWWTP potentially impacting on the environment:

EPA (2000). Perth's Coastal Waters: Environmental values and objectives – the position of the EPA, a working document. February 2000. Report 17. Department of Environmental Protection, Perth WA.

The Corporation will also have regard to:

ANZECC/ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality.

11.4 CURRENT STATE OF KNOWLEDGE

11.4.1 Hydrogeology

Rockwater Pty Ltd investigated and reported (Rockwater 2004) to the Corporation on the potential for and consequences of treated wastewater infiltration at the AWWTP. Field trials established the infiltration capability and numerical groundwater modelling was used to predict the impact on groundwater. Citing Davison 1995, Rockwater stated that background groundwater nutrient concentrations were low, nitrate around 1 mg/L and phosphorous less than 0.03 mg/L.

Groundwater flow and solute transport modelling was carried out to predict impacts on the groundwater, including at the coast at the point of discharge to the marine environment. The Rockwater report provides calculated nitrogen concentrations and loads in groundwater discharging to the ocean and predicts the fate of phosphorous.

Modelling predicted:

Nitrogen-enriched groundwater would intersect the coast over a 1.5 km to 2 km section, at concentrations between 0.6 to 3 mg/L, contributing a load between 5 and 39 kg/d after 13 years of infiltration; and

Phosphorous would not reach the coast for 28 years under worst case conditions, and after 100 years of operation concentrations at the coast would be 7 to 8 mg/L, noting that experience elsewhere indicated that actual concentrations would be much smaller than the model predicted.

Rockwater (2004) state that the groundwater flows will enter the ocean through the intertidal zone, to be dispersed by the prevailing northerly current along the coast and near-shore water well mixed by swell and wind. Rockwater observes that the predicted quantity of nitrogen reaching the coast will be small relative to the naturally occurring nitrate reaching the coast in many other parts of the coastal plain.

This AWWTP proposal can also be compared to the recently decommissioned system at the Bunbury, where approximately 7ML/d was infiltrated into ponds located much closer to the shoreline than will be the case at Alkimos. At Bunbury, measurements showed faecal coliform levels along the adjacent shoreline to be well within the National guidelines for primary contact recreation.

11.4.2 Marine Water Quality

Perth's coastal waters are characterised by very low nutrient levels and high clarity. The low nutrient levels are due to the warm, nutrient poor Leeuwin Current and the lack of significant terrestrial inputs from a dry, geologically ancient land mass.

The Perth Coastal Waters Study (PCWS; Lord and Hillman, 1995) undertook water quality surveys in the region from Yanchep to Tims Thicket and west to the 100 m depth contour at 127 sites in winter (1993) and at 75 sites in summer (early 1994).

Background nutrient concentrations for nearshore (less than 25 m depth) and offshore (greater than 25 m depth) waters in northern (North Mole to Yanchep) and southern (Tims Thicket to North Mole) coastal areas are shown in **Table 11-1**. In summer there was a distinct increase in total nitrogen (TN), total Kjeldahl nitrogen (TKN) and dissolved inorganic nitrogen (DIN) from south to north.

Phytoplankton biomass, measured as chlorophyll a concentration, was higher nearshore in summer and winter for northern waters and higher nearshore in winter in southern waters. Offshore median background chlorophyll a values were less than 0.3 micrograms per litre (µg/L).

Table 11.1 Regional Water Quality Data

	Southern waters				Northern waters			
	Offshore		Nearshore		Offshore		Nearshore	
	summer	winter	summer	winter	summer	winter	summer	winter
FRP	2.6	2.3	2.2	3.0	1.8	3.8	3.1	4.5
TP	5.4	11.0	6.1	12.5	7.8	8.0	12.1	12.2
NH4+	2.2	-	2.2	-	9.8	-	9.5	-
NO3,2-	1.5	1.8	1.6	2.5	3.0	3.6	3.2	3.7
DIN	5.1	-	4.2	-	13.0	-	13.0	-
TKN	112	214	136	224	204	216	257	268
TN	115	217	138	227	206	220	265	270
Chlorophyll a	0.20	0.18	0.20	0.44	0.29	0.22	0.41	0.34

Note: All data are median values, in µg/L. Values for 'offshore' waters (waters deeper than 25m) have been separated from 'nearshore' waters (waters shallower than 25m) (source Lord & Hillman 1995)

Preliminary assessment of the AWWTP ocean outlet proposal has been performed for the Corporation by Oceanica Consulting (Oceanica 2004). The initial environmental risk assessment was undertaken by comparing Ocean Reef outlet with the Alkimos proposal, as the Beenyup WWTP and its associated Ocean Reef outlet is probably the most similar to the Alkimos proposal, in terms of treated wastewater quality, flows and receiving marine environment.

Oceanica Consulting concluded that marine environmental impacts at Alkimos are likely to be similar or smaller than those at the Beenyup WWTP Ocean Reef outlet. The key factors considered in arriving at that conclusion, were:

There is a more energetic marine environment at Alkimos (Ocean Reef outlet has high reef partially surrounding it, which reduces flushing);

It is likely that the diffuser will be located in deeper water, thus improving initial dilution;

The diffuser will be located further offshore, further reducing an already negligible risk of beach contamination and interaction with recreational activities;

The flow of treated wastewater is smaller, in the short and medium-term;

Improvements in level of treatment due to ongoing improvements in treatment technologies mean concentrations of nitrogen are likely to be lower; and

The Alkimos outlet will not be located in a marine park.

11.4.3 Coastal Hydrodynamics

Oceanographic and modelling studies undertaken as part of Perth's Long-term Ocean Outlet Monitoring (PLOOM) program have shown that northward, shore parallel, wind-driven currents dominate at the outlets.

In the early 1980s, the Water Corporation commissioned Curtin University (then WAIT) to undertake an oceanographic measurement programme and a modelling study for the proposed outlet (Andrew *et al*. 1983; Hunter 1985).

11.5 PROPOSED INVESTIGATIONS

11.5.1 Water Quality Characterisation

Oceanica Consulting has been appointed to contract, supervise, interpret and report a water quality characterisation study to a scope of work specified in their report 427/5 of January 2005, which will be provided to the EPA with this scoping document.

The objectives of the study are to:
Characterise the marine water quality conditions existing in the Alkimos region prior to the construction or operation of the proposed WWTP Ocean Outlet;
Evaluate the potential effects of the treated wastewater discharge on the marine receiving environment;
Contribute to the development an Environmental Quality Management Framework for the WWTP Ocean Outlet; and
Contribute to baseline data for use in the subsequent development of an appropriate monitoring programme.

Key tasks identified by Oceanica are:

1 Nutrient-Related Water Quality Surveys: undertaken at each of the 6 shoreline sites, 6 near-shore (≈9.5-12.5 m) and 6 offshore (≈14-15.5 m) sites at monthly intervals over the period December 2004-April 2005.
2 Human Health-Related Water Quality Surveys: undertaken at monthly intervals over summer 2004-2005 (December-April) at each of the 6 shoreline sites, 6 near-shore and 6 offshore sites.
3 Preparation of a Water Quality Characterisation Report: to provide details of the field methods, analytical techniques, results, and a detailed description and interpretation of the water quality conditions over the study period. The monitoring results will be presented graphically to assist with interpretation. All the data collected during the monitoring programme will be tabulated and presented in the report.
4 Design a Baseline Water Quality Monitoring Programme: to provide appropriate baseline water quality data prior to the construction and operation of the proposed WWTP and ocean outlet.

The water quality parameters to be measured are listed in **Table 11-2**.

Table 11.2 Water Quality Parameters to be Measured at Alkimos

Nutrients	Primary Production	Microbial Indicators
Total Phosphorus	Chlorophyll-*a*	Thermo-tolerant Coliforms
Filterable Reactive Phosphorus	Phaeophytin	Faecal Streptococci
Total Nitrogen		
Ammonium Nitrogen		
Nitrate + Nitrite Nitrogen		

The data will be analysed to address the following:
Spatial variation in water quality conditions across the study area – shoreline, near-shore and offshore sampling sites;
Seasonal variation in water quality conditions;
Comparison of the water quality parameters with the appropriate ANZECC/ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality and relevant Western Australian Guidelines (e.g. Revised Environmental Quality Criteria Reference Document (Cockburn Sound), Environmental Protection Authority 2004);
Compliance of bacterial water quality conditions for bathing and for shellfish harvesting; and
Underpin the development of draft Environmental Quality Criteria (EQC) for waters adjacent to the proposed Alkimos Ocean Outlet.

11.5.2 Hydrodynamic Modelling and Outlet Diffuser Design

Oceanica Consulting has been appointed to contract, supervise, interpret and report a hydrodynamic modelling study to characterise the likely dilution, advection, and far-field dispersion of the outlet effluent plume.

The hydrodynamic modelling will be used to:
Feedback into the engineering design to ensure that the concept design meets environmental requirements (e.g. treated wastewater does not reach the shoreline and adequate initial dilution occurs);
Calculate flushing time of water immediately adjacent to the coast to assist in assessing impacts of wastewater infiltration to groundwater; and
Establish the boundaries at which ecological, toxicological and human health criteria will be met based on current EPA draft guidelines.

The hydrodynamic model will use well established mathematical equations to model the movement of water under the influence of various forcings (e.g. wind, surface elevation differences, density differences). The model relies on the collected bathymetric, oceanographic and meteorological information for calibration and validation.

The Corporation intends using existing current-meter and wind data, collected by Dr John Hunter and others at Alkimos in 1982/83, to calibrate and validate the model output. At this stage, there are no plans to undertake further oceanographic studies.

The Corporation has established meteorological stations at Alkimos, which have been collecting wind data since March 2002. Representative 12 months of continuous data from the western-most "Hill" station, which is about 1 km from the coast, will be used in the model.

The Corporation and the Department of Planning and Infrastructure have collected bathymetry in the region.

The model will be run for a variety of cases including initial and capacity flow conditions for the outlet as well as varying discharge water quality based on likely ranges of treatment and water recycling and/or recovery schemes. The final model presentation will examine 'worst case' meteorological and oceanographic conditions; namely capacity flow under calm conditions with onshore flow. It is intended that the model presentation includes one full year of simulation to enable concentrations of materials in the effluent to be depicted in a statistical manner that is related to accepted water quality criteria.

The concept diffuser design will be prepared by Consulting Environmental Engineers (CEE). The modelling will be used to confirm that the design will achieve appropriate initial dilutions (i.e. greater than 1:100 times) and dispersion (i.e. away from beaches and reefs).

12. OTHER ENVIRONMENTAL MATTERS

In planning, establishing and operating the AWWTP, the Corporation will have regard to a range of other important environmental matters, which are not considered *Relevant Environmental Factors* for the purpose of scoping the PER. They are not considered relevant for detailed formal assessment and control due to their relative insignificance in the context of the overall urban development in the north-western corridor, or due to being appropriately managed through other policies, instruments and statutory requirements. These factors will, however be addressed within the PER to the extent that their relative significance will be explained and relevant management processes will be identified. These factors include:

1. Subterranean fauna (Stygofauna)
2. Excavation of Land (Karstic Formations)
3. Aboriginal ethnography and archaeological sites;
4. Off-site noise and vibration.
5. Off-site public risk
6. Visual amenity of the treatment plant;
7. Greenhouse gases/environmental offsets; and
8. Disposal of Treated Wastewater/Re-use

The reasons for not considering them relevant environmental factors are summarised in *Table 12-1* overpage.

Table 12.1. Summary Table of Other Environmental Factors

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Biophysical						
Fauna (subterranean) Stygo-fauna	Within Alkimos Lot 101, the proposed buffer zone and in particular in the vicinity of the infiltration pons.	The Water Corporation seeks to maintain the abundance, diversity, geographic distribution and productivity of stygofauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Stygofauna are known to be present within the unconfined aquifer of the coastal plain near the proposed site for the WWTP and the proposal to infiltrate treated wastewater will impact the quality of the underlying groundwater to some degree of significance. Treated wastewater is intended not to exceed 10 mg/L nitrogen in an area where background nutrient levels in the area are about 1 mg/L nitrate and less than 0.03 mg/L phosphorous. In the context of the WWTP being sited in the north-western urban development corridor, within which significant impacts on groundwater from domestic fertiliser use, urban drainage, terra-forming of the landscape and commercial and industrial activities will occur, the WWTP infiltration is unlikely of to represent a significant impact to Stygo-fauna.	The Corporation intends using in-house expertise to investigate the presence of stygo-fauna. The study, will include a desktop study of previous surveys and knowledge of stygo-fauna within region and the immediate area of the project, including consultation with: • CALM; • WA Museum; and • Tertiary Institutions; An assessment will be made of the relative risk of significant impact to stygo-fauna the project presents. The results of the investigation will be presented in the PER.	If ecologically significant stygo-fauna are identified in the area, the Water Corporation will endeavour to manage its land to minimise the project impact on stygo-fauna.	The relative risk to stygo-fauna from infiltration at the AWWTP is unlikely to be significant when compared with the cumulative urban impacts. Therefore stygo-fauna is not considered a Relevant Environmental Factor for assessment in the PER. However, the Water Corporation will undertake baseline studies to establish the presence, abundance, diversity and distribution of stygo-fauna prior to and during the PER public review period to validate this assumption.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Geophysical						
Excavation of land (Karstic Formations)	Site A or B, Ocean Outlet Pipe	To determine and describe the potential impact of disturbance to Karstic limestone.	Disturbance of 47 Ha of limestone formation for the excavations necessary to establish the AWWTP may impact karstic formations. The AWWTP will be sited in the north-western urban development corridor, within which significant impacts on other karstic formations are likely to occur. These impacts emanate from the development of transport (road and rail) corridors and terra-forming of the landscape for urban, commercial and light industrial activities. The construction of the AWWTP is unlikely of to represent any significant relative risk of impact to karst formations in this context.	Geotech drilling to identify the presence of caverns or voids for the purpose of construction methodology will be conducted in approximately six months.	The area disturbed for the AWWTP (47ha) is such a small proportion of the 1,332 ha of residential development and 232 ha of other development land uses within the Alkimos-Eglinton regional metropolitan urban coastal area that it is not of itself significant.	The impacts on karstic formations due to excavation to establish the AWWTP, while presenting a geotechnical stability issue to be considered in the plant design and construction, is not considered a key Relevant Environmental Factor for assessment in the PER.
Excavation for WWTP and launching pad for ocean outlet	Lot 101 Intersection with unconfined aquifers, water courses etc.	To reduce the amount of disturbance to the land in terms of clearing, excavation and any water courses and underground aquifers.	The excavations required for the WWTP may encounter caverns, vesicles and vughs within the Tamala limestone strata; however it is unlikely to reach the ground water level..	Geotechnical investigations will be undertaken, in addition to those already received, to identify and categorise water courses and underground aquifers and karstic limestone. It will also identify the water flow rates through the rock and the potential for passage to the ocean. The Water Corporation will investigate the mechanism of how ground water is potentially discharged into the ocean through the ground strata that is potentially karstic in nature.	Review of recommendations of the Rockwater report and identify actions to be taken, if required. Review of all relevant reports on the respective area and appropriate action to be taken where necessary. If water courses or unconfined aquifers are exposed during excavation the void will be back filled with crushed limestone or adequate drainage channels will be installed.	It is unlikely that any of the WWTP works will be within the water table. Therefore the significance is extremely low. The impacts on karstic formations due to excavation to establish the AWWTP, while presenting a geotechnical stability issue to be considered in the plant design and construction, is not considered a key Relevant Environmental Factor for assessment in the PER.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Social Surroundings						
Aboriginal ethnographical and archaeological sites	Project Site	To ensure that changes to the biophysical environment resulting from the proposal do not adversely affect historical and cultural associations within the area and comply with relevant heritage legislation	Possible ethnographical and archaeological conflicts with the proposed development site(s).	An ethnological survey and an archaeological survey will be conducted as soon as a WWTP site has been chosen and the Water Corporation knows how much and which land is going to be cleared.	Provisions of the Aboriginal Heritage Act (AHA) will be fully complied with to the satisfaction of the Department of Indigenous Affairs (DIA).	Consultation and surveys will be undertaken and any issues raised will managed to the satisfaction of the DIA as required by the AHA. The findings will be reported in the PER. Aboriginal ethnographical and archaeological issues are not considered Relevant Environmental Factors for assessment.
Off-site noise and vibration.	WWTP zone of noise and vibration influence	To protect the amenity of surrounding areas from noise and vibration impacts resulting from activities associated with the proposal, by ensuring that the noise levels and vibration meet statutory requirements and acceptable standards.	WWTP site preparation may necessitate blasting and crushing, producing vibration and noise. Pumps and fans at the operational WWTP will generate noise.	Professional advice will be obtained to establish that construction and operational noise and vibration will not significantly impact off-site.	Both sites A and B are in swales surrounded by dunes which will reduce the noise vibration from the WWTP and Corporation is currently investigating using noise baffles to reduce noise problems if they arise.	Noise and vibration will be managed to comply with the Environmental Protection (Noise) Regulations 1997. Noise and vibration are not considered Relevant Environmental Factors for assessment in the PER
Off-site public risk.	WWTP zone of risk influence	To ensure that the risk from the proposal is as low as reasonably achievable and complies with acceptable standards and EPA criteria.	Fly-rock from blasting during site preparation. Chemicals stored and used within the operational WWTP.	The extent of secure site will be determined during detailed design which will be presented in the PER.	The WWTP site will be developed in advance of any urban development and a secure area will be established around the construction site before blasting. A substantial, permanent buffer zone will separate the WWTP site and future surrounding land-uses. Chemicals will be stored and used in accordance with EPA Guidance No. 2 (July 2000).	The dimensions of the secure site and the subsequent buffer zone will be calculated to ensure an acceptable level of risk is attained. The findings will be reported in the PER. Off-site public risk is not considered a Relevant Environmental Factor for assessment in the PER.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Visual amenity of the treatment plant.	WWTP zone of visual influence	To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable.	Visibility of the WWTP in the landscape and within the vista between urban areas and the coast	Town planners and landscape designers are providing advice on WWTP layout, design and material selection. The existing view-shed assessment will be reviewed during WWTP design finalisation.	Sites A and B, respectively, are within a natural valley and an excavated basin, therefore substantially concealed from horizontal sight-lines. A substantial, permanent amenity buffer zone will separate the WWTP site and surrounding land, and therefore mitigate against direct view from surrounding developments. Architectural design features will be applied to the WWTP having regard to functionality and aesthetics when viewed by visitors overlooking the plant from within the surrounding buffer zone.	The results of view-shed analysis will be presented in the PER. The visual amenity likely to be impacted beyond the buffer zone is not considered to be significant and therefore is not a Relevant Environmental Factor for assessment in the PER.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Pollution Management						
Greenhouse gases/Environmental Offsets	AWWTP Site	To reduce green house gases (GHG) where possible.	Energy consumption of the wastewater collection and treatment system, with resultant GHG emissions.	No further investigations	The Corporation's estimate of greenhouse emission from electrical use at Alkimos for treatment of sewage at full capacity of 160ML/d beyond year 2050 is calculated at between 20-30,000 t/yr. This is only 30% of the EPA threshold of 100,000 t/yr cited in S.2.9 of the EPA referral form as being a substantial greenhouse gas emission. Offsets are low in the hierarchy of management issues as the Water Corporation will be using "state of the art" technology to build the WWTP in terms of energy efficiency, plus the WWTP will operate within a gravity fed collection and disposal system.	The GHG implications of the AWWTP are below the EPA threshold, will be described in the PER and the Water Corporation has as its fundamental design criteria a gravity solution to minimise as far as practicable the dependence on energy for conveyancing of sewage and disposal of treated wastewater. The water Corporation will as far as practicable source its residual energy requirements from low GHG and/or renewable sources. GHG and offsets are not considered a Relevant Environmental Factor.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Significance
Pollution management						
Disposal of treated Wastewater including Re-use options	At the infiltration ponds, ocean outlet pipe, aquifer recharge and irrigated horticulture sites, where maintenance of groundwater ecosystems including wetlands and caves is undertaken, where infiltration or injection of water into a groundwater aquifer and its re-abstraction occurs.	1) To clearly outline explain in the PER document how the proposed WWTP reuse and disposal options are consistent with the Government commitments made in the State Sustainability Strategy to reuse 20% of TWW by 2012 and the waste water 2040 strategy. 2) To clearly explain in the PER the alternative TWW reuse and management options considered and provide justification for taking our preferred options. 3) Ensure that the PER is a strategic document that evaluates the range of TWW management options to avoid and minimise environment in the long term. 4) Outline the investigations to be carried out to evaluate the relative environmental merits and problems associated with the TWW management options considered.	Marine pollution from ocean outlet diffuser, microbiological, nutrient and other contaminant impacts on MAR groundwater resources. The societal and public health related acceptability of using managed aquifer recharge (MAR) with treated wastewater for (a) improvement of groundwater quality, (b) horticultural irrigation and environmental benefits, (c) integrated water management in new residential areas, and (d) to increase public drinking water supplies	The Corporation will conduct further investigations into meeting the commitments that are consistent with the State Sustainability Strategy to reuse 20% of TWW by 2012 and the waste water 2040 strategy. These will be clearly explained and outlined in the PER.	A sustainable approach to the water cycle dictates that the precautionary principle be employed where there is the risk of serious or irreversible environmental damage, and that intergenerational equity applies, to ensure that the health, diversity and productivity of the environment be maintained or enhanced for the benefit of future generations. This is also required by the 2003 amendments to the Environmental Protection Act 1986. The Corporation may need to further treat its waste water via reverse osmosis, chemical disinfection, and mechanical filtration to reduce the level of nutrients and harmful bacteria in the TWW to enable the environmental benefits of clean and easily available water re-use resource to be realised. However, ocean discharge will always need to be available as an option, irrespective of reuse option chosen, for disposal of the concentrate from reverse water osmosis water treatment and for emergency discharges during power shortages.	The significance of the options available to the Corporation (i.e. ocean discharge and multiple TWW reuse opportunities) depends upon the options available. These are currently constrained by technical, policy and societal acceptability. The Water Corporation will investigate and report on potential re-use opportunities in the PER. The Water Corporation regards the opportunities to develop and implement the acceptable re-use of a large proportion of the AWWTP treated wastewater as essential, and will use this assessment to put these options before the EPA and public through the PER process. However, the Water Corporation does not consider the acceptability (or otherwise) of wastewater re-use, or the details of a specific re-use option a Relevant Environmental Factor directly affecting the approval of the proposal.

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13. REFERENCES AND RESOURCES

Andrew J.W., Dixon C.J., Edmett T.A., Penrose J.D., Rye P.J., Vowles D.J., Wells J.B., and West O.G. (1983). A study of inshore water movement near the Alkimos wreck site, Perth Western Australia. Western Australian Institute of Technology, December 1983.

ATA Environmental (2003). MRS Amendment 1029/33: Alkimos Eglinton Environmental Review. Prepared for LandCorp and Eglinton Estates Pty Ltd, September 2003.

Auret T. (2004). Alkimos Strategic Planning Background (Draft Report). Tim Auret, Town Planning Consultant, October 2004.

Australian & New Zealand Environment and Conservation Council (ANZECC), 1992. Australian Water Quality Guidelines for Fresh and Marine Waters. Australian & New Zealand Environment and Conservation Council.

Australian & New Zealand Environment and Conservation Council (ANZECC), 2000. Australian and New Zealand Guidelines for Fresh and Marine Waters (Draft). Australian & New Zealand Environment and Conservation Council.

Bamford, M.J. (1992). The impact of fire and increasing time after fire upon *Heleioporus eyrei*, *Limnodynastes dorsalis* and *Myobatrachus gouldii* (Anura: Leptodactylidae) in Banksia woodland near Perth, Western Australia. Aust. Wildl. Res. 19: 169-78.

Bamford M.J. & A.R. (2005). Study Proposal - Fauna Assessment: Alkimos Wastewater Treatment Plant. December 2004.

Bamford M.J. & A.R. (2005). E-mail, interim advice regarding the design of terrestrial fauna studies appropriate to the investigation of the proposed Alkimos WWTP.

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). The New Atlas of Australian Birds. Royal Australasian Ornithologists Union, Melbourne.

Borgas M. (2004a). Alkimos Ponding Study (Draft). CSIRO Atmospheric Research, June 2004.

Borgas M. (2004b). Alkimos Emissions and Dispersion Study: Discussion Document (Draft). CSIRO Atmospheric Research, September 2004.

Borgas M. (2005). Alkimos Emissions and Dispersion Estimates. Prepared by CSIRO Atmospheric Research for Consulting Environmental Engineers, February 2005.

Bush, B., Maryan, B., Browne-Cooper, R. and Robinson, D. (1995). A guide to reptiles and frogs of the Perth region. University of Western Australia Press.

Christidis, L. and Boles, W.E. (1994). The Taxonomy and Species of Birds of Australia and its Territories. RAOU, Monograph 2.

Cogger, H.G.,Cameron, E.E., Sadlier, R.A. and Eggler, P. (1993). The Action Plan for Australian Reptiles. Environment Australia, Canberra

Consulting Environmental Engineers (2002). Report on Buffer Zone for Proposed Future Alkimos Wastewater Treatment Plant. June 2002.

Consulting Environmental Engineers (2003). Report on Buffer Zone for Proposed Future Alkimos Wastewater Treatment Plant, Version 2. November 2003.

Consulting Environmental Engineers (2004). Report on Buffer Zone for Proposed Future Alkimos Wastewater Treatment Plant, Version 7. April 2004

D.A. Lord & Associates (1997): Recreational Values of the Nearshore Marine Environment between Burns Beach and Yanchep Beach in the Perth Metropolitan Area. Report to the Water Corporation, October 1997.

DAL Science & Engineering Pty Ltd (2004a). Perth Long-term Ocean Outlet Monitoring (PLOOM) 3.2 2003/2004 - Metals and Pesticides Surveys at Ocean Reef and Sepia Depression and 12–year Review of the Ocean Reef Programme. Report to Water Corporation, April 2004

DAL Science & Engineering Pty Ltd (2004b). Perth Long-term Ocean Outlet Monitoring (PLOOM) 3.1 2002/2003 – Annual Report. Report No. 299/1, May 2004.

Department of Environmental Protection (2002). Odour Methodology Guideline. Department of Environmental Protection, Perth, Western Australia, March 2002.

Duncan, A., Baker, G.B. and Montgomery, N. (1999). The Action Plan for Australian Bats. Environment Australia, Canberra.

EPA (2000). Perth's Coastal Waters: Environmental values and objectives – the position of the EPA, a working document. February 2000. Report 17. Department of Environmental Protection, Perth WA.

Environmental Protection Authority (2002a). Guidance for the Assessment of Environmental Factors: Assessment of Odour Impacts from New Proposals. Guidance No. 47, March 2002.

Environmental Protection Authority (2002b). Guidance for the Assessment of Environmental Factors: Guidance Statement for Minimising Greenhouse Gas Emissions. Guidance No. 12, October 2002.

Environmental Protection Authority (2003). Guidance for the Assessment of Environmental Factors: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia. Guidance No. 54, December 2003.

Environmental Protection Authority (2004a). Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetations Surveys for Environmental Impact Assessment in Western Australia. Guidance No. 51, June 2004.

Environmental Protection Authority (2004b). Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance No. 56, June 2004.

Environmental Protection Authority (2004c). Guidance for the Assessment of Environmental Factors: Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment. Guidance No. 29, June 2004.

Environmental Protection Authority (2004d). Environmental Offsets. Position Statement No. 9 (Preliminary), July 2004.

Environmental Protection Authority (2004e). Towards Sustainability. Position Statement No. 6, August 2004.

Environmental Protection Authority (2004f). Principles of Environmental Protection. Position Statement No. 7, August 2004.

Environmental Protection Authority (2004g). Revised Environmental Quality Criteria Reference Document (Cockburn Sound): A supporting document to the Draft State Environmental (Cockburn Sound) Policy. October 2004.

Environmental Protection Authority (2005). Environmental Quality Criteria Reference Document for Cockburn Sound (2003-2004). A Supporting Document to the State Environmental (Cockburn Sound) Policy 2005. Environmental Protection Authority Report 20, January 2005.

Environodour Australia Pty Ltd (2004). Odour Intensity Study. Report to the Western Australia Water Corporation, September 2004.

Garnett, S.T. and Crowley, G.M. (2000). The Action Plan for Australian Birds 2000. Environment Australia, Canberra.

Government of Western Australia (2000). Bush Forever: Keeping the Bush in the City: Volumes 1 and 2. Department of Environmental Protection, Perth.

Government of Western Australia (2004). Draft State Environmental (Cockburn Sound) Policy, Draft for public comment. October 2004.

How, R.A. and Shine, R. (1999). Ecological traits and conservation biology of five fossorial "sand-swimming" snake species (*Simoselaps*: Elapidae) in south-western Australia. Journal of Zoology, London. 249: 269-282.

Hunter J.R. (1985). Data analysis and predictive modelling for the proposed Alkimos wreck site outfall. Western Australian Institute of Technology, December 1985.

LandCorp – Eglinton Estates Pty Ltd (2003). MRS Amendment 1029/33, Alkimos-Eglinton Structure Plan: Planning Context. September 2003.

Lee, A.K. (1995). The Action Plan for Australian Rodents. Environment Australia, Canberra.

Lemmon,T.C., Gee, R.D., Morgan, W.R. and Elkington, C.R. (1979) Important Geological Sites in the Perth and Southwestern Area of Western Australia – a report on their scientific significance and future protection. Geological Society of Australia Incorporated, Oct 1979.

Mace, G. and Stuart, S. (1994). Draft IUCN Red List Categories, Version 2.2. Species; Newsletter of the Species Survival Commission. IUCN - The World Conservation Union. No. 21-22: 13-24.

Maxwell, S., Burbidge, A.A. and Morris, K. (1996). Action Plan for Australian Marsupials and Monotremes. Environment Australia, Canberra.

Murdoch University (2000). Proposed Alkimos Wastewater Treatment Plant: Biodiversity Management Plan. Prepared for the Water Corporation by the students of N319: Murdoch University, September 2000.

Oceanica (2004a). Bunbury Wastewater Treatment Plant Ocean Outfall Monitoring Programme. Annual Report (2003-2004). August 2004.

Oceanica Consulting Pty Ltd (2004b). Alkimos WWTP: Marine Studies for Environmental Impact Assessment. Report No. 427/1, prepared for the Water Corporation by Oceanica Consulting Pty Ltd, November 2004.

Oceanica Consulting Pty Ltd (2004c). Alkimos Marine Studies Programme, Detailed Project Brief: Phytoplankton Surveys (draft). Report No. 427/6, prepared for the Water Corporation of Western Australia by Oceanica Consulting Pty Ltd, December 2004.

Oceanica Consulting Pty Ltd (2005). Alkimos Marine Studies Programme, Detailed Project Brief: Water Quality Characterisation (draft). Report No. 427/5, prepared for the Water Corporation of Western Australia by Oceanica Consulting Pty Ltd, January 2005.

Oceanica Consulting Pty Ltd (2005). Alkimos Marine Studies Programme, Detailed Project Brief: Benthic Habitat Mapping (draft). Report No. 427/7, prepared for the Water Corporation of Western Australia by Oceanica Consulting Pty Ltd, January 2005.

Roberts Day & RPS Bowman Bishaw Gorham (2004). Alkimos Waste Water Treatment Plant: Site Location Assessment.

Rockwater (2004). Hydrogeological Investigations at the Proposed Alkimos WWTP Site. Report for Water Corporation, October 2004.

Semeniuk V & C, Research Group (2004). Assessment of the Alkimos coastal area: Stage 1 – the onshore areas, August 2004. Report to Syrinx Environmental P/L for the Water Corporation, 25 August 2004.

Semeniuk V & C, Research Group (2004). A description of the coastal and marine zones of the Alkimos area, October 2004. Report to Syrinx Environmental P/L for the Water Corporation, October 2004.

Strahan, R. (1995). The Mammals of Australia. Reed New Holland, Sydney.

Thompson G. (2004). Vertebrate fauna species likely to be found in the Alkimos-Eglinton area, with a notion on significant fauna species. Report to ATA Environmental.

Trudgen, M. & Keighery, B. (1990). Report of the Flora and Vegetation of the Alkimos Area and Conservation Issues Affecting It. Unpublished report prepared for LandCorp.

WA Museum. (2001). Checklists of the Vertebrates of Western Australia. Records of the WA Museum Supplement No. 63.

Water Corporation of Western Australia (2000). Bunbury: Proposed ocean outlet for treated wastewater. Public Environmental Review. October 2000.

Water Corporation of Western Australia (2004). Alkimos Wastewater Treatment Plant: Wastewater disposal strategy and proposed ocean outlet Referral Document. July 2004.

Western Australian Planning Commission (2003). Metropolitan Region Scheme Amendment No. 1029/33: Alkimos-Eglinton. Amendment Report, September 2003.

Weston A.S. (2004). Comparison of Significance of Vegetation in Buffer Zones: Alkimos Waste Water Treatment Plant Site Location Assessment. Prepared for Bowman Bishaw Gorham, 26 April 2004.

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APPENDIX A
FIGURES

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