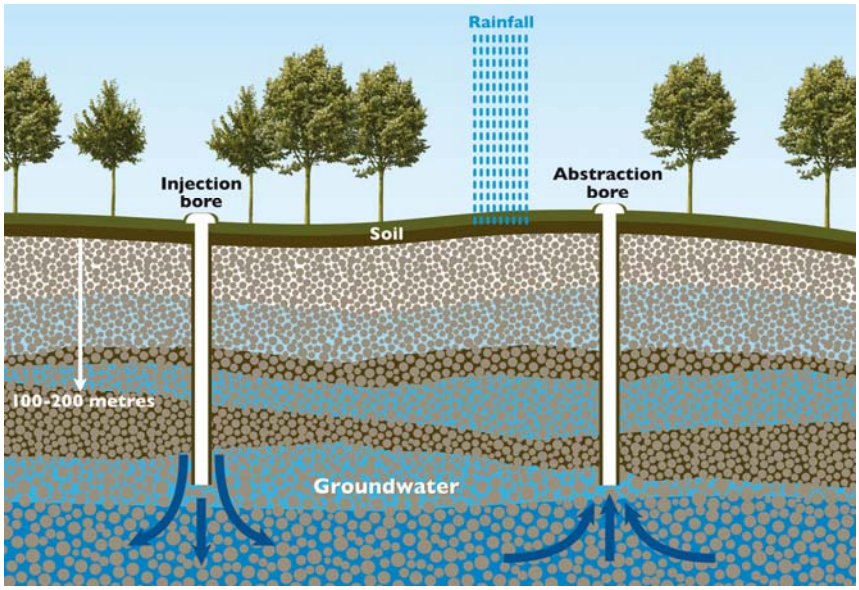
WATER CORPORATION

Australian Government Water Fund
Water Smart Australia

Supplementary Document to the Project Referral (under s.38 (1))

Groundwater Replenishment Trial

March 2008



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1.0 Introduction

Groundwater replenishment is the "deliberate infiltration or injection of highly treated water into the aquifer and refers specifically to the potential public future drinking water source" (IAA, 2007). The Water Corporation distinguishes groundwater replenishment (GWR) from Managed Aquifer Recharge (MAR) by the level of treatment that the water receives prior to infiltration or injection into the groundwater and its end-use; MAR refers more generally to "immediate or deferred beneficial uses" (IAA, 2007). Perth is an ideal environment to consider groundwater replenishment or MAR due to extensive groundwater systems underlying the area. Groundwater replenishment could provide up to 100GL/yr of Perth's drinking water supplies in the long term.

The Water Corporation is proposing to undertake a Groundwater Replenishment Trial (the Trial) to inject advanced tertiary treated wastewater into groundwater in an area of low risk to human health and the environment. The proposed process will take up to 7.5 ML/day of secondary treated wastewater from Beenyup Wastewater Treatment Plant (WWTP), use an advanced tertiary treatment process to treat the water further to a very high standard and then inject up to 5 ML/day into the Leederville aquifer. The purpose of the Trial is to build knowledge of the technical, health, environmental and social issues associated with groundwater replenishment and collect sufficient information to build community and regulator confidence that groundwater replenishment is a safe, viable and sustainable drinking water source option. The Trial will also provide information to support a future assessment of an indirect drinking water scheme through groundwater replenishment.

The Trial is being overseen by the Department of Health (DoH), Department of Water (DoW) and Department of Environment and Conservation (DEC). The Agencies have executed an Inter Agency Agreement (IAA), provided in Appendix 1, to assist the Water Corporation to progress the Trial. An Inter Agency Working Group (IAWG) has been established to deliver the commitments of the IAA, including determination of water quality guidelines that will protect health and environmental objectives, clarification of information requirements and evaluation criteria for the Trial based on definition of the issues that the Trial must address.

In addition to this Inter Agency approach, the Environmental Protection Authority (EPA) advised the Water Corporation in October 2006 (EPA Letter, 20 October 2006) that a risk assessment and mitigations strategy and communications strategy must be developed and evaluated by the DoH and DoW. In consultation with both Agencies, the Water Corporation has now finalised a communications strategy and developed the risk assessment and mitigation process that provides the basis for the risk management framework.

The DoH and DoW have provided their evaluation regarding the Trial to date in Appendix 9. In their letter, the DoH states that it "agrees with the conclusions that the risks to public health of undertaking the Trial are low, but notes that the Water Corporation will still need approval from the DoH prior to commencing injection" and notes that the DoH will monitor performance during the operation of the Trial to ensure that the DoH requirements are being met. It also states that it is "satisfied that appropriate stakeholder consultation has taken place and will continue to occur during the Trial".

The DoW note that they have been consulted during the definition of the scope and objectives of the Trial, provided direction regarding the risk management framework and assessment process that has been applied and after review of the Water Corporation's risk assessment for the Trial, considers that the process applied meets the DoW's requirements. The DoW understands that risk will continue to be assessed through the design, construction and commissioning stages and that injection will not commence without DoH approval and the confirmation that the risks are low. The DoW has also advised that they are satisfied that the appropriate stakeholder consultation has occurred to date and will continue during the Trial. The DoW concludes its evaluation by stating that "it is the Department's opinion that, with regard to the environmental and water resource management issues, the EPA's requirements (EPA Letter, 20 October 2006) to allow a Level of Assessment of "Not Assessed" have been met".

1.1 Information about the Proponent

Water Corporation provides water and wastewater services to Perth and hundreds of towns and communities spread over 2.5 million square kilometres of Western Australia. The Corporation also

provide drainage and irrigation services to thousands of households, businesses and farms across the state. Water Corporation holds many Wastewater Treatment Plant licences with the DEC.

The Water Corporation has an environmental policy and operates to an environmental management system which enables the systematic identification of environmental risks, setting of targets and development of environment improvement plans to reduce risks and ensure its activities are sustainable. The Water Corporation is heavily involved with a diverse range of environmental programs and ongoing sponsorship programs.

1.2 Context of the Proposal

In 2003, the State Government developed the "*State Water Strategy for Western Australia"*. The Strategy recommended that some of the State's water requirements should be met through using recycled water and subsequently proposed that this be investigated as part of a multi-faceted approach to water management. The State Water Strategy set a target of recycling 20% of treated wastewater by 2012 through large scale schemes for a range of uses, including possible residential uses. The Strategy recognises that augmenting depleted groundwater levels through injection or infiltration of highly treated wastewater (recycled water) had the potential to provide the greatest triple bottom line benefit.

In April 2005 the Water Corporation released its Source Development Plan for the Integrated Water Supply Scheme (Water Corporation, 2005) which recognised that storing high quality recycled water in groundwater supplies could provide a drinking water source option in the future. This option is now known as groundwater replenishment.

Using recycled water as a drinking water source may allow for new water source developments to be deferred, wastewater disposal to the marine environment to be reduced and high quality recycled water to be retained for high-value uses. The option to use of recycled water as a drinking water source also has the potential to free up other water sources for public and private use and to restore water levels in lakes, rivers and wetlands and provide water for vegetation (WRC, DEP, DoH, 2002).

In October 2005 the EPA assessed implementing MAR in the Perth metropolitan area amongst various other options for recycling and presented the findings in the "Strategic Advice for Managed Aquifer Recharge using Treated Wastewater on the Swan Coastal Plain" (Bulletin 1199, October 2005). The EPA assessment identified issues associated with establishing a MAR scheme and provided advice on approvals required to progress to a full MAR or groundwater replenishment scheme. In summarising its assessment, the EPA stated:

> "The EPA supports further investigation of managed aquifer recharge (MAR) on the Swan Coastal Plain, while advocating a precautionary approach to ensure that the environment and public health are protected. A staged approach is recommended, starting with trials and projects of low risk. Given the lack of experience with MAR on the Swan Coastal Plain to date, and the site-specific nature of transport and attenuation of contaminants, the EPA expects that trials will be necessary prior to the implementation of any large scale MAR scheme." (EPA, 2005)

Accordingly, the Water Corporation have developed the Groundwater Replenishment Trial.

1.3 Legislative Framework

The accompanying form is the formal referral submission of the Groundwater Replenishment Trial under section 38 of the *Environmental Protection Act 1986*. This project proposes an alternative discharge stream for up to 7.5 ML/day of advanced treated secondary wastewater from Beenyup WWTP. Beenyup WWTP is a prescribed premise, licensed under Category 54 of Schedule 1 of the *Environmental Protection Regulations* (1987) (licence number L7882/1991/11) for treatment of 120 ML/day. It is envisaged that the GWR plant will be individually licensed under Category 54, discharging advanced tertiary treated wastewater to the Leederville aquifer.

The environmental issues relating to the construction and operation of the Trial can be managed under Part V of the *Environmental Protection Act 1986*. A works approval application has been submitted to the DEC concurrently with this referral. Assuming that a works approval will be granted, a licence application will be submitted when compliance with the works approval conditions is confirmed.

2.0 Stakeholder Consultation

2.1 Background

The EPA have conducted consultation with members of the public and government agencies as part of the development of the Strategic Advice (EPA, 2005), representing a significant early step in communicating with the public on the issue of MAR or groundwater replenishment.

The Water Corporation have developed the Trial in response to recommendations made by EPA as part of the Strategic Advice, including the recommendation that a high level of community consultation occur as part of a proposed MAR scheme.

The communications strategy for the Trial is described below. The strategy is designed to engage with the community at a number of levels. Some elements focus on the local residents in the vicinity of Beenyup WWTP, dealing mainly with the construction and operation of the Trial. Parallel activities focus more on groundwater replenishment as a future drinking water source option, and will use the Trial to provide information aimed at raising broad community awareness about groundwater replenishment as a future drinking water source option.

2.2 Communications Strategy

The Water Corporation's Groundwater Replenishment Trial communications strategy (provided in Appendix 2) focuses on providing information, developing accountability mechanisms with stakeholders and the community and encouraging deliberation about the project through personal briefings and presentations, rather than relying solely on advertising, widespread media coverage and other traditional public relations tools.

In addition, the communications strategy recognises community perception as a key element to be addressed in the communications approach. Many people are not comfortable with the concept of drinking recycled water, regardless of its technical and scientific feasibility. The strategy recognises that acknowledging this reality is a key step in encouraging a dialogue with the community on groundwater replenishment.

With these points in mind, the objectives of the communications strategy are to:

- identify ways to work cooperatively with the regulatory agencies to ensure the Trial and groundwater replenishment concept are communicated consistently across government;
- develop a long-term strategy to enable the community to become familiar with and debate the concept of groundwater replenishment;
- develop community engagement and stakeholder management plans to identify and brief individuals and organisations and address stakeholder concerns for the duration of the Trial;
- develop a process through which stakeholders can oversee the Trial and embed a process for collecting data from the Trial that addresses stakeholder and community concerns;
- identify a series of communication tools that use key messages to inform and generate broad community understanding of the Trial and the concept of groundwater replenishment to boost drinking water supplies;
- develop a program to measure the level of community and stakeholder support for groundwater replenishment at regular intervals throughout the Trial; and
- develop a strategy to inform the local community surrounding the Trial area about the Trial and address any potential impacts or concerns.

The key components of the communications strategy are:

- a community engagement plan, which includes specified levels of engagement (ie. inform, consult, involve) at each stage of the Trial and a plan for communicating with local residents;
- a stakeholder management plan outlining how individuals and organisations will be informed, consulted and involved in the Trial and beyond;
- a crisis communications plan which incorporates an outrage management plan, outlining the processes for responding to the community, stakeholders and the media should any major incidents occur during the Trial;
- terms of reference for the establishment of an independent advisory panel to oversee the Trial; and

- a communications implementation plan which details actions and responsibilities for delivering the communications strategy.

To date, the Water Corporation has focused on briefing individuals, groups and organisations either personally or via direct mail from the following areas:

- local residents surrounding the Beenyup WWTP, including the Beenyup Community Reference Group;
- local governments with jurisdiction over the Trial site or an interest in the Trial itself;
- Members of Parliament within the vicinity of the Trial site;
- peak environment groups such as the Conservation Council; and
- peak health organisations such as the Australian Medical Association and the Health Consumers Council.

A record of communications activities conducted to date, including briefings, presentations, mail-outs and advertising is provided at Appendix 3.

The Water Corporation has also sought to generate broad community awareness about groundwater replenishment through establishment of web pages on the corporate website, advertising in community newspapers, media releases, presenting at community forums and providing content for stakeholder newsletters.

A separate stakeholder and community engagement process, known as *Water Forever*, is currently being implemented to encourage public debate and discussion on the most sustainable medium to long-term water source options for Perth and other areas serviced by the Integrated Water Supply Scheme (IWSS).

Groundwater replenishment is one of the options that will be considered as part of *Water Forever. Water Forever* will assist in raising broad community awareness about groundwater replenishment as source option and allow for stakeholders and the community to provide input into the Water Corporation's decision-making process for development of future water sources.

Regular community surveys are also undertaken to determine levels of awareness and support for groundwater replenishment. In a telephone survey of 400 Perth residents conducted in July 2007, 57% of residents stated they were aware of groundwater replenishment when prompted. In addition, 46% of residents supported the concept and 41% requested further information on drinking water quality and safety before they would decide to whether to support it. Only 13% of residents fully opposed the concept.

The results of this research will assist the Water Corporation to review the communication strategy at regular intervals as well as develop, review and update communications materials about groundwater replenishment.

As the Trial progresses, these communications activities will broaden to further increase awareness and encourage feedback on the Trial.

The Water Corporation continues to work closely with the DoH, DoW and DEC to ensure they are satisfied with the approach taken in relation to communications for the Trial. The DoH and DoW are provided with the opportunity to review and comment on the communications strategy annually, or more frequently if required.

3.0 Existing Environment

Located in Perth's northern suburbs, the Beenyup site is bounded by the Mitchell Freeway to the east, Ocean Reef Road to the north, the residential suburb of Craigie to the west and Craigie Open Space, an area of regionally significant bushland, to the south. The area is identified by Property Identifier A0639 for the main site and A1627 for the Quindalup Dune.

The Beenyup site is approximately 83ha of Crown Land vested to the Water Corporation. The site has a number of land uses, including its primary function, wastewater treatment. The Beenyup WWTP (16.5ha) is situated in the southern section of the Beenyup site. The proposed Trial site is located adjacent to the northern boundary of the WWTP. The injection bore will be 70m to the north of the Trial site.

The natural environment of the Beenyup site is managed in accordance with the Beenyup Site Management Plan (Bennett Environmental Consulting, 2006) with the main activities including weed control, fire management and vegetation rehabilitation.

Figure 1 illustrates the location of the Beenyup site, all land uses and significant environmental features of the site.

3.1 Adjacent Land Use

Beenyup WWTP is located directly south of the proposed location of the Trial. Other land uses on site include some woodland areas of Paulownia (removed in 2007) and Radiata Pine, Bush Forever Site 303 and bushland areas outside of the Bush Forever site. These bushland areas consist of a mixture of vegetation communities varying in condition from quite good to highly degraded. Commercial land at the northern boundary of the Beenyup site occupies 5ha and includes a depot site with workshops and a bitumen lay-down/ storage area. Additionally, the Water Corporation's Construction Branch occupies 0.6ha south of the commercial area, which consists of a bitumen lay-down/ hardstand area for the storage of pipes and equipment used in water and sewer reticulation mains repairs. The Trial site will be located approximately 400m east of the nearest residents.

3.2 Bush Forever Site 303

Bush Forever is the primary mechanism for implementing the State Government's commitment to conserving regionally significant bushland in Perth. The Beenyup site contains 24.5ha of land designated Bush Forever (site 303). This area occurs as a number of remnant bush islands that accompany a greater area of bushland along the eastern boundary of the site. The surrounding bushland varies in quality from quite good to highly degraded.

The Trial site will be located approximately 100m west of the Bush Forever boundary. Currently, the Beenyup Site Management Plan provides management planning and actions to manage the potential effect of Water Corporation activities on the Bush Forever land.

3.3 Quindalup Dune

The Quindalup dunes occur as a series of elongated dunes created by the geological interface of the Quindalup and Spearwood dune system. They generally run north-south, parallel to the coastline and are restricted to a narrow coastal band. The dunes consist mostly of unconsolidated calcareous sands with some cementing in lower layers. The dunes in their natural form represent a unique landform and associated vegetation community that has become regionally significant as urban development increases through the Metropolitan area.

A large stretch of a Quindalup dune occurs along the western margin of Beenyup site and the Craigie Open Space, commencing at the southern boundary of Warrandyte Reserve to the north through to Whitfords Avenue to the south. The Water Corporation has acquired 2.7ha of the dune, from Warrandyte Reserve southwards to the pine logs steps. The remaining section of the dune, in addition to Craigie Open Space, is vested to City of Joondalup for management. Remnant vegetation covers the dune, but it is relatively disturbed by human impacts such as rubbish dumping, weed invasion and localised erosion.

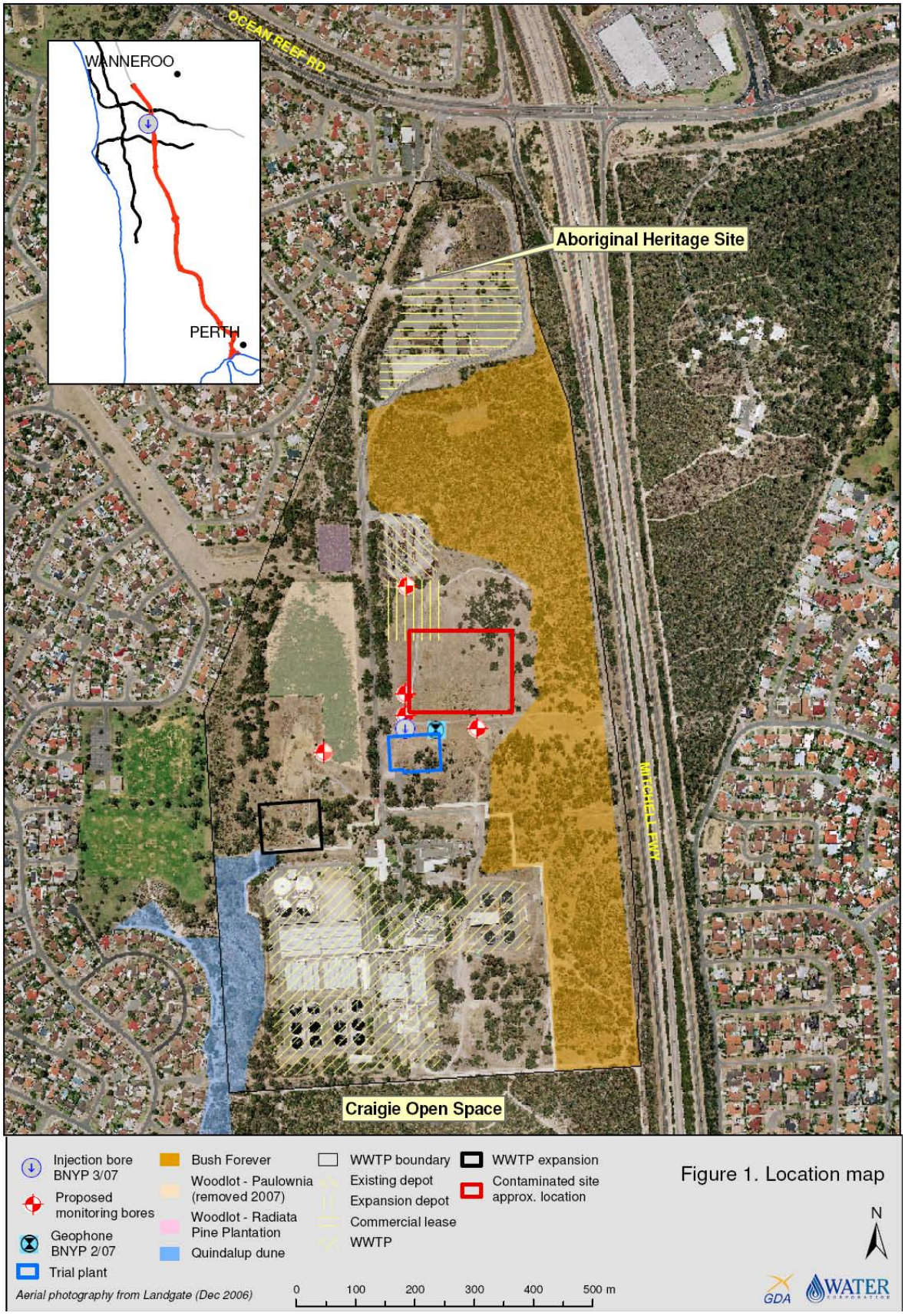

Figure 1. Location map

The Water Corporation purchased land containing the dune to ensure a separation distance between the WWTP and the houses that are encroaching on the WWTP's western boundary. This area has not been actively managed as part of the Beenyup site, and, as such, is not fenced, allowing uncontrolled public access. Past management has been mainly in response to community requests for rubbish removal that has been illegally dumped and ad-hoc erosion control and weed management.

3.4 Flora, Vegetation and Fauna

A flora, vegetation and fauna survey was conducted for the general Beenyup site (including the Bush Forever Site) to inform the Beenyup Site Management Plan (Bennett Environmental Consulting, 2006). The proposed site for the Trial was not the focus of this survey because it is mostly cleared and affected by weed invasion and human disturbance; however it is covered in a general nature. Only a few isolated individual plants will be removed for the proposed works. . The detailed design process will consider the placement of infrastructure to minimise the requirement to remove native plant individuals where possible.

The Beenyup site is included in the Karrakatta Vegetation Complex – Central and South. The vegetation of the Karrakatta Complex – Central and South – is described as predominantly an Open Forest of *Eucalyptus gomphocephala, Eucalyptus marginate* subsp. *marginate* and *Corymbia calophylla* and a Woodland of *Eucalyptus marginate* subsp. *marginate – Banksia* species (Bennett Environmental Consulting, 2005).

The vegetation survey described three vegetation units for the site:

1. Woodland of *Eucalyptus gomphocephala* over Tall Open Shrubland of *Acacia saligna* over a Closed Herbland / Grassland of weeds in grey sand (EgAc).

2. Low Woodland of *Eucalyptus marginata* subsp. *marginata, Banksia attenuata* and *Banksia grandis* over an Open Heath dominated by *Xanthorrhoea preissii* or *Acacia pulchella* in grey sand (EmXp).

3. Low Woodland of *Eucalyptus marginata* subsp. *marginata, Banksia menziesii, Banksia attenuata, Allocasuarina fraseriana* with emergent *Eucalyptus gomphocephala* over Tall Shrubland of *Dryandra sessilis* and Low Shrubland of *Grevillea vestita* in grey sand with limestone outcropping (EmGv).

No Declared Rare or Priority Flora were recorded in the survey area.

In 2005, Western Wildlife (Wilcox and Davies as cited in Bennett Environmental Consulting, 2006) undertook a Level 1 fauna survey of the Beenyup site. They concluded that Bush Forever Site 303 is likely to support a diverse range of vertebrate fauna, including some species of conservation significance. They emphasised the importance of preserving Tuart trees (*Eucalyptus gomphocephala)*. The proposed location for the Trial is heavily disturbed and only minimal habitat is expected to be removed during construction works. There is no known *Phytophthora* dieback at the site.

3.5 Contamination

The Trial site is situated on a degraded section of land adjacent to the northern boundary of the Beenyup WWTP. A geotechnical investigation including cone penetration testing did not indicate the presence of any foreign fill or other dumped materials (Worley Parsons, 2007). A site approximately 150m to the north of the Trial site has been reported to DEC in May 2007 as a "suspected site" and assessment is ongoing. The proposed construction site for the Trial does not disturb the potential contamination to the north.

3.6 Marine Environment

The Beenyup WWTP currently discharges approximately 116 ML/day (DEC discharge License limit of 120ML/d) of secondary treated wastewater to the ocean environment through two ocean outlets at Ocean Reef. The Trial will divert up to 7.5 ML/d of secondary treated

wastewater to the GWR plant for further treatment and eventual injection of up to 5 ML/d to the Leederville aquifer.

The Ocean Reef Ocean Outlet and surrounding marine environment have been included in the 10 years of data collection and analysis of wastewater disposal and management for Western Australia (Water Corporation, 2007). The benthic habitat around the outlets comprises of an area of rocky limestone reef with macroalgae and sand habitats with areas of seagrass. Monitoring has concluded that the wastewater plume rapidly dissipates outside the immediate mixing zone of influence, and the waters consistently meet ecosystem protection guidelines.

It is envisaged that the GWR plant will be individually licensed under Category 54 of Schedule 1 of the *Environmental Protection Regulations* (1987), discharging its advanced tertiary treated wastewater to the Leederville aquifer.

3.7 Geology

The sub-surface geology of the Trial site is generally made up of Quaternary Age sands of the Bassendean sand unit (Bennett Environmental Consulting, 2006). The sands are typically pale to darker olive yellow in colour and are medium to coarse with evidence of sub-rounded quartz and trace quantities of moderately sorted residual feldspar. They are derived from local weathering of the underlying Tamala Limestone.

3.8 Groundwater

The Beenyup site is located in a Priority 3 Perth Coastal Underground Water Pollution Control Area. The product water from the GWR plant will be injected to the Leederville aquifer only, which is below and separated from the superficial aquifer by the Pinjar Member of the Leederville aquifer, which is an aquitard.

A site evaluation was conducted by hydrogeology consultants Rockwater Pty Ltd at the Beenyup site to evaluate and characterise the Leederville aquifer for the Trial (see full report in Appendix 4). Preliminary investigations have been conducted to determine the stratigraphy, lithology and hydrogeology of the Beenyup site from a cored borehole, correlation with two nearby bores and seismic surveying. Drilling intersected the superficial aquifer, the Mirrabooka aquifer, the Leederville aquifer and the Yarragadee aquifer, and is representative of the aquifer systems found beneath the Gnangara Mound. Data from these investigations has been used to model groundwater flow and water quality changes during injection. The stratigraphy at the site has been assessed and summarised in Table 1.

Table 1: Hydrostratigraphic summary for BNYP 1/07

Depth (m BGL)	Description	Formation	Aquifer
0 - 20	Sand, quartz and limestone grains	Tamala Limestone	Superficial
20 - 51	Limestone	Tamala Limestone	Superficial
51 - 73	Sandstone, moderately to weakly consolidated, silty, fine to medium, occasionally coarse quartz and glauconite.	Molecap or Poison Hill Greensand.	Mirrabooka
73 - 95.5	As above	Mirrabooka Member.	Mirrabooka
95.5 - 117.3	Siltstone (21.8 m) and sandstone (7 m) interbeds. Moderately consolidated.	Pinjar Member	Aquitard
117.3 - 173.7	Upper injection interval, Sandstone, minor siltstone (0.7 m)	Wanneroo Member.	Leederville
173.7 - 199.3	Mid injection interval, Sandstone (17.1 m), siltstone (5.3 m) mudstone (3.2 m).	Wanneroo Member	Leederville
199.3 - 223.9	Lower injection interval, Sandstone, minor mudstone (0.5 m)	Wanneroo Member	Leederville
223.9 - 259.9	Siltstone, silty sandstone (11.6 m)	Mariginiup Member	Aquitard
259.9 - 341	Siltstone, minor mudstone	South Perth Shale	Aquiclude
341 -	Sandstone	Gage Formation	Yarragadee

Note: yellow shading highlights the proposed injection zone

3.8.1 Superficial Aquifer

The Perth Groundwater Atlas indicates the historical maximum water table level at the site is at 4.0m AHD, corresponding to 17-19m below current ground level. A dissipation test at the site indicated that the water table was present at 18.1m below ground level (3.6m AHD)(Worley Parsons, 2007); therefore, interference of plant structural and civil elements by groundwater is not expected.

3.8.2 Leederville Aquifer

The direction of groundwater movement in the Leederville aquifer is influenced by pressure differentials associated with groundwater abstraction from Leederville production bores, overriding the expected natural groundwater flow to the south west. The regional groundwater flow can be seen clearly in Figure 5, which illustrates the expected travel time of injected GWR plant product water.

The GWR plant product water (advanced tertiary treated wastewater) will be injected into the Wanneroo Member of the Leederville aquifer, which is the main transmissive part of the aquifer. The upper, mid and lower intervals of the Wanneroo Member have been identified and presented in Table 1.

The Pinjar Member of the Leederville aquifer overlies the Wanneroo Member. The dominant lithology of the Pinjar Member is siltstone, which forms an upper seal between the overlying Mirrabooka aquifer and the underlying Wanneroo Member. The cored borehole indicates a total siltstone thickness of 14.8m with the greatest bed thickness of 10.1 m.

The dominant lithology of the Mariginiup Member and South Perth Shale, which underlies the Wanneroo Member, is siltstone and mudstone, forming a lower seal more than 100 m thick at the base of the proposed injection interval.

3.8.3 Stygofauna

Based on an assessment of the cored borehole sample and water quality data, advice provided by Aquatic Zoologist and stygofauna specialist Dr Brenton Knott from UWA, indicates that the necessary components to support healthy, sustainable populations of sub-terrestrial fauna such as stygofauna are not present in the Leederville aquifer (Appendix 5). Two supporting reasons are:

- Stygofauna are highly unlikely to have had the ability to colonise this aquifer from the superficial aquifer due to the presence of two confining beds separating the aquifers;
- The aquifer's water chemistry and the unlikelihood of an adequate source of food preclude the presence of stygofauna in the Leederville aquifer.

Therefore, stygofauna is very highly unlikely to be present in the Leederville aquifer, or be impacted by the Trial.

3.9 Social Values

An Indigenous Heritage study revealed that there is a modified tree in the north-west corner of the Beenyup site boundary. The Trial site is approximately 800m to the south east of the modified tree. It is not expected that this site of Indigenous significance will be affected by the proposal. Should any artefacts be discovered/uncovered as part of the proposed construction works, the Water Corporation will implement applicable heritage management procedures.

Water in the cultural landscape is taken to include surface water bodies such as streams, wetlands, springs and soaks, the latter three being surface expressions of groundwater. The Beenyup site does not contain any surface water bodies, including surface expressions of groundwater. The Site Evaluation Report (Appendix 4) provides a preliminary assessment of the expected horizontal and vertical movement of the GWR plant product water. The report indicates that the GWR plant product water will be restricted to the Leederville aquifer, within a maximum 440 m radius of the injection bore, clearly not impacting on any surface expressions of the Leederville aquifer. See sections 4.2.2 for details of the effect of the GWR plant product water on the Leederville aquifer.

Initial discussions with members from the indigenous community, including the South West Aboriginal Land and Sea Council (SWALSC) and Northern Australian Indigenous Water Policy Group has been undertaken regarding groundwater replenishment and the Trial as part of the process for identifying the Environmental Values relevant to the Trial (provided in Appendix 6). To date, no specific issues have been raised; however, the Water Corporation acknowledges that the injection of treated wastewater into groundwater is of interest to Aboriginal Groups. Subsequently the Water Corporation will continue to engage with the SWALSC and other Indigenous groups as the Trial progresses. A workshop to discuss the cultural significance of groundwater is planned for the coming months.

The injection zone for GWR plant product water into the Leederville aquifer is between 117 – 224m and is not accessible for recreation or aesthetic purposes. Based on expected horizontal and vertical movement outlined in the Site Evaluation Report (Appendix 4) the Trial will not affect aesthetic and recreational values of the Leederville aquifer.

4.0 Proposal Description

4.1 Required Water Quality

The DoH and DoW have directed that water injected into the Leederville aquifer during the Trial must be suitable for drinking, thus protecting human health, and must protect the identified Environmental Values (EVs).

The IAWG identified the EVs for the Trial including the Water Quality Objectives and the assignment of the water quality guidelines that should be met to protect the identified EV. The process of development is described in detail in the document *"Trial Environmental Values for the Leederville Aquifer for the Groundwater Replenishment Trial. February 2008"* (IAWG, 2008). Table 1 presents the outcomes of this process. This document is available in full in Appendix 6 or on the Water Corporation website - www.watercorporation.com.au.

Table 2: Trial Environmental Values

Environmental Value	Environmental Quality Objectives	Water Quality Guideline
Primary Industry	Maintenance of primary industry water supply values	1. *Health effects of recycled water use:* Class A – Classes of Recycled Water. WA Department of Health *draft Recycled Water Groundwater Recharge Guidelines (June 27, 2005)* 2. *Maximum concentrations of nitrogen and phosphorus on the Swan Coastal Plain:* Table 2 - Water Quality Protection Note 22 – Irrigation with nutrient rich treated wastewater July 2004 WA Department of Water 3. *Metal and metalloids concentrations for Primary Industry purposes*: Table 3.4.1 Primary Industry Trigger values – Australian and New Zealand Guidelines for Fresh and Marine Water Quality #4 (2000) ANZECC/ARMCANZ 4. *Irrigation Infrastructure: Water Reuse. Issues, Technologies and Applications (2007).* Asano T, Burton FL, Laeverenz HL, Tsuchihashi R, Tchobanoglous G
Drinking Water Resource (current and future use)	Maintenance of water value for drinking, and maintenance of value as a future drinking water supply	1. *Australian Drinking Water Guidelines (2004)* Australian NHMRC and ARMCANZ (NWQMS #6). 2. *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) – Augmentation of Drinking Water Supplies* Natural Resource Management Ministerial Council, Environment Protection and Heritage Council and Australia Health Ministers Conference. Draft for Public Comment July 2007. *Note: Research lead by the DoH will inform and revise where necessary water quality guideline limits for WA*
Industrial Water	Maintenance of industrial water supply values	Given the wide nature of industrial process requirements, lack of standard national guidelines and that industry has direct and unrestricted access to potable (drinking) water for the purpose of process water, Drinking Water EV water quality guidelines will be applied for the Industrial Use EV.

The Primary Industry EV includes the use of groundwater for a variety of uses, including the production of foods crops, irrigation of parks and gardens and aquaculture, with potential environmental endpoints of humans, soils, plants, groundwater and surface water. This has

resulted in the assignment of four water quality guidelines managing human health effects, aquatic biota, plant toxicity and irrigation infrastructure. Additional groups of compounds such as pesticides have been identified and confirmed that the health based water quality guidelines are sufficient to also protect the Primary Industry EV.

After consideration of the background water quality of the Leederville aquifer, groundwater movement as a result of the Trial, consultation with members from Indigenous groups (see section 3.9) and stygofauna experts (see section 3.8.3), aquatic ecosystems, cultural and spiritual values and recreation and aesthetics were not considered to be environmental values that were relevant to the Trial.

However, ongoing consultation with Indigenous and other stakeholder groups will occur throughout the Trial. Additionally, the Water Corporation is collaborating on an Ecotoxicity research project, lead by the DoW, to further investigate the effect of advanced tertiary treated water of ecological indicator species.

It is envisaged that the Licence issued by the DEC will provide the water quality requirements that must be met prior to discharge. Product water that does not meet the required water quality of the Licence or that is produced during the commissioning stage of the GWR plant[1] will not be injected into the aquifer. This water will be directed to the inlet of the WWTP via the Wanneroo Main Sewer. The detailed design process will consider other alternative discharge points such as the Ocean Reef Ocean Outlet and alternative uses for this water, such as use within WWTP processes, such as wash-down water or odour scrubbing (see Figure 2).

The Trial has adopted a risk management framework to ensure an acceptable level of risk to human health and the environment is maintained throughout the treatment process, from the wastewater catchment to injection. The water quality guidelines assigned for the identified EVs provide the basis for the hazard (or analyte) based risk assessment. The risk assessment and mitigation identification process will informed design, operations, training and research components of the Trial which ALL form part of the risk management framework.

4.2 Infrastructure

Infrastructure for the Trial will include an advanced tertiary treatment plant, an injection bore and adjacent monitoring bores. The GWR plant will be designed to produce up to 5 ML/day of high quality water and it is expected to operate for 3 years. The operational period of the Trial will allow the Water Corporation to assess the technical feasibility of the treatment technology and provide information to the Agencies to address environmental, water resource and health issues related to groundwater replenishment.

The GWR plant will include the following infrastructure:

- Feed water system;
- Membrane filtration;
- Reverse osmosis;
- UV Disinfection;
- Treated water storage;
- An injection bore;
- Adjacent monitoring bores;
- Chemical bund area and chemical storage; and
- Ancillary site buildings (electrical, ablution, meeting room, control room, laboratory).

Additional works will be required to supply feed water, potable water (including fire water), electricity and other services to the GWR plant. The feed water for the GWR plant will be pumped from the Beenyup WWTP Ocean Reef Ocean Outlet via a pumping station and buried pipework.

[1] Product water that is produced during the commissioning process of the GWR plant is not to be injected into the aquifer until the validation monitoring is complete and DoH approval to commence injection is gained.

Additional pipework will be constructed to transport:

- The waste stream from the advanced tertiary treatment process to the Wanneroo Main Sewer (for treatment at Beenyup WWTP);
- High quality water (product water) to the adjacent bore for injection to the Leederville aquifer; and
- Commissioning water or product water that does not meet Licence requirements to the Wanneroo Main Sewer (for treatment at Beenyup WWTP) and/or use in WWTP or discharge to Ocean Reef Ocean Outlet.

The injection bore (BNYP 3/07) was drilled in December 2007 immediately north of the proposed location for the GWR plant. Although the bore will not be used for abstraction, its construction is based on standard Water Corporation design for production bores (telescopic screens) of up to 10 ML/d capacity in the confined Leederville aquifer. 22 monitoring bores, across five monitoring sites are proposed to be drilled to meet the requirements of the Trial's Monitoring Plan.

4.3 Process Inputs and Outputs

4.3.1 Construction

Construction is expected to commence around August 2008. Construction (including testing and pre-commissioning) is expected to continue for twelve to eighteen months. Emissions during construction are expected to be restricted to localised noise, dust, greenhouse gases and inert waste. The exact location of GWR plant infrastructure will be considered during detailed design to minimise the removal of native vegetation, however the construction may involve a small amount of clearing of native vegetation, restricted to individual plants cumulating to less than 1ha. This will be outside of the Bush Forever Site 303.

Major construction activities for the upgrade of the Beenyup WWTP to 135ML day are currently underway. This site is 250m to the west of the Trial Site, adjacent to the existing northern boundary of the WWTP. Emissions from these activities, including dust and noise, are being successfully managed with Noise and Dust management plans.

Management

Emissions generated during construction will be managed by the Contractors' Environmental Management Plan and will take into consideration successful measures employed by the current Beenyup WWTP upgrade. Particular care will be taken to minimise noise emissions in order to ensure compliance with the *Environmental Protection (Noise) Regulations 1997* and to avoid disturbance to adjacent residences. During the construction phase, noise levels will be similar to those associated with normal construction projects involving the use of earthmoving machinery and building construction plant, equipment and power tools and will are expected to be less than the current construction activities at the site associated with the Beenyup WWTP upgrade. Construction activities will mostly be restricted to day-time hours. Neighbours and the local community will be kept informed throughout construction via direct mail or newspaper articles as appropriate.

The proposed works are expected to only remove a small number of isolated native plant individuals and have little, if any, effect on fauna. The detailed design process will consider the placement of infrastructure to minimise the requirement to remove native plant individuals where possible. Enhancement of fauna habitat in the general area (including Bush Forever Site 303) will continue through the Beenyup Site Management Plan. This plan includes ongoing commitments for weed control, fire management and rehabilitation.

4.3.2 Operation

The Groundwater Replenishment Trial process will include the following steps (Figure 2):

1. Inflow of up to 7.5 ML/day secondary treated wastewater from Beenyup WWTP;
2. Advanced treatment through membrane filtration, reverse osmosis and UV radiation;
3. Stabilisation of advanced treated water prior to injection;
4. Waste stream from the advanced tertiary treatment process returned to the Beenyup WWTP inlet (via the Wanneroo Main Sewer) to be treated;

5. Injection of treated water into the Leederville aquifer (up to 5 ML/d);
6. Commissioning water or product water that does not meet Licence requirements returned to the Wanneroo Main Sewer (for treatment at Beenyup WWTP) and/or use in WWTP or discharge to Ocean Reef Ocean Outlet; and
7. Ongoing monitoring and reporting.

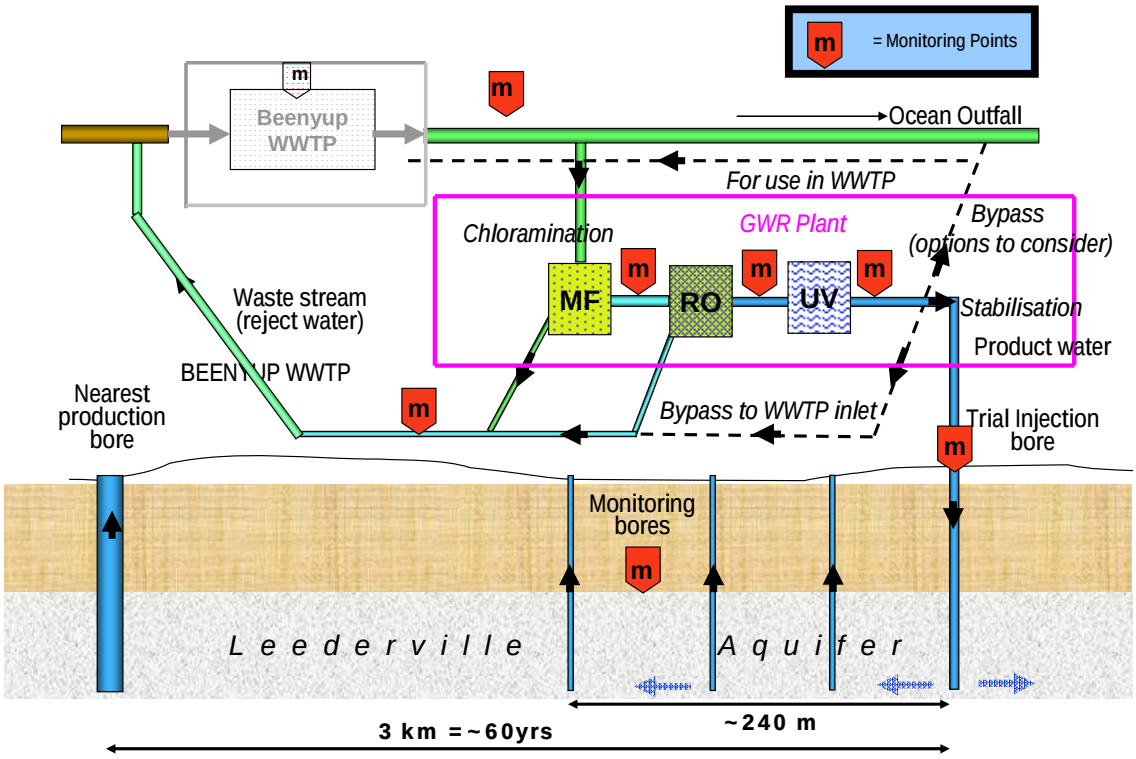

Figure 2: **Process Flow Diagram** (including sampling points: "S")

Inflow (feed water)

The GWR plant will treat secondary wastewater from the Beenyup WWTP in order to produce high quality water suitable for injection into the Leederville aquifer. The GWR plant will draw up to 7.5 ML/day from the Beenyup WWTP Ocean Reef Ocean Outlet. The secondary treated wastewater from Beenyup WWTP is monitored regularly, and its known concentration of analytes will be used to define treatment criteria for the advanced tertiary treatment process.

Treatment

Membrane filtration will remove suspended solids and colloidal material from the feed water. The filtrate from this process will be further treated by reverse osmosis. The water will then be treated with UV for disinfection at a dose rate of >80mJ/cm^2. Product water stabilisation with degassing and caustic dosing post UV treatment will occur prior to injection.

It is expected that chloramination will provide pre-treatment to protect the membranes from biofouling. The membranes will also be cleaned through regular backwashing and depending on the membrane supplier, air scoured to the outside of the membrane.

Anti-scalant will be dosed to the reverse osmosis feed water. Additionally, both the filtration and reverse osmosis membranes will need to be chemically cleaned during operation approximately every 3-4 weeks. Membrane cleaning will incorporate the use of a hot water tank, reticulation pump and chemical dosing system. Likely chemicals will be relatively dilute acid and/or alkaline reagents and will be dependent on the type of fouling. After cleaning, this solution will be neutralised and pumped to the Waste Retention Tank, which will ultimately return to the Beenyup WWTP, via the Wanneroo Main Sewer for treatment.

Wastewater

The waste stream (sometimes referred to as reject water) from the advanced tertiary treatment process will comprise of filter backwash, reverse osmosis brine and cleaning solutions. These waste streams will be collected into the Waste Retention Tank, which will be pumped to the Wanneroo Main Sewer upstream of the Beenyup WWTP.

The waste stream will meet the Water Corporation's Industrial Waste Acceptance Criteria, which is applied to all industrial and commercial businesses that discharge into a Water Corporation sewer. The criteria have been designed to protect the wastewater treatment processes and infrastructure, marine environment, WWTP staff health and safety and the reuse options of treated wastewater and biosolids.

In order to assess the worse-case scenario, Oceanica Consulting Pty Ltd (Appendix 7) modelled a hypothetical situation where the GWR plant waste stream would be directly discharged to the Ocean Reef Ocean Outlet (i.e. not entering Beenyup WWTP for further treatment, as is the design for the Trial). The model compared the dilution of the treated wastewater in the ocean for two circumstances at an increased volume of treated wastewater to account for future growth of the Beenyup WWP, viz:

1. Beenyup WWTP, without the GWR plant - discharge volume of 130 ML/day; and
2. Beenyup WWTP, with the GWR plant discharge volume of 125 ML/day (122.6 secondary treated wastewater plus 2.4 ML/day GWR plant waste stream).

Initial dilution modelling suggested that the second scenario; with the GWR plant, would have a similar or slightly better initial dilution than Beenyup WWTP without the GWR plant. The GWR plant waste stream would introduce a slightly high initial contaminant concentration of the discharge wastewater, but this would be offset by the high dilution, and National (ANZECC/ARMCANZ, 2000) water quality guidelines for the highest level of protection would still be met for key contaminants.

Based on this assessment, the Water Corporation is confident that introduction of the GWR plant waste stream to the inlet of the Beenyup WWTP will not alter or affect marine water quality.

Product Water

The water produced from the GWR plant will be stored in a holding tank. Prior to storage, the water will be degassed to reduce carbon dioxide levels and sodium hydroxide will be added to increase the pH to a target of pH 7. The water will then be piped a short distance to the adjacent injection bore for injection into the Leederville aquifer. Injection will be targeted for the Leederville aquifer between 117.3m and 223.9m below ground surface.

Where product water fails to meet water quality protocols, the water will diverted to the Wanneroo Main Sewer (for treatment at Beenyup WWTP) and/or use in WWTP or discharge to Ocean Reef Ocean Outlet, i.e. not be injected into the Leederville aquifer. It is envisaged that these parameters will be incorporated into the conditions of an operational licence.

Table 3: Basic GWR Plant Water Quality Parameters

Parameter	Water Quality Guideline
Turbidity[1]	<2 NTU
Suspended Solids[1]	5mg/L
pH[1]	6-9
e.coli[1]	<1 / 100mL
Virus[1]	< 1 / 50 litres
Total Nitrogen[2]	11 mg/L as N
Total Phosphorus[2]	1.2 mg/L

Notes: 1 Value derived from the Class A+ - DoH *draft Recycled Water Groundwater Recharge Guidelines (June 27, 2005) (Indirect Potable Reuse Aquifer Recharge)*

2 Value derived from the Water Quality Protection Note 22 – Irrigation with nutrient rich treated wastewater July 2004 WA Department of Water

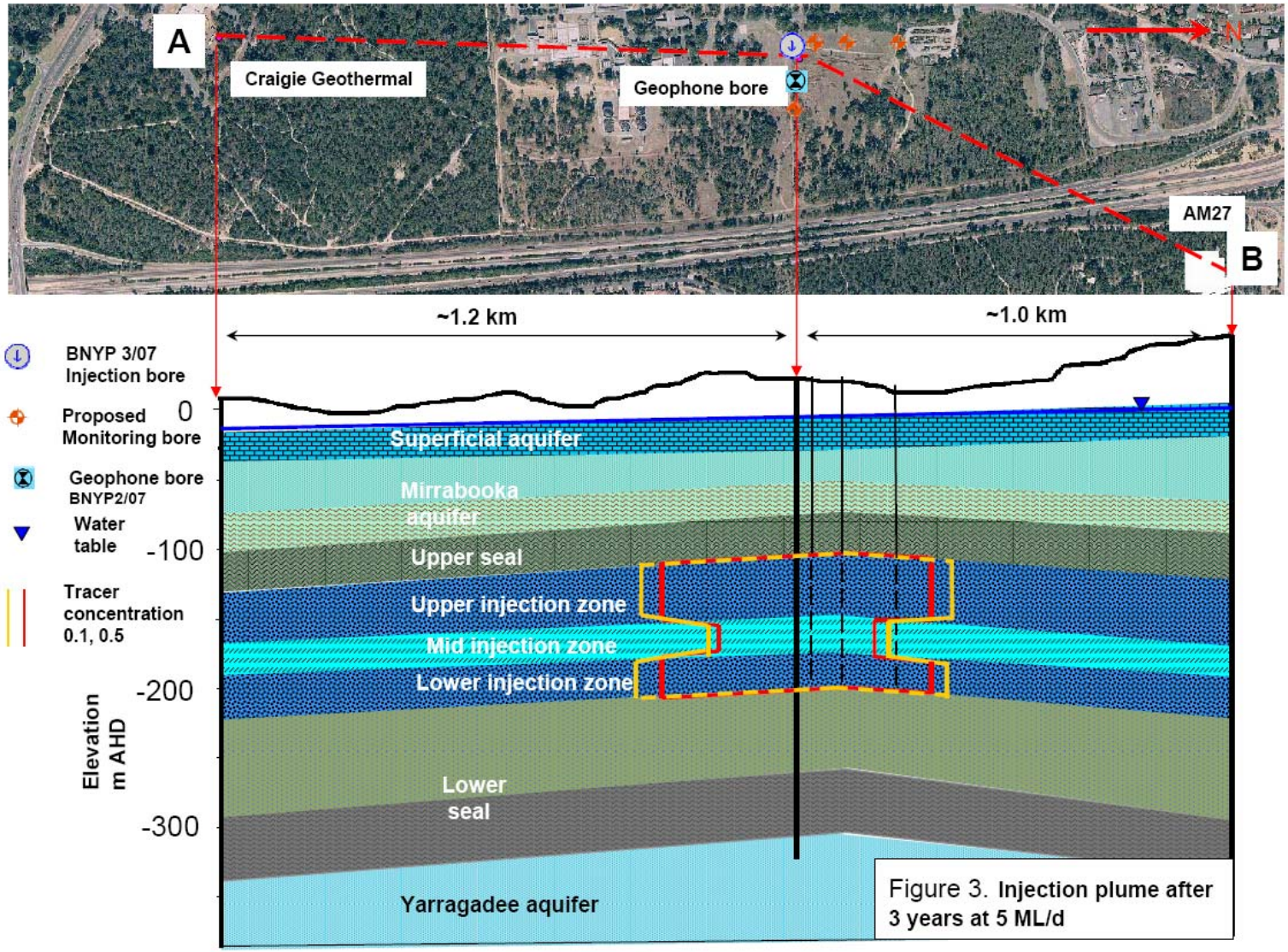

Figure 3. **Injection plume after 3 years at 5 ML/d**

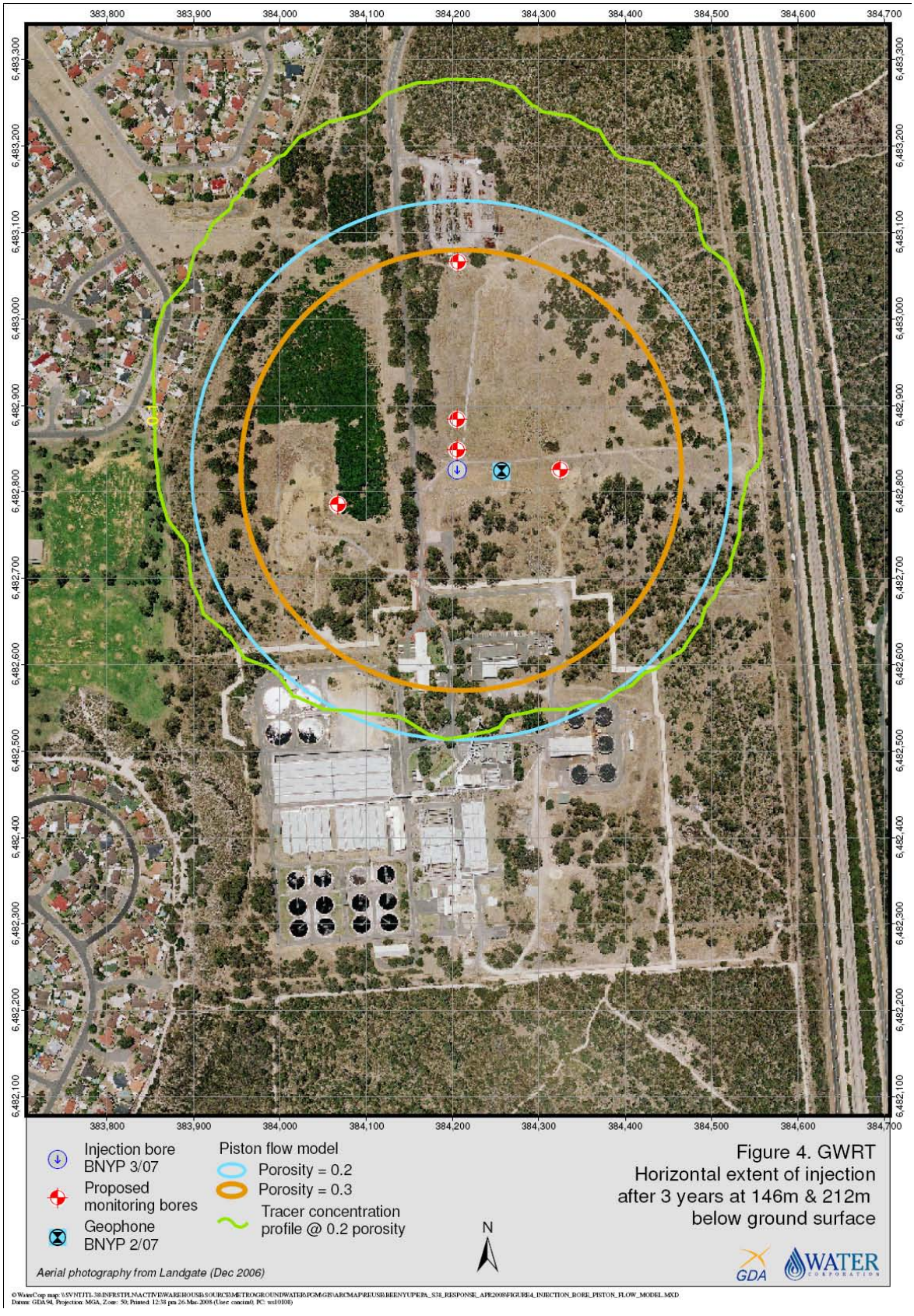

Figure 4. GWRT
Horizontal extent of injection
after 3 years at 146m & 212m
below ground surface

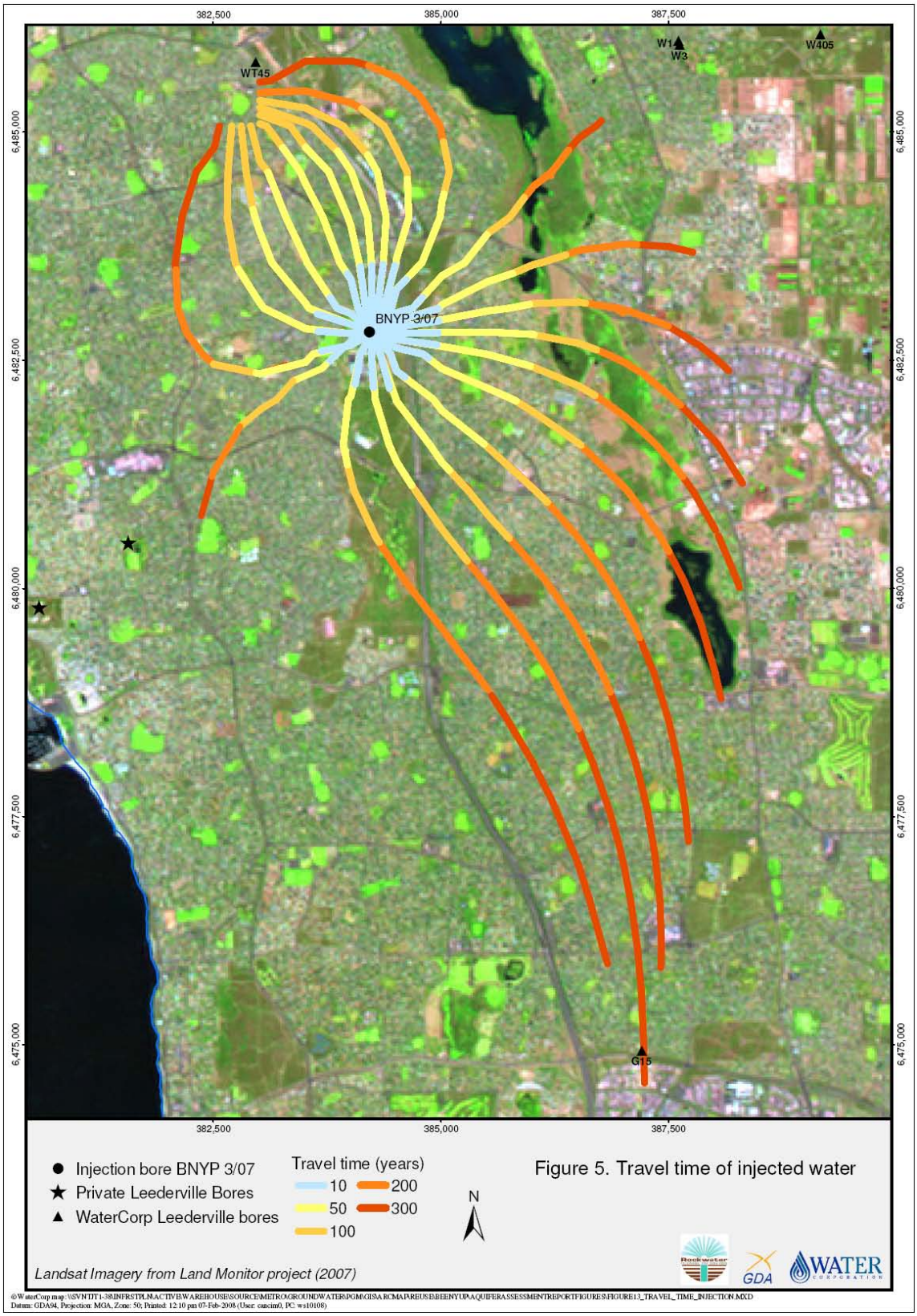

Figure 5. Travel time of injected water

Assessment of the effect of Product Water on the Leederville aquifer

The Leederville aquifer is separated by the superficial aquifer by the predominantly siltstone Pinjar member and it is separated from the lower Yarragadee by the South Perth Shale aquiclude. Vertical flow of injected high quality water was calculated based on preliminary analysis of the geophysical and lithological logs of the cored boreholes. The calculations indicate that it would take more than 300 years for water to cross the siltstone aquitard (Pinjar Member) and reach the Mirrabooka aquifer in the immediate vicinity of the injection zone (where head build-up and hence movement is expected to be greatest). Therefore, it can be assumed that any vertical movement associated with the three year injection period of the Trial will be confined to the Leederville aquifer (Figure 3).

Horizontal flow was modelled using two types of models: an analytical piston flow model using a porosity range of between 0.1 and 0.3, and a numerical local-scale, non-reactive transport model which also considers diffusion and dispersion parameters, using a porosity of 0.2. Table 4 provides the outputs of piston flow modelling using three porosity scenarios for an injection of 5 ML/d for three years.

Table 4: Modelled horizontal groundwater flow at 5ML/d for 3 yrs

Porosity	Maximum distance for horizontal flow of high quality water
0.1	440 m
0.2	315 m
0.3	250 m

Note: this data was generated from the analytical piston flow model

The numerical model indicates that under a 0.2 porosity scenario, it is expected that the area that the injected water will travel over the three year injection period will slightly exceed the Beenyup site boundary by approximately 60m to the west and 20m to the east (Figure 4). Figure 4 illustrates the results of both models, indicating a very similar horizontal groundwater flow.

Particle tracking was undertaken to estimate expected travel time of injected water to existing production bores in the Leederville aquifer based on PRAMS (Perth Region Aquifer Modelling System). These expected travel times are shown in Figure 5. The results indicate that under a 165GL/yr abstraction regime (i.e., the current regime) pressure differentials created by regional groundwater usage will result in water moving to the north towards the Water Corporation's Whitfords production borefield and south-east to the Water Corporation's Gwelup production borefield. Given the predicted groundwater flow pattern indicated by the modelling, the injected water is not expected to reach the two private Leederville bores to the west of the Beenyup site. The modelling also indicates that it will take approximately 60 years for the injected water to reach the closest production bore (a drinking water production bore WT45 to the north) and over 300 years to reach drinking water production bore G15 to the south if injection of 5 ML/d of GWR plant product water is continuous. It is noted that the planned Trial injection period is only three years.

Therefore, analysis of the hydrostratigraphy of the Beenyup site demonstrates that the Wanneroo Member of the Leederville formation provides an appropriate zone for injection of high quality water as part of the Trial. The Pinjar Member provides an adequate seal between the overlying Mirrabooka aquifer and the underlying Wanneroo Member. The most conservative modelling, the numerical model indicated the maximum distance of the horizontal flow of injected water during the Trial injection period would only slightly exceeding the Beenyup site boundary.

Management

The Water Corporation will rigorously manage the Groundwater Replenishment Trial, and the management procedures will be established prior to commissioning of the GWR plant. The advanced tertiary treatment process and bore injection will be managed by the Process Control Plan (PCP). This plan will include target ranges for key parameters at specific process control points. It is expected that compliance with the PCP would become a condition of the DEC licence.

Monitoring of treatment plant processes, product water quality, groundwater water quality and physical properties of the Leederville aquifer will be integral to the Trial and will be managed through the Groundwater Replenishment Trial Monitoring Plan (see section 4.4). It is expected that compliance with the Monitoring Plan will also become a condition of the DEC Licence.

4.4 Monitoring

The Groundwater Replenishment Trial is a small-scale plant that will be used to determine engineering parameters and to monitor environmental changes as a result of groundwater replenishment on the Swan Coastal Plain. The data obtained from the Trial will be used to inform on the regulatory framework and technical and operational requirements and determine feasibility of a full-scale groundwater replenishment system.

The Monitoring Plan is being prepared by the Water Corporation in consultation with the DoH, DoW and DEC and will be based on:

- Information derived from Site Evaluation activities informing on the hydrogeology and geochemistry;
- Data from Premiers Collaborative Research Project and Premiers Water Foundation Managed Aquifer Recharge Project; and
- Outcomes of formal Health and Environmental Risk Assessments;

The monitoring program will be comprehensive and encompass:

- Treatment plant operations;
- Injection operation and hydraulic response in the aquifer;
- Treatment plant water quality outcomes; and
- Groundwater quality changes.

Additionally, ongoing geophysical investigations at the Beenyup site will confirmed as part of the Site Characterisation Report – Aquifer Assessment (due in December 2008) through:

- Further petrophysical analyses;
- 3D seismic reflection surveying;
- Time lapse VSP;
- Geophysical logging and time series geophysical logging; and
- Data integration and analysis.

The Monitoring Plan will have formal expert review and will be reviewed by the Groundwater Replenishment Trial Inter Agency Working Group. Additionally, the Department of Health will assess the Monitoring Plan as part of the approval to commence injection of GWR product water to the Leederville aquifer.

4.5 Additional Research

A number of complimentary research projects are underway to inform aspects of the groundwater replenishment. These include:

- Contaminant removal and resultant water quality to meet Drinking Water criteria through advanced tertiary treatment process and assessment of chemicals of concern as part of the Premiers Collaborative Research Project: *"Characterising Treated Wastewater for Drinking Purposes following Reverse Osmosis Treatment"*. This three year research project is led by the DoH, with contributions from the DoW, DEC, CSIRO Land and Water, Curtin University, Chemistry Centre of WA, National Measurement Institute and the Water Corporation;
- Ecotoxicity assessment of wastewater and recycled water through an advanced tertiary treatment process and the development of an 'Ecotoxicity Toolbox' to Evaluate Water Quality for Recycling. This is a two year collaborative research project led by the DoW, with contribution from Curtin University, University of New South Wales, and the Water Quality Research Australia;
- Disinfection by-product formation and removal during the advanced tertiary treatment process, with Curtin University;

- Assessment of on-line instruments for continuous monitoring of recycled water quality prior to injection into groundwater as a future drinking water resource;
- Attenuation of chemicals of concern in groundwater. Small and large-scale column experiments to investigate under controlled conditions, the fate of introduced chemicals of concern in product water into anaerobic Leederville aquifer sediments. Part of Premier's Water Foundation Managed Aquifer Recharge Project, led by CSIRO Land and Water, with contribution from Curtin University, Chemistry Centre of WA, University of Western Australia and the Water Corporation;
- Social acceptance of recycling water for drinking via aquifer recharge. Part of Premiers Water Foundation Managed Aquifer Recharge Project. CSIRO Land and Water, Curtin University, Chemistry Centre of WA, University of Western Australia and the Water Corporation.

4.6 Environmental Risk Assessment

The Construction and Operational Risk Assessment identified and assessed potential hazards and mitigations related to constructing and operating the Trial that could potentially negatively affect the environment. Construction and operational aspects of the Trial are presented in Table 4.

Although four environmental impacts were considered to have a Moderate risk without environmental management controls, the implementation of identified controls was considered to lower the environmental risk to low for all environmental aspects and impacts.

During construction, the environmental impacts that were rated with the highest risks were the potential spread of weeds and Phytophthora dieback. These potential impacts will be primarily managed through hygiene actions, which are detailed in site-specific environmental management planning tools. During operation, the highest risks – soil contamination from chemical storage and from the GWR plant's storage tanks – were considered to be sufficiently managed by engineering design (including bunding for storage tanks).

Table 5: Construction and Operation Risk Assessment

			RISK IDENTIFICATION		Maximal Risk Assessment (Without Controls)					RESIDUAL RISK (With preventive measures)		
Ref	Hazard (Short Title)	End Point	Consequence of the Hazard	Comment	Consequence	Likelihood	Risk Level	Preventative Measures	Control Effectiveness Rating	Consequence	Likelihood	Risk Level
Risk assignment determined using the Risk matrix provided in the *Water Corporation's Corporate Risk Assessment*												
Construction Impacts												
1	Erosion - wind and water run-off	Surface water	Loss of biodiversity	Sandy site with excellent drainage capacity	1	D	Low					
2	Clearing for construction	Biota - Terrestrial	Loss of biodoversity		1	E	Low					
3	Dust	People	Disturbance to neighbours	Closest neighbours approx 400m to the west. Prevalent afternoon SW winds.	2	D	Low	Visual dust monitoring and control measures if required				
4	Dust	Biota - Terrestrial	Dust smothers plants in adjacent bush forever site leading to loss of biodoversity		2	D	Low	Visual dust monitoring and control measures if required				
5	Greenhouse gases (GHG) produced during construction	Atmosphere	Addition of GHG to the atmosphere		1	E	Low					
6	Noise & Vibration	People	Exceedance of Noise Regs during construction causes distrubance to neighbours		2	D	Low	Noise Mitigation Strategy required	Optimal	2	E	Low
7	Cultural Heritage	Indigenous heritage	Loss of indigenous heritage	Desktop search of Aboriginal sites register does not list registered site within GWRT area	1	E	Low					
8	Native Title	Indigenous heritage	Loss of indigenous heritage	Beenyup Site vested to Water Corporation	1	E	Low					
9	Contamination e.g. fuel spills, waste material	Soils	Soil contamination		1	D	Low					
10	Introduction of weeds as a result of construction activities	Biota - Terrestrial	Spread weeds into Bush Forever site causing a potential loss of biodiversity		2	C	Moderate	Continue implementation of Beenyup site weed management plan	Adequate	2	D	Low
11	Die Back	Biota - Terrestrial	Introduction of dieback through construction equipment causing a potential loss of biodiversity		3	D	Moderate	Implement dieback management guideline if required	Adequate	2	D	Low
12	Fauna	Biota - Terrestrial	Death of fauna		2	D	Low					
Operational Impacts (additional to effect of GWRT product water on Environmental Values of Leederville Aquifer)												
13	Odour from GWRT storage tanks	People	Odour causing a disturbance to neighbours		2	D	Low					
14	Noise	People	Noise causing a disturbance to neighbours		2	D	Low					
15	Greenhouse gases produced during operation	Atmosphere	Addition of GHG to the atmosphere		1	E	Low					
16	Overflow - GWRT storage tanks	Soils	Soil contamination		2	C	Moderate	Allow for bunding in design	Optimal	1	D	Low
17	Waste retention tank & pipework	Infrastructure	Low alkalinity of GWRT product water causes low pH and corrosion of infrastructure		1	C	Low					
18	Overflow - Clean-in-place Chemical Storage	Soils	Soil contamination	Assuming Induvidual volume of tanks is low	2	C	Moderate	Allow for bunding in design	Optimal	1	D	Low
19	Discharge of GWRT reject water to marine environment	Biota - Aquatic	Potential detrimental impact to water quality	Refer to Oceanica report - Aug 2007	1	E	Low					
20	Discharge of GWRT product water (high quality water) to Leederville Aquifer	Biota - Terrestrial	Potential detrimental impact to water quality impacting "Primary Industry" Environmental Value	Refer to hazard-based Environmental Risk Assessment	1	E	Low					

In addition to the standard construction and operation risk assessment required of a wastewater treatment plant or water supply scheme, the DoW and DoH have directed that development of a groundwater replenishment scheme requires an assessment of risk to human health and the identified environmental values of the Leederville Aquifer relevant to the Trial (see section 4.1) as well as to the Leederville aquifer substrate and water quality.

The process of developing the risk assessment and identified mitigations is described in detail in the document *"Risk Assessment Report - Groundwater Replenishment Trial"* (Appendix 8).

The Risk Assessments considered the effect of over 400 potential chemical, microbiological and radiological hazards (as part of the water quality guidelines listed in Table 2) to human health and Trial EVs as a result of injecting high quality water to the Leederville aquifer. This includes the risks present when the treatment processes are operating to standard conditions as well as during a failure of the treatment process (Barriers). Barrier failures were identified by experts in relevant areas, including industrial waste discharge, secondary wastewater treatment and advanced tertiary treatment.

In summary, suitable mitigations were identified to reduce risks to human health and Trial EVs to low for all identified hazards during normal operations and also during identified barrier failures. Key factors contributing to this conclusion are that the Trial is being undertaken on a small scale over a short period, movement of water will be within a limited area of the confined aquifer, and there will be a high degree of monitoring and operational control including shutdown and bypass protocols.

The outcomes of this risk assessment process will inform the continued development of the risk management framework as the Trial progresses through detailed design, commissioning and operation. Risk assessment review will take account of additional water quality data and new knowledge to confirm that residual risks of undertaking the Trial remain low.

The Water Corporation will continue to work with the DoH, DoW and DEC via the IAWG to ensure that the objectives of the Trial are met within a framework that is a low risk to human health and the identified Trial EVs. Approval to commence injection is required from DoH and will be based on commissioning data and demonstration of the completed elements of a risk management framework.

The outcomes of the Risk Assessment process and the Groundwater Replenishment Trial Risk Assessment Report, including all risk assessments and mitigations were presented to the DEC, DoW and DoH on March 12, 2008. Letters from the DoW and DoH evaluating the risk assessment process and the outcomes are attached as Appendix 9.

5.0 Conclusions

Groundwater replenishment is one of the many approaches the Water Corporation is assessing to address long-term water security in Western Australia. Augmenting our depleted groundwater resources through injection of advanced treated wastewater has the potential to benefit economic, environmental and social sustainability. The Groundwater Replenishment Trial is a vital element of the Water Corporation's broader assessment of groundwater replenishment in the Western Australian context and enables the community to become familiar with and debate the concept of groundwater replenishment.

This Trial has been planned and designed to minimise risks to human wellbeing and health of the environment, while providing an opportunity to rigorously monitor and assess the injection of advanced treated wastewater. Environmental risks for construction and operational phases of the Trial have been assessed and appropriate environmental management planning and actions will be implemented to manage potential impacts. Implementation of appropriate management actions such as practices and consideration of environmental aspects during the design process (e.g., for pollution prevention) will manage potential environmental risks to low.

Monitoring and additional research conducted to complement the Groundwater Replenishment Trial will be critical for further exploration of this water recycling method and its application in Western Australia.

The operation of the GWR plant will be simultaneously controlled and monitored in order to prevent any pollution and to gather vital information on groundwater replenishment. The Project Control Plan and the Monitoring Plan are tools that will be used to conduct operations and gather data. It is expected that implementation and compliance with these plans would become requirements of conditions applied through the Part V operating Licence for the groundwater replenishment plant.

Thus the Water Corporation does not believe that the project does not require assessment under Part IV and can be managed under Part V of the *Environmental Protection Act (1986)*.

6.0 References

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