



Government of Western Australia
Department of Water

Coral Bay Water Reserve

Drinking water source protection plan

Coral Bay town water supply



Looking after all our water needs

Water resource protection series
Report WRP 117
May 2010

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Cover photograph: Satellite photograph of the Coral Bay area (Mauds Landing mosaic – Landgate – September 2008)

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Preface

How do we protect public drinking water source areas?

The Australian drinking water guidelines (ADWG) (NHMRC & NRMCC 2004a) outlines how we should protect drinking water in Australia. The ADWG recommend a 'catchment to consumer' framework that uses a risk-based, multiple-barrier approach. A similar approach is recommended by the World Health Organization in other countries worldwide.

The 'catchment to consumer' framework applies across the entire drinking water supply system, from the water source to the tap. It ensures a holistic assessment of risks to drinking water to maximise the delivery of safe drinking water to consumers.

A risk-based approach means that we look at all the different risks to water quality, and how to address them. A multiple-barrier approach means that we use different barriers against contamination at different stages of a drinking water supply system. The first barrier is protecting the catchment (the whole area from which water flows into the drinking water source). This plan helps to do that. Other barriers against contamination include:

- storage of water to help settle out contaminants
- treating the water (e.g. chlorination) to remove contamination
- maintenance of pipes
- monitoring of water quality.

As water treatment practices evolve, many people think that we no longer need to protect the catchment because we can 'engineer out the risks'. Nothing could be further from the truth (Krogh et al. 2008). Recent research and experience shows that a combination of catchment protection and water treatment is safer than relying on either barrier on its own. That is why this drinking water source protection plan is important. It is about protecting the catchment's water quality now and in the future.

In Western Australia, the Department of Water protects public drinking water source areas (PDWSAs) by using the law; putting the ADWG into practice; writing plans, policies and guidelines; and providing input into land-use planning.

The *Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)* and the *Country Areas Water Supply Act 1947 (WA)* allow us to protect water. We proclaim PDWSAs under one of these Acts so that we can apply the legislation to protect water quality.

The ADWG outline 12 elements to protect drinking water. We implement element two (assessment of the drinking water supply system) and element three (preventative measures for drinking water quality management) by writing drinking water source protection plans. Plans have been, or are being written, for all PDWSAs around the

state. They give an overview of a drinking water source and outline the risks to water quality and how to address them. Our regional offices work with the community, other government agencies and landowners to put the recommendations into practice.

We also define special areas within PDWSAs: priority areas and protection zones. There are three different priority areas, each assigned a certain level of risk to water quality. Protection zones surround drinking water extraction points, so that the most vulnerable areas may be protected from contamination. Under legislation, some activities are restricted in protection zones.

If you would like more information about how we protect drinking water in Western Australia, go to <<http://drinkingwater.water.wa.gov.au>>.

The following table outlines the stages involved in the preparation of this drinking water source protection plan:

Stages in development of a plan		Comment
1	Prepare drinking water source protection assessment document.	Prepared after initial catchment survey and preliminary information gathering. This document may not be required if a drinking water source protection plan already exists or alternative documents provide suitable information.
2	Conduct stakeholder consultation. (2007, 2009-10)	Advice sought from key stakeholders using the assessment document as a tool for information and discussion. Draft drinking water source protection plan prepared
3	Consult draft drinking water source protection plan. (2010)	Draft protection plan consulted with key stakeholders.
4	Publish approved drinking water source protection plan. (2010)	Final protection plan published after considering submissions. Includes recommendations on how to protect water quality. Proclamation of this public drinking water source area can now be progressed.

Summary

The township of Coral Bay is located on the Ningaloo coast in Western Australia's Gascoyne region, approximately 1000 km north of Perth and 140 km south of Exmouth. The major industry is tourism.

Coral Bay depends entirely on groundwater for its water supply. Its groundwater is sourced from the Birdrong aquifer, which is part of the Carnarvon Artesian Basin. This is a confined sandstone aquifer that is recharged in the Gregory Range east of Coral Bay.

In 2005 the Water Corporation constructed deep artesian bore 1/04 about 1.5 km south of the town. The bore intercepts the Birdrong aquifer at a depth of about 800 m. The depth and confined nature of the aquifer provide a high level of water quality protection. The potential risks to water quality posed by the land uses and activities in the water reserve (drinking water treatment facilities) are considered to be negligible.

The following strategies are recommended to protect water quality within the proposed Coral Bay Water Reserve:

- the boundaries of the proposed water reserve, which reflect the boundaries of the water treatment plant compound, should be proclaimed under the *Country Areas Water Supply Act 1947 (WA)*
- the water reserve should be managed for Priority 1 source protection
- the water reserve and Priority 1 area should be recognised in the *Shire of Carnarvon local planning scheme*.

The Department of Water has developed this plan in consultation with the Water Corporation, the Shire of Carnarvon and other relevant stakeholders.

1 Drinking water source overview

1.1 Existing water supply system

To establish a town water supply for Coral Bay the Water Corporation examined potential drinking water sources in the area. The only available water (other than sea water) is located in the Birdrong Sandstone Formation between 750 m and 850 m below ground level. Although the quality of this water source is not ideal (salinity is in the range of 5000 – 5200 mg/L TDS), it is suitable for desalination.

Coral Bay deep artesian bore 1/04 was constructed in 2005. It is situated approximately 1.5 km south of the Coral Bay townsite within the water treatment plant compound. Figure A1 shows the compound's location and Figure A2 identifies the bore's location within the compound (Appendix A). At ground level the bore is 11.4 m AHD. It extends to a depth of over 800 m below the top of the casing (BTOC) (Water Corporation 2005).

The Coral Bay deep artesian bore and water treatment plant began operating in 2009. Water from bore 1/04 is pumped to cooling tanks before being desalinated and disinfected (Figure D1). The water is then pumped to an 800 kL holding tank (figures D2 and D3), from which it is gravity-fed to the Coral Bay townsite. In addition to five commercial services in the town, Cardabia Station is also being supplied by this scheme.

The plant can provide up to 200 kL of drinking water each day (73 000 kL/year). Its capacity can be upgraded to 400 kL/day (146 000 kL/year) should demand increase (Water Corporation 2009).

1.2 Water treatment

The salinity of water from the bore during construction was measured at 4,851 mg/L TDS, the temperature was relatively stable at 63°C and the pH was 7.1 (Water Corporation 2005). When the water has cooled sufficiently it is pumped from the cooling tanks to the reverse osmosis desalination plant. After desalination it is disinfected by chlorination before being pumped to the holding tank.

It should be recognised that although treatment and disinfection are essential barriers against contamination, management of the bore compound and surrounding land uses is the first step in protecting water quality and ensuring a safe drinking water supply. This approach is endorsed by the *National water quality management strategy: Australian drinking water guidelines 6, 2004 (ADWG)* (NHMRC & NRMCC 2004a) and reflects a risk-based, multiple-barrier approach for providing safe drinking water to consumers. This combination of bore protection and water treatment will deliver more reliable, safe and lower-cost drinking water to consumers than either approach could achieve individually.

1.3 Catchment details

1.3.1 Physiography

The proposed Coral Bay Water Reserve is situated about 1.5 km south-east of the townsite in a shallow Pleistocene swale (valley), which tends north-south. This valley is bounded on both sides by dune sand ridges that rise to an average height of approximately 24 m AHD.

1.3.2 Climate

The Coral Bay area experiences a moderate arid climate with hot summers and mild winters. The estimated average annual rainfall is between 210 and 250 mm/year. Most rainfall occurs over winter; however, the area can experience occasional cyclonic rainfall events during summer and autumn. Annual evaporation at Coral Bay is estimated at 2,800 mm (Thorpe 1990), which far exceeds annual rainfall.

1.3.3 Hydrology/hydrogeology

The Coral Bay area lies within the Gascoyne sub-basin division of the Carnarvon Basin, which is comprised of a series of sediments ranging in age from Quaternary, through Tertiary and Cretaceous (where the main aquifer is intersected) to Devonian, which in turn rests on Proterozoic bedrock. The sediments dip to the west.

The area is underlain by a series of calcarenites and limestones of Quaternary (Bundera Calcarenite) and Tertiary age (Trealla Limestone and Giralia Calcarenite). While these sediments are cavernous in places, in this area they do not yield any water supplies of significant quantity or quality. They have a maximum thickness of up to 300 m, but at the production bore they total 200 m.

Underlying the limestones and calcarenites are sediments of the Early Cretaceous Winning Group. They consist of up to 200 m of the Gearle Siltstone, which overlies up to 70 m of Windalia Radiolarite, and about 10 m of Muderong Shale. These sediments consist of siltstone, argillaceous sandstone, clayey siltstone, marl and shale and do not contain any water source.

Beneath the Muderong Shale lies the main aquifer – the Birdrong Sandstone – which is a poorly indurated quartz sandstone of up to 30 m thickness. It is a highly productive aquifer and provides abundant water to the Carnarvon Basin's many pastoral bores. It is a confined aquifer and has a significant pressure head in this area. It is recharged where it outcrops or subcrops in the Gregory Range to the east of Coral Bay, although the recharge quantity is considered to be minimal. Water in this aquifer is expected to have a fairly high temperature (55 – 60°C) and a high salinity (5000 – 6000 mg/L TDS). The production bore intersects the aquifer at 781 m where it is 34 m thick (Department of Water 2007; Water Corporation 2005; Thorpe 1990; Hocking et al. 1985).

1.4 Future water supply requirements

The Coral Bay water supply and treatment plant can produce up to 200 kL/day (73 000 kL/year). Current water demand is estimated to be between 30 to 95 kL/day (about 11 000 to 35 000 kL/year). Demand fluctuates during the year, increasing significantly during the tourist season. The plant's capacity can be upgraded to about 400 kL/day (146 000 kL/year) should demand increase (Water Corporation 2009).

1.5 Existing drinking water source protection

Deep artesian bore 1/04 is a new drinking water source for Coral Bay, which is not yet proclaimed under the *Country Areas Water Supply Act 1947* (WA). The Water Corporation's bore compound, storage tanks and treatment facilities are fenced (figures D2 and D3) and inspected regularly by Water Corporation staff.

The water reserve boundaries proposed in this plan should be gazetted under the *Country Areas Water Supply Act 1947* (WA) and recognised in the relevant Shire of Carnarvon planning scheme as a special control area (see also section 4.4). The types of development supported in a public drinking water source area (such as a water treatment plant) are described in the Department of Water's Water quality protection note no.25: *Land use compatibility in public drinking water source areas*.

1.6 Department of Water management

1.6.1 Current allocation licence

Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914* (WA). Under this Act, the right to use and control surface water and groundwater is vested with the Crown. The Act requires licensing of groundwater abstraction (pumping water from a bore, spring or soak) within groundwater areas proclaimed under the Act and all artesian wells throughout the State.

The Department of Water issued groundwater licence number 156265(1) to the Water Corporation to abstract 330 ML/year from the Carnarvon-Birdrong aquifer for public drinking water supply purposes at Coral Bay. The licence is valid until 15 November 2011.

1.6.2 Carnarvon Artesian Basin water management plan

The Department of Water prepared the *Carnarvon Artesian Basin water management plan* in 2007 to ensure the groundwater resources of the basin (Birdrong aquifer) are being allocated appropriately. Artesian groundwater from the Birdrong aquifer has historically been used by the pastoral industry, but demand is increasing. While the volume of water in the aquifer is considerable, recharge is limited due to the lack of significant, regular rainfall over the recharge area. This means abstraction of water

from the Birdrong aquifer needs to be carefully monitored and managed. The plan is focused on managing the impacts of groundwater abstraction from the Birdrong aquifer to maintain any associated environmental and economic values. It sets the total allocation limit for abstraction of groundwater at 30 GL/year.

2 Water quality monitoring and contamination risks

A wide range of chemical, physical and microbiological factors can impact on water quality and therefore affect the provision of safe, good quality drinking water to consumers.

The Water Corporation regularly monitors the quality of raw water from the Coral Bay deep artesian bore 1/04 for microbiological, health-related and aesthetic (non-health-related) characteristics. This data shows the quality of water in the Coral Bay Water Reserve. An assessment of the drinking water quality once treated is also made against the ADWG to ensure safe, good quality drinking water is available to consumers. This assessment is made by an intergovernmental committee called the Advisory Committee for the Purity of Water that is chaired by the Department of Health.

A water quality summary for the Coral Bay Water Reserve from July 2004 to June 2009 is presented in Appendix B. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at www.watercorporation.com.au > What we do > Water quality > Water quality publications > Water quality annual report 2008–09.

Contamination risks relevant to drinking water sources are described below.

2.1 Microbiological

Pathogens are types of microorganisms that are capable of causing disease. These include bacteria, protozoa and viruses. In water supplies, pathogens that can cause illness are commonly found in the faeces of humans and domestic animals (such as dogs and cattle).

A number of pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. salmonella, *Escherichia coli* and cholera), protozoa (e.g. *Cryptosporidium*, *Giardia*) and viruses. *E. coli* counts are a way to measure these pathogens and provide an indication of faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors including the existence of pathogen carriers (e.g. humans and domestic animals), the transfer to and movement of the pathogen in the water source and its ability to survive in the water. The percentage of humans in the world that carry pathogens varies. For example, it is estimated that between 0.6 to 4.3 per cent of people are infected with *Cryptosporidium* worldwide, and 7.4 per cent with *Giardia* (Geldreich 1996).

When people (while fishing, marroning, swimming or the like) or domestic animals come into contact with a body of water, pathogens may enter that water source. This primarily occurs through the direct transfer of faecal material (even a very small amount can cause contamination) or indirectly through runoff moving faecal material into the water.

The ability of pathogens to survive in surface water also differs between species. Salmonella may be viable for two to three months, *Giardia* may still infect after one month in the natural environment (Geldreich 1996) and *Cryptosporidium* oocysts (cells containing reproductive spores) may survive weeks to months in fresh water (NHMRC & NRMMC 2004a).

When people consume drinking water contaminated with pathogens the effects vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and sometimes even death. During 2000, seven people died in Walkerton, Canada, because the town water source and supply was contaminated by a pathogenic strain of *E. coli* and campylobacter (NHMRC & NRMMC 2004b; Hrudehy & Hrudehy 2004). Where possible, avoiding the introduction of pathogens into a water source is the most effective way to protect public health.

During the period from July 2004 to June 2009 no positive *Escherichia coli* counts were recorded.

2.2 Health related

Land- and water-based uses and activities within a catchment can directly affect water quality and treatment. For example, off-road driving contributes to erosion and the uprooting of vegetation, which can increase turbidity in water. This increased turbidity can subsequently reduce the effectiveness of treatment processes (such as disinfection).

Erosion results in the mobilisation of soil particles that are released into the air and tributaries, increasing the turbidity of the main water body. Pathogens can adsorb onto these soil particles and may be shielded from the effects of disinfection. Increased turbidity also impacts on other environmental constituents: it smothers riparian vegetation and reduces the transfer of light within the water column, which in turn affects plant growth.

Chemicals attached to suspended material, such as soil particles, can occur in drinking water sources. This may occur as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMMC 2004a). A number of these chemicals (organic and inorganic) are potentially toxic to humans.

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control worms), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills, incorrect use or leakage from storage

areas. In such cases, the relevant authorities should be notified promptly and the spill cleaned up.

Drinking water supplies can also be contaminated by nutrients (such as nitrogen) from fertiliser applications, faulty septic systems, leach drains and from domestic animal faecal matter that washes through or over soil and into a water source. Nitrate and nitrite can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMMC 2004a).

Hydrocarbons (e.g. fuels, oils) are potentially toxic to humans, and harmful chemical by-products may be formed when they are combined with chlorine during the water-treatment process. Hydrocarbons can occur in water supplies as a result of spills and leakage from vehicles.

A few health-related parameters (e.g. fluoride, iodide and sulphate) may on occasion exceed the ADWG in raw water samples from the Coral Bay Water Reserve. This is due to the brackish nature of the artesian source water and is addressed during the treatment process.

2.3 Aesthetic

Impurities in drinking water can affect its aesthetic qualities, including its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to human health; for example, cloudy water with a distinctive odour or strong taste is not necessarily harmful to health, while clear, pleasant-tasting water may still contain harmful microorganisms (NHMRC & NRMMC 2004b).

Iron and dissolved organic matter can affect the colour and appearance of water and salinity can affect the taste. Some properties such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes.

The ADWG set aesthetic water quality criteria to meet the aesthetic requirements of consumers and to protect water supply infrastructure (such as pipes). A few aesthetic parameters (e.g. chloride, sodium and sulphate) may on occasion exceed the ADWG in raw water samples from the Coral Bay Water Reserve. This is due to the brackish nature of the artesian source water and is addressed during the treatment process.

2.4 Groundwater bores

The Coral Bay Water Reserve is located within the Gascoyne Groundwater Area which is proclaimed under the *Rights in Water and Irrigation Act 1914* (WA). Under the provisions of sections 26D and 5C of the Act, a licence is required to construct a bore or abstract water within a proclaimed groundwater area (unless exempt under the Rights in Water and Irrigation Exemption and Repeal [Section 26C] Order 2001).

The Water Corporation operates a drinking water bore in the proposed Coral Bay Water Reserve. If bores for other purposes (e.g. irrigation, private household use) are

drilled near a public drinking water supply bore, they can cause contamination of the drinking water source. For example, a poorly constructed private bore may introduce contaminants from surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer.

It is therefore important to ensure that any bores are appropriately located and constructed to prevent contamination of the public drinking water source. This will be assessed through the Department of Water's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914* (WA). All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003).

3 Land-use assessment

3.1 Existing land uses and activities

The proposed Coral Bay Water Reserve is located on Crown land. Current land uses and activities are outlined below. This information has been summarised in Table 1 at the end of this section. This table also identifies the recommended management priorities for different hazards. Appendix C of this plan uses information in Table 1 and this section to recommend protection strategies for key stakeholders to consider.

3.1.1 Crown land

The Coral Bay bore and water treatment plant compound (Lot 301 on plan 47762) is located on unallocated Crown land. The surrounding land (Lot 511 on plan 53813) is also classified as unallocated Crown land and under pastoral lease (Cardabia Station). Unallocated Crown land is vested in the Department of Regional Development and Lands and managed by the operators (i.e. the Water Corporation and the Baiyungu Aboriginal Corporation).

The land is zoned 'rural' under the *Shire of Carnarvon district zoning scheme 11* (Department of Planning, 2009). Figure A3 shows the compound's location and the proposed Coral Bay Water Reserve in relation to the pastoral lease boundary and the Coral Bay townsite. The nearest residential dwellings are located approximately 1 km from the compound. Surrounding land uses include the Coral Bay power station, a quarry, a landfill site, roads and tracks and the pastoral station.

Given the aquifer's confined nature and the depth of the bore (> 800 m) that accesses it, the risk of water in the aquifer being contaminated is negligible. It should be noted that any future bores drilled near the drinking water source bore have the potential to contaminate the drinking water source. Through the Department of Water's bore application and assessment process it is important to ensure that private bores are appropriately located and constructed to prevent contamination and other impacts on the public drinking water source.

The potential for pollutants to reach the bore and contaminate the water via surface flows is also negligible because the bore is sealed. Potential sources of such pollutants include

- diesel fuel for a back-up power generator (Figure D4) and chemicals used in the water treatment process stored within the Water Corporation's compound
- herbicides, pesticides and other chemicals that may be stored or used in the compound
- diesel fuel stored in the neighbouring power station compound (figures D5 and D6).

While the likelihood of these potential pollutants reaching the bore infrastructure is considered negligible, the use of best management practices within the compound is recommended (see Table 1).

3.1.2 Native title

Native title is a form of land title that recognises the unique ties some Aboriginal groups have to land. Native title exists where Aboriginal people have maintained a traditional connection with their land and waters, since sovereignty, and where acts of government have not removed it.

The proposed Coral Bay Water Reserve falls within native title claim WC97/028 lodged by the Gnulli native title claim group. The Yamatji Land and Sea Council and Gnulli representatives performed an Aboriginal heritage survey of the site (including access tracks) in July 2004, before the bore and treatment works were constructed. No registered Aboriginal heritage sites were identified within or near the proposed water reserve.

3.2 Proposed land uses and activities

Land use zonings in and around the proposed Coral Bay Water Reserve (Figure A4) are not expected to change significantly within the next five years. When reviewing the Shire of Carnarvon's planning scheme the Department of Planning and the Shire of Carnarvon should consider applying a special control area to the proposed water reserve to allow assessments of future development applications to consider water quality protection issues. This approach is consistent with Statement of planning policy no. 2.7 *Public drinking water source policy* (Western Australian Planning Commission 2003).

Table 1 Land uses and potential water quality risks

Land use/activity	Hazard	Management priority	Compatibility of land use/activity*	Best management practice guidance
Water supply and treatment plant <ul style="list-style-type: none"> fuel and chemical storage weed / pest control 	<ul style="list-style-type: none"> hydrocarbons chemicals herbicides, pesticides 	Low Low Low	Water treatment plants are compatible with conditions in Priority 1 (P1) areas. Chemical storage in above ground tanks is incompatible in P1 areas.	<ul style="list-style-type: none"> WQPN no. 56: <i>Tanks for elevated chemical storage</i> (DoW 2006) WQPN no. 10: <i>Contaminant spills - emergency response</i> (DoW 2006) PSC 88: <i>Use of herbicides in water catchment areas</i> (DoH 2007)
Neighbouring land uses / activities				
Power station <ul style="list-style-type: none"> fuel and chemical storage weed / pest control 	<ul style="list-style-type: none"> hydrocarbons chemicals herbicides, pesticides 	Low Low Low	Within a public drinking water source area, a power station would be considered incompatible. Chemical storage in above ground tanks would be considered compatible with conditions in P2 and P3 areas.	<ul style="list-style-type: none"> WQPN no. 56: <i>Tanks for elevated chemical storage</i> (DoW 2006) WQPN no. 10: <i>Contaminant spills - emergency response</i> (DoW 2006) Statewide policy no. 2: <i>Pesticide use in public drinking water source areas</i> (WRC 2000) PSC 88: <i>Use of herbicides in water catchment areas</i> (DoH 2007)

*Refer also to the Department of Water's Water quality protection note no. 25: *Land use compatibility in public drinking water source areas* (2004).

4 Catchment protection strategy

4.1 Protection objectives

This plan's objective is to protect the drinking water source so that safe drinking water is supplied to the town of Coral Bay. Existing approved land uses in and around the proposed water reserve can continue.

The boundaries of the proposed Coral Bay Water Reserve have been assigned to ensure consistency with the Department of Water's current framework for public drinking water source protection. The boundaries reflect the land tenure, the strategic importance of the water source, land use and zoning and consider the aquifer's low vulnerability to contamination.

Due to the aquifer's confined nature, existing and future land uses surrounding the proposed Coral Bay Water Reserve should have a minimal effect on the public drinking water source. The recommended protection strategy for this water reserve is to manage the area as Priority 1 (see Section 4.3 Priority areas) and to encourage landowners, managers and operators of land use activities in and around the proposed water reserve to employ best management practices (refer Appendix C).

4.2 Proclaimed area

Coral Bay deep artesian bore 1/04 is a new drinking water source that has not yet been proclaimed. It is proposed that the Water Corporation's compound containing the bore and the water treatment plant be proclaimed as the Coral Bay Water Reserve (see Figure A5) under the *Country Areas Water Supply Act 1947* (WA).

4.3 Priority areas

The protection of PDWSAs relies on statutory measures available in legislation for water resource management and land-use planning. The Department of Water's policy for the protection of PDWSAs includes three risk-based priority areas:

- Priority 1 (P1) areas have the fundamental water quality objective of risk avoidance
- Priority 2 (P2) areas have the fundamental water quality objective of risk minimisation
- Priority 3 (P3) areas have the fundamental water quality objective of risk management.

The determination of priority areas is based on the strategic importance of the land or water source, the local planning-scheme zoning, the form of land tenure and existing approved land uses or activities. For further detail, please refer to the Department of

Water's Water quality protection note no. 25 (WQPN no. 25): *Land use compatibility in public drinking water source areas*.

The proposed priority area for the Coral Bay Water Reserve has been determined in accordance with current Department of Water policy. The area is described below and displayed in Figure A5. The department's WQPN no. 25: *Land use compatibility in public drinking water source areas* outlines activities that are 'acceptable', 'compatible with conditions' or 'incompatible' within the different priority areas. For an explanation of the background and support for protection of PDWSAs, please refer to WQPN no. 36: *Protecting public drinking water source areas*.

Water from this source constitutes a strategic supply to the Coral Bay town water supply scheme and should be afforded the highest level of protection. Therefore the land should be managed as a P1 area in accordance with the land use and tenure of the water reserve (Figure A5).

4.4 Protection zones

In addition to P1, P2 and P3 areas, protection zones are defined to protect drinking water sources from contamination in the immediate vicinity of water extraction facilities. Specific conditions may apply within these zones such as restrictions on the storage of chemicals.

Wellhead protection zones (WHPZs) are generally circular (unless information is available to determine a different shape or size), with a 500 m radius around each production bore in a P1 area and a 300 m radius around each production bore in P2 and P3 areas. WHPZs do not extend outside the boundary of the water reserve.

The risk of contamination from existing and potential future land uses in and around the proposed Coral Bay Water Reserve is negligible due to the aquifer's confined nature. Accordingly, a WHPZ is not required.

4.5 Land-use planning

It is recognised under the Western Australian Planning Commission's (WAPC) *State planning strategy* (1997) that appropriate protection mechanisms in statutory land-use planning processes are necessary to secure the long-term protection of drinking water sources. As outlined in the WAPC's Statement of planning policy no. 2.7: *Public drinking water source policy* (2003) it is appropriate that the proposed Coral Bay Water Reserve and its priority area be recognised in the *Shire of Carnarvon local planning scheme*. Any development proposals within the Coral Bay Water Reserve that are inconsistent with advice in the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas* or recommendations in this plan should be referred to the Department of Water for advice.

For further information on the integration of land-use planning and water source protection, please refer to the Department of Water's WQPN no. 36: *Protecting public drinking water source areas*.

The department's protection strategy for PDWSAs provides for lawfully established and operated developments to continue despite those facilities posing a potential level of risk to water quality that would not be accepted for new developments. The department will provide advice to landowners/operators on measures to improve these facilities and reduce water quality contamination risks.

In strategically significant areas the department has developed a policy that allows it to approach landowners, managers or operators with a view to negotiating water-contamination-risk reduction measures.

4.6 Best management practices

There are opportunities to significantly reduce water contamination risks by carefully considering design and management practices. To help protect water sources, the Department of Water will continue to encourage the adoption of best management practices for various land uses.

Guidelines on best management practices for many land uses are available in the form of industry codes of practice, environmental guidelines and water quality protection notes. They outline the recommended practices to ensure the protection of water quality and can thus help managers reduce any detrimental effects of their operations. Such guidelines have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples include WQPN no. 56: *Tanks for elevated chemical storage*, WQPN no. 10: *Contaminant spills – emergency response* and PSC 88: *Use of herbicides in water catchment areas* (Department of Health 2007), which are listed in this plan's References.

Education and creating awareness (e.g. signage and information) are also key mechanisms for protecting water quality, especially for people visiting the area. A brochure will be produced once this plan is finalised, describing the Coral Bay Water Reserve, its location and the main threats to water quality. This brochure will be available to the community and will inform people in simple terms about the drinking water source and the need to protect it.

4.7 Surveillance and by-law enforcement

The quality of water in public drinking water source areas within country areas of the state is protected under the *Country Areas Water Supply Act 1947* (WA). Proclamation of PDWSAs allows existing by-laws to be applied to protect water quality.

The Department of Water considers by-law enforcement, through surveillance of land-use activities in PDWSAs, to be an important mechanism to protect water quality.

Signs will be erected on the boundaries of this water reserve to educate and advise the public about activities that are prohibited or regulated.

4.8 Emergency response

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of Carnarvon local emergency management committee (LEMC), through the Mid West-Gascoyne emergency management district, should be familiar with the location and purpose of the Coral Bay Water Reserve. A locality plan should be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team. The Department of Environment and Conservation (DEC) is the lead agency for wildfire control management for most of the land areas outside gazetted fire emergency response zones. The Water Corporation should have an advisory role to the HAZMAT team for incidents in and around the Coral Bay Water Reserve.

Personnel, who deal with WESTPLAN–HAZMAT (Western Australian plan for hazardous materials) incidents within the area, should have access to a map of the Coral Bay Water Reserve. These personnel should have an adequate understanding of the potential impacts of spills on this water resource.

4.9 Implementation of this plan

Table 1 identifies the potential water quality risks associated with existing land uses in the proposed Coral Bay Water Reserve. Further information and the recommended protection strategies to deal with those risks are outlined in Appendix C.

When the final *Coral Bay Water Reserve drinking water source protection plan* is complete, an implementation strategy will be drawn up based on the recommendations in Appendix C.

5 Recommendations

The following recommendations apply to the Coral Bay Water Reserve. The bracketed stakeholders are those expected to have responsibility for, or an interest in, the relevant recommendation being implemented.

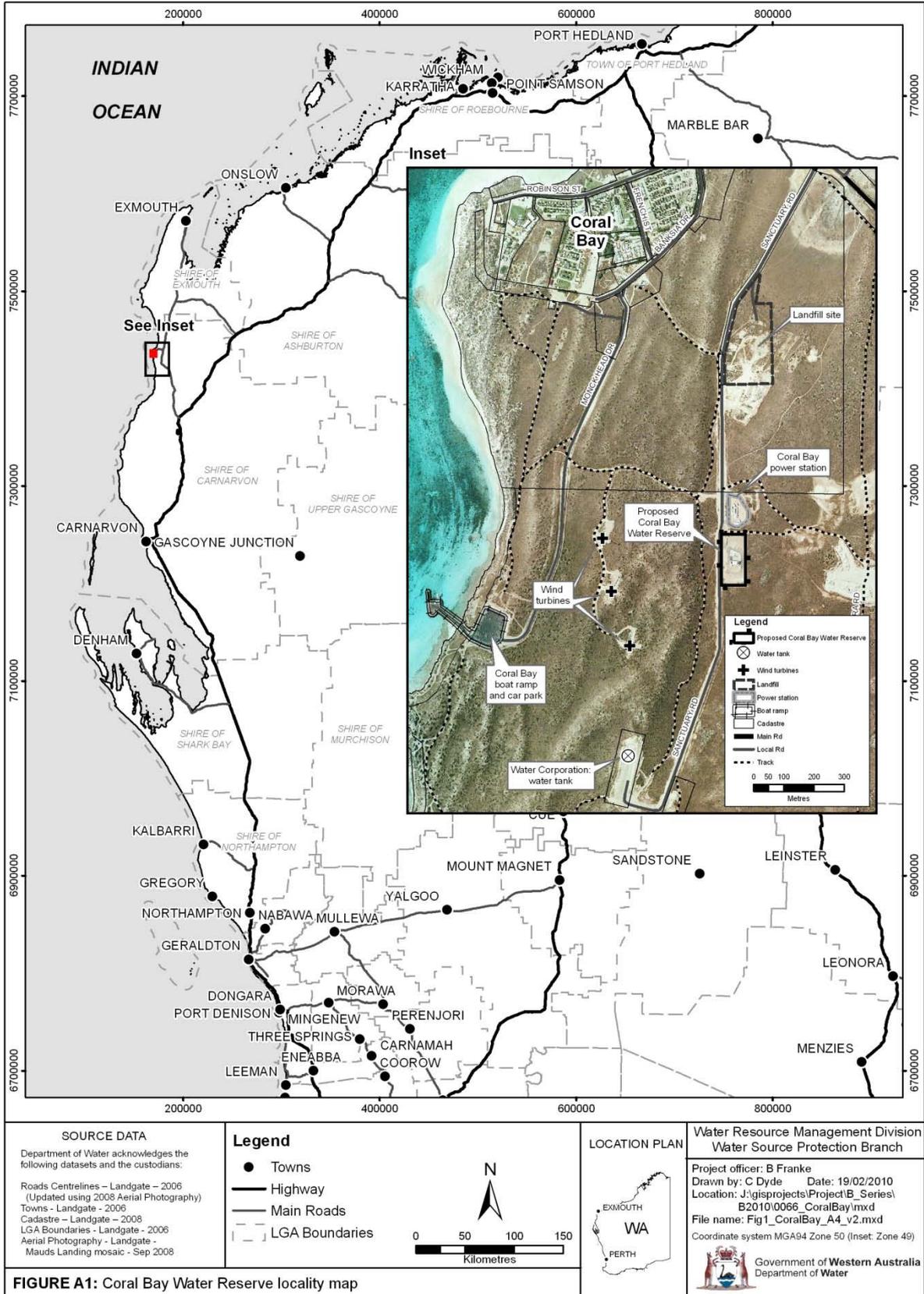
- 1 The boundary of the Coral Bay Water Reserve should be proclaimed under the *Country Areas Water Supply Act 1947* (WA). (Department of Water)
- 2 Develop an implementation strategy for this plan's recommendations (including the recommended protection strategies as detailed in Appendix C) showing responsible stakeholders and planned timeframes. (Department of Water, applicable stakeholders)
- 3 The *Shire of Carnarvon local planning scheme* should incorporate this plan and reflect the identified Coral Bay Water Reserve boundary and Priority 1 area in accordance with the WAPC's Statement of planning policy no. 2.7: *Public drinking water source policy*. (Shire of Carnarvon, Department of Planning, Department of Water)
- 4 All development proposals within the Coral Bay Water Reserve that are inconsistent with the Department of Water's Water quality protection note no. 25: *Land use compatibility in public drinking water source areas* or recommendations in this plan should be referred to the Department of Water for advice and recommendations. (Department of Planning, Shire of Carnarvon, proponents of proposals, Department of Water)
- 5 Incidents covered by WESTPLAN–HAZMAT in the Coral Bay Water Reserve should be addressed by ensuring that:
 - the Shire of Carnarvon LEMC is aware of the location and purpose of the Coral Bay Water Reserve
 - the locality plan for the Coral Bay Water Reserve is provided to the FESA headquarters for the HAZMAT emergency advisory team
 - the Water Corporation acts in an advisory role during incidents in the Coral Bay Water Reserve
 - personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Coral Bay Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality.(Department of Water, Water Corporation)
- 6 Signs should be erected along the boundary of the Coral Bay Water Reserve to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number. (Department of Water)
- 7 Applications to construct a bore and/or abstract groundwater near the Coral Bay Water Reserve should be assessed to ensure that the bores are appropriately located. Best management practices should be recommended for the construction

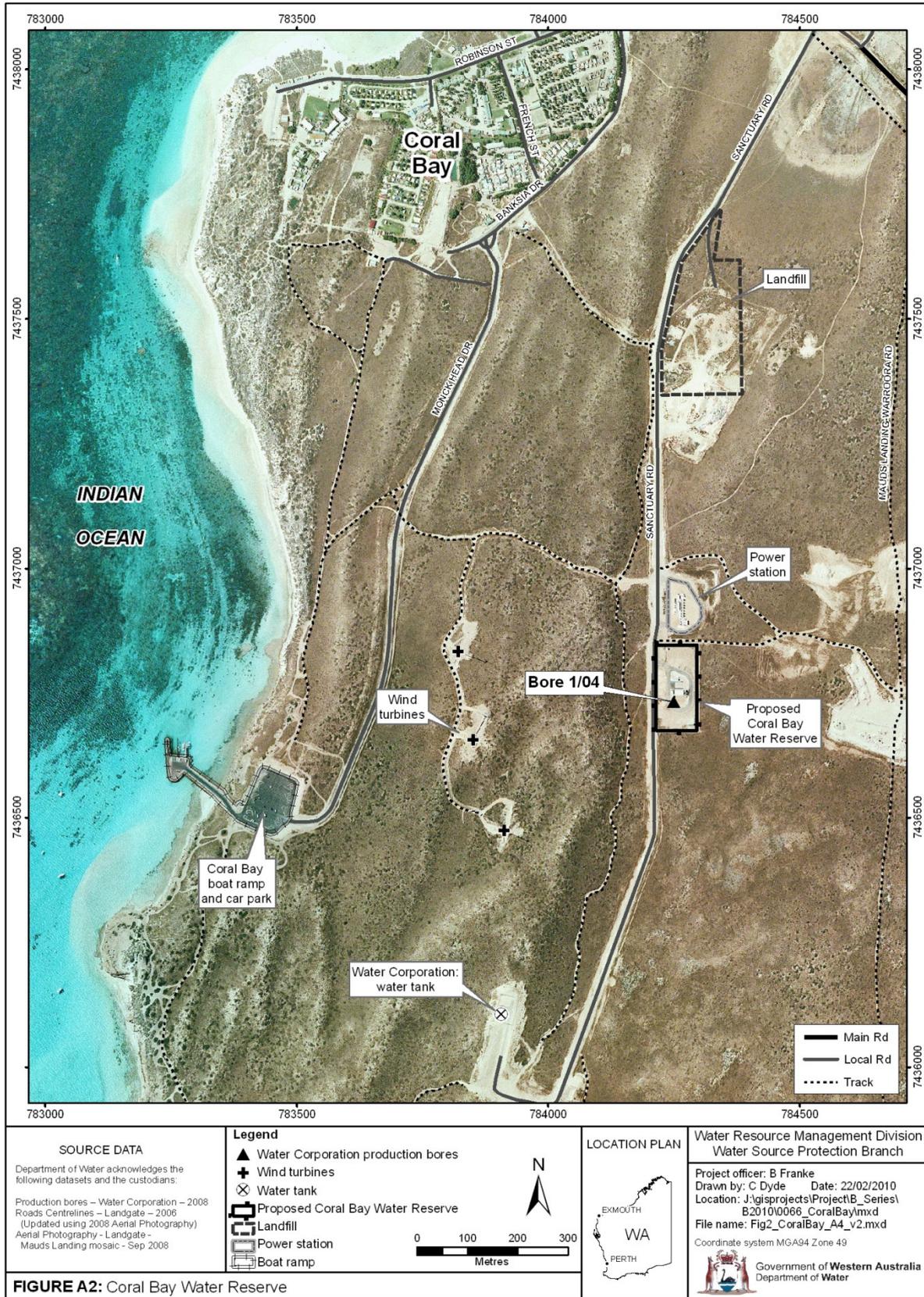
and maintenance of bores to prevent potential contamination of the drinking water source. (Department of Water)

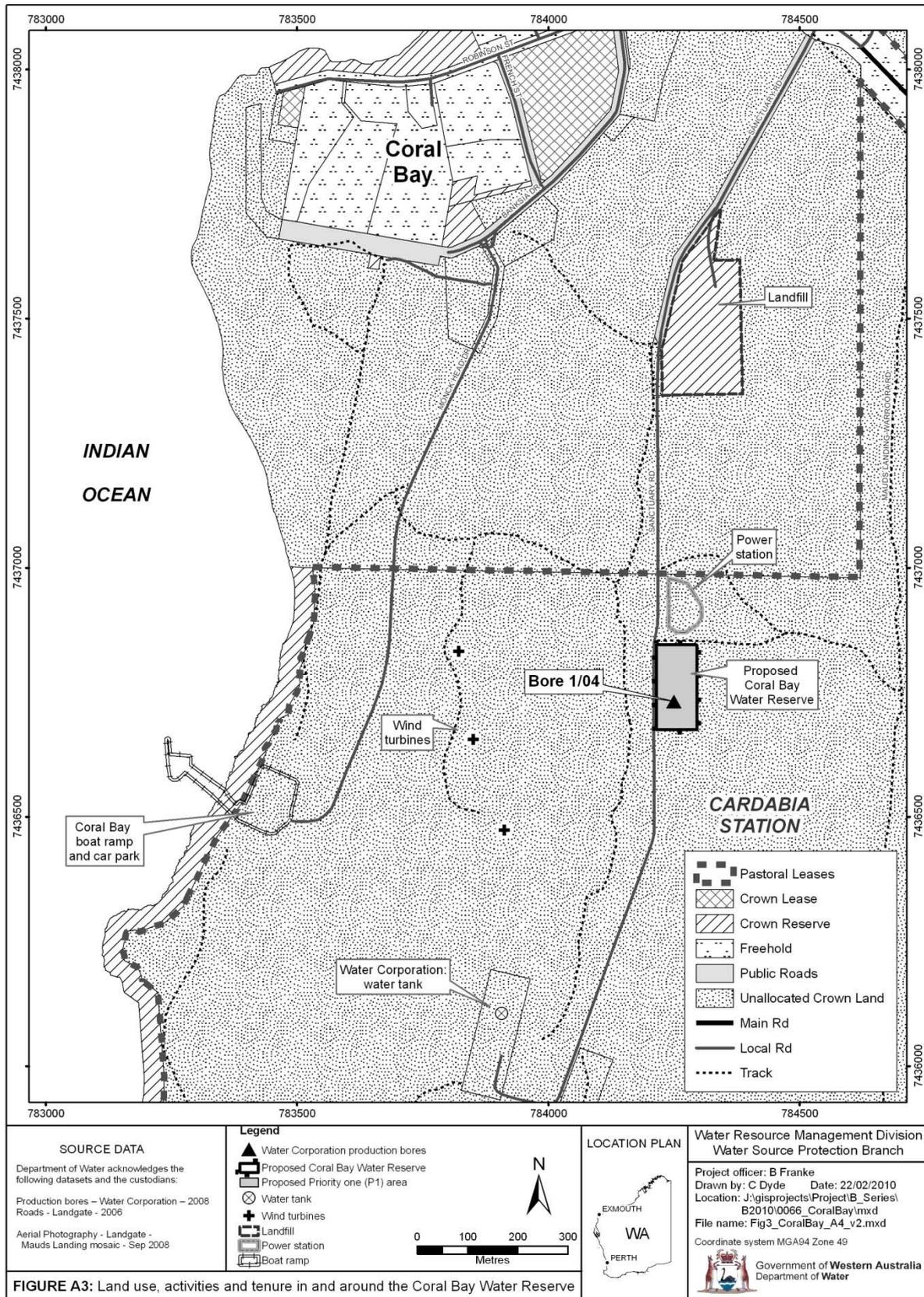
- 8 A review of this plan should be undertaken after five years. (Department of Water)

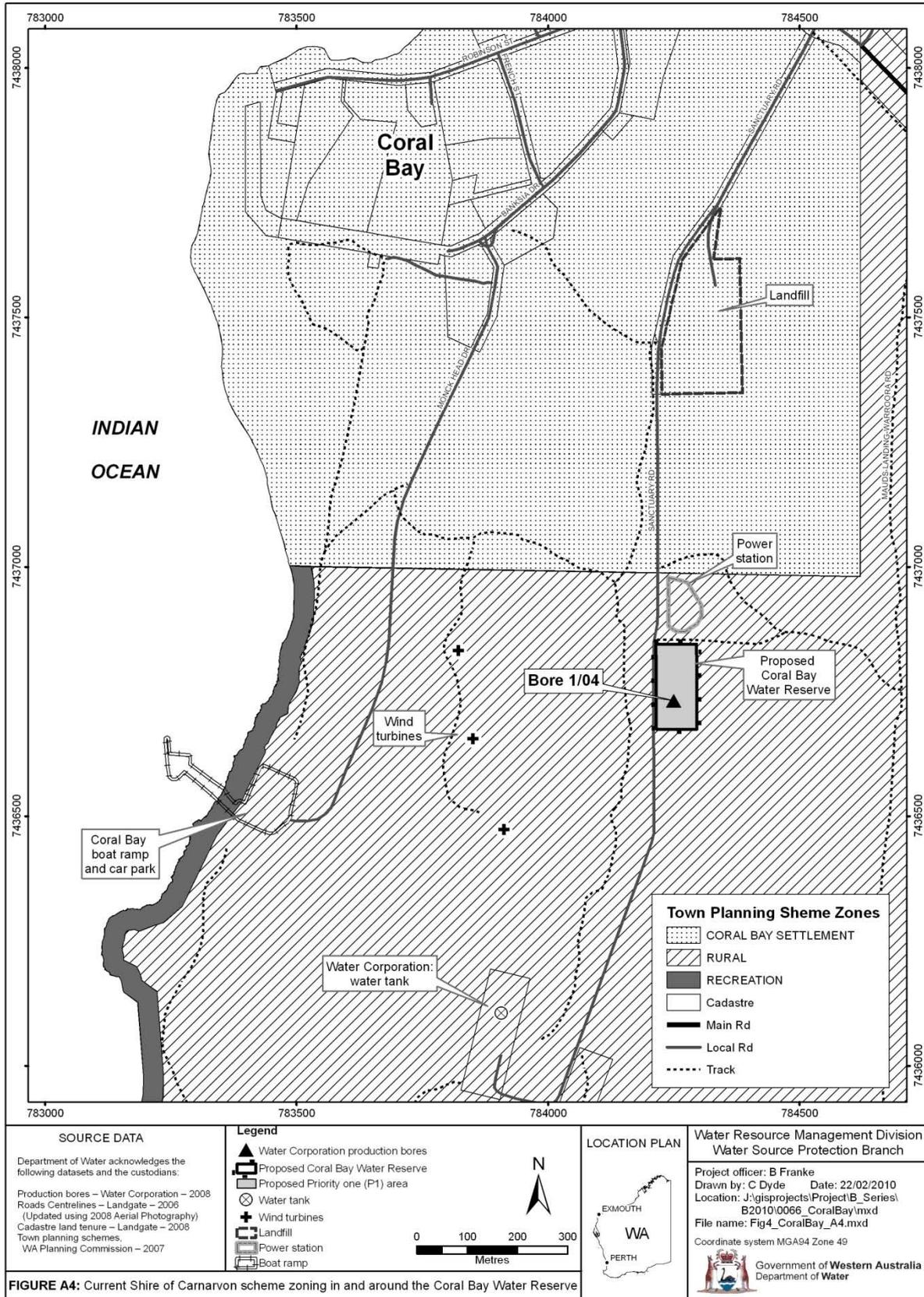
Appendices

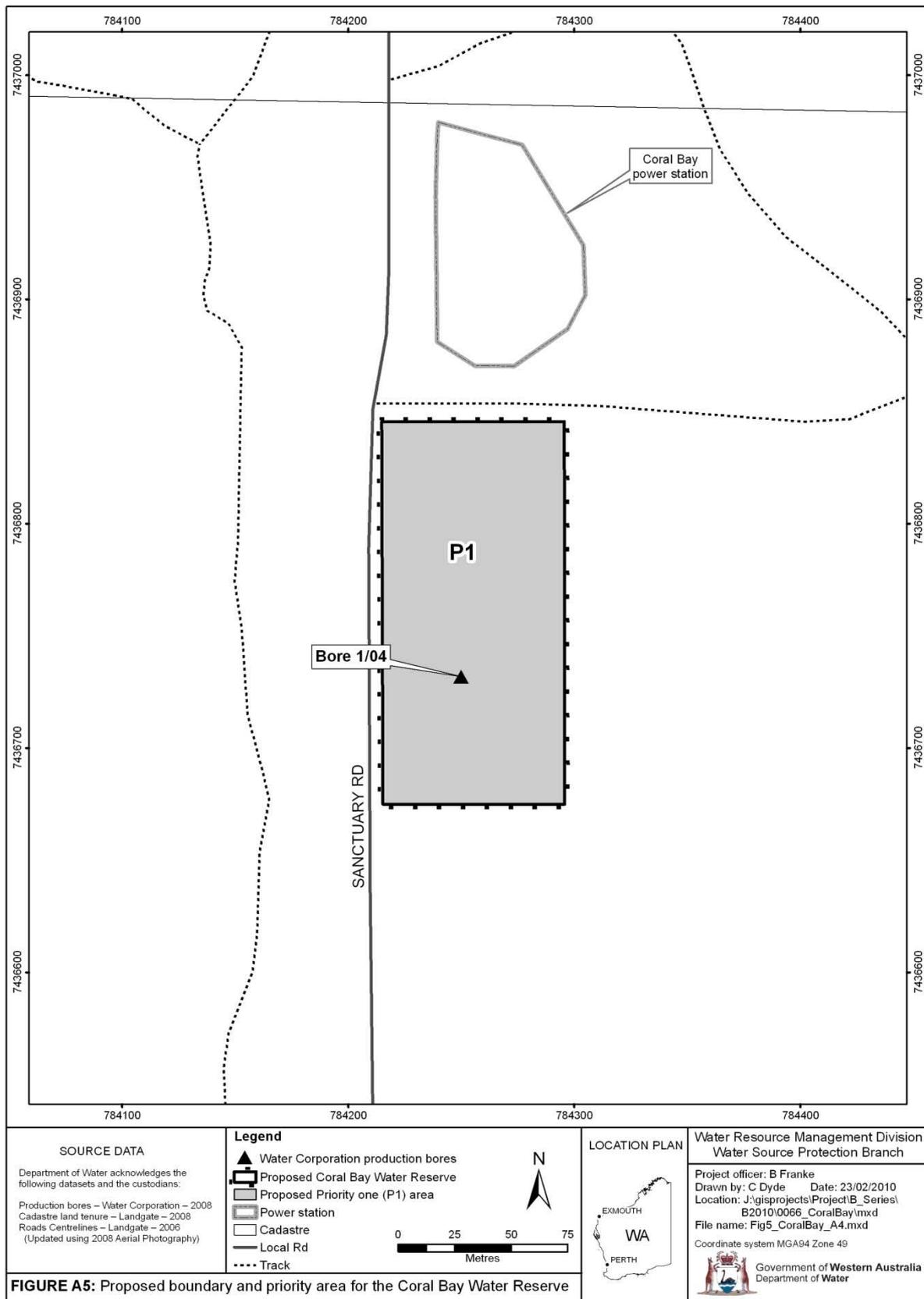
Appendix A Figures











Appendix B Water quality data

The information provided in this appendix has been prepared by the Water Corporation.

The Water Corporation has monitored the raw (source) water quality from Coral Bay. This data shows the quality of water in the catchment. An assessment of the drinking water quality is also made in accordance with the *National water quality management strategy: Australian drinking water guidelines 6, 2004* (ADWG) (NHMRC & NRMCC 2004a) and interpretations agreed to with the Department of Health. The raw water is monitored regularly for:

- aesthetic characteristics (non-health-related)
- health-related characteristics including
 - health-related chemicals
 - microbiological contaminants

The following data represents the quality of raw water in the Coral Bay borefield. In the absence of specific guidelines for raw-water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customer's tap. Results that exceed the ADWG have been shaded to give an indication of potential raw-water quality issues associated with this source.

It is important to appreciate that the raw-water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment exist downstream of the raw water to ensure it meets the requirements of the ADWG. The values are taken from ongoing monitoring for the period July 2004 to June 2009.

Any water quality parameters that have been detected are reported; those that on occasion have exceeded the ADWG are shaded.

For more information on the quality of drinking water supplied to the Coral Bay region refer to the most recent Water Corporation drinking water quality annual report at <www.watercorporation.com.au> What we do > Water quality > Water quality publications > Water quality annual report 2008-09.

Aesthetic

The aesthetic quality analyses for raw water from the Coral Bay deep artesian bore are summarised in the following table.

Aesthetic detections for the Coral Bay borefield

Parameter	Units	ADWG Aesthetic Guideline Value*	Coral Bay Borefield RAW SP	
			Range	Median
Aluminium unfiltered	mg/L	N/A	<0.008 - 0.012	<0.009
Chloride [†]	mg/L	0 - 250	2150 - 2260	2205
Conductivity at 25 °C	mS/m	na	850 - 880	860
Hardness as CaCO ₃ [†]	mg/L	0 - 200	300 - 329	314.5
Iron unfiltered	mg/L	0 - 0.3	0.2 - 0.24	0.22
Manganese unfiltered	mg/L	0 - 0.1	0.065 - 0.07	0.065
pH measured in laboratory	No Unit	6.5 - 8.5	7 - 7.19	7.15
Sodium [†]	mg/L	0 - 180	1680	1680
Sulphate [†]	mg/L	0 - 250	715 - 758	736.5
Total filterable solids by summation [†]	mg/L	0 - 500	5060 - 5220	5140
Turbidity	NTU	0 - 5	1.4 - 2.4	1.95
Zinc [†]	mg/L	0 - 3	0.04	0.04

* An aesthetic guideline value is the concentration or measure of a water quality characteristic that is associated with good quality water.

† Based on three or less samples.

Health related*Health-related chemicals*

Raw water from the Coral Bay borefield is analysed for chemicals that are harmful to human health, including categories of chemicals such as inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that impact on water quality are summarised in the following table.

Health-related detections for the Coral Bay borefield

Parameter	Units	ADWG Health Guideline Value*	Coral Bay Borefield RAW SP	
			Range	Median
Barium [†]	mg/L	0 - 0.7	0.06	0.06
Boron [†]	mg/L	0 - 4	2.8	2.8
Cadmium [†]	mg/L	0 - 0.002	0.0002	0.0002
Fluoride	mg/L	0 - 1.5	1.5 - 1.6	1.5
Iodide [†]	mg/L	0 - 0.1	<0.02 - 0.72	0.69

Parameter	Units	ADWG Health Guideline Value*	Coral Bay Borefield RAW SP	
			Range	Median
Manganese unfiltered	mg/L	0 - 0.5	0.065 - 0.07	0.065
Nitrate as nitrogen[†]	mg/L	0 - 11.29	0.002 - 0.005	0.0035
Sulphate[†]	mg/L	0 - 500	715 - 758	736.5

* A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & ARMCANZ 2004a).

† Based on three or less samples.

Microbiological contaminants

Microbiological testing of raw-water samples from the Coral Bay borefield is currently conducted on a weekly basis. *Escherichia coli* counts are used as an indicator of the degree of recent faecal contamination of the raw water from warm-blooded animals. A count of less than 20 MPN (most probable number) per 100 mL sample is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark of the raw water (WHO 2004). As such, counts less than 20 MPN are seen as indicating raw water that has not been recently contaminated with faecal material.

During the reviewed period of July 2004 to June 2009, no positive *Escherichia coli* counts were recorded in the samples.

Appendix C Land use, potential water quality risks and recommended protection strategies

This table was prepared from information in Section 3 of this plan.

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Water supply and treatment plant <ul style="list-style-type: none"> • fuel and chemical storage • weed / pest control 	<ul style="list-style-type: none"> • hydrocarbons • chemicals • herbicides, pesticides 	Low Low Low	The water treatment plant is required to produce and supply potable water. Chemical use and storage are managed to avoid contamination risks to the source.	The aquifer is deep and confined (it is protected by the overlying rock strata). The bore is sealed. The compound is fenced and managed by the Water Corporation.	<i>Acceptable activity with best management practices.</i> <ul style="list-style-type: none"> • WQPN no. 56: <i>Tanks for elevated chemical storage</i> (DoW 2006) • WQPN no. 10: <i>Contaminant spills - emergency response</i> (DoW 2006)
Neighbouring land use / activity – power station <ul style="list-style-type: none"> • fuel and chemical storage • weed / pest control 	<ul style="list-style-type: none"> • hydrocarbons • chemicals • herbicides, pesticides 	Low Low Low	The power station is located outside the water reserve. Chemical storage within the power station compound is located outside the water reserve. Chemical use and storage are managed to avoid contamination risks to the source.	The aquifer is deep and confined (it is protected by the overlying rock strata). The bore is sealed. The diesel storage tanks are bunded to contain any spills.	<ul style="list-style-type: none"> • Statewide policy no. 2: <i>Pesticide use in public drinking water source areas</i> (WRC 2000) • PSC 88: <i>Use of herbicides in water catchment areas</i> (DoH 2007)

Appendix D Photographs



Figure D1 Coral Bay desalination plant, deep artesian bore 1/04 and cooling towers (back) [Photo: B. Franke]

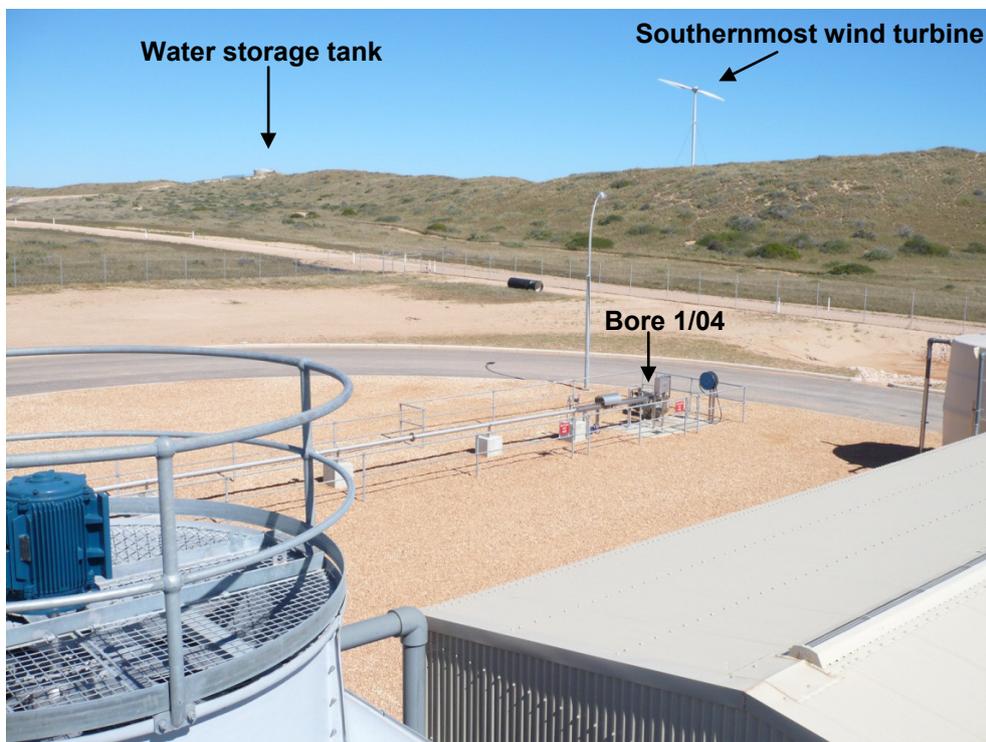


Figure D2 View from the top of the plant cooling tower towards the water storage tank on the dunes south of Coral Bay [Photo: F. Coaker]



Figure D3 Coral Bay water supply storage tank [Photo: B. Franke]



Figure D4 Coral Bay water supply plant back-up diesel generator (self-bunded) [Photo: B. Franke]



Figure D5 View north from the top of the Coral Bay water supply cooling tower towards the neighbouring power station [Photo: F. Coaker]



Figure D6 Diesel storage tanks (externally banded) at the Coral Bay power station [Photo: B. Franke]

List of shortened forms

ADWG	<i>Australian drinking water guidelines</i>
AHD	Australian height datum
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
DEC	Department of Environment and Conservation
GL	gigalitre
HAZMAT	hazardous materials
kL	kilolitre
km	kilometre
LEMC	local emergency management committee
m	metres
mg/L	milligram per litre
mL	millilitre
ML	megalitre
mm	millimetre
MPN	most probable number
mS/m	milliSiemens per metre
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
PSC 88	public sector circular number 88
PDWSA	public drinking water source area
TDS	total dissolved solids
WHPZ	wellhead protection zone
WESTPLAN–HAZMAT	Western Australian plan for hazardous materials

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Adsorb	Adsorb means to accumulate on the surface of something. For example, microorganisms can adsorb onto soil particles.
Aesthetic guideline value	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMMC 2004a).
Australian drinking water guidelines	The <i>National water quality management strategy: Australian drinking water guidelines 6, 2004</i> (NHMRC & NRMMC 2004a) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's References).
Australian height datum	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
Allocation	The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).
Aquifer	An aquifer is a geological formation or group of formations able to receive, store and transmit significant quantities of water.
Bore	A bore is a narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).
Catchment	The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Confined aquifer	An aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure.
Department of Environment and Conservation	The Department of Environment and Conservation was established on 1 July 2006, bringing together the Department of Environment and the Department of Conservation and Land Management.
Electrical conductivity	This estimates the volume of TDS or the total volume of dissolved ions in a solution (water) corrected to 25°C. Measurement units include milliSiemens per metre and microSiemens per centimetre.

Fractured rock	An aquifer where groundwater is present in the fractures, joints, solution cavities, bedding planes and zones of weathering igneous, metamorphic and deformed sedimentary rocks. Fractured rock aquifers are highly susceptible to contamination from land-use activities when aquifers crop-out or sub-crop close to the land surface.
Gigalitre	A gigalitre is equivalent to 1 000 000 000 litres or one million kilolitres.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMCC 2004a).
Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Leaching/ leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
Most probable number	Most probable number is a measure of microbiological contamination.
MilliSiemens per metre	MilliSiemens per metre is a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.
Nephelometric turbidity units	Nephelometric turbidity units are a measure of turbidity in water.
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i>), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i>) and viruses.

Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
pH	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.
Point source pollution	Pollution originating from a specific localised source, e.g. sewage or effluent discharge; industrial waste discharge.
Pollution	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.
Public drinking water source area	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> and the <i>Country Areas Water Supply Act 1947 (WA)</i> .
Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Recharge	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.
Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Runoff	Water that flows over the surface from a catchment area, including streams.
Scheme supply	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.

Total dissolved solids	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulphate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMCC 2004a).
Total filterable solids by summation	Total filterable solids by summation is a water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO ₄ equivalent (sulphate) or S (sulphur) in grams, Fe (iron), Mn (manganese), and SiO ₂ (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.
Water quality	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	A water reserve is an area proclaimed under the <i>Country Areas Water Supply Act 1947 (WA)</i> or the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> for the purposes of protecting a drinking water supply.
Wellhead	The top of a well (or bore) used to draw groundwater is referred to as a wellhead.
Wellhead protection zone	A wellhead protection zone (WHPZ) is usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination threats in the nearby area.

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