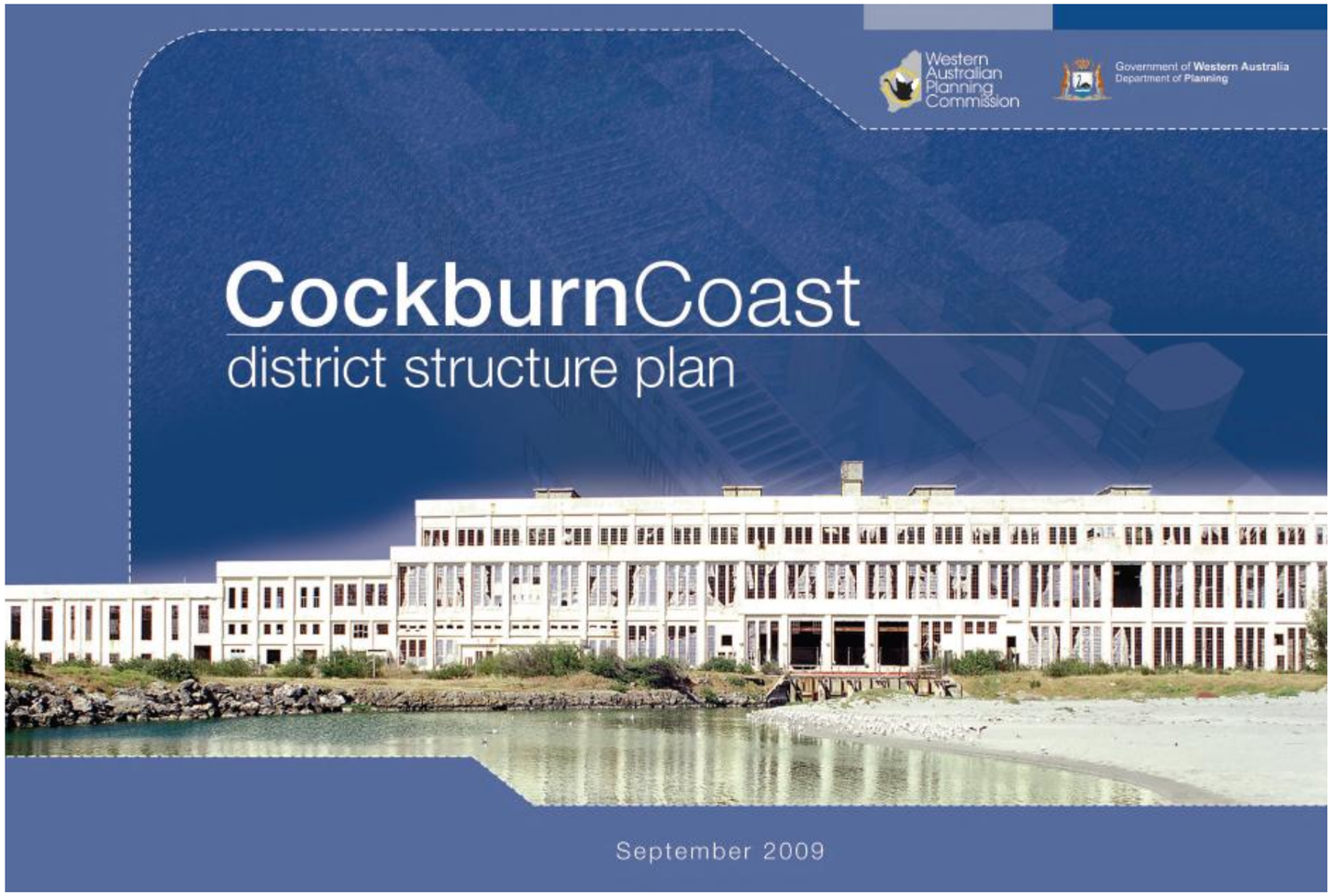
**LandCorp**

# Report for Cockburn Coast District Structure Plan

## District Water Management Strategy

May 2011



# Contents



## Table Index



## Figure Index

# 1. Introduction

GHD Pty Ltd was commissioned by LandCorp to prepare a district water management strategy for the Cockburn Coast urban redevelopment. The land covers parts of suburbs South Fremantle, Hamilton Hill and Spearwood adjacent to the coast.

## 1.1 Site Location and description

The Cockburn Coast urban redevelopment is a 331 hectare site, with its centre located approximately 24 km south west of Perth and approximately 4 km south of Fremantle. The Cockburn Coast District Structure Plan area is bound by the coastline to the west, the new development of Port Coogee to the south, the residential area of South Fremantle to the north and the residential area of Hamilton Hill to the east.

This majority of the site lies within the City of Cockburn.  A small area in the north east of the DSP area lies within the City of Fremantle.

The project boundary includes a 92 hectare industrial strip, South Fremantle power station, South Fremantle landfill site and 446 government and private landholdings owned by eight State government agencies, two local government authorities and 182 private landowners.

In accordance with state government planning framework as outlined in Better Urban Water Management (WAPC, 2008), a district water management strategy is required to accompany the structure plan. Local water management strategies will be required to support precinct local structure plans and urban water management plans will be required to accompany the subsequent development applications.

## 1.2 Planning background

The planning framework for land and water planning is illustrated in Diagram 1. The district water management strategy demonstrates how water resources can be considered in the land use planning system and to ensure consistency with State Planning Policy 2.9: Water Resources (WAPC, 2004).

The strategies presented in this district water management strategy have been prepared to be consistent with the requirements of the following key documents:

- *City of Cockburn town planning scheme no. 3*
- *City of Cockburn local planning strategy*
- *City of Cockburn guidelines and standards for the design, construction and handover of subdivision within the municipality*

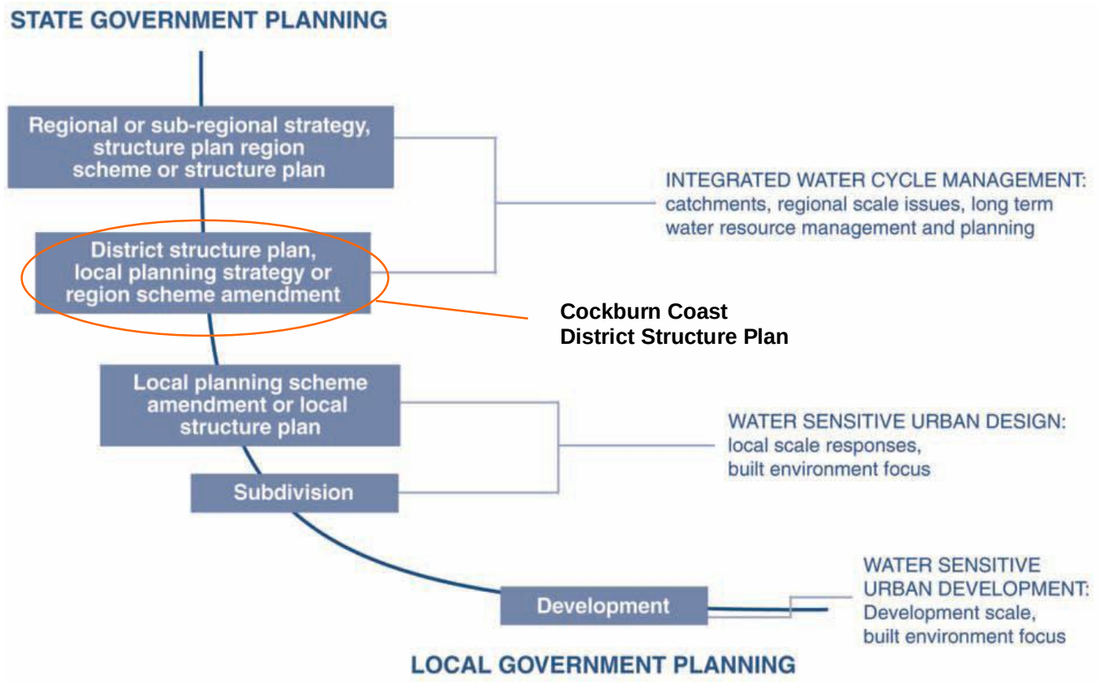



Diagram 1  Planning framework for integrating the drainage planning with land planning

SOURCE: *Better Urban Water Management* (WAPC, 2008)

## 1.3 Previous studies

A number of key investigations have been undertaken in support of the Cockburn Coast redevelopment. It is the aim of the district water management strategy to incorporate information from all of these studies and present design criteria and management strategies.

The study area has been assessed for acid sulfate soil risk, the results of which are presented in the *Western Australian Planning Commission Planning Bulletin No. 64/2009 Acid Sulfate Soils'*.

Preliminary and detailed site investigations have been undertaken by GHD over parts of the Cockburn Coast redevelopment area.

An integrated water management strategy is currently being developed for the Cockburn Coast district structure plan area which will further develop options for fit-for-purpose water sources.

# 2. Proposed Development

The proposed development is based on the Cockburn Coast District Structure Plan 2009 (Figure 2) prepared by Western Australian Planning Commission and approved by the Minister for Planning in September 2009, which details the land use planning and future development of the Cockburn Coast District. The district structure plan distils the high level principles outlined in Directions 2031 - Draft Spatial Framework for Perth and Peel to guide the Perth and Peel regions to a sustainable future which creating a plan for the future that is integrated, creative, forward looking and sustainable.

## 2.1 Land uses

The land use framework facilitates a diversity of residential, commercial, retail, entertainment, hospitality, and community oriented uses that complement the existing activities in surrounding areas, while bringing additional opportunities that may not currently be available.

The range of land uses and landforms that can be established through the structure plan area will allow new communities, economies and activities to be developed to the benefit of existing and future residents and landowners, and the wider community. Proposed land use areas are allocated in Table 1.

**Table 1** Cockburn coast project land use areas

| Land Use | Area (ha) |
|---|---|
| Mixed Use | 40 |
| Residential | 55.8 |
| Mixed Business | 3.8 |
| Primary School | 1.5 |
| Local Activity Centre | 4.5 |
| Rockingham Road Area | 17.1 |
| District Open Space | 16.6 |
| Regional Open Space | 128.8 |
| Local Roads and Infrastructure | 26.2 |
| Rail | 11.4 |
| Community | 0.6 |
| Regional Roads | 25.3 |

## 2.2 Special Development Area

The existing South Fremantle Power Station and Darken/Emplacement will be redeveloped and associated revitalisation of the surrounding precinct. This area will function as a commercial, civic and recreational coastal node.

## 2.3 Transport

Transport Analysis report has been prepared by Worley Parsons in May 2007 to summarise investigations and assessments undertaken as part of the preparation of the *Cockburn Coast District Structure Plan* (DSP). The philosophy of transit oriented design is adopted in order to maximise the development potential while maintaining a strong focus on achieving the projects sustainability objectives.

The structure plan aims to promote the use of public transport as alternatives to the private car within the Cockburn coast area to ensure that these emerging sustainable transport patterns are reinforced and prioritised in new urban areas.

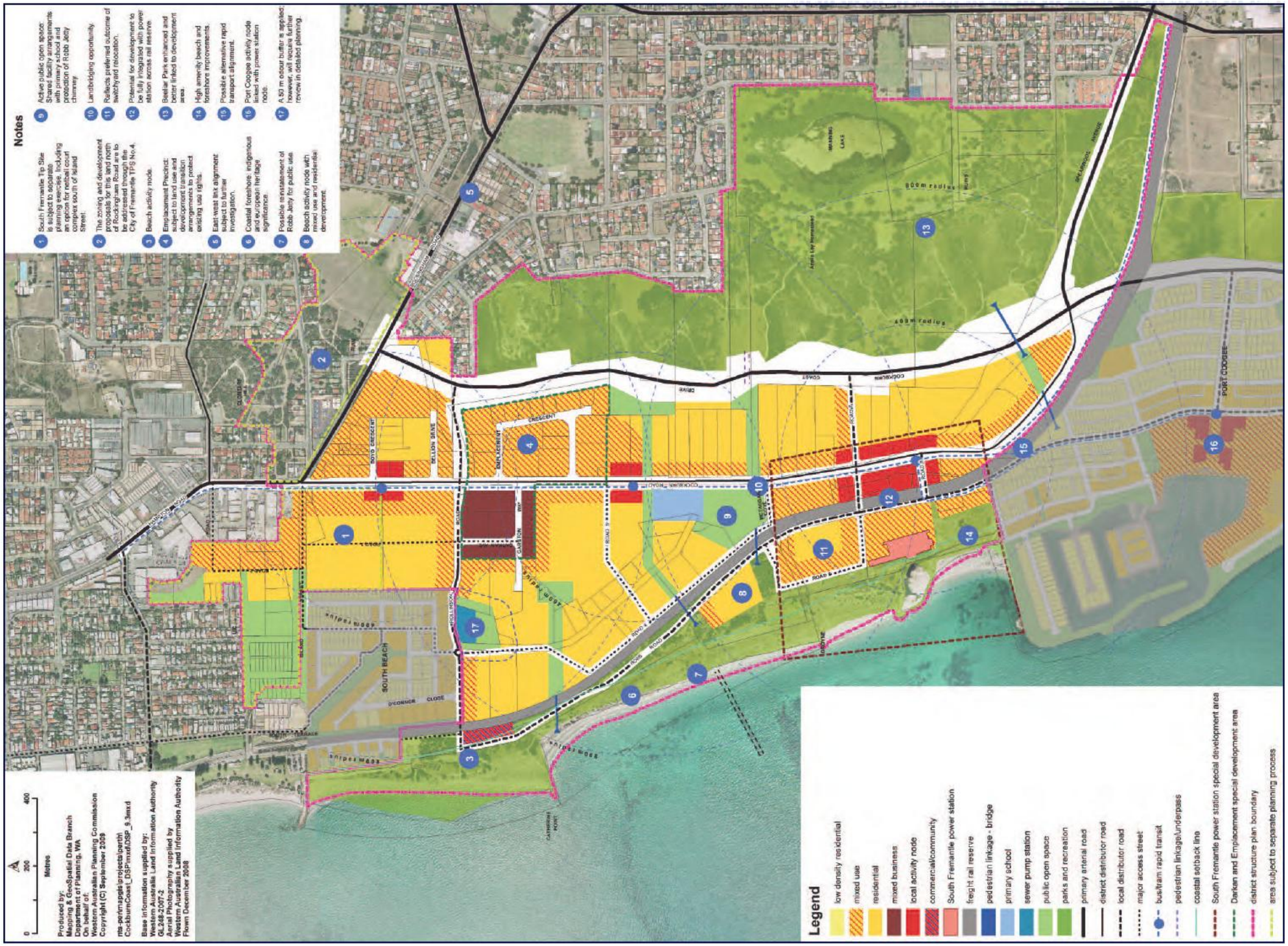
## 2.4 Precinct Development

The Cockburn Coast development areas was divided into seven Precincts to separate out distinct development areas according to characteristics such as land use, environmental attributes and built form character. These Precincts are used as the basis for water balance modelling in Section 5.4 of this report. The Precincts and their proposed land use attributes are listed below in Table 2:

**Table 2** Cockburn Coast Precincts

| Precinct | Proposed Land use |
|---|---|
| Power Station | Residential, mixed use, mixed business, local activity node |
| Hilltop | Residential, mixed use, local activity node |
| Robbs Jetty | Residential, mixed use, commercial |
| Emplacement | Mixed use |
| Darkan | Mixed business |
| Fremantle Village | Residential, mixed use, local activity node |
| Newmarket | Residential, mixed use, local activity node |

**Figure 1** Cockburn Coast district structure plan (WAPC, 2009)



# 3. Design Criteria

The *Cockburn Coast district structure plan* establishes several key objectives for water management within the redevelopment area. The following principles and criteria area adapted from those objectives, taking into consideration the outcomes of more recent investigations to set realistic and achievable targets.

## 3.1 Water conservation and efficiency

***Principle***

Achieve the sustainable management of all aspects of the water cycle within the development and ensure that the use of potable water is as efficient as possible.

To achieve the above principle the following criteria will be applied:

- Consumption target for water of 80 kL/person/yr, including not more than 40 kL/person/yr scheme water;
- No potable water is to be used outside of homes and buildings
- All new fixtures and fittings are to be a minimum of 4 stars WELS rated
- The use of native plants is to be promoted, with native species constituting a minimum of 30-35% of total public open space area

## 3.2 Water quantity management

***Principle***

The post development annual stormwater discharge volumes and peak flows are to be maintained relative to pre-development conditions, unless otherwise established through determination of ecological water requirements for sensitive environments.

To achieve the above principle the following criteria will be applied:

- Retain all catchment runoff up to and including the 1 in 100 year ARI event within the development area.

## 3.3 Water quality management

***Principle***

Maintain water quality at pre-development levels (winter concentrations) and if possible, improve the quality of water leaving the development area to maintain and restore ecological systems.

To achieve the above principle the following criteria will be applied:

- Ensure that all surface and groundwater contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the *Stormwater Management Manual.*

## 3.4 Commitment to best management practice

The hierarchy of best practice water sensitive design principles is as follows:

- Implement controls at or near the source to prevent pollutants entering the system and/or treat stormwater
- Install in-transit measures to treat stormwater and mitigate pollutants that have entered the conveyance system
- Implement end-of-pipe controls to treat stormwater, addressing any remaining pollutants prior to discharging to receiving environments

Current best practice water sensitive urban design measures at the different scales include:

- Residential lot scale:
  - On site retention
  - Waterwise and Nutrient-wise landscaping
  - Porous pavements
  - Amended topsoils
  - Rainwater tanks
  - Raingardens and vegetated soakwells
- Commercial lot scale:

As for residential and in addition:

  - Landscaped infiltration structures
  - Hydrocarbon management and sediment traps
- Street scale:

As for residential lots and in addition:

  - Landscaped infiltration structures
  - Hydrocarbon management and sediment traps
  - Conveyance biofilter systems.
- Estate Scale:

As for street scale and in addition:

  - End of catchment treatment structures
  - Non-structural strategies such as interpretive signage and community engagement

## 3.5 Disease vector and nuisance insect management

To reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated in a time period not exceeding 96 hours.

Permanent water bodies are discouraged, but where accepted by the Department of Water, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of the Department of Water and the Department of Health.

# 4. Pre-Development Environment

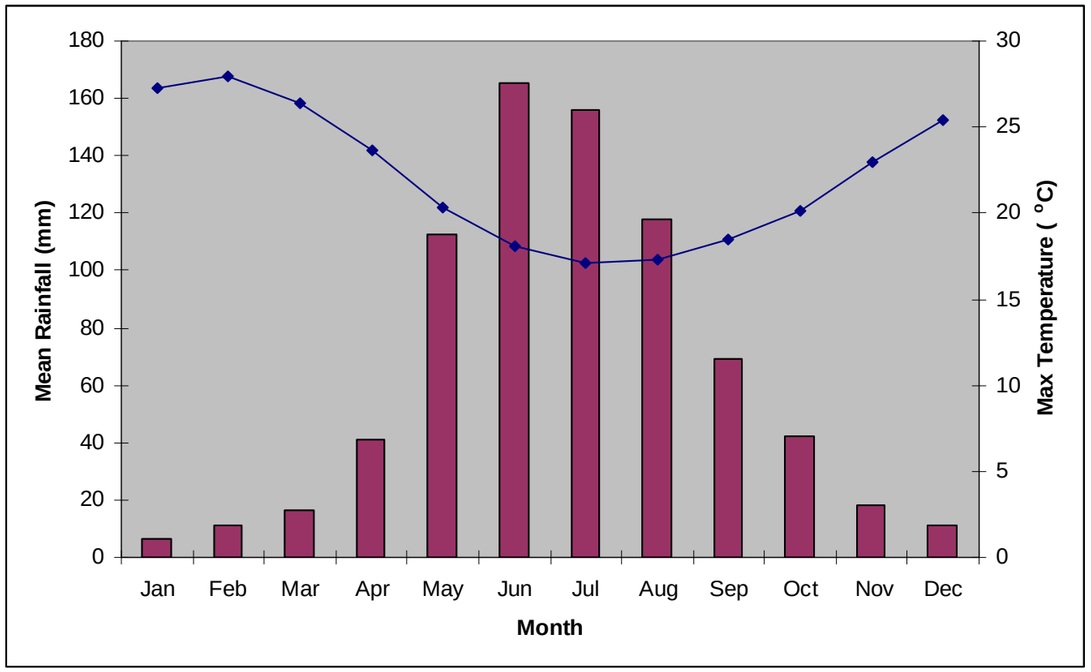
## 4.1 Climate

The Cockburn Coast area has a Mediterranean climate with hot, dry summers and cool, wet winters. The nearest currently operational meteorological station is at Fremantle, approximately 4 km North of the site. The average annual maximum temperature at Fremantle is 20°C, which varies between 27.9°C in February and 17°C in July. The average annual rainfall at Fremantle is 765 mm/yr, of which approximately 80%, or 620 mm, falls between May and September (Figure 2). The monthly rainfall statistics from the Fremantle Station is shown in Table 3.

**Table 3** Climate statistics near Cockburn Coast

| | Temperature | | Rainfall |
|---|---|---|---|
| **Land Use** | **Max** | **Min** | **mm** |
| January | 27.3 | 17.8 | 6.3 |
| February | 27.9 | 18.1 | 11.3 |
| March | 26.4 | 17 | 16.3 |
| April | 23.6 | 14.9 | 41.3 |
| May | 20.3 | 12.7 | 113 |
| June | 18.1 | 11.1 | 166 |
| July | 17.1 | 10 | 156 |
| August | 17.3 | 10.2 | 118 |
| September | 18.5 | 11 | 69.2 |
| October | 20.1 | 12.3 | 42.2 |
| November | 23 | 14.5 | 18.2 |
| December | 25.4 | 16.5 | 11.4 |

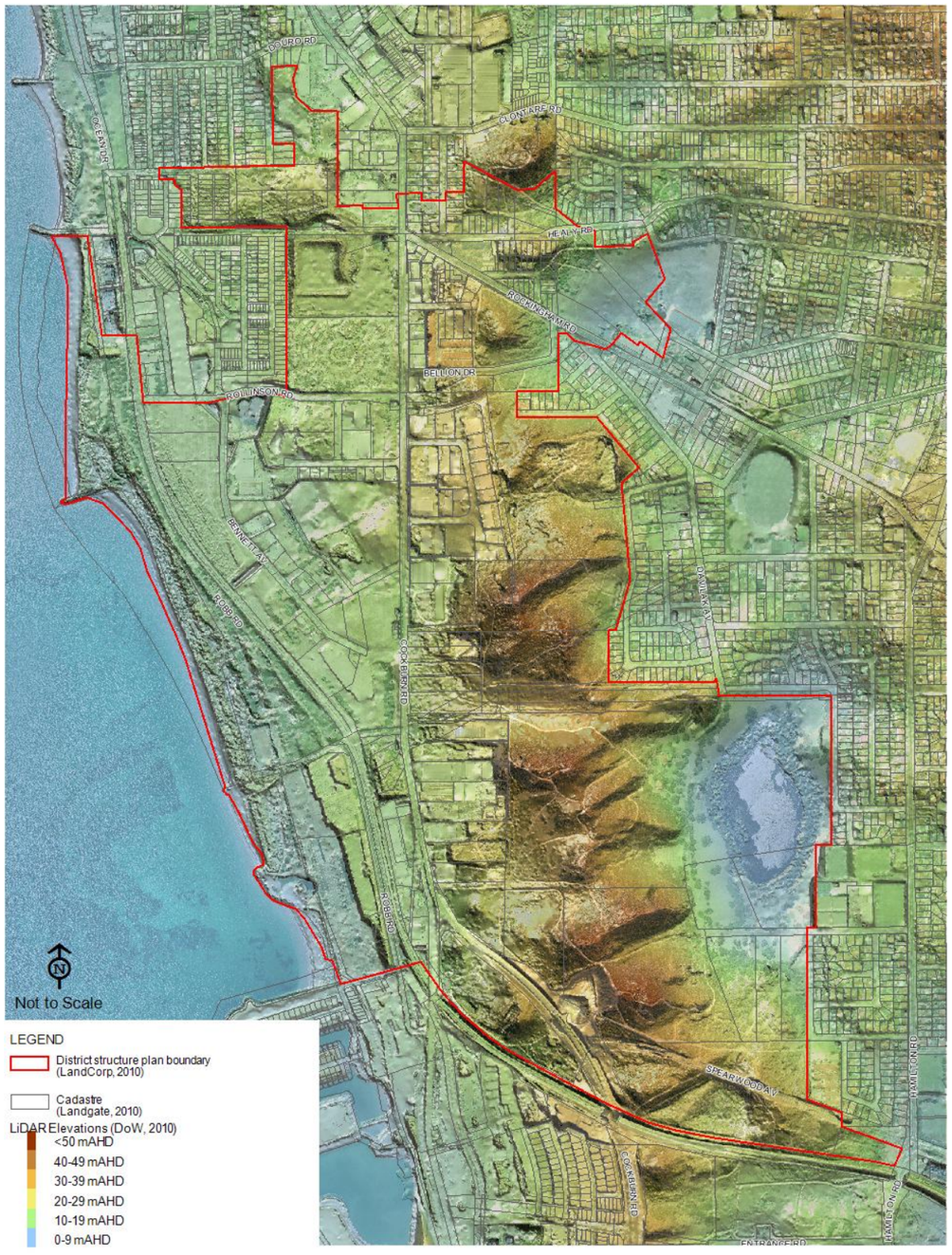
**Figure 2** Climate statistics



## 4.2 Topography

The site is dominated by the parallel features of the coastline and ridgeline, which rises approximately 1.5 km inland from the coast (Figure 3). The existing Cockburn coastline forms the west boundary of the site. The coastal reserve area consists of an elevated primary dune approximately 5m AHD with a swale and secondary dune in some sections. The land that extends behind dunes is relatively flat over much of the Cockburn Coast until the ridge (City of Cockburn 2001). The topography of the land west of Cockburn Road generally ranges between 6 mAHD and 8 mAHD. The area in and around the old South Fremantle Tip site (now in part supporting the Fremantle Holiday Village) rises to an elevation of approximately 20 mAHD and the land behind the South Fremantle Power Station is mapped at an elevation of 12 mAHD (DoE, 2004). The land rises and falls gently in sections to the east of Cockburn Road to 15 m to 20 mAHD ultimately forming the 'Spearwood Ridge', which runs in a north south direction and peaks at 40 mAHD and 50 mAHD (DoE, 2004). The terrain drops steeply to the east of 'Spearwood Ridge' down to the gentler slopes around the Manning Lake, which is within Beeliar Regional Park.

**Figure 3** Topography*

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Data source: LandCorp: study area boundary - 2010, DoW: LiDAR Elevation Mapping – 2010, Landgate (SLIP): Cadastre – 2010, Created by: H Brookes

## 4.3 Aboriginal heritage

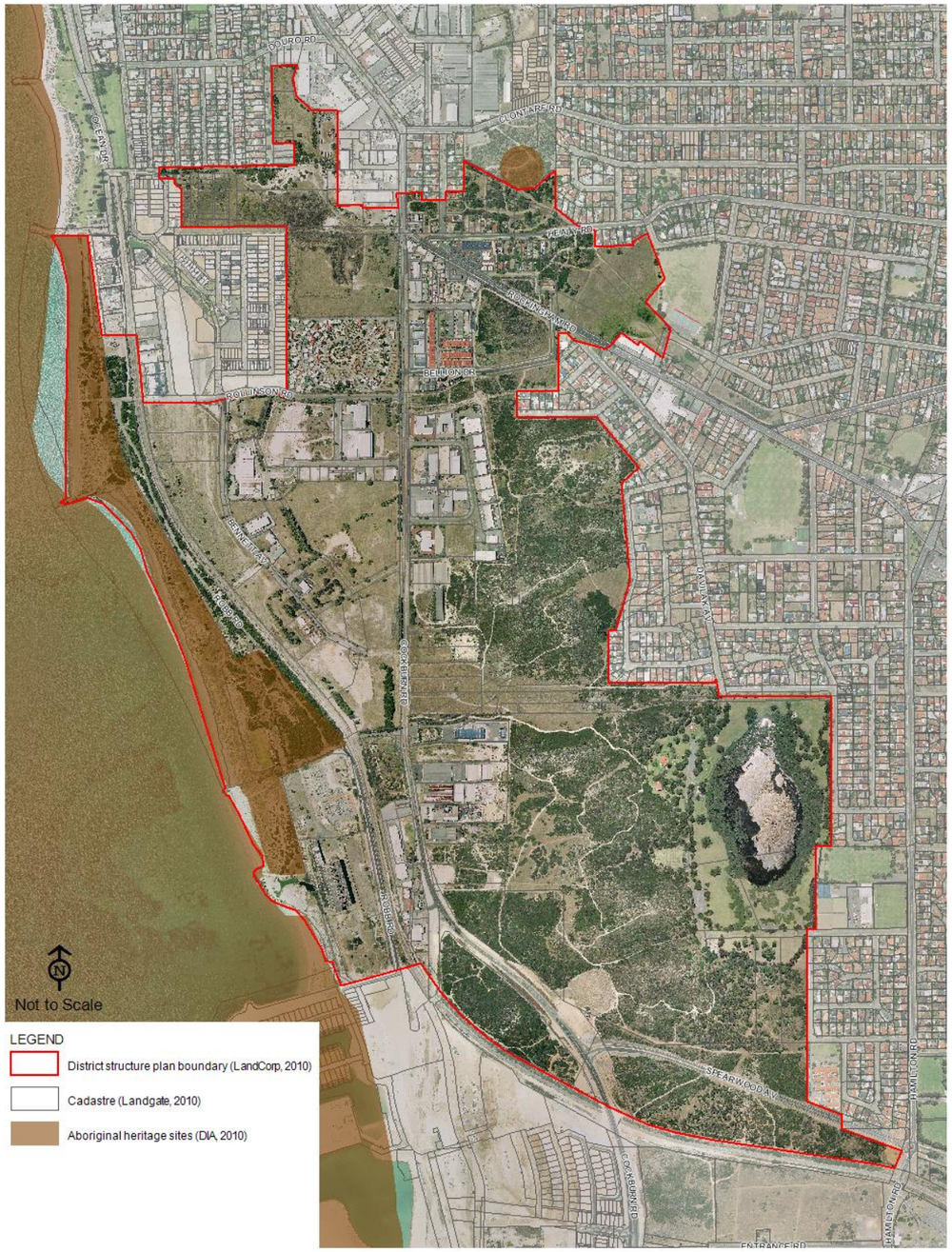
A preliminary assessment on Aboriginal heritage for the Cockburn coast district structure plan has been carried out to identify the need to address the considerable constraints existing across the land area prior to proceeding with further development. The assessment revealed nine aboriginal heritage sites within and adjacent to the project area. Included in these are sites listed on the Department of Indigenous Affairs' Aboriginal heritage sites register (Figure 4)

Strong evidence in both archaeological and ethnographic has been found that Cockburn Coast area have been utilised in the past by Aboriginal people, as part of a particular 'chain' or route of favoured camping grounds, linked by wetlands and other water sources throughout the Perth Metropolitan area; that is, the DSP project area has significant associations with the 'pads' (Hammond 1933) or routes along which Aboriginal people frequently travelled and camped.

The second focus of Aboriginal heritage issues identified for the Cockburn area are its mythological significances – a matter interrelated with the former issue of the importance of water sources in the Cockburn area much favoured in the past as camping areas by Aboriginal people traversing the coastal 'run' or route which passes through the Cockburn Coast (North Coogee) area.

The investigation of Aboriginal heritage issues within the sites is still preliminary, unrecorded cultural sites may still be found with significant research potential (AIC 2006). Hence, it remains inconclusive as to whether all nine heritage sites exist within the site, or if any of the sites are located within the study area.

**Figure 4** Aboriginal heritage sites*

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Data source: LandCorp: study area boundary - 2010, DiA: Aboriginal heritage sites – 2010, Landgate (SLIP): Cadastre – 2010, Created by: H Brookes

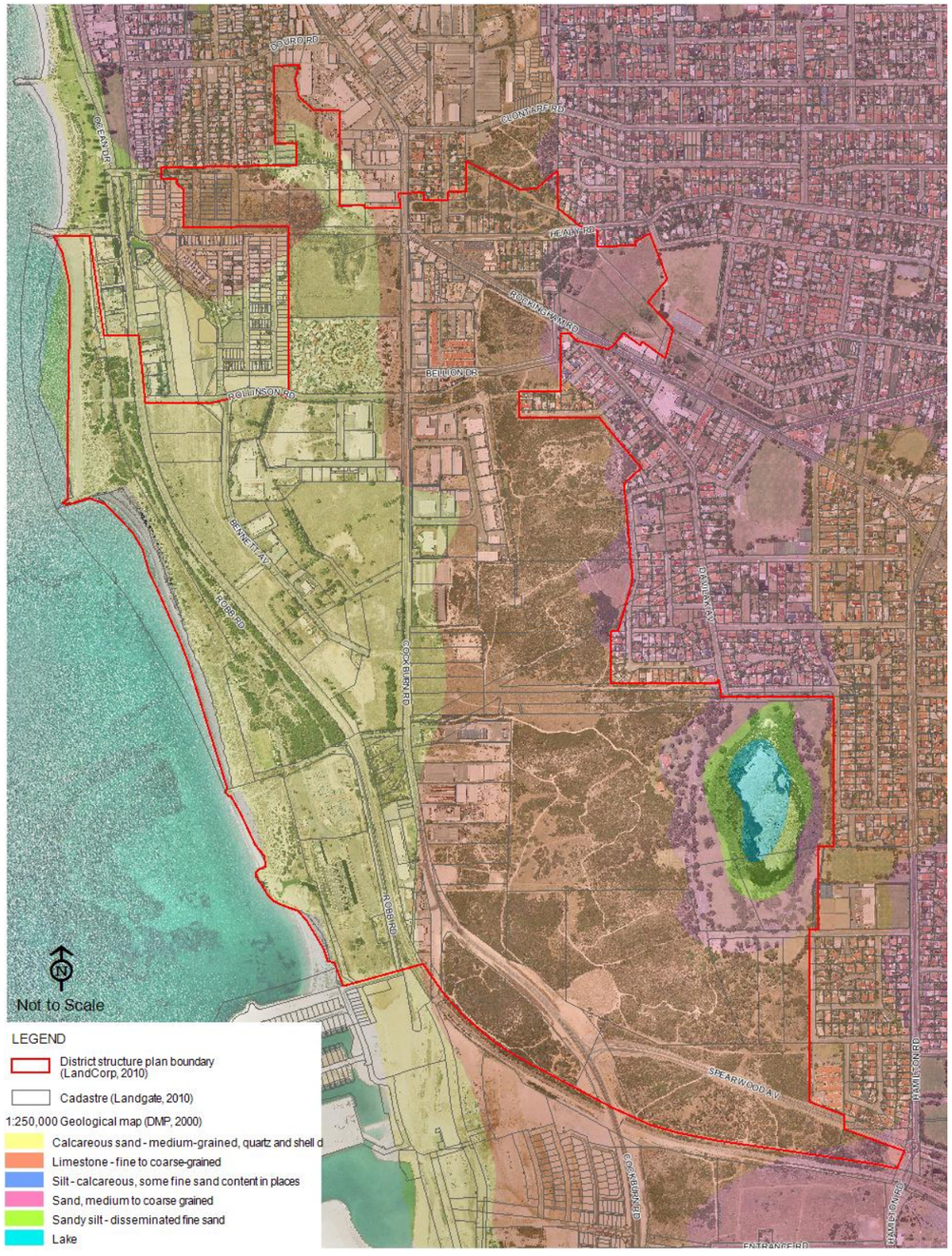
## 4.4 Geology and soils

Mapping by the Geological Survey of Western Australia indicates that the superficial geology for the majority of the site consists of Safety Bay Sand, which is described as being white, medium grained, rounded quartz and shell debris, well sorted, of aeolian origin (Figure 5). This surface geological unit is mapped over the site west of Cockburn Road. The hydraulic conductivity of such soils is high and was estimated at approximately 16 m/day, based on Davidson (1995).

East of Cockburn Road the superficial geology is mapped as Tamala Limestone which underlies the Safety Bay Sand. This geological unit is associated with the ridgeline which extends in a north south orientation parallel with the coast and is a variably-cemented calcareous eolianite (Rockwater 2000). East of the ridgeline within Manning Park Reserve is a small area of Beeliar Regional Park and is mapped as sand derived from Tamala Limestone, with an area of sandy silt surrounding Manning Lake.

Tamala limestone is generally karstic and often contains wide solution channels that increase the rate of water movement through the soil. The hydraulic conductivity of Tamala limestone is extremely high and is estimated at between 100 and 1000 m/day. The superficial formation in this area extends to a depth of -25 to –30 mAHD.

**Figure 5** Geology*

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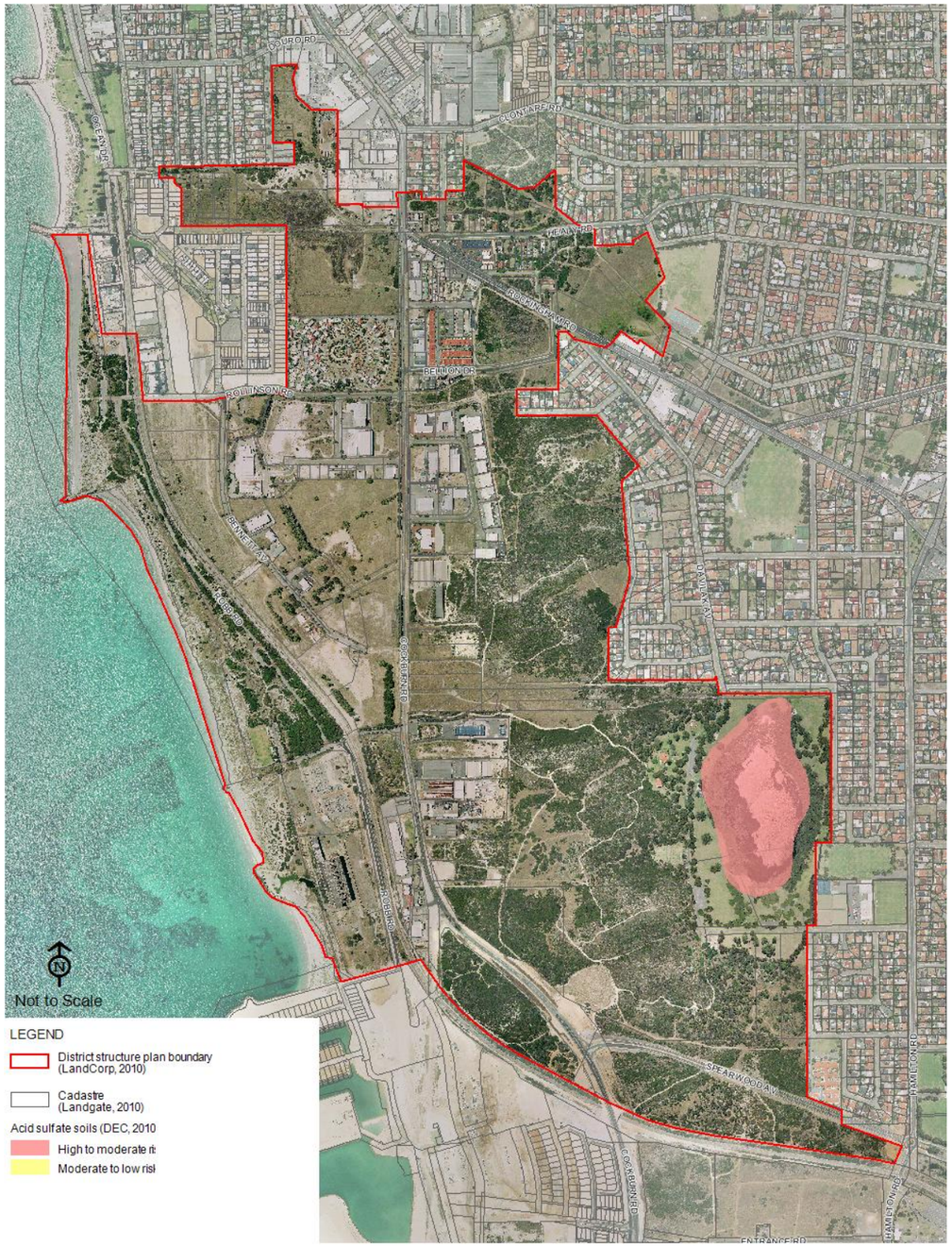
Data source: LandCorp: study area boundary - 2010, DMP: 250k Geology – 2000, Landgate (SLIP): Cadastre – 2010, Created by: H Brookes

## 4.5 Acid sulfate soils

Mapping by the Department of Environment and Conservation indicates that there is one site within the study area where there is a moderate to high risk of acid sulfate soils occurring within 3 m of the surface which is associated with Manning Lake within the Beeliar regional park (Figure 6). All other parts of the study area are classified with no known risk.

**Figure 6** Acid sulfate soils*

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Data source: LandCorp: study area boundary - 2010, DEC: Acid Sulfate Soils, Swan Coastal Plain – 2010, Landgate (SLIP): Cadastre – 2010, Created by: H Brookes

## Flora and vegetation

The study area contains one significant environmentally sensitive area which is associated with the Beliar regional park and is also a registered Bush Forever site (Figure 7).

The majority of remnant vegetation within the site contained within Manning Park, to the east of the ridge line and the coastal Catherine Point Reserve. One hundred and forty-six taxa, 49 families and 108 genera were recorded within the study area, however no plant taxa gazetted as Declared Rare, Endangered or Vulnerable were located. One population of the Priority Four species *Dodonaea hackettiana* was found in the study area.

The Cockburn Coast site contains a high number of weed species (72 taxa). One weed species, Bridal Creeper is listed as a Declared Plant by the Agriculture Protection Board. This species is listed as P1 for the whole State, and therefore weed management for the site may be required as a condition of development. Another weed species *Leptospermum laevigatum*, is relatively dominant and invasive throughout the site, and weed management for the site may also be required for this species.

The condition of vegetation across the site was considered to range from very good where remnant native vegetation has been excluded from clearing, to completely degraded in cleared and developed areas. The vegetation in completely degraded condition is considered of low habitat value because of the lack of native vegetation and the high density of weeds. The vegetation in this condition is therefore considered not to be a constraint to development.

The Cockburn District Structure Plan area is mapped as occurring on the Cottesloe Complex – Central and South. In the Swan Coastal Plain, this complex has 41.1% of its pre-European settlement extent remaining (EPA 2006). This vegetation complex's current extent therefore meets the EPA's required 30% retention status, and will not pose a constraint to development in terms of vegetation complex retention.

## 4.6 Fauna

A threatened fauna search was conducted through the Department of Environment and Conservation. Fauna taxa which are under threat from extinction are also protect by the Wildlife and Conservation Act 1950. Department of Environment and Conservation (2009) identifies there are four schedules and five categories of threatened taxa.
The results of this database search are presented in Table 4.

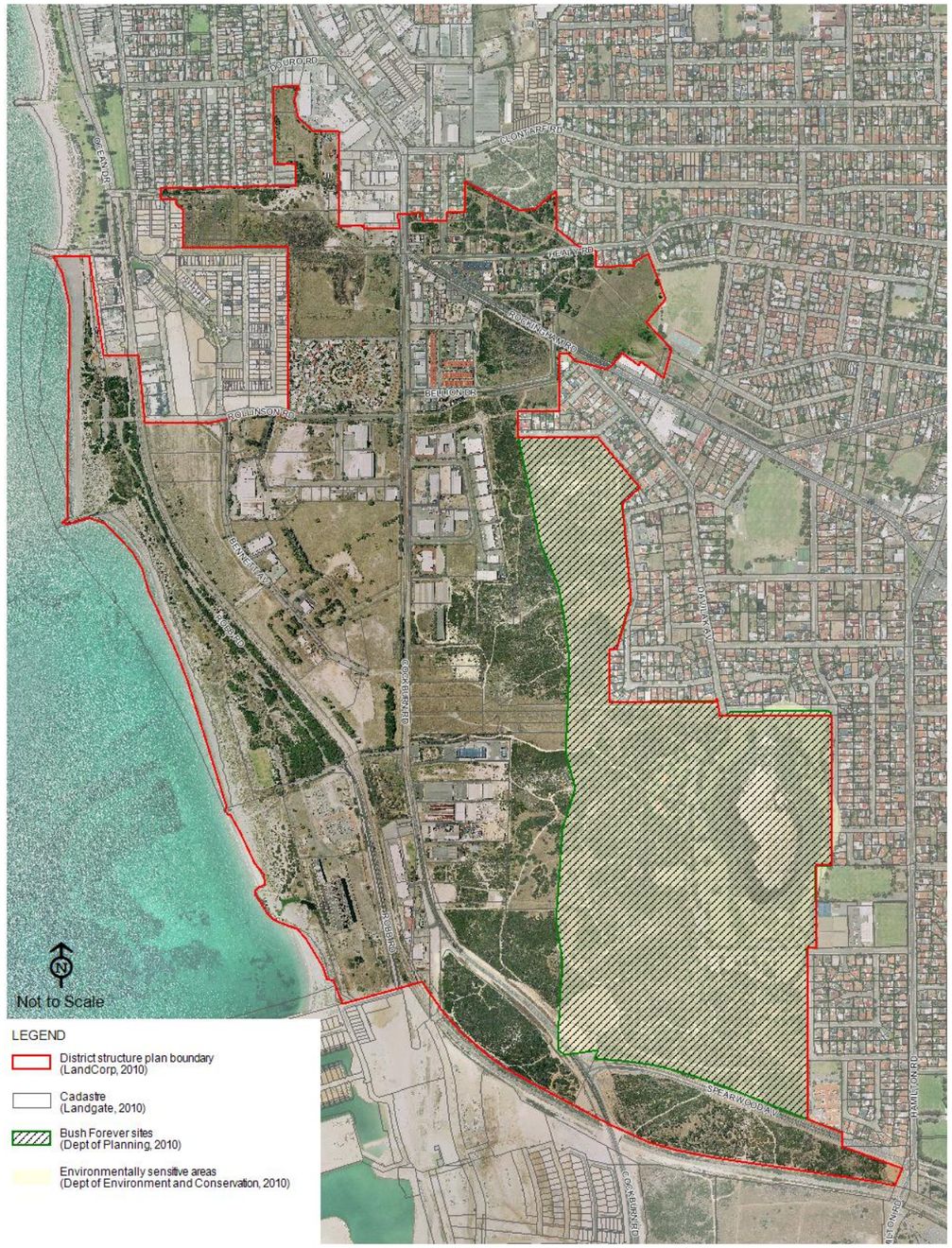
**Table 4** Cockburn Coast priority fauna

| Priority Rank | Name |
|---|---|
| Schedule 1 | Quokka (Setonix brachyurus)<br>Carnaby's Black-Cockatoo (Calyptorhynchus latirostris) |
| Priority 3 | Lined Skink (Lerista lineata) |

Notes:

- Schedule 1 – Fauna which are rare or likely to become extinct, in need of special protection.
- Priority 3 – Taxa which are known from few specimens or sightings and some of those populations are not habituating land under immediate threat

**Figure 7** Environmentally sensitive areas*

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Data source: LandCorp: study area boundary - 2010, DEC: Bush Forever Sites – 2010, Environmentally Sensitive Areas, Swan Coastal Plain – 2010, Landgate (SLIP): Cadastre – 2010, Created by: H Brookes

## 4.7 Surface water

### 4.7.1 Existing catchment

There are no surface watercourses within the Cockburn Coast area.

There is a limestone ridge present on the eastern edge of the Beeliar Regional Park (Figure 8) which effectively splits the study area into two broad catchments. Surface water to the east of this ridge flows in an easterly direction, while surface water to the west flows in a westerly direction towards the coast.

The railway line which runs parallel to the coast until it intersects Cockburn Road in the south of the site represents an artificial barrier to surface water. There is no drainage infrastructure connecting surface water flows to the east and west of this barrier.

Runoff generated within the currently developed part of the study area is generally infiltrated on individual lots in soakwells or is collected in local piped drainage systems and infiltrated in drainage sumps at an individual street or collection of streets scale.

### 4.7.2 Manning Lake

Manning Lake is located within the study area in Beeliar Regional Park to the east of the limestone ridge. The lake sits in a depression with a base level just below 0 mAHD and is a spring-fed ephemeral expression of the local groundwater table. The lake receives some stormwater from a small surrounding catchment by overland flow during the winter and receives stormwater from the Hamilton Hill area via two drains entering from the north. The boundary of the lakes catchment to the west is the limestone ridge and therefore the development area does not contribute surface water flows to the lake. The lake has no outflow. The water level in the lake tends to peak in September or October at a level between 0.9 and 1 mAHD, and drops to its lowest during summer at about 0.1 mAHD. It dries out to a few pools in summer and begins to fill up with the first rains in April and May. The average water level of the lake for the last 10 years is about 0.5 mAHD. The City of Cockburn has reported that there are no problems with midges, mosquitoes or algae in the lake.

The central portion of Manning Lake is identified as a conservation category wetland in the Department of Environment and Conservation (DEC) Swan Coastal Plain Geomorphic Wetland Dataset. The area immediately surrounding the conservation category wetland is identified as a resource enhancement wetland and the surrounding parkland area is identified as a multiple use wetland (Figure 8).

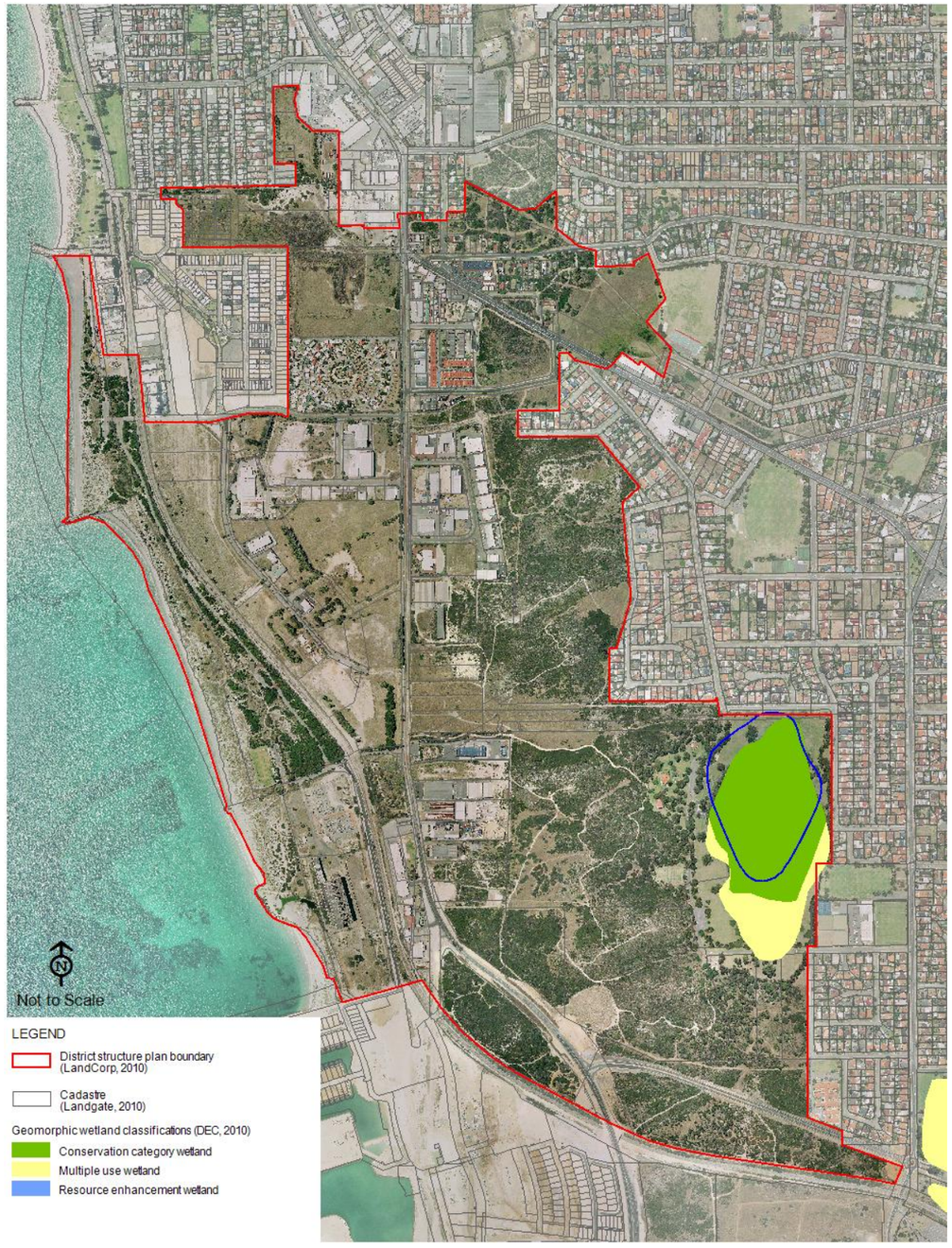
Manning Lake is also an Environmental Protection Policy Lake under the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (Figure Z). This is the highest level of State protection that a wetland can have. Development is not proposed within 500 m of the conservation category wetland boundary.

### 4.7.3 Water quality

Surface water quality information within the district structure plan area is limited to Manning Lake.

Manning Lake is generally alkaline with an average pH of 9.0 and regional variation between 6 and 12 (ENV, 2007). The lake is generally brackish to saline with an average electrical conductivity of 12,000 µS/cm. The average total phosphorus concentration is 0.12 mg/L, although values as high as 1 mg/L have been recorded. Total nitrogen levels in the lake averaged 4.4 mg/L.

**Figure 8** Surface water*

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Data source: LandCorp: study area boundary - 2010, DEC: Geomorphic Wetlands, Swan Coastal Plain – 2010, Landgate (SLIP): Cadastre – 2010, Created by: H Brookes

## 4.8 Groundwater

### 4.8.1 Superficial aquifer

The superficial aquifer has been measured at between 0 and 1 mAHD throughout the district structure plan area, which corresponds to depths ranging between 3 and 39 m below ground level according to the Perth Groundwater Atlas (2004).

There are six existing Department of Water bores within the structure plan area and further 20 bores are located within 1 km of the structure plan area. In addition several bores have been constructed for contaminated sites investigations across the structure plan area. An analysis of available groundwater level data indicates that depths to groundwater range from approximately 24 mBGL at the inland edge of the structure plan area to a minimum of 3 mBGL close to the coastline (Figure 9). Groundwater levels are typically less than 1 m AHD across the site, with some localised variation. Groundwater flow is generally in an east west direction, again with some localised variation.

Extensive superficial groundwater quality sampling has been undertaken across the district structure plan area due to the presence of several suspected contaminated sites. Limited additional water quality data is also available from the Department of Water's WIN database. Data from these sources indicates that groundwater quality in the superficial aquifer is variable and a summary of available data is presented in Table 5.

**Table 5** Summary of available groundwater quality data

| Parameter | Concentration |
|---|---|
| Total nitrogen | 1.9-24 mg/L |
| Total phosphorous | <0.01-0.19 mg/L |
| Electrical conductivity | 472-1760µS/cm |
| pH | 7.1-7.9 |

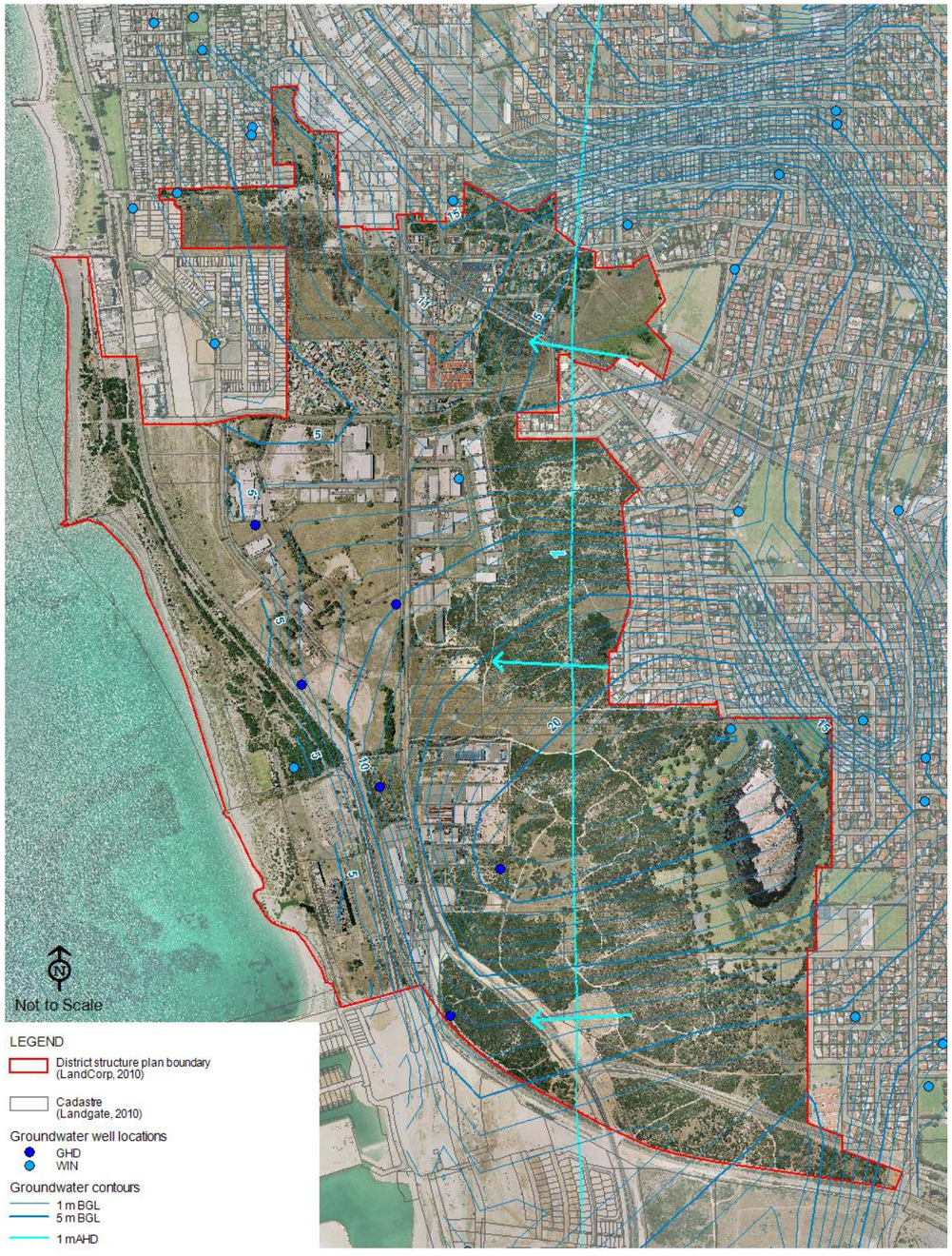
### 4.8.2 Leederville Aquifer

The Leederville Aquifer is confined beneath the Kardinya Shale and Henley Sandstone members of the Osborne Formation at depths of approximately 100 - 150 below ground surface and has a thickness of around 200 – 250 m (DoW 2007). The aquifer is generally brackish to saline with total dissolved salts in the range of 500 – 2000 mg/L in the upper Leederville and up to 3000 mg/L in the lower Leederville (DoW 2007). The Department of Water reports that no recharge to the Leederville Aquifer occurs within the Cockburn groundwater area due to the presence of the Kardinya Shale Member (DoW 2007).

### 4.8.3 Yarragadee Aquifer

The Yarragadee Aquifer is confined by the South Perth Shale at depths of approximately 450 – 550 m below ground surface. The aquifer is generally brackish to saline with total dissolved salts typically in the range of 1000 – 200 mg/L (DoW 2007). The Department of Water reports that no recharge to the Yarragadee Aquifer occurs within the Cockburn groundwater area due to the presence of the South Perth Shale Member (DoW 2007).

**Figure 9** Groundwater levels and monitoring locations*

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Data source: LandCorp: study area boundary - 2010, DoW: WIN Sites and associated data – 2010, Landgate (SLIP): Cadastre – 2010, Created by: H Brookes

## 4.9 Groundwater Allocations

Both the Leederville and Yaragadee aquifers are fully allocated within the Cockburn groundwater area. The superficial aquifer represents the only groundwater source where water is currently available for abstraction on request. Approximately 1.2 GL/yr is currently available from this source across the Cockburn groundwater area. These details were provided from DoW as recorded in June 2010 and are presented below in Table 6:

**Table 6** Groundwater allocations and licenses for the Cockburn Coast development

| GW Subarea | Aquifer Name | Allocation limit (kL/yr) | Licensed allocation (kL/yr) | Groundwater available (kL/yr) |
|---|---|---|---|---|
| Cockburn Confined | Perth – Leederville | 1,350,000 | 1,500,000 | 0 |
| | Perth Yarragadee North | 5,150,000 | 5,555,689 | 0 |
| Kogalup | Perth – Superficial Swan | 11,460,000 | 10,177,044 | 1,282,956* |

* 87,592 kL have been requested

## 4.10 Existing water and wastewater infrastructure

There is substantial existing infrastructure located inside the district structure plan area, including fully reticulated water and wastewater and a major wastewater pumping station which transfers wastewater from the entire site to the Woodman Point Wastewater Treatment Plant.

The Water Corporation have advised that the wastewater and potable water requirements of the District Structure Plan area can be met with only minimal upgrades to existing water and wastewater infrastructure (Wood and Grieve, 2010). Potable water will be supplied by the Water Corporation's Integrated Water Supply Scheme from existing water sources and wastewater will continue to be collected for treatment at Woodman Point Wastewater Treatment Plant.

## 4.11 Historic land use and contamination

The site has a historical association with industrial activities and with the exception of areas retained as recreational and natural reserves, the majority of the site continues to support some industrial activity. Relatively large areas of land, particularly in area identified as the Robbs Jetty precinct, currently do not support any infrastructure for residential development. The site's industrial heritage is evident by the presence of the decommissioned South Fremantle Power Station and the Robbs Jetty abattoir chimney. The sites recent industrial and commercial revitalisation is evident by the relatively new development in Emplacement Crescent, Cockburn Road and Bennett Avenue. The Cockburn Coast is increasingly being surrounded by residential development. There are existing adjacent residential areas in South Fremantle and Hamilton Hill and areas of Port Coogee and North Coogee are currently under development.

The historical use of the area for industrial activities and the presence of a landfill in the area generate a risk of soil and groundwater contamination within the site. The nature of the residual contamination remaining from previous industrial activity and the decommissioned landfill needs assessment. The level of risk depends on the historical and current uses of the site and the level of remediation is not yet fully evaluated for all lots. Of the sites that have been fully assessed, some are included within the Department of Environment and Conservation's public *Contaminated Sites Database*.

GHD (2010) have undertaken detailed site investigations for several contaminated sites in the area and groundwater quality data collected in those investigations are included in Table 5

# 5. Water sustainability initiatives

## 5.1 Water efficiency measures

***Principle***

Achieve the sustainable management of all aspects of the water cycle within the development and ensure that the use of potable water is as efficient as possible.

To achieve the above principle the following criteria will be applied:

- Consumption target for water of 80 kL/person/yr, including not more than 40 kL/person/yr scheme water;
- No potable water is to be used outside of homes and buildings
- All new fixtures and fittings are to be a minimum of 4 stars WELS rated
- The use of native plants is to be promoted, with native species constituting a minimum of 30-35% of total public open space area

Water efficiency is part of the Business as Usual approach and is enabled through the use of technology and by changing behaviour to use less water.

The Waterwise Display Village concept has been developed by the Water Corporation to commence the process of moving towards Waterwise Developments. The Waterwise Display Village Criteria, which has been expanded to include whole developments, aims to ensure appropriate action is taken to achieve best management water outcomes. The Criteria for Waterwise Homes requires the installation of appliances with a minimum four star WELS rating. The standards for in-house appliances to be adopted in Cockburn Coast are in alignment with the waterwise display village concept including:

- All tap fittings must be minimum 4 stars WELS rated
- All showerheads must be minimum 4 stars WELS rated
- All sanitary flushing systems must be a minimum 4 stars WELS rated dual flush
- Hot water heaters to be located within 5 m of major hot water using points

The following water efficiency measures are also proposed for further consideration as part of the local water management strategies:

- Central control on all irrigation systems constructed within development area;
- Weather stations linked to irrigation systems;
- Soil monitoring devices within POS areas;
- Improvements to the soil structure within POS areas to reduce water percolation and assist in plant development.

In addition:

- No potable water is to be used outside of homes and buildings
- Swimming pool covers will be required.

The implementation of water efficient appliances and fixtures is proposed through design guidelines and promoted through waterwise display villages and awareness campaigns. The local water management strategies will detail the implementation mechanisms further.

## 5.2 Potable water

The potable water supply for Cockburn Coast will be provided from the Water Corporation's Integrated Water Supply Scheme from existing water sources.

## 5.3 Fit-for-purpose use

### 5.3.1 Water sources and opportunities for reuse

***Rainwater***

Collection and reuse of rainwater at a lot scale within rainwater tank systems can be constrained by storage requirements within a high density urban development. However, there are opportunities for rainwater tanks to be installed in lower density parts of the District Structure Plan, and for small scale rainwater storage and distribution systems to be used for multi-residential dwellings. The use of this water is generally limited to in-house fit-for-purpose demand (toilets and washing machines) because rainfall does not occur during the irrigation season and tank sizes to retain sufficient water for year round irrigation demands are likely to be excessive.

***Stormwater***

Harvesting of stormwater from drainage infrastructure is similarly constrained by storage requirements and again its use may be limited by the seasonality of irrigation demands.

There is some scope to investigate the potential for stormwater harvesting for Aquifer Storage and Recovery. This involves injection of treated stormwater into a suitable groundwater aquifer to be later re-abstracted and used locally or distributed to the wider development area for use as a year round fit-for-purpose water source. Storage and treatment requirements for this type of scheme can vary significantly according to the quality and suitability of the receiving aquifer as well as the quality and availability of stormwater for harvesting.

The typically sandy soil types which are prevalent in the Cockburn Coast district structure plan area are ideally suited to the promotion of infiltration at, or close to source. This has the advantage of maintaining recharge into the superficial aquifer as well as minimising the need for drainage infrastructure. The existing drainage systems in place within the district structure plan area are therefore limited to onsite soakage devices, small scale collection systems and traditional drainage sumps.

In order to gain additional abstractable water it would be necessary to demonstrate that additional recharge was occurring. For a greenfield development this typically results from a decrease in evapotranspiration through clearing of vegetation and redirection of stormwater that is discharged off-site. However In this case, there is very little vegetation to be cleared and no discharge of stormwater off-site. This means that there is little to be gained through aquifer storage and recovery.

***Groundwater***

The availability of groundwater reserves for licensed abstraction has been discussed in section 4.8.4 and there is approximately 1.2 GL/year available within the superficial aquifer. The Cockburn Coast redevelopment is likely to gain access to a limited proportion of this available resource (potentially only up to 10%). This water source may contribute to the fit-for-purpose demands of the district structure plan but is unlikely to meet them in isolation of another source. It is estimated that the fit-for-purpose water demand for the structure plan area will be approximately 500 ML/year (36 KL/person/year).

***Imported groundwater***

Additional groundwater reserves imported from the groundwater interception trench at Port Coogee may be able to contribute 2.4 ML/day during the summer to help meet the irrigation demands of the district structure plan. Preliminary information indicates that the quality of this resource is sufficiently good to enable its use for irrigation. Further investigation will be required to establish in more detail the quality and quantity of water available from this source.

***Wastewater***

There is a substantial wastewater pumping station (Bennett Ave main PS) within the district structure plan area which collects and conveys wastewater to the Woodman Point Wastewater Treatment Plant. This provides a substantial opportunity for onsite wastewater harvesting for local distribution.

The current average daily inflow through the Bennett Ave Main PS is in the order of 7 ML/day (approximately 3 GL/year).

Advice received from the Water Corporation suggests that the pump station will ultimately be upgraded to a 350 L/s capacity (approximately 30 ML/day or 11 GL/year). There is a substantial quantity of wastewater available from this pump station, however the cost of building infrastructure to extract, treat, store and distribute treated wastewater needs to be examined in detail and costed and a suitable service provider secured. The possibility of sewer mining and treatment at this location for local re-use is an option worth exploring further.

Alternatively, the Water Corporation's long term planning indicates an aim to recycle 20% of treated wastewater from Woodman Point by 2030. It may therefore be preferable for the Cockburn Coast district structure plan area to continue contributing its wastewater into this larger, regional scale recycling plan.

The total volumes of treated wastewater from Woodman Point are currently 44 GL/year (approximately 120 ML/day) with projected flows in 2030 of 74 GL/year (approximately 200 ML/day).

## 5.4 Water balance modelling

A conceptual water balance was developed for the study area to quantify the existing water demand and supply and to determine the likely impact of a conventional (100% scheme water) development, compared with current practice waterwise development. The final scenario considers an increased efficiency development which incorporates the in-house water efficiency measures discussed in section 5.1 as well as a more efficient approach to irrigation. This scenario will be refined within the detailed integrated water management strategy (currently under development) and will include guidelines for the implementation of water efficient irrigation.

The site water balance has been prepared using information supplied in the Water Corporation's Water Supply Consumption Tool (Table 7). It was assumed the Water Corporations household consumptions were based on average 2 star WELS ratings. The Maximum Efficiency Water Wise scenario assumed 4 star WELS rating for all possible household appliances. The following assumptions were also made:

- 20 % of the indicated POS area is active (turf) irrigation based on development of the landscape plan;
- 100% runoff generated in the catchment is infiltrated;
- The water balance considered water transition by runoff coefficients through the following means - 1) direct evaporation; 2) surface runoff; and 3) direct infiltration;
- Scheme water to supply all in house demands (drinking and non potable);
- In house water consumption based on multiple dwellings per lot (high density development);
- Ex House water consumption (irrigation) based on reduced garden irrigation demand per dwelling (multiple dwellings per lot) and will be supplied by fit for purpose water; and
- Groundwater to irrigate domestic gardens and POS in the Water Wise scenarios only;
- No irrigation on regional open space;
- Maximum efficiency Water Wise scenario assumes ex-house irrigation limited to 1 day/week.

## 5.5 Water source recommendations

The potable water supply for Cockburn Coast will be provided from the Water Corporation's Integrated Water Supply Scheme from existing water sources.

The current preferred option for fit-for-purpose water supply is groundwater sourced both locally and imported from Port Coogee. The balance of these options and the potential for other options including wastewater harvesting from the on-site pumping station will be considered further during the development of a detailed integrated water management strategy.

Table 7 Annual Water Balance for Cockburn Coast District Structure Plan (ML/yr)

| **Supply** | **Current State** | **BAU Water Wise 100% scheme water** | **BaU Water Wise with GW for all irrigation** | **Maximum efficiency Water Wise** |
|---|---|---|---|---|
| Rainfall (719 mm/year) | 2,384 | 2,384 | 2,384 | 2,384 |
| In House Use | 66 | 729 | 729 | 483 |
| Ex House Use | 68 | 602 | 602 | 301[#] |
| POS Irrigation | 0 | 306 | 306 | 306 |
| **Total Supply** | **2,518** | **4,021** | **4,021** | **3,474** |
| *Total Potable Scheme Water Supply* | *134* | *1,636* | *729** | *483** |
| **Outputs** | | | | |
| Evaporation and Evapotranspiration | 1,929 | 1,480 | 1,480 | 1,420 |
| Surface Water Runoff | 194 | 499 | 499 | 484 |
| Net Recharge | 329 | 1,313 | 1,313 | 1,087 |
| Wastewater | 66 | 729 | 729 | 483 |
| **Total outputs** | **2,518** | **4,021** | **4,021** | **3,474** |
| *Net Groundwater Addition[#]* | *523* | *1,279* | *904* | *964* |

* Assumes 100% non potable supply to POS and ex house

# Assumes 1 day/week watering allowance based on current restrictions

**Table 8 Water Consumption Summary**

| **Development Scenario** | **Total Water (kL/per/yr)** | **Scheme Water (kL/per/yr)** | **Development Consumption (kL/per/yr)** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Current state | Unknown | Unknown | Unknown |
| BAU WW 100% scheme water | 109 | 109 | 1,636,000 |
| BaU Water Wise with groundwater for irrigation | 109 | 48 | 1,636,000 |
| Maximum efficiency Water Wise | 72 | 32 | 1,090,000 |

## 5.6 Matters to be addressed in district master planning

District scale master planning is underway and will include an integrated water management strategy which provides further detail on each of the above options for fit-for-purpose water supply. The integrated water management strategy will confirm the preferred option and outline matters to be addressed in precinct local water management strategies.

# 6. Stormwater Management Strategy

## 6.1 Surface water quantity

***Principle***

The post development annual stormwater discharge volumes and peak flows are to be maintained relative to pre-development conditions, unless otherwise established through determination of ecological water requirements for sensitive environments.

To achieve the above principle the following criteria will be applied:

- Retain all catchment runoff up to and including the 1 in 100 year ARI event within the development area.

All lots are required by the City of Cockburn to provide on site retention and infiltration for all events up to and including the 100 year ARI event. This will be provided within rainwater tanks (where possible), soakwells and other infiltration facilities.

Post development runoff volumes for all areas excluding lots were calculated for each development precinct to assist with sizing of stormwater management infrastructure. These runoff volumes for the 1, 5, 10 and 100 year ARI events are presented in Table 9. Modelling has incorporated an infiltration rate of 0.00005 m/s applied to storage areas. This rate will be reviewed and revised at subsequent stages of development and design in response to on-site geotechnical investigations.

Table 9 Total storage required to maintain pre-development flows

| Precinct | Area (ha) | Required storage volume ($m^3$) | | | |
|---|---|---|---|---|---|
| | | 1 yr ARI | 5 yr ARI | 10 yr ARI | 100 yr ARI |
| Power Station | 46.70 | 2020 | 3885 | 4615 | 12340 |
| Hilltop | 10.16 | 275 | 530 | 640 | 2040 |
| Robbs Jetty | 47.36 | 1160 | 2260 | 2710 | 9010 |
| Emplacement | 10.85 | 265 | 520 | 620 | 2065 |
| Darkan | 5.95 | 145 | 285 | 340 | 1130 |
| Fremantle Village | 26.19 | 350 | 590 | 690 | 3995 |
| Newmarket | 9.24 | 125 | 210 | 240 | 1410 |

**1 year ARI event**

Runoff from events up to the 1 in 1 year ARI event will be retained as close to source as possible within raingardens and bioretention areas integrated into the urban form.

Runoff from all (residential and commercial) lots will be captured within rainwater tanks where possible, with the excess disposed of on site via the use of soakwells or other infiltration facilities. For high density lots where retention and infiltration within the boundary of the lot is not possible retention and infiltration areas will be located within local public open space areas as close to source as possible.

The use of permeable paving will be maximised to provide opportunities for infiltration at source.

**5 year ARI event**

Road runoff from events greater than 1 in 1 year ARI and up to 1 in 5 year ARI will be conveyed in an underground pipe system designed to maximise infiltration through the use of bottomless pits and permeable joints, to low point infiltration areas integrated into public open space areas.

**100 year ARI event**

Roads and public open spaces will be designed to cater for the surface overflow for more severe storms with habitable floors at least 300 millimetres above the 1 in 100 year ARI flood or storage level at any location. Low point infiltration areas will be sized to store and infiltrate the 100 year ARI flood event on site.

## 6.2 Surface water quality

***Principle***

Maintain water quality at pre-development levels (winter concentrations) and if possible, improve the quality of water leaving the development area to maintain and restore ecological systems.

To achieve the above principle the following criteria will be applied:

- Ensure that all surface and groundwater contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the *Stormwater Management Manual.*

There are no existing or proposed surface waterways or water bodies within the study area. Further information regarding the impact of stormwater infiltration on groundwater quality is provided in section 7.2.

## 6.3 Impact on water dependent ecosystems

The only identified water dependent ecosystem within the District structure plan area is Manning Lake which is hydrologically separated from the development area by the presence of a limestone ridge and will therefore not be impacted.

## 6.4 Disease vector and nuisance insect management

Mosquito breeding sites can occur where there is standing water such as flood detention/infiltration areas. It is proposed to control mosquito breeding within the Cockburn Coast District Structure Plan Area by ensuring:

- detention/infiltration areas drain within 3 days of filling
- detention/infiltration areas are free from depressions, potholes, and related irregularities
- detention/infiltration areas do not seep to other low lying areas

## 6.5 Matters to be addressed in district master planning

District scale master planning is underway and will include further refinement of the stormwater management strategies outlined herein to establish the locations of low point infiltration areas.

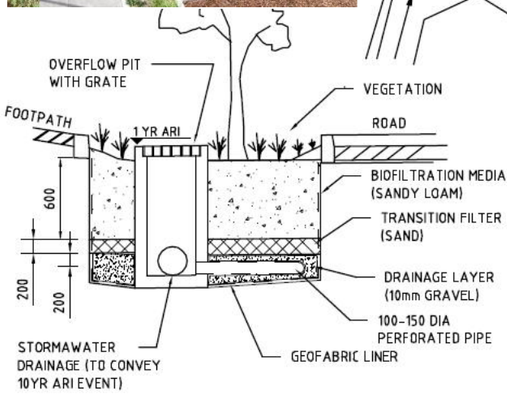
## 6.6 Matters to be addressed in precinct local water management strategies

Infiltration testing should be carried out in conjunction with geotechnical investigations at a localised level to confirm areas that are suitable for the proposed infiltration methods and to identify appropriate infiltration rates to enable further refinement of modelling at subsequent stages of development.

**Figure 10** Summary of Surface water Management Strategies

**Water Quality – 1 year average recurrence interval event**

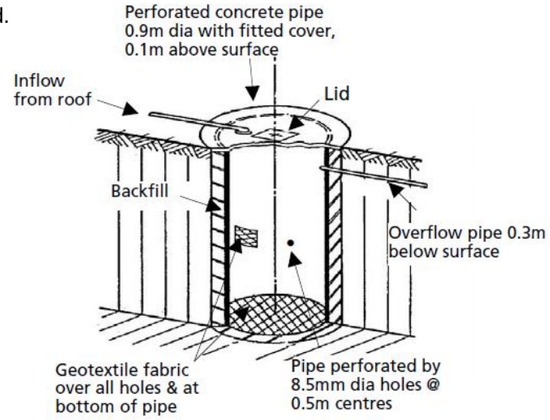
Runoff from events up to the 1 in 1 year ARI event will be retained as close to source as possible within raingardens and bioretention areas integrated into the urban form.

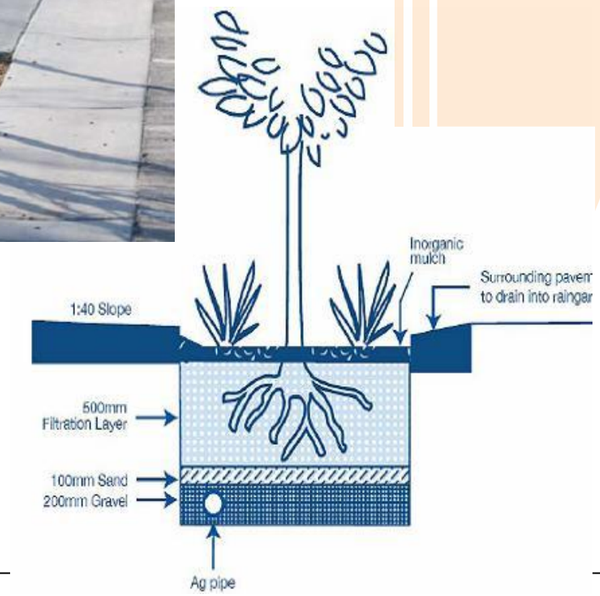




Runoff from all (residential and commercial) lots will be captured within rainwater tanks where possible, with the excess disposed of on-site via the use of soakwells or other infiltration facilities. The use of permeable paving will also be maximised to provide further opportunities for infiltration at source.

**Servicability – 5 year average recurrence interval event**

Runoff from events greater than 1 in 1 year ARI and up to 1 in 5 year ARI will be conveyed in an underground pipe system designed to maximise infiltration through the use of bottomless pits and permeable joints, to low point detention areas integrated into public open space areas. Any discharge to POS areas incorporating drainage swales shall be fitted with a gross pollutant trap (GPT) if directly receiving storm events are drained through side entry pits from road.




**Flood protection – 100 year average recurrence interval event**

Roads and public open spaces will be designed to cater for the surface overflow for more severe storms with habitable floors at least 300 millimetres above the 1 in 100 year ARI flood or storage level at any location.

Low point detention areas will be sized to store and infiltrate the 100 year ARI flood event on site.

Mosquito breeding sites can occur where there is standing water such as flood detention/infiltration areas. Mosquito breeding can be controlled by ensuring:

- detention/infiltration areas drain within 3 days of filling
- detention/infiltration areas are free from depressions, potholes and related irregularities
- detention/infiltration areas do not seep to other low lying areas

# 7. Groundwater Management Strategy

## 7.1 Groundwater levels

Areas of the site where the groundwater level is within 5 m of the surface are limited to the foreshore public open space and therefore no groundwater drainage system or extensive areas of fill are proposed at this time. However, local site investigations will be required at subsequent stages of planning to confirm depths to groundwater are considered satisfactory by the City of Cockburn.

## 7.2 Groundwater quality management

***Principle***

Maintain water quality at pre-development levels (winter concentrations) and if possible, improve the quality of water leaving the development area to maintain and restore ecological systems.

To achieve the above principle the following criteria will be applied:

- Ensure that all surface and groundwater contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the *Stormwater Management Manual.*

Urban runoff is a significant source of nutrients and other contaminants that are discharged to the shallow aquifer. Runoff water quality from roads and other paved surfaces can be variable and is dependent on local soil types, land use and climate.

The quality of the stormwater infiltration will be maximised through:

- Soil amendment (where the tested phosphorous retention index is less than 10) within all stormwater infiltration areas and public open space
- Infiltration will not be promoted in areas of known soil contamination
- Xeriscaping to avoid the use of fertilisers
- Recommending a maintenance plan for the upkeep of the stormwater management system

## 7.3 Impact on water dependent ecosystems

The only identified groundwater dependent ecosystem within the District structure plan area is Manning Lake which is upstream of the development area and will therefore not be impacted.

## 7.4 Matters to be addressed in precinct local water management strategies

Prior to the use of groundwater for irrigation purposes additional monitoring data, including confirmation of the nature and extent of contamination and the suitability of groundwater for irrigation purposes will be prepared and presented within local water management strategies.

Geotechnical investigations at a localised level will be required to confirm local depths to groundwater.

Infiltration testing should be carried out in conjunction with geotechnical investigations at a localised level to confirm local groundwater, areas that are suitable for the proposed infiltration methods and to identify appropriate infiltration rates to enable further refinement of modelling at subsequent stages of development.

Soil phosphorous retention index testing should be carried out in conjunction with geotechnical investigations at a localised level to identify areas where soil amendment will be required to ensure that the ultimate phosphorous retention index will be greater than 10.

# 8. Implementation Framework

## 8.1 Monitoring program

### 8.1.1 Pre-development monitoring program

Detailed site investigations, including monitoring, are required to satisfy the requirements of the contaminated sites act.

Baseline groundwater levels and quality have been determined from existing data.

The site is sandy and within the area to be developed there is greater than 5 m depth to groundwater as determined from site investigations and regional bore records. The area of the site where potential exists for groundwater to be within 5 m of the surface is limited to the immediate coastal strip is to be retained as public open space only.

The existing site is currently industrial in nature and stormwater runoff receives no water quality treatment before direct infiltration to groundwater. The proposed development will involve substantial improvements to stormwater management on the site by following water sensitive urban design principles and therefore is considered highly likely to improve groundwater quality.

As there will be minimal impact on surface or groundwater from the proposed development, groundwater in the area to be developed is > 5 m from the surface, and monitoring is being undertaken to address contaminated sites issues no additional pre-development monitoring is proposed.

Groundwater has not yet been confirmed as the preferred source of water for irrigation on this site. Monitoring for detailed site investigations that have been undertaken to date, suggest that the groundwater is suitable for irrigation purposes. If groundwater is selected as the preferred option for irrigation then prior to its use, appropriate monitoring will need to be undertaken to ensure that the water quality is satisfactory and that saline intrusion will not be an issue.

### 8.1.2 Post-development monitoring program

As there will be minimal impact on surface or groundwater from the proposed development, no post-development monitoring is proposed.

### 8.1.3 Contingency action plan

As there is no recommended monitoring program, no contingency action plan is proposed.

## 8.2 Requirements for following stages

The next stage of precinct planning will require the development of local water management strategies for each of the development precincts. This will include preparation of conceptual designs for drainage infrastructure. Specifically, the following issues will need to be addressed within the local water management strategies:

- Further local contaminated sites investigations where necessary
- Soil permeability and phosphorous retention testing to confirm soil amendment requirements
- Location and sizing of stormwater drainage systems including infiltration areas
- Provision of infrastructure for alternative water supply

## 8.3 District water management strategy technical review

It is intended that this district water management strategy be reviewed within ten years or earlier if deemed necessary until development has occurred.

The review should be undertaken by the developer, with agreement from the Department of Water, Environmental Protection Agency, Western Australian Planning Commission, and the City of Cockburn. The review should cover, but not be limited to the following:

- Assessment of impacts of development;
- Design objectives; and
- Requirements for local water management strategies.

## 8.4 Roles and responsibilities

Table 9 outlines the roles and responsibilities for the actions recommended in this district water management strategy.

**Table 10** Roles and responsibilities

| Role | Responsibility | Requirement and Period |
|---|---|---|
| Preparation of district scale master planning | LandCorp to lead with other landowners in support | In conjunction with precinct planning |
| Preparation of precinct scale local water management strategies | LandCorp to lead with other landowners in support | In conjunction with precinct planning |
| Local contaminated sites investigations and remediation where necessary | Landowners are individually responsible for their own site investigations | For reporting within local water management strategies and urban water management plans |
| Local geotechnical investigations including confirmation of:<br>- Depth to groundwater<br>- Soil permeability<br>- Phosphorous retention index | Landowners are individually responsible for their own site investigations | For reporting within local water management strategies and urban water management plans |

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