Environmental Profile and Strategy

Shire of Broome Local Planning Strategy

Prepared for the Shire of Broome

By Essential Environmental

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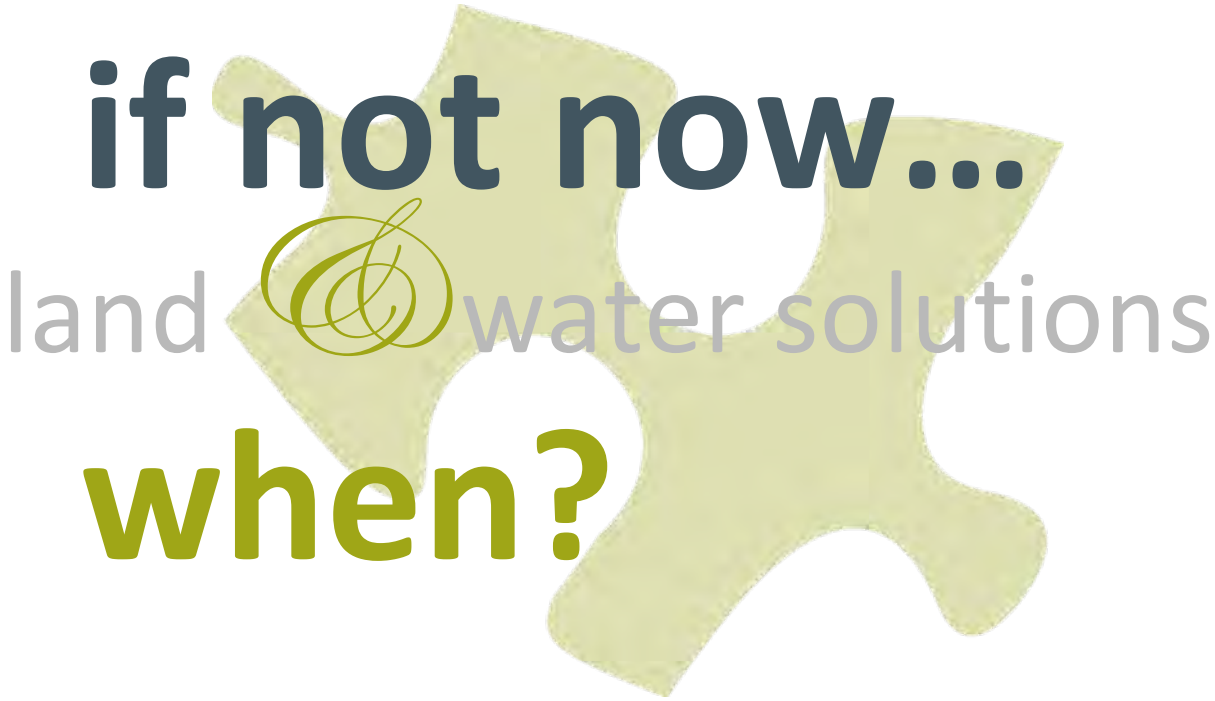
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1 INTRODUCTION

This Environmental Profile and Strategy has been developed to support the Shire of Broome's draft Local Planning Strategy. The Environmental Profile provides an overview of environmental assets and issues within the context of the future growth and development of the Shire at the broad landscape scale. The Environmental Strategy provides a response to the identified environmental issues associated with delivering the local planning strategy. It contains objectives and actions (strategies) to be implemented in order to achieve the objectives, including mechanisms for implementation via the land use planning system.

Information on the likely growth and development scenarios for the Shire is contained within the draft local planning strategy. Key aspects of the anticipated levels of growth and development across the Shire that have the potential to impact on the environmental assets and values of the Shire include:

- substantial growth of the Kimberley tourism sector
- flow-on increases in government services as well as aquaculture and agriculture, with additional resultant growth in retail and social infrastructure needs, predominantly located within the town of Broome
- growth in resource projects, primarily the Browse Basin oil and gas reserves, located more than 400 kilometres north of Broome and 250 kilometres off shore, including the proposed on-shore processing facility at James Price Point, 60km to the north of the Broome townsite.

These development scenarios are likely to result in substantial growth of the Broome townsite and associated impacts on the environment from increases in population and infrastructure. It is also necessary to acknowledge the potential impacts on the environment from climate variability and changes in rainfall patterns and temperatures.

2 ENVIRONMENTAL PROFILE

This environmental profile addresses biodiversity, water, soils, fire risk, coastal areas, waste management and air quality, incorporating climate change considerations into each element where relevant. It does not address Aboriginal or cultural heritage or mineral/petroleum resources.

The Shire of Broome is recognised throughout the world for its natural beauty, characterised by a variety of landscapes which range from rocky cliffs to white sandy beaches, turquoise to turbid waters, and mangroves to spinifex plains. This incredible landscape supports a diverse array of biodiversity and is one of the key attractions for the Shire and a driver for land use change to accommodate growth in tourism, resource development, agriculture and eco-lifestlyes. The substantial value of the natural environment to the people and the economy of Broome is difficult to quantify and yet the values are indisputable.

The Broome climate is dominated by two main seasons with two short transitional periods. The 'tropical summer' or wet season extends from November to April. Almost 90% of the annual rainfall falls during this period, which is also characterised by very hot temperatures. The dry season occurs from May to October and is typified by sunny days and cooler nights. It is important to note that these climate patterns may require different planning solutions to those generally applied in the south west, particularly with regards to biodiversity protection, water resources management and bushfires.

2.1 Biodiversity

The Shire of Broome is recognised as having substantial biodiversity value, evidenced by a diverse array of landscapes, flora and fauna. These ecosystems exist within a tropical savannah landscape dominated by eucalyptus and acacia open woodlands, known as Pindan, with hummock and tussock grasslands (figure 1). Ecosystems in the Shire include coastal archipelagos, mangrove creeks and mudflats, coastal dunes with vine thickets, swamp rainforests, mound springs with monsoon forest, clay pans, red soil plains, and sandstone and limestone ranges. These diverse landscapes create habitats that support a significant array of terrestrial and marine mammal, reptile, bird and invertebrate species.

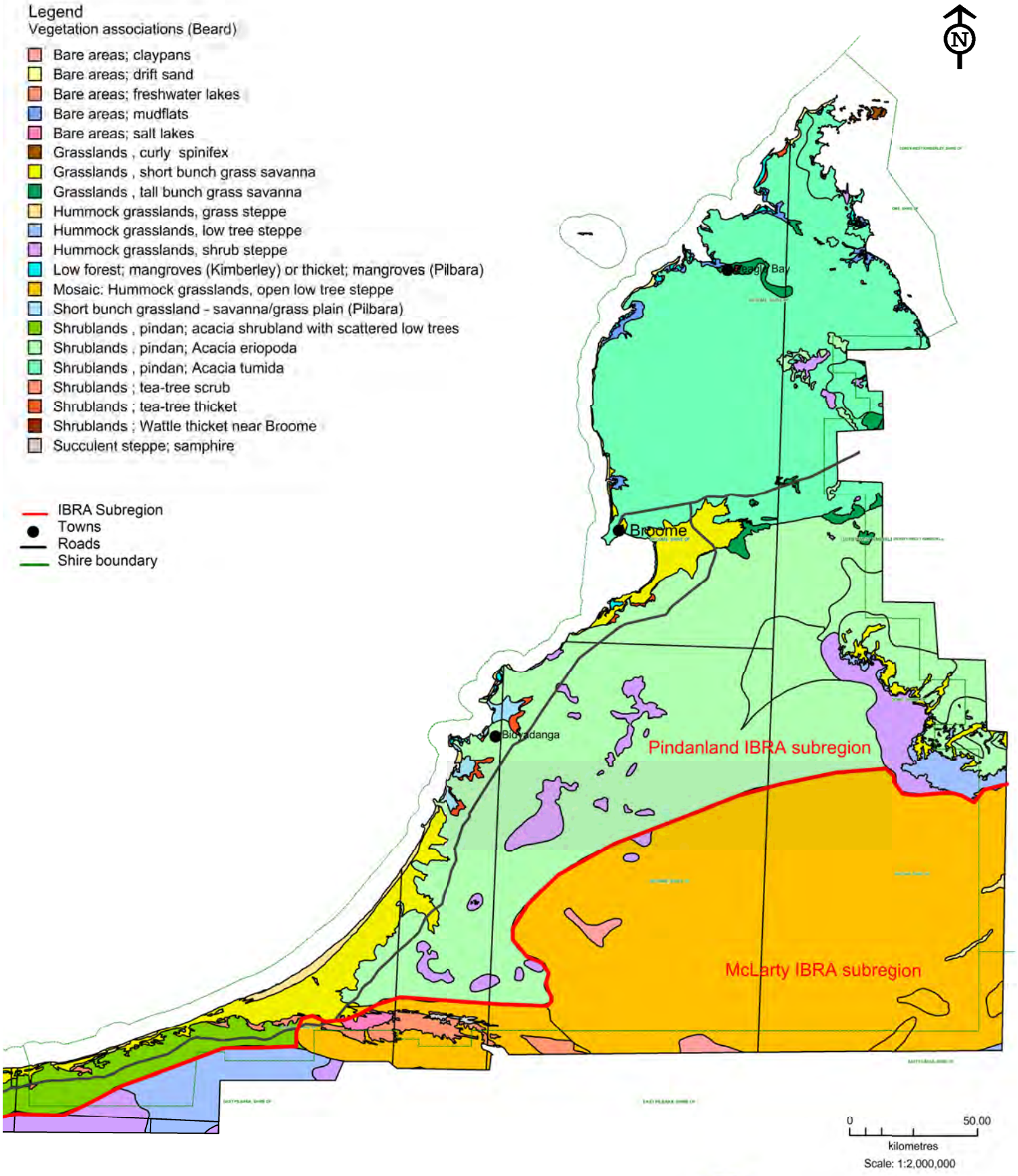
The Shire's biological uniqueness is supported by large areas of relatively intact native vegetation and healthy ecological processes. Although other areas across the State have been largely cleared for agriculture or development, within the north-west, native vegetation remains largely uncleared with the exception of areas for agriculture, transport and other infrastructure, small isolated communities and the townsite of Broome. It is noted; however, that although pastoral activities are not considered to be a use that results in land clearing, pastoral activities have the potential to significantly impact on the biodiversity values of vegetation, particularly where overgrazing leads to the degradation of vegetation condition and soils.

In order to better understand the terrestrial and aquatic biodiversity, a bioregional framework was developed by the Commonwealth and State governments which classifies the country into Interim Biogeographical Regions or bioregions and bio-subregions. The Shire of Broome contains parts of two Interim Biogeographical Sub-Regions: Pindanland (Dampierland 02) and McLarty (Great Sandy Desert 01) (figure 1). Broad scale vegetation mapping of the region identifies a number of broad vegetation types. Over two-thirds of the area is covered by a mixture of Pindan woodland and Pindan shrubland, with the remainder a mixture of hummock grasslands and grasslands, with small amounts of mudflats and shrublands located in coastal regions (figure 1).

There are a number of DEC-managed lands and reserves within the Shire of Broome (figure 2). These include Coulomb Point Nature Reserve, Dragon Tree Soak Nature Reserve, Lacepede Islands Nature Reserve, and Swan Island Nature Reserve. Compared to other regions in Western Australia, the Kimberley has a low representation of its bioregions in nature reserves, having less than one per cent of its land area reserved for conservation. The internationally recognised standard of between 10 and 15% reservation of each bioregion has not been achieved in either bio-subregion; however this is consistent with the remainder of the Kimberley which also averages about 5% reservation of bio-subregions. This level of reservation does not account for Indigenous Protection Areas as previously there was no opportunity to recognise these lands or allow joint management with traditional owners but recent changes to the Conservation and Land Management Act will now allow alternative management of lands for conservation. The Department of Environment and Conservation is currently working with landowners on the Dampier Peninsula to increase the level of recognised conservation areas through the establishment of a number of conservation parks/reserves as part of the Dampier Peninsula Planning Strategy.

The Shire's coastline around Broome and including areas of Roebuck Bay to the south is a combination of Unallocated Crown Land and Crown Reserve widely known as the 'Coastal Park'. The Coastal Park contains important vegetation including mangroves near Roebuck Bay and vegetated dunes along Cable Beach which have significant ecological values and also provide environmental corridors as well as erosion control. The Coastal Park is jointly vested in Yawuru Corporation and the Shire while the Department of Environment and Conservation is the management authority (Shire of Broome, 2010) and management plans for these areas are currently being prepared.

Shire of Broome Environmental Profile
Figure 1: Vegetation



Data source: Landgate, DSEWPaC. Created by: S Shepherd. Projection: lat/long

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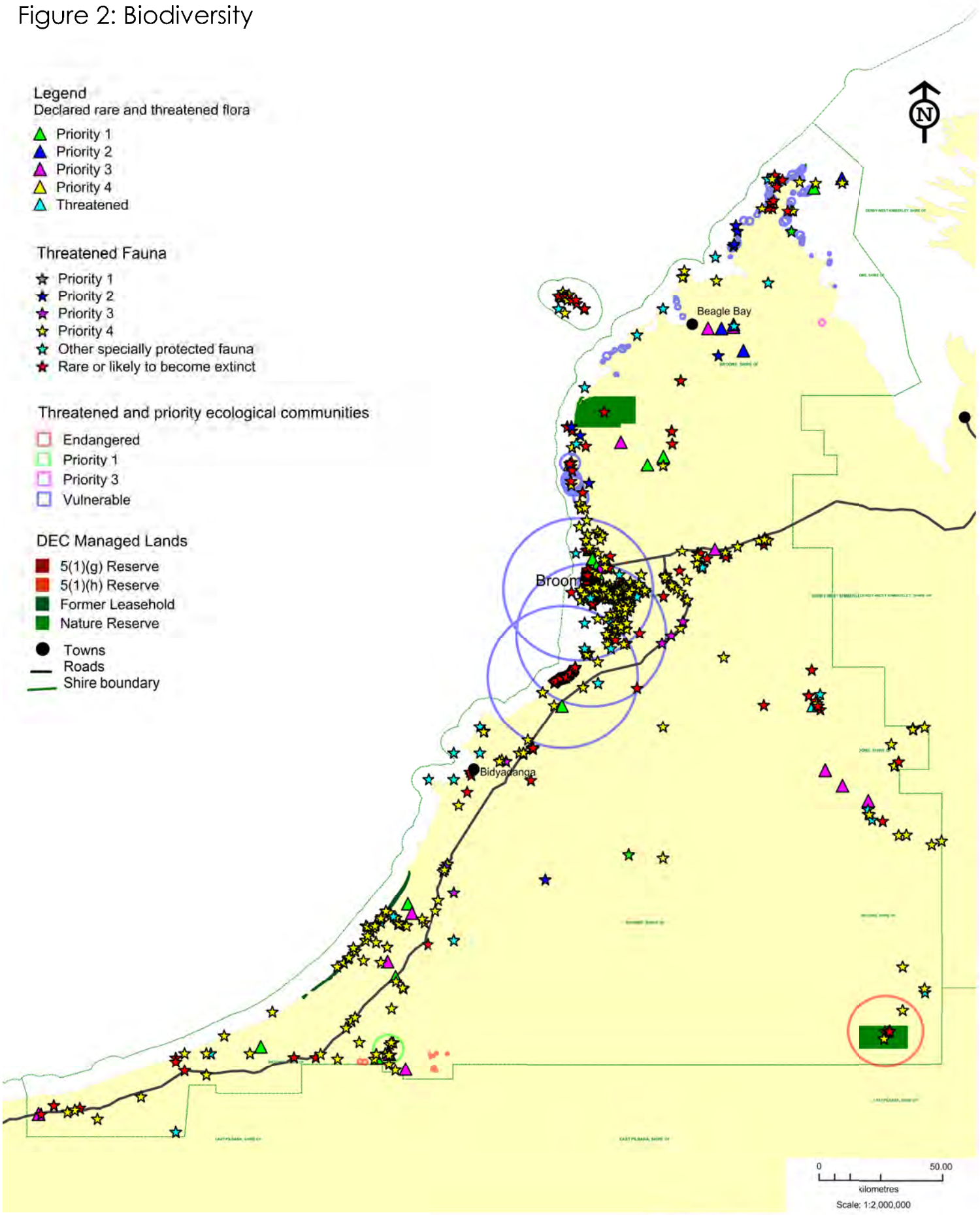
Shire of Broome Environmental Profile
Figure 2: Biodiversity



Data source: Department of Environment and Conservation. Created by: S Shepherd. Projection: Lat/long.

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The Shire's scheme, which currently covers the Broome townsite to the Willie Creek wetlands in the north, extending south of Crab Creek, contains a number of bushland reserves as part of the 'Environmental Cultural Reserve'. These areas have been largely unmanaged and therefore human impacts and invasive weeds have had a detrimental effect. Protection, rehabilitation, and management of these reserves are important with the predicted increase in population growth and an increasing number of tourists during the peak season. These reserves are also subject to joint management arrangements (Shire of Broome, 2010).

The marine environment of the Shire of Broome provides vital habitat for a variety of marine species including whales and turtles, as well as many species of migratory birds, of which 60 species are protected under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) 1999. The Eighty Mile Beach area is the most important area for waders in north-Western Australia and is internationally recognised as a Ramsar wetland. Many species cited in international bilateral agreements such as the China Australia Migratory Bird Agreement and the Japanese Australia Migratory Bird Agreement use this site, as well as other internationally recognised sites including Mandora Marsh and Roebuck Bay.

At the Commonwealth level, flora and fauna is protected under the EPBC Act, administered by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). The categories of threatened flora and fauna protected under the EPBC Act are (i) extinct in the wild (ii) critically endangered, (iii) endangered and (iv) vulnerable. An additional category of "conservation dependent" exists, which requires special consideration but is not protected under the EPBC Act.

Flora and fauna is also protected at the State level under the *Wildlife Protection Act, 1950*, administered by the Department of Environment and Conservation (DEC). The categories of threatened flora under the *Wildlife Conservation Act 1950* include Declared Rare Flora, Priority 1, Priority 2, Priority 3, and Priority 4 flora. The categories for threatened fauna are Schedule 1, Schedule 2, Schedule 3 and Schedule 4 fauna. The different categories have different management requirements.

A search of the DEC Threatened species data base revealed two species of declared rare flora (*Keraudrenia exastia* and *Pandanus spiralis var. flammeus*), seventeen species of priority 1 flora, five species of priority 2 flora, 29 species of priority 3 flora and two species of priority 4 flora within the Shire of Broome. There are also fourteen species of rare fauna, five specially protected fauna species and twenty two species of priority fauna (1 P1, 3 P2, 3 P3 and 15 P4) which are known to occur in the municipality (figure 2). These include the humpback whale, green and flatback turtles, grey headed albatross, northern and southern marsupial mole, black footed and west Kimberley rock-wallaby, great desert skink, golden bandicoot, Gouldian finch, bilby and the dugong. Most of these species are also protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Shire also contains a number of threatened ecological communities, including the species-rich faunal community of the intertidal mudflats of Roebuck Bay, assemblages of the organic springs and mound springs of the Mandora Marsh area, Lolly Well Springs wetland, and Bunda Bunda, as well as the monsoon (vine) thickets which occur on the coastal sand dunes of Dampier Peninsula (figure 2). There are also a number of priority ecological communities which require further investigation. These include the Dwarf pindan heath community of the Broome coast and the *Corymbia paractia* dominated community on dunes (figure 2). Any action that is likely to have a significant impact on any listed threatened species or threatened ecological community or other matter of national environmental significance requires referral to the Federal Minister for the Environment for assessment.

Land use planning issues

Changes in land use and development have direct and indirect impacts on biodiversity. The most significant impact results from the clearing of native vegetation for development and construction of associated infrastructure. The destruction of vegetation and habitat leads to a direct loss in biodiversity of both flora and fauna species and communities. Other indirect impacts on areas of native vegetation and habitat result from increased numbers of residents and tourists. These "edge effects" include uncontrolled access, rubbish dumping and litter, increased sediment transport, increased risk of fire and the spread of weeds, pests and feral animals including cats, donkeys, camels and dogs.

It is also anticipated that climate variability and population growth is likely to contribute to the increased spread of vector-borne, water-borne and food-borne diseases (CSIRO, 2006). Changing climate patters may also lead to changing flora and fauna spread and diversity, including increased spread of weeds and pests. These factors have the potential to significantly impact on biodiversity. Accordingly, it is important to incorporate biodiversity corridors or linkages into land use plans, providing for their appropriate use and encourage improved management of these areas.

Environmental and agricultural weeds are considered to pose a significant risk to biodiversity in the Shire. The Department of Agriculture and Food maintains a list of Declared weeds that are listed under the *Agriculture and Related Resources Act*. There are 88 weeds on this list in the Shire, 49 of which require eradication from the area (listed as P2 weeds). In addition, there are 3 Weeds of National Significance in the Shire which have been identified by the Australian Government due to their invasiveness, impacts on the environment and primary production, potential for spread and socioeconomic impacts. Those undergoing active control and management include Rubber vine (*Cryptostegia grandiflora*), Mesquite (*Prosopis spp*.) and Parkinsonia (*Parkinsonia aculeate*).

2.2 Water

Wetlands and water systems have significant ecological values as water is generally the critical sustaining element for ecosystems. Water resources also sustain many social values associated with human use and appreciation, including fishing, bird watching and tourism. They also hold significance for Aboriginal culture, such as hunting, fishing, cultural stories or heritage sites.

Water resources in the Shire are typical of those in northern Australia. Although there is often a perception that rainfall is plentiful and therefore water is an abundant resource, this is not the case, as indicated in the CSIRO's Northern Australia Land and Water Science Review (2009), which recognises that:

> *All water is fully in use. The water balance is closed; even "wasted" water running out to sea is needed by estuarine systems and near-shore ecosystems. Underground, groundwater supports riparian vegetation, maintains perennial reaches of many rivers and provides a dry-season source of water. Whilst current levels of use are low relative to total water stocks, any perturbation will have consequences through the hydrological cycle (CSIRO, 2009).*

The key water resource assets within the Shire of Broome are generally associated with groundwater or the seasonal flow of watercourses (surface water) during the wet season. This is typical of northern Australia where there is a large variation in rainfall throughout the year, with over 90% of the approximate average 600mm falling between November and April in the wet including only 35 days or so with rainfall over 1mm, and a very high evaporation rate due to the high temperatures.

2.2.1 Surface water

There are very few examples of perennially flowing rivers within the Shire, most drying to a series of pools (some fed by groundwater) during the dry season. The primary waterway catchment is that of the Fitzroy River (figure 3). The area around Broome drains into the Cape Leveque coastal catchment and the southern parts of the Shire drain inland into the Sandy Desert Basin. Surface water generally moves across the landscape as sheet flow rather than through defined channels (waterways) that flow all year round. This has a strong impact on the landscape and requires thoughtful consideration in terms of location of development and management of stormwater.

There are two wetlands in the Shire which are of international significance, listed under the Ramsar Convention. These are Roebuck Bay and Eighty Mile Beach (figure 3). These wetlands provide critical habitat for the region's fauna, including millions of migratory waterbirds each year. Ramsar sites are listed as matters of national environmental significance under the EPBC Act.

Other wetlands in the Shire are recognised as having national conservation significance, listed in the *Directory of Important Wetlands in Australia*. These include Bunda-Bunda mound springs, Dragon Tree Soak, Eighty Mile Beach, Mandora Salt Marsh, Roebuck Bay & Plains System, and Willie Creek Wetlands (figure 3). The Mandora Marsh is the most inland distribution of mangroves (*Avicennia marina*) in Australia. It contains a very complex and diverse wetland system which includes mound springs and a distinctive tall *Melaleuca leucadendra* closed forest.

Because of the aridity of the region, permanent and semipermanent pools are of high ecological value. These pools and wetlands sustain populations of terrestrial and aquatic flora and fauna during times of drought and are refuge areas from which biota expand during times of flood. These areas are often associated with mound spring communities which are generally listed as Threatened Ecological Communities due to their limited distribution and high ecological values.

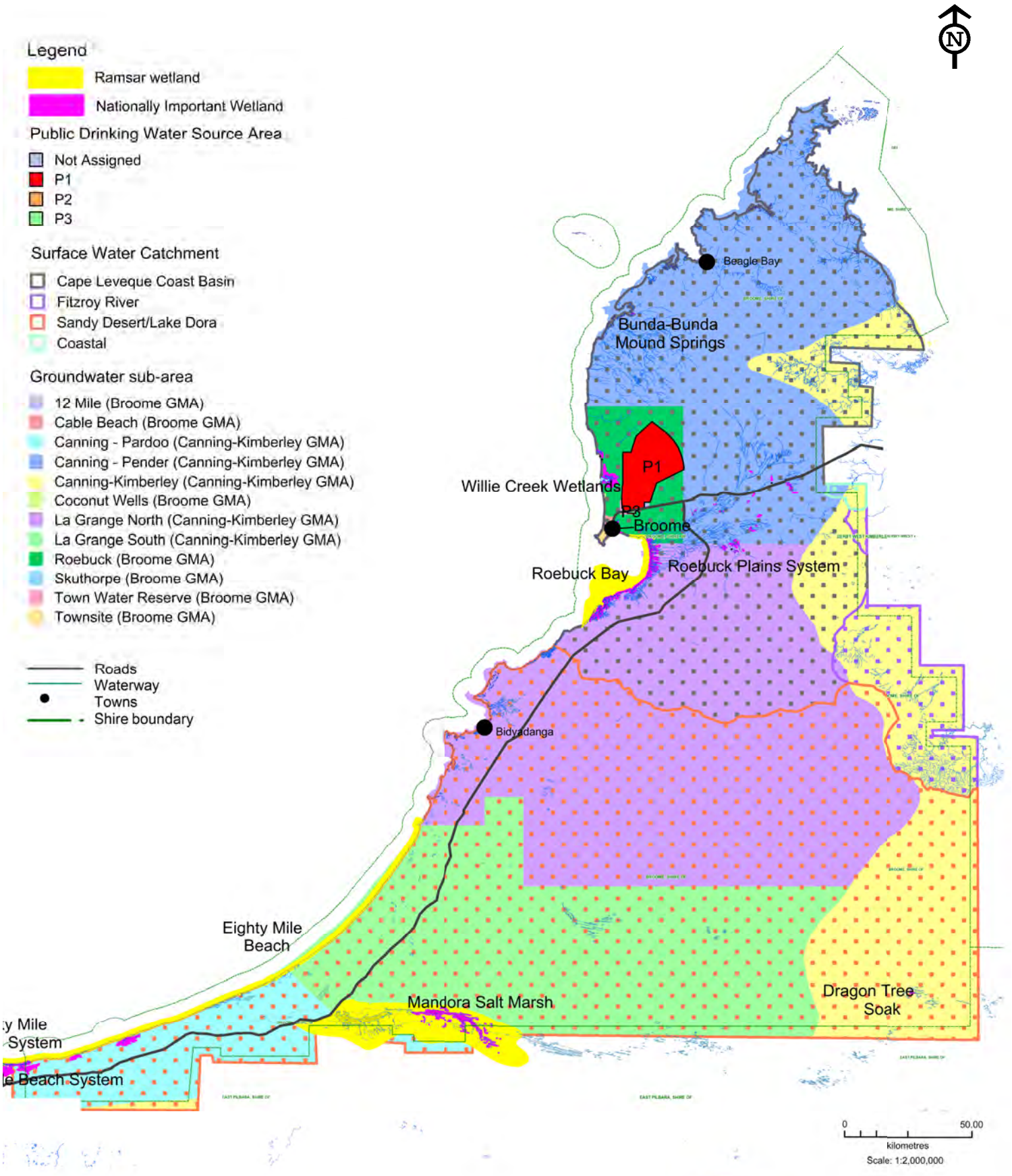
2.2.2 Groundwater

The majority of the groundwater resources in the Shire are contained within the sedimentary rock aquifers which are found in the Fitzroy sub-region around Broome and the Fitzroy River Basin. These aquifers vary considerably in quality and quantity.

Literature on water ecosystems, including groundwater and groundwater dependent ecosystems in north-western Australia is scarce. However, groundwater is widely used for domestic use, stock, irrigated agriculture, resources development and other purposes and almost all domestic water supplies in the Shire including those for remote towns and communities come from groundwater.

Groundwater management areas may be proclaimed under the *Rights in Water and Irrigation Act 1914.* This allows the Department of Water to protect and manage groundwater resources through licensing and development of management plans. The Shire is covered by the Canning-Kimberley Groundwater Area and the Broome Groundwater Area, which are divided into a number of groundwater subareas (figure 3). Although no allocation plan exists for the Broome Groundwater area, an allocation plan has been released for the La Grange North and South subareas to provide protection for the area's groundwater-dependent environmental and cultural values including the Mandora Marsh, while providing users with secure access to water (DoW, 2010).

Shire of Broome Environmental Profile
Figure 3: Water Resources



Data source: LandGate. Created by: S Shepherd. Projection: lat/long.

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A Public Drinking Water Source Area has been proclaimed over urban groundwater supplies for Broome. The protection and management of the Broome Water Reserve, which supplies groundwater from the Broome Sandstone Aquifer within the Roebuck groundwater subarea, is outlined in the *Broome Water Reserve Water Source Protection Plan* (WRC, 2001). Water source protection plans have also been prepared for the communities of One Arm Point, Djarindjin-Lombardina, Beagle Bay and Bidyadanga. These are to be implemented by the Department of Housing.

Groundwater aquifers used for water supply are generally recharged directly from rainfall, particularly from larger events, which makes them potentially vulnerable to contamination from inappropriate land use and affected by changes in rainfall patterns. The groundwater supply for many remote communities has the potential to be affected by inappropriate land use practices and the Shire of Broome is currently working with the Department of Water to address the management of water and wastewater within the indigenous communities across the municipality.

Other issues with the use of groundwater include potential impacts on groundwater dependent ecosystems and biodiversity as a result of groundwater drawdown; saltwater intrusion in coastal areas; changes in groundwater chemistry from contamination from mining, agriculture, industry and urban development; as well as the acidification of groundwater from the disturbance of acid sulphate soils.

Land use planning issues

The management of stormwater, particularly where it discharges directly into sensitive environments including the ocean has the potential to impact on water quality, largely as a result of sediment transport. Where development occurs, surface water needs to be managed so as to not impact on the environment or cause flooding. The seasonal, high volume rainfall runoff in the Broome townsite flows either towards the dune system along Cable Beach to the west or towards the Dampier Creek mangroves to the east. Anecdotal evidence suggests there are some issues with the capacity of the drainage system in the existing Broome townsite areas which require retrofitting. Some concerns have also been raised by the community regarding the likelihood of recent algal blooms in Roebuck Bay being a result of high nutrients in stormwater runoff.

Key stormwater management issues associated with development in Broome include the identification of appropriate drainage design to adequately manage erosion/scouring, silt, sediment, water quality and weeds, particularly into sensitive coastal environments. It is recognised that Pindan soils have a high capacity for erosion and this, coupled with the high volumes of stormwater which flow in the wet season, requires active and effective management to adequately control erosion and sediment transport. In addition, when Pindan becomes wet, it is highly impervious which limits the opportunities for on-site retention of stormwater. These characteristics require different approaches to those currently being implemented across the Swan Coastal Plain, largely due to the nature and volumes of rainfall and different soil conditions. There is a strong preference for the integration of stormwater drainage into swales contained within networks of open spaces rather than the use of pipes and pocket parks. These corridors should have multiple functions including active and passive recreation and allow for cultural connections and activities as well.

Inappropriate land uses located in proximity to borefields or recharge areas have the potential to contaminate groundwater supplies. This includes landfill sites, unsewered industrial areas and wastewater treatment plants, amongst other uses. *State Planning Policy 2.7: Public Drinking Water Source Policy* (Government of WA, 2003) recommends the inclusion of a special control area over gazetted public drinking water source areas to ensure that planning decision-

making is consistent with the Department of Water's land use compatibility table. It is recommended that the water source protection plans prepared for remote communities are incorporated into community layout plans and gazetted by the Department of Water.

Predicted changes in climate patterns in the future means that more frequent and severe droughts are likely to occur, as the anticipated small decrease in annual rainfall combined with higher evaporative demand would probably result in less river flow, although this has not been quantified. Increases in extreme weather events are also likely to lead to more cyclone-damage, flash flooding, strains on sewerage and drainage systems, greater insurance losses, possible black-outs, and challenges for emergency services (CSIRO, 2006). Other potential impacts are likely to include declining groundwater recharge and increased erosion.

The Department of Water is currently investigating the water source opportunities for irrigation on the Dampier Peninsula and the Department of Agriculture is undertaking similar investigations in La Grange north and south. It will be important for any decision regarding allocation of groundwater to consider all users of the water including traditional owners for cultural purposes.

2.3 Soils

The geomorphology of the Shire is characterised by Quaternary sandplains of red sands and alluvial plains of grey-brown clays. Low uplands of sandstone and limestone have shallow stony soils (figure 4). The most common soil type within the Shire is Pindan - a red silty sand with a high clay content and low nutrient content (Shire of Broome, 2011). This soil type has implications for surface water management, as Pindan soils can become waterlogged and are susceptible to erosion. Additionally, little is known about their ability to retain nutrients and/or contaminants.

Although the mapping of acid sulphate soils is limited in the Kimberley region, it is considered that there is a high potential for acid sulphate soils to occur in the intertidal mudflats along the coast including the Dampier Peninsula, Roebuck Bay and Dampier Creek (figure 4).

A search of the DEC's contaminated sites database revealed three registered sites within the Broome townsite area. These sites are affected by hydrocarbons and require remediation. It should be noted that these sites are not likely to be the only contaminated sited within the Shire.

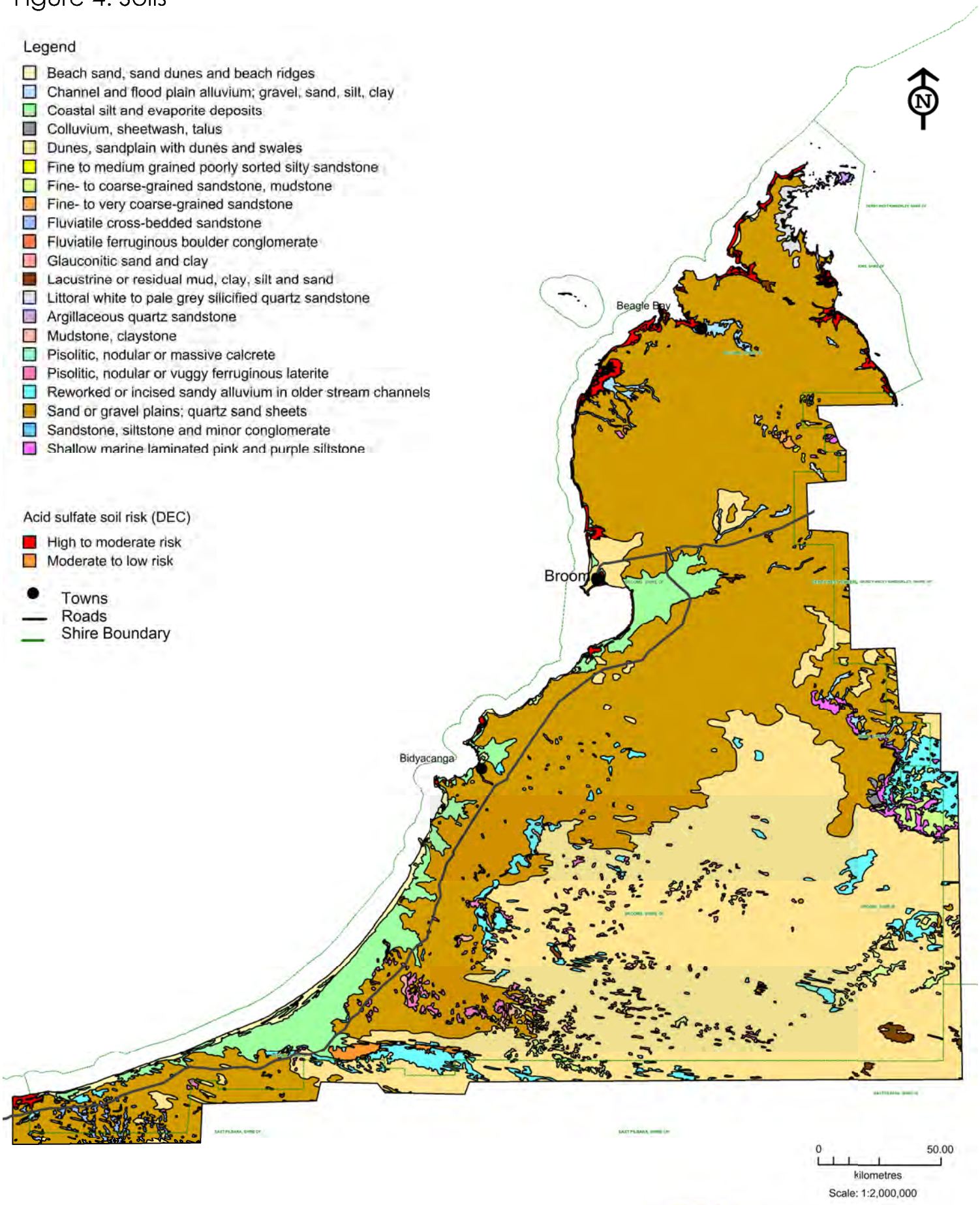
Land use planning issues

The control and management of sediment and erosion is a key issue for land use change and development, as site works can result in a loss of soil through clearing of native vegetation, wind or water-borne erosion, leading to the discharge of sediment off site which may be transported to nearby coastal and other sensitive environments. Development should ensure that effective measures are made to control any sediment which may arise as a result of subdivision or site works. This may include the addition of organic matter which may also serve to increase the retentive capacity of the soils for nutrients.

In agricultural and pastoral areas, the over grazing of these areas may impact on soil quality, resulting in land degradation, erosion, vegetation decline and loss of agricultural productivity.

Declining soil and land quality may also occur as a result of development where acid sulphate soils are disturbed. This leads to the release of acid and heavy metals which can cause significant harm to the environment and infrastructure. The WAPC has released the *Acid Sulfate Soils Planning Guidelines* (WAPC, 2008) which outline a range of matters that need to be

Shire of Broome Environmental Profile
Figure 4: Soils



Data source: Department of Mines and Petroleum. Created by: S Shepherd. Projection: lat/long.

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addressed at various stages of the planning process to ensure that the subdivision and development of land containing acid sulfate soils is planned and managed to avoid potential adverse effects on the natural and built environment.

Planning and development should consider historical land uses as some have the potential to have resulted in contamination of soil and groundwater. Potentially contaminating land uses include landfill sites, unsewered industrial areas and industrial activities, and agricultural areas such as market gardens.

2.4 Fire

Fire is recognised as an important process for maintaining vegetation structure, as it aids regeneration of some species. Altered fire regimes; however, particularly those that occur late in the dry season, have the ability to significantly impact on the land and biodiversity values of the area. Fires are often started by human error in remote areas and have the ability to cause widespread damage, burning out of control in the hot, Kimberley climate. There is potential for the incidence of fires to increase as temperatures rise in the future as a result of climate variability, but this has yet to be quantified.

Land use planning issues

Bushfires are a significant land management issue which should be recognised appropriately by the land use planning system, primarily in terms of the location of firebreaks in rural and rural-residential areas; emergency management including access routes; and population-intensive land uses in proximity to bushfire prone areas.

2.5 Coastal areas

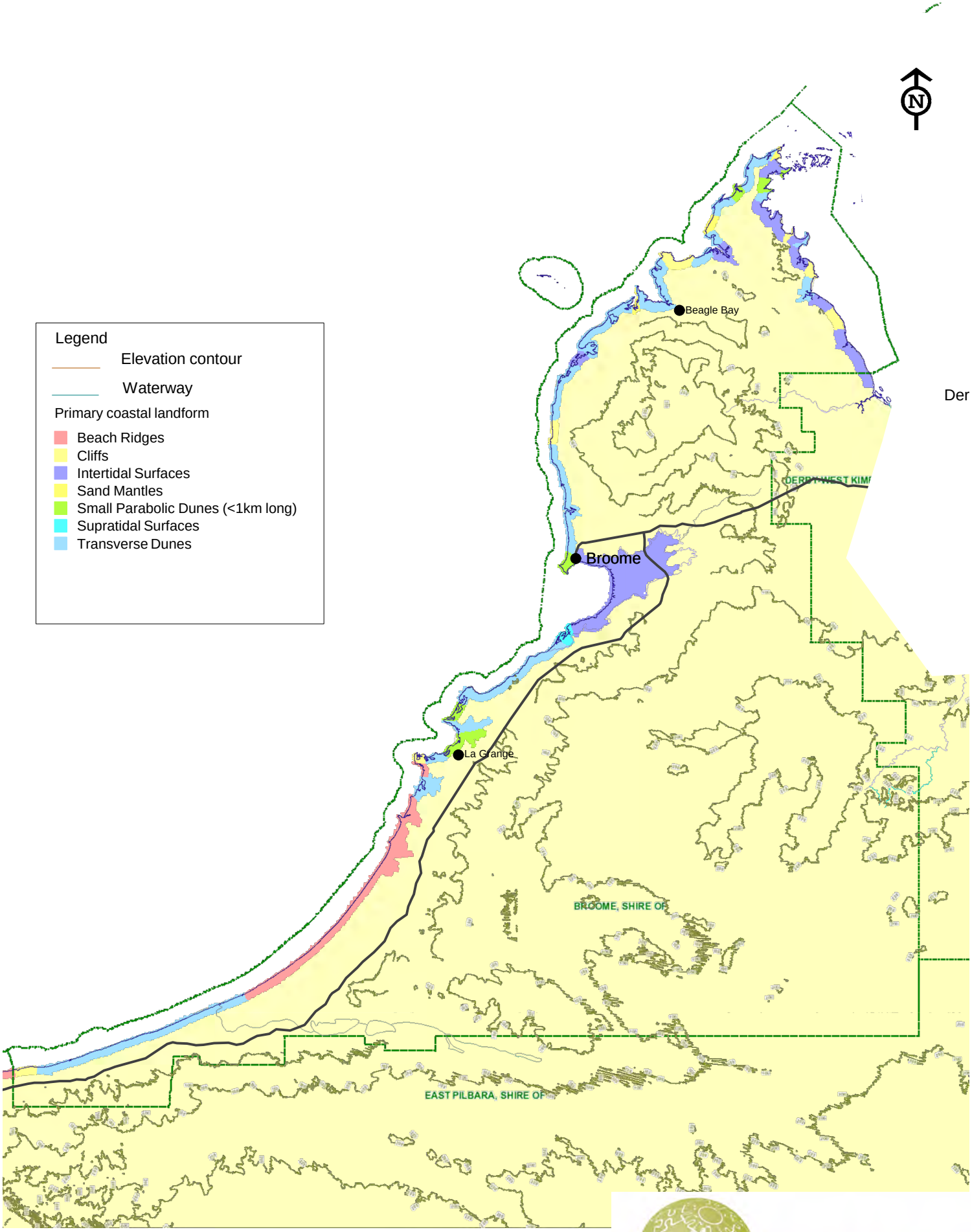
Broome experiences a semi-diurnal tidal regime, with a lowest to highest astronomical tidal range of 10.5m (Eliot, 2008). Since 1910 there have been 22 cyclones that have caused gale-force winds at Broome. On average this equates to about one every four years although the frequency has been less in recent times, there being only two cyclones from 1990 to 2004 (Bureau of Meteorology, 2012).

Coastal vulnerability is affected by a number of complex interrelationships including the interplay between extreme weather and tidal processes and the complex and highly varied geologic structure of the region which includes sandy beaches, rocky cliffs, mangrove mudflats etc (figure 5). The identification of areas which are vulnerable to changing coastal processes requires consideration of the variability of the primary processes driving change along the coast, together with the probability of that change, within the context of the geology of the area. Consideration must also be given to the likely outcomes of climate variability which include sea level rise and a predicted increase in extreme weather events.

Land use planning issues

Exposed parts of the Shire's coastline are vulnerable to storm surge; however, the coastline orientation makes the town centre of Broome less susceptible to storm surge than other parts of the northwest coast (Bureau of Meteorology, 2012) although anecdotal evidence suggests that areas of the Broome townsite, predominantly in Chinatown, may become flooded in high spring tides. Other areas have been protected by the series of coastal dunes.

Shire of Broome Environmental Profile
Figure 5: Coastal landform



Data source: custodians. Created by: H Brookes. Projection: MGA: zone 50

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Although the system of tidal creeks along the coast are generally well equipped to absorb the effect of storm surges, modifications made to accommodate growing towns, roads, railways and ports are not always able to cope with the strain of rising tides and often result in low-lying areas being affected. It is noted anecdotally that areas of the townsite currently flood after cyclonic events.

Although erosion and accretion of the coastline are naturally occurring processes, coastal erosion can result in significant impacts on property and infrastructure. Land-use planning should be informed by the most current and available information on sea level rise and encourage a strategic retreat from development and infrastructures in low-lying coastal floodplains and high hazard areas, such as Riddell beach. Any new structures should be located behind an appropriate setback.

Planning for expansion and future development of ports and/or resource industries, the Broome townsite and remote coastal communities will require appropriate (currency and scale) information with regards to likely coastal vulnerability scenarios to support decision making including the identification of areas which may be vulnerable to sea level rise, coastal instability including erosion, extreme tides, tropical cyclones and storm surge. Land use planning decision-making should also be consistent with *State Planning Policy 2.6* (Government of WA, 2003) and the WAPC's position statement on sea level rise (WAPC, 2010).

2.6 Waste management

Effective waste management is essential to protect groundwater resources and wetlands, coastal zone areas and other areas with environmental values. Waste management is largely a Shire responsibility, with the exception of remote communities, however the isolation of the Shire and the costs associated with the transport of waste, as well as the highly seasonal nature of the population including the influx of tourists, pose many challenges, particularly for the recycling and reuse of waste.

Waste management in remote communities is also difficult, due to low levels of opportunity for community awareness and participation in recycling, distance from landfill facilities and recycling markets, as well as inappropriate waste management practices that have the potential to impact on drinking water resources.

The Shire operates one landfill site which services the town of Broome. This landfill facility is estimated to have remaining capacity for less than 5 years of operation based on current disposal rates, although these are recognised as being below average for remote areas (Shire of Broome, 2010).

A site for a resource recovery facility and new landfill has been identified and planning has commenced to address the waste management practices and landfill capacity of the Shire. In order to address the cost associated with transporting recylables to larger markets in Perth, resource recovery will be largely directed at recycling and using products locally.

The Shire of Broome, together with the shires of Derby / West Kimberley and Halls Creek has committed to the implementation of the Regional Waste Management Plan. The Plan provides strategies and actions to guide the Shires and their communities to improve waste management practices consistent with the State's vision of Towards Zero Waste (ASK Waste Management, 2009, as cited in Shire of Broome, 2010).

Land use planning issues

Landfills should be located so as not to impact on any sensitive land use and incorporate an appropriate buffer. Consideration must be given to the location of the landfill in proximity to sensitive environments including the groundwater so that any impacts on these environments is minimised.

Any new landfill should be designed and operated in accordance with the DEC landfill guidelines (DoE, 2005).

2.7 Air quality

Air quality in the north-west is generally of good quality; however it can be affected by mining, agriculture and industry, as well as by bushfires. Key pollutants are dust from port activities and particulates (measured as PM10 and PM25) from bushfires. Pollutants are predominantly driven by wind patterns and topography and have the ability to effect the environment and landscape as well as human health in the region, particularly when the fires burn for several days, resulting in very large area of land burned and the significant accumulation of pollutants. Additionally, when Pindan soils are exposed, these can cause significant dust problems due to the small size of the Pindan particles.

Other pollutants of interest are oxides of nitrogen, ozone, sulphur dioxide, and carbon monoxide. Current information indicates that concentrations of particulates, ozone and nitrogen dioxide may occasionally approach or exceed National Environment Protection Measure (NEPM) ambient air standards from existing contributing sources (Government of Western Australia, 2010).

Land use planning issues

Urban development and in particular industrial areas and infrastructure such as ports, as well as intensive agriculture and horticulture precincts, have the ability to impact on adjacent land uses including residential areas and natural areas. Impacts include dust, noise, light and other pollutants. These may result in declining air quality, pollution of adjacent land and waters and impacts on biodiversity.

Land use planning should ensure that appropriate buffers are identified to minimise and manage any impacts on sensitive land uses and significant environmental assets, consistent with draft *State Planning Policy 4.1: State Industrial Buffer Policy* (WAPC, 2004). Consideration should be given to the identification of corridors which link and protect significant environmental and cultural values.

2.8 Key land use planning considerations

There are a number of significant environmental assets and issues that should be addressed by the land use planning system. The key land use planning considerations that have the potential to impact on the environmental values within the Shire of Broome are:

- Townsite expansion and service provision
- Tourism and recreation development
- Coastal erosion and sea level rise
- Pastoral activities
- Horticulture production/ development

These issues are summarised in table 1.

Table 1: Key environmental planning issues affecting the Shire of Broome

Considerations for land use planning	Challenges for the Shire's environmental values	Pressure areas	Strategy(s)
Townsite expansion and service provision	o Loss of biodiversity from clearing and indirect impacts o Stormwater management including sediment transport o Identification of future land supply requirements and their impacts on environmental values	Broome, Dampier Peninsula (Browse Basin infrastructure)	o Protection of important vegetation, communities and/or habitat in reserves and/or Coastal Park o Shire policy regarding the implementation of WSUD which requires sediment basins, weed management and NW-specific stormwater designs
Tourism and recreation development	o Coastal vulnerability including dune management and restoration o Management of Ramsar areas o Management of marine and terrestrial ecosystems o Location of tourism infrastructure on the coast o Opportunities within pastoral leases	Broome	o Development of management plan for the Broome Coastal Park o Consideration of pastoral exclusion areas and tenure options o Engagement of Aboriginal communities in nature conservation
Coastal erosion and sea level rise.	o Ensuring that new coastal developments are located in suitable areas that are not impacted by coastal erosion, storm surge and sea level rise. o Protection, adaptation and prevention of sea level rise impacts on coastal infrastructure, such as ports and marinas. o Loss of marine/coastal habitats.	Broome, Dampier Peninsula (Browse Basin infrastructure)	o Undertake a risk assessment of coastal vulnerability now and into the future, focussing on the Broome townsite, other tourist attractions and coastal indigenous settlements. o Studies into infrastructure design standards in coastal areas
Pastoral activities	o Stock and grazing management o Biodiversity management o Soil conservation o Riparian zone management o Groundwater management	Rangelands, especially areas around watering points, permanent pools, and stands of vegetation.	o Consider land use management practices as part of any application for diversification and/or change of use or development
Horticulture production/ development	o Groundwater management planning that considers environmental water requirements o Management of water quality, riparian zones and surface water flows into Roebuck Bay, Eighty Mile beach and the Mandora Marsh o Preservation of high quality agricultural land	Currently limited but could potentially increase in the La Grange region and across the Dampier Peninsula	o Ensure any application for horticulture has access to sufficient water resources and implements best practice water efficiency and nutrient and sediment management
Climate change contributing to an increase in mean temperature and variability in seasonal rainfall. More severe storms and increased periods of drought.	o Rise in sea level o Increase in coastal erosion o Increase in the severity of cyclones events and associated flooding o Rise in global mean temperature o Determination of foreshore reserve and location of coastal infrastructure o Biodiversity preservation and management	Coastal areas and all ephemeral river systems. Native vegetation and national parks/ reserves.	o Ensure Council has access to latest information regarding climate change impacts on natural assets o Establish natural corridors as part of a reserve system o Ensure development is consistent with design guidelines and appropriate standards for high natural hazard areas

3 ENVIRONMENTAL STRATEGY

The Broome environment is well recognised around the world for its incredible natural beauty and diversity of landscapes and marine, terrestrial and aquatic habitats which support an abundance of flora, fauna and ecological communities. These sensitive and significant environments within the Shire of Broome include:

- Ramsar sites: Roebuck Bay and Eighty Mile Beach
- Important Wetlands: Bunda-Bunda mound springs, Dragon Tree Soak, Eighty Mile Beach, Mandora Salt Marsh, Roebuck Bay & Plains System, and Willie Creek Wetlands
- Other waterways and riparian areass, mound springs, permanent pools including groundwater dependent flora and fauna
- Karst systems including those that support stygofauna and troglofauna
- Groundwater management and water catchment areas particularly the Priority 1 Broome public drinking water supply area and other groundwater resources for potable supply
- Regional parks, conservation parks and nature reserves
- Declared rare and priority flora, specially protected fauna, threatened ecological communities and migratory species (both State and Commonwealth listed)
- High value vegetation, particularly involving poorly reserved communities, including that with locally important values (both State and Commonwealth listed)
- Coastal landforms, offshore islands and marine reserves
- Mangroves and benthic primary producer habitat
- Habitat of threatened fauna including sea turtles, dugong and cetaceans.

The future growth and development within the Shire will need to consider these environmental assets and ensure that any potential impact on them is minimised.

In addition, appropriate management measures should be incorporated into any planning decision making that addresses indirect, ongoing or cumulative impacts. These may include:

- uncontrolled access to fragile environments
- rubbish and waste management
- contamination of marine environments, surface water, groundwater and soils including from landfills and oil spills
- weeds, exotic species, feral animals and pests
- erosion and sediment transport
- bushfires
- coastal erosion, storm surge, sea level rise and tidal patterns
- extreme weather events

3.1 Objectives

The following objectives are proposed for the protection and management of the environment in the Shire of Broome. These objectives should be achieved as part of future land use change and development in Broome. These are to:

- Recognise, protect and enhance significant environmental assets;
- Optimise the sustainable use of environmental resources and prevent degradation of land, water resources and air quality; and
- Work with the community and stakeholders to improve environmental management outcomes as part of land use planning and development.

Achievement of these objectives is supported through the recommendation of strategies and actions, as well as a range of initiatives to facilitate better implementation of the strategies.

3.2 Initiatives

In order to address the identified environmental issues and deliver the objectives, some State Government support may be required to assist proponents and the Shire to implement the local planning strategy. It is recognised that there is a large body of work that has been undertaken in the Shire; however, there remain a number of key areas where information is scarce or unreliable. The following initiatives are recommended to be undertaken by other Government agencies in partnership with the Shire to address these gaps.

1. Undertake a risk assessment of contamination to groundwater supplies within remote communities and develop a strategy to better improve the management of waste, water quality and land use in these areas.
2. Undertake a technical investigation into the potential for impacts of flooding, inundation and storm surge in the vicinity of the Broome townsite that considers the local climate conditions, future variability and tidal ranges. Define appropriate development setbacks or levels for coastal processes consistent with the revised *State Planning Policy 2.6: Coastal Planning* and prepare Coastal Foreshore Management Plans where required.
3. Work with the DEC to identify areas of under-represented, high quality vegetation associations to be incorporated into the DEC estate.
4. Develop and implement a local biodiversity strategy consistent with the *Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region* (WALGA & PBP, 2004) focussing on establishing local biodiversity corridors and which includes mechanisms and tools for its implementation to be incorporated into the land use planning process.
5. Work with the Department of Agriculture and Department of Water to identify areas of high value agricultural land and incorporate these into the local planning strategy.
6. Undertake an assessment of the future need for basic raw materials across the Shire, identify areas suitable for resource extraction and develop a strategy to provide for the estimated growth needs which includes appropriate extraction methods and requirements for rehabilitation of the site upon closure.
7. Establish the current and pre-development conditions of receiving environments including Roebuck Bay and Dampier Creek to provide baselines for post-development monitoring so that the quality and values of these sensitive environments can be maintained.

8. Liaise with the Department of Water regarding the need for an allocation plan for the Broome sandstone aquifer within the Roebuck groundwater subarea.
9. Prepare a water management strategy for the whole Shire to improve the management of the water cycle and optimise the use and reuse of all forms of water for fit-for-purpose needs for users now and into the future, consistent with *Better Urban Water Management* (WAPC, 2008) that includes best practice drainage design for north-west conditions.
10. Review and update the State of the Environment Report (SoB, 2000) to identify and address priority environmental issues across all sections of the town and surrounding area of Broome.
11. Prepare a Weed Management Strategy, which would also incorporate post-fire weed control, in order to control, manage and reduce the incidence of environmental weeds.
12. Undertake a waste audit of the current waste facility and research the feasibility and viability of a Resource Recovery facility to reduce the amount of waste into a new landfill site.

3.3 Actions for incorporation into the local planning strategy

The following actions are proposed to be incorporated into the local planning strategy itself (either via text or figures) to address the issues raised above.

1. Include a special control area over the Broome PDWSA in the local planning scheme so that land use planning decisions are consistent with the protection of the groundwater resource and the requirements of the *Broome Water Reserve Water Source Protection Plan* (WRC, 2003).
2. Identify high value environments including those stated in section 3 above on the local planning strategy map and ensure their protection through appropriate reservation and/or through complementary land use(s) that minimise indirect impacts.
3. Identify areas of locally important vegetation and/or environmental values in the vicinity of the Broome townsite and incorporate these into local reserves or Cultural Corridors.
4. Develop a management plan for the Broome Coastal Park addressing potential impacts of increased population on coastal and marine areas including management of weeds, rubbish and recreational fishing.
5. Identify high value landscapes and viewscapes associated with the Broome townsite and key tourist areas in the local planning strategy so that they can be preserved should these areas be targeted for future development.

3.4 Strategies for future land use change and development

The following strategies should be implemented as part of future land use changes or development proposals and are recommended to be included in the local planning strategy. Any future application for land use change and/or development should:

(i) Aim to avoid impacts, then manage or mitigate impacts, on any matters of national environmental significance. Matters of national significance in the Shire of Broome include Roebuck Bay & Plains wetland system, Eighty Mile Beach, Bunda-Bunda mound springs, Dragon Tree Soak, Mandora Salt Marsh, and Willie Creek Wetlands (figure 3), as well as nationally threatened species and ecological communities and migratory species. Where a proposed development is likely to result in an impact on a

matter of national environmental significance, it should be referred to the Federal Minister for the Environment for assessment under the EPBC Act.

(ii) Undertake a spring survey to identify the presence, significance and condition of any protected or priority flora, fauna, community and/or fauna habitat and provide appropriate protection where necessary. Site investigations should be consistent with EPA requirements.

(iii) All amendments to the local scheme should be supported by a District Water Management Strategy and all structure plans should be supported by a Local Water Management Strategy which both outline the objectives and strategies for flood protection, water quality management and water use and efficiency, including of coastal waters, groundwater and ephemeral creeks, consistent with *Better Urban Water Management* (WAPC, 2008), *Shire of Broome Guidelines for the design of stormwater drainage systems (Engineering services)*, and the Department of Water's *Interim: Developing a Local Water Management Strategy* (WAPC, 2008a). The management of surface water including erosion, sediment and weeds should be addressed as a priority.

(iv) Define any floodway, having consideration of cyclone events, climate variability and tides, and should contain the regional 100-year average recurrence interval event flow. Floodways which convey the regional 100-year average recurrence interval event flow should not be developed or obstructed in any way. Residential development should not occur within floodways. Any areas subject to flooding or inundation should requite finished floor levels to be established at least 0.5m above the 100 year average recurrence interval event flood.

(v) Provide appropriate setbacks for coastal processes consistent with the revised *State Planning Policy 2.6: Coastal Planning*, based on appropriate and up-dated technical studies which investigate the potential for impacts of flooding, inundation and storm surge in proximity to the coast as well as any ephemeral creeks and floodplains and are appropriate for tropical climate conditions and large tidal ranges.

(vi) Develop and implement a sediment and erosion control management plan where significant site works are proposed or where the site is located in the vicinity of a sensitive environment such as Dampier Creek and/or Roebuck Bay.

(vii) Where available, connect to a reticulated sewer network for all residential, commercial and industrial development proposals.

(viii) Ensure any application for horticulture has access to sufficient water resources and implements best practice water efficiency and nutrient and sediment management

(ix) Undertake preliminary site investigations for the presence of acid sulphate soils in areas that have a high to moderate risk of the presence of acid sulphate soils; and

(x) Undertake a desktop analysis of past land use to identify those with the potential to result in contamination. Where they exist, undertake site investigations and management as required.

(xi) Consider land use management practices as part of any application for diversification and/or change of use or development in pastoral areas.

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