

# Water resources of the Howard River region, Northern Territory:

## A report on the social and cultural values and a stakeholder assessment of water use scenarios



by

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CSIRO Sustainable Ecosystems, 2008



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TRaCK brings together leading tropical river researchers and managers from Charles Darwin University, Griffith University, University of Western Australia, CSIRO, James Cook University, Australian National University, Geoscience Australia, Environmental Research Institute of the Supervising Scientist, Australian Institute of Marine Science, North Australia Indigenous Land and Sea Management Alliance and the Governments of Queensland, Northern Territory and Western Australia.

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## EXECUTIVE SUMMARY

There has been relatively little pressure on the Northern Territory's water resources, due to its comparatively small population base and an overall low intensity of land use. This, however, is changing, and increasingly the NT's largely intact water resources are becoming subject to a complex range of needs and demands. Demand for water is especially increasing from Darwin residents, as is competition for groundwater to supply residential and agricultural developments in the capital's rural hinterland. The Howard River catchment in particular has experienced rapid population growth in the form of rural lifestyle blocks and small horticultural holdings and, as a result, water extraction from the dolomite aquifer has increased markedly. Darwin's metropolitan water supply currently depends on water extracted from a number of bore fields within the Howard region and demand is expected to continue to rise.

The Northern Territory Government has now prioritised the development of water allocation plans for the rural regions of Darwin and is currently gathering hydrological data and other information on water use in the Howard River region to inform a water allocation plan. This plan will state how groundwater in the Howard River area is to be shared between the current uses, and will seek to protect all values. This report describes the results of social research designed to inform the plan., with two primary aims:

1. To document the social use and importance of Howard River water resources and aquatic environments to Indigenous and non-Indigenous groups (e.g. hunters, plant enthusiasts, Landcare groups, recreational fishers), including:
  - The use of surface water and groundwater resources by Indigenous traditional owners and by others with an interest in the cultural values, as defined by the beneficial use concept of the *Water Act 1992* (NT);
  - Community perceptions of change in environmental condition and use, and perceived threats to valued resources, places and traditions or beliefs, and
- 2 To identify and assess the relative significance of resource impacts possible under different water resource use scenarios, including stakeholder perspectives on the means of protecting or enhancing social and cultural values through water resource management.

An allied aim was to increase community capacity and enthusiasm to participate in water resource management research and planning by facilitating stakeholder input into the research underpinning the identification of the water and flow requirements of user groups. In meeting these aims the project team was required to incorporate scientific, local and Indigenous knowledge and the outputs from the second aim were to be expressed in terms meaningful to stakeholder groups.

The Howard River catchment covers approximately 1,500km<sup>2</sup> of the rural hinterland of the Northern Territory's capital, Darwin. The study area is characterised by extensive wetland systems, including the Howard River and its tributaries, springs, swamps, floodplain areas and lagoons. Surface water features include lakes, lagoons, wetlands and streams. In the Darwin

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region, there are generally two separate groundwater aquifers; a shallow unconfined aquifer in the lateritic subsoil layer and a deep aquifer confined to weathered rocks such as dolomite. The catchment supports a diversity of land uses including residential, horticultural, pastoral, conservation and mining.

Access to groundwater plays an important part in supporting many of the area's intensifying land uses and both groundwater and surface water flow provide a focus to public use of the ecological and cultural assets of the area, sustaining the many highly valued waterways, wetlands, rainforests, fish, plant and bird species utilised and/or appreciated by various residents and other groups. Water therefore underpins the social and cultural values associated with the area, including recreational fishing and hunting, cultural heritage, customary hunting and collecting, educational and leisure activities.

In this study area a number of recent water management issues have focussed public attention on the health of the area's waterways and on the sustainability of water resource use and, as a result, there is now a government undertaking to more closely regulate and monitor water use and to develop water allocation plans for the rural hinterland of Darwin.

Most prominent amongst recent incidents suggesting an underlying water management problem was the closure of Howard Springs, a popular freshwater spring and recreational area, in 2004, due to low flows and poor water quality. Elsewhere questions have been raised about the effect of groundwater extraction on the catchment's vegetation, particularly vulnerable and valuable rainforest patches. A recent study of the water balance of the tropical woodland ecosystem in the Howard River catchment (Liddle et al. 2006) found that the small patches of rainforest and Melaleuca swamp forests are sustained by groundwater through-flow from recharge areas. However, increased development in the area since 1980 has resulted in a drop in end of dry season groundwater levels compared to groundwater levels not subject to the same intensity of land use (Liddle et al. 2006). However, the effects of increased water use are not uniform across the landscape, with the creation of 'cones of depression' within the aquifer where water extraction is most intense. Modelling of different development scenarios by the NT Department Natural Resources Environment and the Arts concluded that land use change has had minimal impact on other springs in the area (Yin Foo 2004).

The land use changes experienced in the area have also resulted in fragmentation of landscapes, privatisation of some wetlands and a reduction in the availability of land for recreational and cultural pursuits. Stakeholders reported that changes in management of favoured areas had resulted in reduced access, for example, and a reduction and contraction in available land. This in turn has resulted in a concentration of multiple and sometimes competing and conflicting activities. Other tensions relating to competition between water for Darwin's residents and rural industries and land-holders were brought to light during the course of the study

The research described in this report used employed socio-economic decision support tools that can help settle trade-offs between competing outcomes. To do this a combination of methods was used to build understanding of the values and issues for the Howard catchment, explore the conflicts and potential trade-offs, and evaluate several scenarios for the future. These methods included stakeholder consultations, interviews, desk-top review of literature and participatory workshops.

The report begins by defining social and cultural values in the context of Australian water resource management. It introduces the water management administration system of the Northern Territory and describes the Howard River water planning area: its biophysical characteristics, dominant land uses and socio-economic features. The purpose of the first five chapters of the report is to outline the specific activities that occur in the region, provide a preliminary assessment of use, including frequency and magnitude of activities, and an indication of any linkages between activities, uses and flow regime. These chapters consolidate data currently held by various organisations pertaining to the social use and importance of the Howard River region. The report also identifies the most popular locations and describes their history, current management arrangements and the environmental changes and other pressures identified by stakeholders during the course of the study. Significant Aboriginal cultural sites are also identified and the utilisation of water sites in the study area is described. Qualitative data drawn from interviews with stakeholder groups is analysed in these sections.

The last chapter of the report provides an analysis of the stakeholder assessment of impacts of water use scenarios: reporting on the outcomes of a stakeholder consultation and evaluation that employed a Citizen's Jury combined with a Multi-Criteria Analysis (MCA). One objective of this project required that we gain an understanding of the way in which potential changes to water use in the greater Darwin area might affect the social and cultural values of the Howard River catchment. To achieve this we conducted a community consultative workshop spanning two days in late April and mid May, 2008. The purpose of the workshop was to examine a set of water use scenarios, and build a picture of how each scenario may affect those present at the workshop. A separate report on the workshop process and outcomes (Straton *et al.* 2008) has been produced and circulated to stakeholders for comment.

The deliberative multi-criteria evaluation enabled information to be shared and positions discussed. The structuring of the scenario evaluations using MCA, the MCAT software and the information and discussion sessions enabled participants to become aware of the multiple variables, objectives and complex relationships between population growth, individual perspectives and aspirations, the realities of water supply, rates of household water use, patterns of rainfall, hydrology and land use and water planning.

During this stage of the project the researchers witnessed an emerging awareness among stakeholders that the interests of all water users are inextricably linked in managing the quantity and quality of this limited and shared resource. This realisation focused attention on the relationship between land use planning and water planning. For example, it is necessary to understand the effects of land use on the groundwater recharge rates and the quality of recharging water from ground disturbance from mining, subdivision of rural blocks and industrial developments.

Discussions about water use and management revealed a clear need to improve our knowledge base, to know precisely how much water is available, and how the hydrological system works, particularly rates of re-charge. There are many unregulated bores and improvements to be made to the monitoring of water use in the region. Public perceptions of the reliability of hydrological and water consumption data will be critical to the success of future water planning initiatives. During this study for example, doubts were expressed about the reliability and accuracy of existing data on rates of land-owner domestic consumption and Power and Water extraction figures. Irrespective of the level of awareness within the small group consulted here,

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participants referred to a general community resistance to bore monitoring and greater regulation of water use. Given the importance of groundwater resources to the local economy, there is a particular need for further scientific effort to better understand the connectivity between surface and groundwater resources and for connected systems to be managed as a single resource.

The research found that there are multiple and diverse social and cultural values of water being realised and practiced in the Howard River region. These include nature appreciation, education, indigenous hunting and gathering and non-indigenous hunting, fishing, motorsports, swimming, picnicking, the teaching and transfer of knowledge, exploring, boating, kayaking and canoeing, historical and archaeological appreciation, as an inspiration for art, craft and photography and research. Members of the community are also actively managing wetlands and waterways within the region are demonstrating a strong sense of ownership and custodianship over both public and private lands that contain these water places.

However demands on groundwater are already compromising the realisation of some social and cultural values, including the perceived threat of bores and groundwater pumping to wetlands for hunting, and the reduced flow of the spring at Howard Springs, a popular picnic area, leading to reduced water quality and its subsequent closure to swimming. Other threats to the continued realisation of these values include clearing, subdivision and development and the modification of flow patterns. An increasing population and diminishing wetland areas will likely lead to increasing conflict between values and users as competition for space increases.

The workshops held for the deliberative multi-criteria evaluation determined that while there was a range of opinions about the importance of certain criteria to a preferred outcome for the region, there was overwhelming agreement among participants in wanting to see the catchment's environmental condition maintained and improved in order to sustain the diverse social and cultural values appreciated by many. Participants acknowledged that this scenario was unlikely if current trends for water use, land sub-division and uncoordinated planning were to continue.

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## 1. INTRODUCTION

### 1.1 Background

The Howard River region within Darwin's rural hinterland supports a diversity of land uses including residential, horticultural, pastoral and mining. It is an area within the Darwin Water Control District that has experienced rapid population growth during the past decade and, as a result, water extraction from the dolomite aquifer has increased markedly. Darwin's water supply planning depends on water extracted from a number of bore fields within the region. Groundwater plays an important part in supporting many of the intensifying land uses and both groundwater and surface water flow provide a focus to public use of the ecological assets of the area, sustaining the many highly valued waterways, wetlands, rainforests, fish, plant and bird species utilised and/or appreciated by various resident and other groups. Water therefore underpins the social and cultural values associated with the area, including recreational fishing and hunting, cultural heritage, customary hunting and collecting, educational and leisure activities.

The Northern Territory Government is currently gathering hydrological data and other information on water use to inform a water allocation plan prepared under the Northern Territory's *Water Act 2004* (NT). This plan will be built on knowledge of:

- The aquatic environmental and social values (including cultural values),
- How much water is required for different uses and when, and
- The potential effects of increased groundwater use and appropriate management actions.

The plan will state how groundwater in the Howard River area is to be shared between the current uses and will seek to protect all values.

In 2005 CSIRO, Charles Darwin University and the NT Department of Natural Resources, Environment and the Arts (NRETAS) received funding from the Australian Government's National Heritage Trust (NHT) to recommend:

*Cultural and environmental water requirements for wetlands and surface and groundwater resources within the Howard River sub-catchment (NHT 2005/151).*

This study stems from the NT Landcare Council's recognition that social and cultural values are essential elements for developing strategies to manage the water resources of the study area.

The project was divided into two largely independent components to:

- Assess the social and cultural values and requirements as well as social impacts of water use options (undertaken by CSIRO); and
- Assess the environmental flow requirements based on aquatic plants and fish (undertaken by a team from CDU, Griffith University, NT DPIFM and NRETAS).

This study reports on the results from the first component of the larger NHT project.

## 1.2 Project aims

The social component of the project has two primary aims:

1. To document the social use and importance of Howard River water resources and aquatic environments to Indigenous and non-Indigenous groups (e.g. hunters, plant enthusiasts, recreational fishers), including:
  - The use of surface water and groundwater resources by Indigenous traditional owners and by others with an interest in the cultural values, as defined by the beneficial use concept of the *Water Act 2004* (NT);
  - Community perceptions of change in environmental condition and use, and perceived threats to valued resources, places and traditions or beliefs; and
2. To identify and assess the relative significance of resource impacts possible under different water resource use scenarios, including stakeholder perspectives on the means of protecting or enhancing social and cultural values through water resource management. This includes consideration of the preliminary cultural water requirements.

An allied aim was to increase community capacity and enthusiasm to participate in water resource management research and planning by facilitating stakeholder input into the research underpinning the identification of the water and flow requirements of user groups. In meeting these aims the project team was required to incorporate scientific, local and Indigenous knowledge and the outputs from the second aim were to be expressed in terms meaningful to stakeholder groups.

## 1.3 Project design and report structure

Section 2 outlines the conceptual background to the project. It confirms the scope of the report by defining social and cultural values in the context of Australian water resource management. and introduces the water management administration system of the Northern Territory. Section 3 describes the Howard River water planning area: its biophysical characteristics, dominant land uses and socio-economic features.

Sections 4 through Section 5 of the report bring together and consolidate relevant data currently held by various organisations pertaining to the social use and importance of the Howard River region. Popular and important water sites including significant Aboriginal cultural sites are identified, and the utilisation of water sites in the study area is described. Qualitative data drawn from interviews with stakeholder groups is analysed in these sections.



The combined purpose of these sections is to outline the specific activities that occur in the region, provide a preliminary assessment of use, including frequency and magnitude of activities, and an indication of any linkages between activities, uses and flow regime.

Section 6 of the report provides an analysis of the stakeholder assessment of impacts of water use scenarios: reporting on the outcomes of a stakeholder consultation and evaluation that employed a Citizen's Jury combined with a Multi-Criteria Analysis.

### **1.4 Methodology**

#### **1.4.1 Desktop study**

A desktop study was carried out drawing on available literature and documentary sources, heritage survey reports and Northern Land Council and NT Archival files.

The desktop study provided background information relating to Indigenous and non-Indigenous cultural and historical associations with groundwater-dependent environmental features and ecological processes. The key environmental features taken into consideration include lagoons, swamps, wetlands, springs, creeks and the Howard River channel. Identified registered Aboriginal heritage sites are linked to these environmental features where relevant.

During this phase, the members of the study team liaised with the Department of Natural Resources, Environment and the Arts (NRETAS), the Aboriginal Areas Protection Authority, the Larrakia Nation and researchers at Charles Darwin University to obtain information of relevance to the study.

The key sources of information utilised during the desk study are described in more detail below. A full list of documentary references used is provided in the reference list.

#### **1.4.2 Literature and documentary sources**

The literature review took into account published and unpublished material primarily relating to Indigenous and non-Indigenous associations with and use of groundwater resources within the study area. The review provided background information from archaeological, ethnographic and historical literature including published material such as Wells' (2001) book on Larrakia history titled *Salt Water Country*, Bourke and Williams' (2006) research on sites of archaeological significance within the Darwin region, titled *Discovering the cultural landscape of Hope Inlet, Shoal Bay*, and Hodgson's (1997) report titled *Aboriginal Use of Natural Resources in the Darwin Region – Past and Present*, as well as unpublished collected papers and video material of interviews of past residents of the Knuckey Lagoons area.

The Northern Territory Collection held by the NT Library and the National Archives were searched for historic information on use of the Howard River region. These sources include material relating to Aboriginal use of water resources, camping and hunting, historical information relating to Koolpinyah pastoral station and other early agricultural and horticultural endeavours. Archival sources also provided information relating to areas popular

with the early settler population. This step in the review process also included a search of the Northern Territory and South Australia Libraries' photographic image collections to obtain an insight into past recreational activities, and where possible, a record of historical environmental condition and water use.

Literature searched included reports from government agencies, consultants, non-governmental organisations, academic researchers and community-based organisations. The NT Department of Natural Resources, Environment and the Arts (NRETAS) was a source of management plans for the Howard Springs Nature Park and Hunting Reserve, Knuckey Lagoons, McMinns Lagoon and Holmes Jungle. These were also reviewed as was information on water supply planning and water consumption available from the Power and Water Corporation and land use guidelines from NRETAS.

Local management groups were forthcoming with unpublished material including a collection of photos and information relating to the group's activities spanning 20 years from Knuckey Lagoons, old slides taken at the Howard River, and a management framework written by the Girraween Landcare group. Web material was scanned for leads to historical information.

### **1.4.3 AAPA register of Aboriginal sites**

The Aboriginal Areas Protection Authority (AAPA) maintains a Register of Aboriginal Sites under the *Northern Territory Aboriginal Sacred Sites Act 1989* (NT). The Howard River study area contains places listed on the Register, the overwhelming majority of which are associated with groundwater features. As at 17/10/2007 the Howard River study area contained 30 Recorded Sites and 33 Registered Sites. A map showing the location of these sites is contained within the report (see Figure 37). Many of these places are groundwater features of cultural significance such as river systems, lakes, wetlands and springs. Others, such as camping areas, hunting places and artefact scatters, are indirectly associated with the presence of water although the water source itself may have since disappeared.

Information relating to sites on the Register is stored in an electronic database. The site files include descriptive and locational information regarding the sites listed on the Register in the form of report extracts, location maps, photographs and correspondence. This component of the desk study involved reviewing the information contained in the Register for all water-related heritage sites within the study area.

### **1.4.4 Consultation with indigenous representatives**

The Indigenous consultation phase of the study had three main objectives:

- 1 To involve Indigenous groups with knowledge of and traditional links to the study area in the identification of heritage and other values associated with water-related resources and the preliminary consideration of their water requirements;
- 2 To improve Indigenous representative group awareness of water planning processes and the ways in which Indigenous people can be involved in future monitoring, assessment and management of the resources; and

3. To ensure that the traditional owner group for the Darwin area, the Larrakia Nation, assisted in the selection of an Indigenous research assistant to the project.

The consultation took the form of a series of meetings with staff and committee representatives of the Larrakia Nation and individuals with recognised rights and interests in the study area. A special meeting of the Larrakia Harbour Committee was held in March 2008 to discuss the project and provide an opportunity for Larrakia representatives to provide information or raise concerns. This traditional owner reference group supports the Darwin Harbour Advisory Committee and was nominated as the most suitable point of contact between the researchers and the wider Larrakia community during initial consultations in 2007. At that special meeting in March 2008, Mr Chris Wicks, water planner with responsibilities for water planning preparation in the Darwin Water Control District for NRETA, delivered a presentation on progress towards a water plan, including background information on hydrology, water use and pressures. Emma Woodward of CSIRO reported on interim findings from desk-top surveys and interviews.

The Larrakia representatives consulted were particularly concerned about the increasing degradation of wetlands and land clearing associated with urban development. Specific places such as Knuckey Lagoons were discussed. Those present at the meetings were aware of high levels of water extraction and lack of regulation. The Committee expressed interest in the water planning process and a desire to be further involved in its development.

Early in the project the Larrakia Nation was approached by the project leader to nominate a person to work as a research assistant to the project. Mr Tibby Quall was nominated by the Larrakia Nation to facilitate the inclusion of Larrakia views and values through interviews and advice on other elements of the project. Tibby Quall commenced in mid 2007 during which time he interviewed ten Larrakia elders and representatives and asked them about their current and past use of the Howard area. These questions were often asked in the context of family connection, including who currently lives or has lived in the area in the past. Such questions drew recollections and stories about visiting different places within the Howard region with family, often to go hunting or camping. More specific questions were also asked about the significance of water to people, and whether any change had been noticed in either the amount of water around or the ability to access water areas that had been accessed in the past. Interviews were digitally recorded and transcribed by Emma Woodward to be later analysed with the other interviews undertaken during the consultation phase.

### **1.4.5 Consultation with non-indigenous representatives**

The non-Indigenous consultation phase of the study had two main objectives:

1. To involve stakeholder groups and interested individuals with knowledge of and associations with the study area in the identification of heritage, recreation and other values associated with water-related resources and the preliminary consideration of their water requirements; and
2. To improve stakeholder group awareness of water planning processes and the ways in which resident, user groups and others can be involved in future monitoring, assessment and management of the resources.

To this end two advertisements were placed in local papers (NT News and the Darwin Sun) at the commencement of the project's consultation phase in November 2007 (see Appendix A). There was a very low response to the advertisements with only one member of the general public responding; nonetheless this response did produce a very informative interview.

A project pamphlet was produced to draw public attention to the project and the opportunity to be involved in the social research component. This was made available online through CSIRO and the Amateur Fishermen's Association of the NT, who offered to add a link to their website (see Appendix B). This attracted the attention of Northern Territory Field and Game and an editorial in the NT News. CSIRO researchers contacted the Club and invited them to participate.

A poster was produced and placed at popular community centres and locations, such as local libraries.

On invitation, presentations were made to two community interest groups: the Top End Native Plant Society and the NT Field Naturalists (Darwin). This provided a good opportunity to promote community involvement in the project as well as cover water planning processes and early findings.

A mini-questionnaire was administered to attendees of the NT Field Naturalists meeting at which a presentation of the project was given. Attendees were asked to list:

- A favourite water/wetland/water dependent place
- What make it special to you?
- Does anything prevent your 'total' enjoyment?
- Concerns for the future?

A stakeholder analysis identified thirty-four groups and key individuals across a range of interests, including Landcare and other environment-aware groups, passive and non-passive recreational pursuits, interest groups and community based organisations involved in the arts and heritage management (see Appendix C).

Thirty letters were sent to key user groups and individuals requesting an opportunity to meet, discuss the project and be interviewed. The NT Department of Natural Resources, Environment and the Arts acted as a conduit to Landcare and other community land management groups – so a letter was sent via the Department. Individuals were identified through web searches, the local phonebook and the snowballing method.

The project team sought information from the public on the following topics:

- The importance of water and water places to people such as hunters, recreational fishers, environment groups like bird watchers and people who like plants, or visit springs and jungles;
- What water places are used by people;

## INTRODUCTION

- What environmental changes people have seen and perceptions of waterway and wetland health;
- Changes people have noticed in the use of areas;
- People's views about the pressures facing these places and features;
- Current conflict with other users;
- Views on current infrastructure and the ability of areas to support future use, and
- Best and worst case future scenarios for their favourite wetland area.

Twenty-two people, not including the ten Indigenous representatives interviewed by Tibby Quall, were interviewed in twenty interviews. Eighteen of the respondents were digitally recorded and notes were taken at those interviews not recorded. Each of the interviews were carried out and transcribed by Emma Woodward, except for the interview with the Northern Territory Horticultural Association which was undertaken by Anna Straton. The software package NVivo was used to search and identify key words and themes from the interviews.

### **1.4.6 Impact assessment workshops**

One objective of this project required that we gain an understanding of the way in which potential changes to water use in the greater Darwin area might affect the social and cultural values of the Howard River catchment. To achieve this we conducted a community consultative workshop spanning close to three days in late April and mid May, 2008.

The purpose of the workshop was to examine a set of water use options, or scenarios, and build a picture of how each option may affect those present at the workshop.

We aimed to involve many people with an interest in the catchment and people with expertise in hydrology, cultural heritage, plants, fish and aquatic environments. The water use options presented were informed by NT water managers and models employed by the NT Department of Natural Resources, Environment and the Arts.

The workshop made use of a method called Deliberative Multi-Criteria Evaluation (DMCE) and a computer-based tool, called the Multi-Criteria Analysis Tool (MCAT), neither of which had been used in the NT before. Researchers from CSIRO and elsewhere have successfully used this method in other situations where there are many different perspectives on how to use and manage natural resources and multiple important criteria for evaluating different alternatives. An experienced facilitator was employed to ensure the process was open, fair and productive.

The workshop was designed to offer participants an opportunity to contribute to a structured discussion about water management and to learn more about:

- Water allocation planning;
- The hydrological processes affecting the Howard River and the catchment's wetlands;

- Likely pressure on water resources from future growth in demand for water;
- Environmental, economic and social impacts of increased water use;
- The full range of social and cultural values associated with the area;
- Options for reducing negative impacts and enhancing positive changes, such as increased employment in horticulture, and
- Methods and means of improving public debate and discussion about managing water resources.

After fully discussing the priority issues and the implications of different water use scenarios from social, economic, cultural and environmental viewpoints, the workshop was expected to reveal points of disagreement requiring further attention, as well as opportunities for agreement. The results are reported in chapter seven below along with the complete methodology employed for this component of this study.

### **1.4.7 Consultation regarding impact assessment findings**

One of the objectives of the impact assessment component of the study was to obtain broad endorsement from key stakeholders of the study's findings. This involved supplying the groups and individuals consulted with copies of a draft report from the workshops and inviting comments. The report titled *Evaluating Scenarios for the Howard River Catchment: Summary Report for Workshop Participants and Stakeholders* (Straton *et al.* 2008) was sent out for comment in October 2008.

### **1.4.8 Report compilation**

Relevant data collected during the desktop study, the consultation and impact assessment phases of the project was then used to compile this report. The report addresses the study objectives outlined in Section 1.2 above. As a whole, the report aims to:

- Integrate the findings of the literature review and information gathered from consultation and interviews with Aboriginal communities and other stakeholders to addresses the key research questions of the project;
- Provide evidence of consultation with relevant Aboriginal people and other stakeholders with interests in the area;
- Identify groundwater dependent ecosystems and other water features valued by the Indigenous and non-Indigenous community including their location and extent;
- Describe the valued features and their defining attributes, as well as the pressures and threats to those values;
- Assess the impacts of water use scenarios on social and cultural values, and

## INTRODUCTION

- Contribute to the determination of the water requirements of cultural beneficial uses.

## **2. SOCIAL AND CULTURAL VALUES IN WATER RESOURCE MANAGEMENT**

### **2.1 National water policy and the role of water planning**

Over the last few decades Australia has experienced momentous changes in water policy and administration. The pace and scale has not been matched in any other country with the possible exception of South Africa (Tan *et al.* 2008). The thrust of reform is the management of water in a more efficient and sustainable manner. The first milestone for reform was set in 1994 when the Council of Australian Governments (COAG) agreed on a strategic framework for national change to water use, management and pricing. The second milestone occurred a decade later when, in 2004, COAG renewed its commitment to water reform by developing the National Water Initiative (NWI).

With the exception of water planning, the many substantial changes brought about by the COAG reforms will not be further discussed here, suffice to say that the Northern Territory is a signatory to the Agreement on the National Water Initiative and that it intends to complete full implementation of the National Water Initiative by 2010 (Northern Territory Government 2006). As a result, water market and trading arrangements are being introduced to ensure efficient water use (Straton *et al.* 2006), as are mechanisms to guarantee water allocations to aquatic and groundwater dependent environments and the water accounting systems to underpin planning, monitoring, trading, environmental and on-farm management. Given the importance of groundwater resources to the local economy, there is a particular need for further scientific effort to better understand the connectivity between surface and groundwater resources and for connected systems to be managed as a single resource.

Water planning is of fundamental importance to the water reform agenda. According to the National Water Commission, the body that oversees the implementation of the NWI, water planning

*... provides certainty about the terms of access for consumptive and environmental water users within an evidence-based, participatory and transparent process. Water planning is central to dealing with the challenges of stressed water systems and to determining how we share valuable water resources between competing uses (National Water Commission 2008: vi).*

The National Water Initiative places a great deal of emphasis on water planning as the mechanism through which water resource management will be restructured and sustainable and equitable water allocations achieved. It indicates that a prime purpose of water plans is ‘settling the trade-offs between competing outcomes’ (Council of Australian Governments 2004: Clause 36).

A strong principle in this national water policy is that water users, interest groups and the general community are to be involved as partners in catchment planning processes. Rising concern for environmental sustainability and the need for water planning, water entitlements



and water trading processes to take account of local circumstances explain the emphasis given to public participation in the NWI (Connell *et al.* 2005).

Paragraph 2 of the preamble of the NWI explicitly refers to social values and the critical part they play in water management. Noting that water is used for a variety of purposes, the preamble unequivocally states that decision-making over water involves ‘balancing sets of economic, environmental and other interests’. It affirms all governments have an obligation ‘to ensure that water is allocated and used to achieve socially and economically beneficial outcomes in a manner that is environmentally sustainable’ (Council of Australian Governments (COAG) 2004).

‘Public benefit outcomes’ is a term frequently referred to within the NWI, and invariably used in conjunction with environmental outcomes. It is explained thus:

- *Environmental and other public benefit outcomes* – are defined as part of the water planning process, are specified in water plans and may include a number of aspects, including:
  - *Environmental outcomes*: maintaining ecosystem function (e.g. through periodic inundation of floodplain wetlands); biodiversity, water quality; river health targets, and
  - *Other public benefits*: mitigating pollution, public health (e.g. limiting noxious algal blooms), indigenous and cultural values, recreation, fisheries, tourism, navigation and amenity values (NWI, Schedule B(ii)).

From the explanation and other NWI provisions, Tan *et al.* (2008) note:

- Public benefits clearly encompasses a wide range of values, these values being sets of ideals and beliefs to which people individually and collectively aspire and which they desire to hold;
- Public benefits outcomes, as the NWI intends, are identified through water planning processes: NWI para 35;
- Water management arrangements required to meet public benefit outcomes must be defined within water plans: NWI para 35(ii);
- Water to meet the agreed public benefit outcomes are to be given statutory recognition and at least the same degree of security as water access entitlements for consumptive use: NWI para 35(i);
- Any entitlements for public benefit outcomes need to be fully accountable: NWI para 35(i), and
- Any entitlements for public benefit outcomes may also be tradable when not required to meet those outcomes provided trading in not inconsistent with those outcomes: NWI para 35(iii).

According to Tan *et al.* (2008) water planning is the only mechanism contemplated under the NWI for constructing the public benefit outcomes desired by a particular community. Knowing this makes it all the more important that the objective of open and transparent processes is achieved.

Water planning processes tend to involve some element of community consultation and participation in setting water management objectives, usually via the establishment of advisory committees comprising representatives of groups from industry, community and government. In this regard, the NT's water planning processes is a value-based system: the determination of a regional community's preferred values and uses is an essential step in developing a water management program. The NT's classification of values in water management has been drawn from the National Water Quality Management Strategy. The values are referred to as 'environmental values' and described as 'what we want and need to protect' (Department of Environment and Heritage 2002). In the NT, environmental values are described in terms of water quality for various uses, referred to as beneficial uses, and include the provision of water for the following: agriculture, aquaculture, environment, public water supply and culture.

## 2.2 Defining social and cultural values

It is important to define what is meant by social and cultural values, key terms used in this study. The notion of values is employed as an increasingly popular means of addressing social, cultural and economic considerations in natural resource management (Jackson 2006; Jackson and Langton 2006). Once limited to protected area management, particularly World Heritage management, the term 'value' has now been applied to a range of resource management fields, not least water resource management, and planners and managers are increasingly required to take into account differences in human perspectives attributed to social, cultural and economic background and interests.

Differences in the environmental valuations people make may arise from personal differences affected by historical experience, for example, or by cultural beliefs or practices. Increased competition between water user groups for scarce, or at least limited, water has resulted in greater contestation over values, particularly where over-allocated water systems are required to be returned to an environmentally sustainable level of extraction (Hussey and Dovers 2006). It is precisely for the purposes of reconciling conflict between stakeholders that water planning processes are expected to include social and economic assessments, draw on robust scientific knowledge, involve all affected parties and be transparent in reaching water use decisions.

There are however many different meanings to the term value and, perhaps not surprisingly, values have been poorly defined in natural resource management (Jackson 2006; Tan *et al.* 2008). Value in common usage is understood as something that has merit or importance, of worth or that which is cared about. Valuation refers to the process of estimating an object's values, often with a common metric (most conveniently, a monetizing one), such that comparisons can be made (Ascher and Steelman 2006). Norton (2000) argues that there are:

*Many ways in which humans value nature and these ways range along a continuum from entirely self-directed and consumptive uses, and include also human spiritual values and aesthetic values, and also non-instrumental valuations (2000: 1038).*

There is a tendency in Australian natural resource management to establish separate categories of value that embrace evaluations described as economic, social, environmental and sometimes, cultural. This categorisation reflects the consideration given to the ‘triple-bottom line’ in ecological sustainability. In many studies of the social values associated with a natural resource management issue commentators are very often referring to environmental attributes, or qualities of particular significance or even to environmental attitudes held by members of the public (Reser and Bentrupperbaumer 2000), although the use is rarely well defined.

It is commonplace to see the social and cultural values encompass non-use or non-consumptive values<sup>1</sup>, and these were given relatively little emphasis in the early period of the COAG water reform (Syme and Hatfield-Dodds 2007). It has been argued that, with the emphasis on market-based water trading systems, the reform dialogue has been ‘unintentionally framed’ in terms of individual self-interest and

*...encouraged a discourse which assesses outcomes primarily in terms of economic criteria rather than a balance between social, environmental and economic considerations’ (Syme and Hatfield-Dodds 2007: 18).*

This tendency may, in some large part, explain why social assessment has been largely ignored in Australian water planning (Hamstead and Baldwin 2008).

Syme and Hatfield-Dodds further note that ‘culture as an input to water resource policy has been given little or no substantive attention’ (2007:18) in the Australian water reforms. Similar to the problem of poor definition discussed above, the term ‘cultural values’ is rarely defined in water management and there are no nationally endorsed guidelines for how best to account for ‘cultural values’ to provide consistency in water planning, indeed any NRM activity. For example, the NWI does not define the range of terms used to encompass Indigenous interests in water, including ‘social, spiritual, and customary objectives’ and water for ‘traditional cultural purposes’ (Jackson and Morrison 2007).

There is a tendency for notional ‘cultural values’ to be associated with spiritual significance, and particularly with Indigenous heritage values, where values are objectified as places, products and performances (Jackson 2006). For instance, the National Water Quality Management Strategy’s guidelines for protecting ‘environmental values’ reveal a spiritual and exclusively Indigenous focus to its interpretation of a subsidiary concept called ‘cultural value’.

It is doubtful whether the distinction made between cultural and social values has been particularly helpful in NRM processes. It appears to be based on a number of assumptions that some scholars wish to challenge, as outlined by Head *et al.* (2005). The first is the widespread view that culture refers purely to the ‘mythical and irrational parts of human life that are not amenable to rigorous research and scholarship’ (ibid: 256). The second is the idea that culture occupies a separate sphere; that it does not pervade all our lives and institutions, including scientific ones. And lastly, that culture is usually associated with a high level of difference manifested by Indigenous or ethnic minorities (ibid). All human groups ‘have culture’, create cultural forms and processes, undertake cultural practices and are socialised to think about land,

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<sup>1</sup> Referred to as amenity values in the preamble to the NWI.

water and nature in particular ways (ibid). In contrast, Strang provides a culturally rich description of values and how they are formed:

*Beliefs and values are received, inculcated and passed on through a process of socialisation that creates a culturally specific relationship with the environment. This process consists of several elements: the creation of categories, the learning of language, and the acquisition and dissemination of cultural knowledge. Each involves an interaction with the physical, social and cultural environment and contributes to the formation of individual and cultural identity (1997: 178).*

From the above we can see that the very act of creating the categories employed in NRM, environmental, economic, cultural, social, is of course greatly influenced by culture.

It is likely that explicit attention to ‘cultural values’ has arisen in contexts where Indigenous interests are significant, in an attempt to ensure that the values held by this group(s) receives due attention. Indeed many Indigenous people use this term in preference to the term ‘social value’ (Jackson 2006). Notwithstanding this arguably valid attempt at including the interests of an often neglected sector, for the sake of conceptual clarity and consistency in value inquiry, we consider that the term ‘social value’ encompasses the social and cultural values held by all communities including Indigenous ones. This study does not give explicit attention to the economic value of water to industries and communities reliant upon water sourced from the Howard catchment for employment or livelihood pursuits.

Young (2004) looks at the constituent elements of social value in his preliminary study of the Daly River (NT) and maintains that they are ‘explicitly collective and associated with what groups of people find significant’ (2004: 3). This interpretation is supported by the Burra Charter which provided one of the first Australian guidelines for assessing the conservation of places of cultural significance. The Charter defines social values as:

*Embracing the qualities for which a place has become a focus of spiritual, political, national or other cultural sentiment to a majority or minority group (cited in Young 2004: 3).*

The implication is that places must be known or experienced in some way by the public. This may be by direct visitation and experience of a place or alternatively by knowledge of a place through the media or social networks.

As for the literature on the cultural significance of water there are a growing number of Australian studies of water and its symbolic meanings. These studies employ frameworks of analysis drawn from anthropology and cultural geography (Gibbs 2006; Jackson 2006; Langton 2002; Strang 2002; Strang 2004; Toussaint *et al.* 2005), disciplines that are concerned with the documentation and analysis of society and culture. These studies reveal the role of water in the creation of cultural systems of value within Indigenous and non-Indigenous communities, although most north Australian studies have given greater attention to Indigenous landscape interpretations and attachment to water.

As mentioned above, the values one may consider to be cultural can not easily be separated from other social values associated with a landscape feature or riparian environment. The

cultural element relates to a distinctive and preferred way of life of a group or groups of people, a notion that is important to group identity.

### 2.3 Social and cultural values in NT water management

In line with national policy, the Northern Territory water resource legislation also defines a role for environmental values, although its water management system refers to them as beneficial uses. These values are increasingly referred to as important consideration in managing the Territory's largely pristine water resource base (Northern Territory Government 2005). The focus of this report is the social and cultural value of water, as defined by the 'cultural' beneficial use established by the *Water Act 2004* (NT):

*Cultural* – water to meet aesthetic, recreational and cultural needs.

In particular, the research focuses on those social and cultural values that are derived from the non-consumptive use of water, where water provides a benefit that does not generate a direct economic return. Other beneficial uses identified by the *Water Act* are mentioned because of their close connection with 'cultural' values. These are:

*Environment* – water to maintain the health of rivers, waterways, wetlands, and other ecosystems that rely on groundwater or surface water, and

*Riparian* – public rights and ownership rights to take water for homes along rivers and for cattle on properties that run along waterways.

Defined in this way, the cultural beneficial uses are of interest to any person or group who appreciates waterways and wetlands for their beauty or inspiration, as places where they might enjoy nature, swim, fish, hunt, camp or picnic, and as sites of spiritual, historical or archaeological significance. It also includes the importance of waterways and water places to Aboriginal tradition and culture, and to the beliefs, practices, identity and way-of-life of any group with an interest in the land and waterscapes of the region.

The Northern Territory's NRM plan highlights the role of cultural identity, for example, in setting the aspirational target for inland waters. The NT's Integrated Natural Resource Management Plan reads:

*By 2050, rivers, wetlands and groundwater systems are conserved, managed and rehabilitated to maintain aquatic biodiversity, ecological processes and their associated values for the livelihoods and lifestyles of Territorians and their intrinsic value (Northern Territory Government 2005: 53).*

Rivers, aquifers and aquatic ecosystems, including groundwater dependent ecosystems (GDEs) can be thought of as assets that provide a range of services to individuals, communities and society as a whole. These services are now commonly referred to as *ecosystem services* and can include breeding locations for migratory birds of international significance, fish breeding habitat, and aesthetically pleasing places. As the above target from the NT's Integrated Natural

Resource Management Plan indicates, waterways and wetlands also have an intrinsic or inherent value beyond the utility they provide to humans.

The values identified by this study include:

- Values that exist independently of direct human use (e.g. bequest value, option value);
- Water's humanitarian value as a fundamental requirement of all life;
- The aesthetic and recreational values that rivers provide to residents and domestic and international tourists;
- The conservation significance of tropical rivers and groundwater sources, particularly their promotion of biodiversity and opportunities they provide for learning about nature and/or ecology;
- Heritage value including archaeological features and associations, and
- The value of cultural group associations with rivers and water in socialisation and forming identity, underpinning religious beliefs and generating a sense of well-being and belonging.

### 3. DESCRIPTION OF THE HOWARD RIVER REGION

#### 3.1 Introduction and delineation of study area

This section will describe the key features of the Howard River region. It will first address the biophysical environment and the biodiversity values, including vegetation systems, and hydrology. It will then address current land uses, regional development trends and current and future projected demands on water resources. Lastly it will describe the socio-economic characteristics of the region, and identify the stakeholders with an interest in water resources and management.

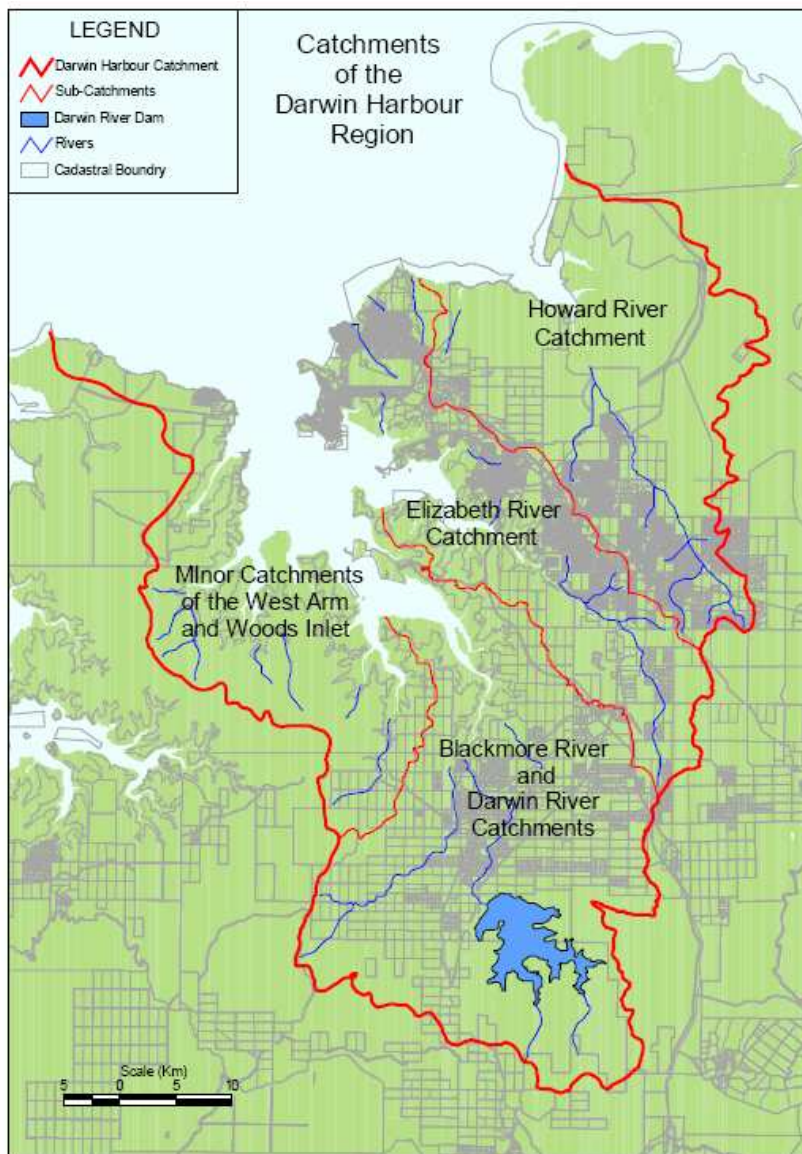


Figure 1 Map showing the catchments that make up the Darwin Harbour region. Source: Haig and Townsend (2003)

The Darwin Harbour catchment can be subdivided into four sub-catchments: Howard River, Elizabeth River, Blackmore River and the minor creeks and streams of the West Arm and Woods Inlet (Haig and Townsend 2003). The Howard region, for the purpose of this research, was defined in accordance with a map provided by NRETAS in the early stages of the research. The study area is shown in Figure 2.

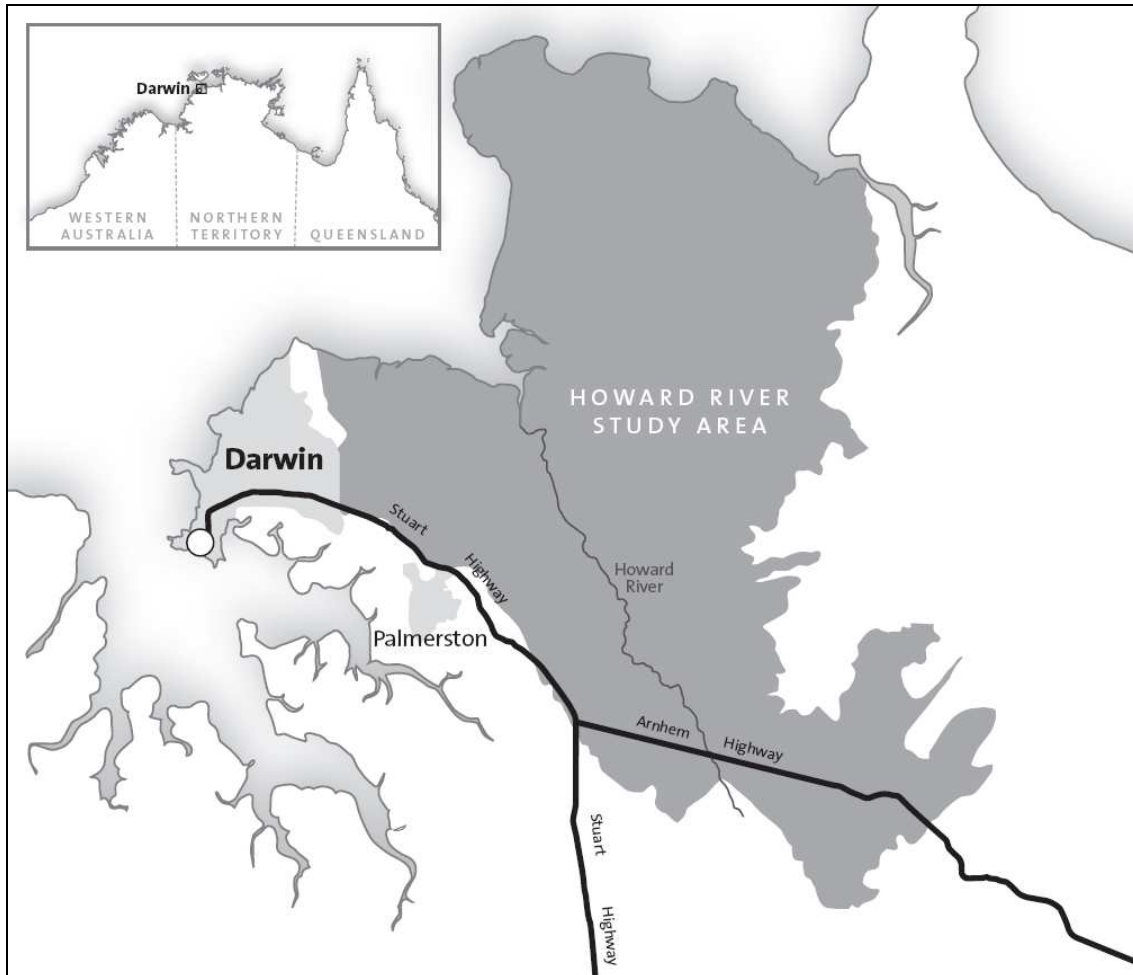


Figure 2 Map showing the Howard River study region shaded grey.

Upon the commencement of this study in 2007, NRETAS had not finalised the delineation of the Howard water planning area. After discussion with the lead water planner at NRETAS, the research team selected the area shown above in grey. The area extends further than the surface water catchment of the Howard River to include the main subsurface Dolomite aquifer as shown below in Figure 3. It extends through the eastern portion of the Darwin Rural Water Control District which is shown in Figure 4. This Water Control District was declared in 1999 for the purpose of groundwater and surface water management in the greater Darwin area. Both Fogg Dam and Harrison Dam were excised from the original map and therefore have not been considered in the study.



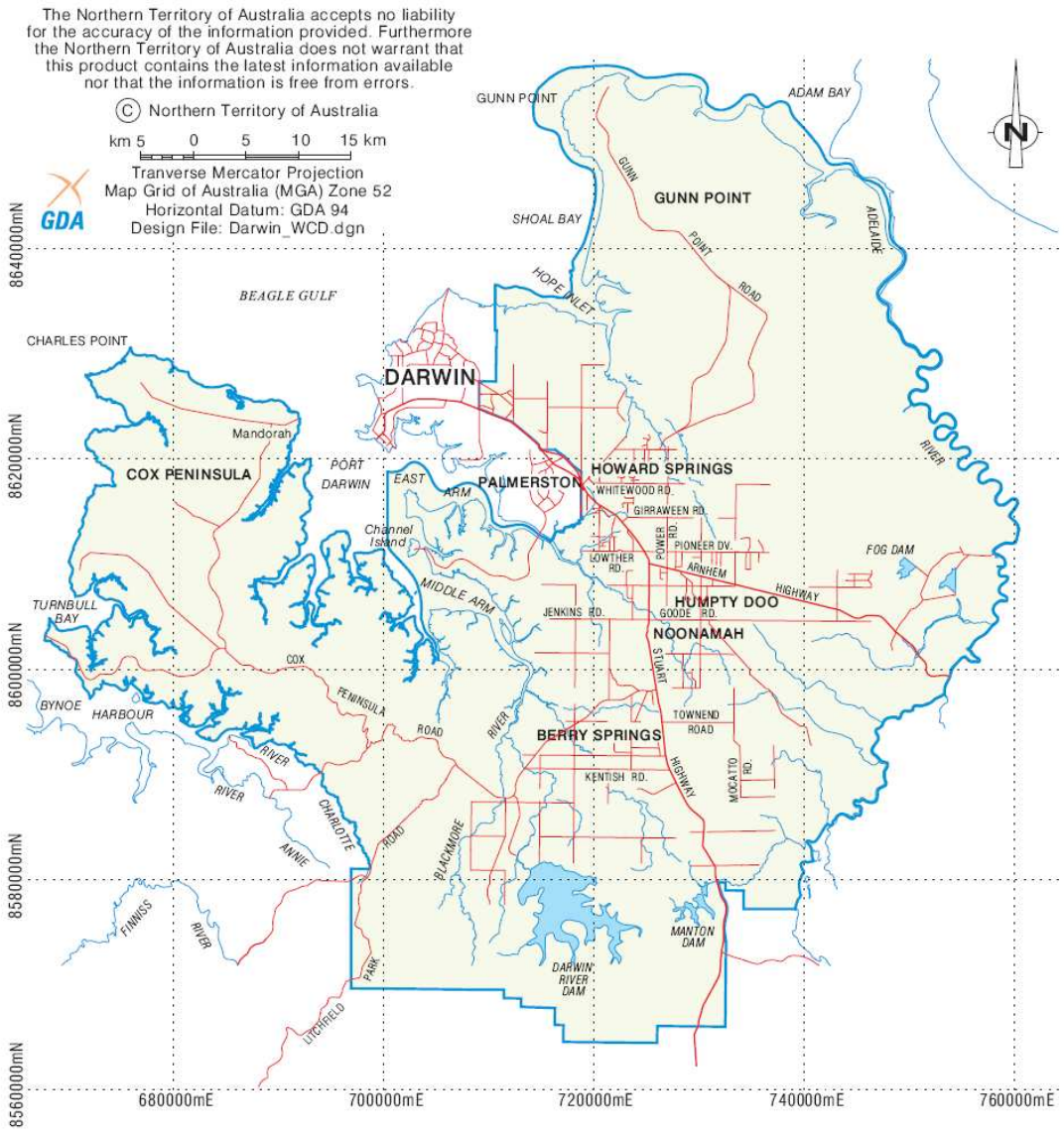
## DESCRIPTION OF THE HOWARD RIVER REGION



Figure 3 Main dolomitic aquifer in the Howard River study area, shown in blue. Source: NRETAS (2008)

The study area reaches from the outskirts of Darwin's suburbs at Knuckey Lagoons to the Adelaide River floodplain to the east. Extending northwards from the Arnhem Highway, it includes McMinns and Lambells Lagoons to the south and the coastal reaches of Gunn Point to the north. The major settlements and features of the region, which falls entirely within the Litchfield Shire, include Humpty Doo, Howard Springs, Girraween, Lambells Lagoon and Koolpinyah Station. The extent of the Litchfield Shire is shown in Figure 5 below.

SOCIAL AND CULTURAL VALUES OF WATER IN THE HOWARD RIVER REGION



- Notes :
1. See Northern Territory Government Gazette No. G21 dated 2 June 1999 for declaration notice and technical description of the Darwin Rural Water Control District.
  2. Darwin Rural Water Control District declared for surface water and groundwater management purposes.
  3. Northern Territory Government Gazette No. G21 dated 2 June 1999 revokes the Darwin Rural Water Control District as declared in the Northern Territory Government Gazette No. S35 dated 30 June 1992.
  4. This plan prepared in August 1999 supercedes all previous plans
  5. Converted to GDA Datum August 2002.



**Northern Territory Government**  
 Department of Infrastructure, Planning and Environment

**DARWIN RURAL WATER CONTROL DISTRICT**

Figure 4 The Darwin Rural Water Control District. Source: NRETAS (2002)

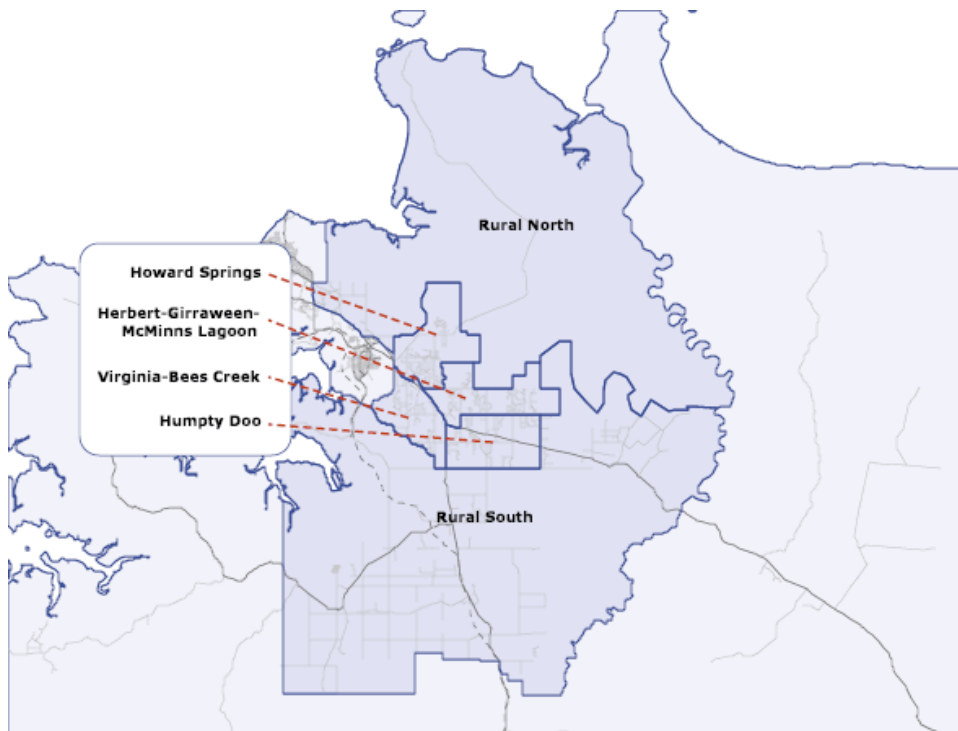


Figure 5 Litchfield Shire Council Boundary showing sub-areas. Source: NT Online (2008)

The region is characterised by a mix of land tenures, including leasehold allowing for pastoral activities, mineral extraction and exploration and defence purposes, and freehold residential and horticultural properties. Land use is regulated under the zoning system of the Northern Territory under the NT Planning Scheme and other laws such as the *Mining Act 1980* (NT). These land uses have particular water requirements which are regulated by the *Water Act 2004* (NT), and in the case of mining, by the Northern Territory's *Mining Act 1980* (NT). Other land uses, such as conservation, are regulated by NT conservation statutes. Land use and resource governance arrangements will be further discussed in below.

## 3.2 Biophysical characteristics

### 3.2.1 Landscape features, vegetation systems and biodiversity values

The main vegetation types in the region include: open savanna woodlands dominated by Darwin Woolly-butt, Stringy-bark and a *Sorghum* grassland understory; woodland of Darwin Woolly-butt, Stringy-bark, Smooth-stemmed bloodwood (*Eucalyptus bleeseri*) and *Sorghum*; monsoon vine forest, mangroves and samphire (saline tidal flats with scattered chenopod low shrubland) (Wightman and Andrews 1989; Wilson *et al.* 1990). Notable landscape features include spring-fed rainforest patches, ephemeral and perennial perched lagoons, broad drainage channels, sand sheets, rivers and floodplains.

While the region's natural areas are predominantly eucalypt woodland, dominated by *Eucalyptus miniata* and *Eucalyptus tetradonta*, there is considerable plant diversity with 1,259 species (including 128 introduced species) recorded within the boundaries of the Litchfield Shire. Three species; *Typhonium taylori*, *Cynanchum leibianum* (as seen in Figure 6) and *Utricularia sp. Red* are believed to be endemic to the Shire, which means they are found nowhere else in the world (Holmes *et al.* 2005). They do not have common names as they are both relatively unknown and rarely seen.



Figure 6 *Cynanchum leibianum* © Joyce Stobbo

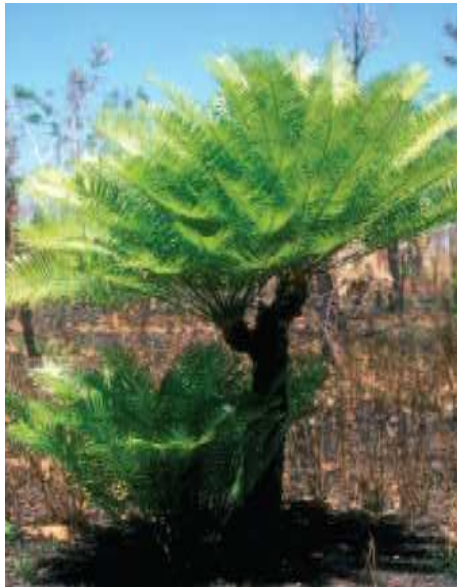


Figure 7 *Cycas armstrongii* © NT Herbarium

Two threatened species; a cycad known as *Cycas armstrongii* (Figure 7) and a palm called *Ptychosperma macarthurii* (Figure 8), although not endemic to the Shire, have a considerable portion of their range within the Shire.



Figure 8 *Ptychosperma macarthurii* © NT Herbarium

## DESCRIPTION OF THE HOWARD RIVER REGION

A further 117 species known from Litchfield Shire are either found only in the NT or nowhere else in Australia (but occur in other countries) (Holmes *et al.* 2005).

Wetland areas, including lagoons and swamps supporting *Melaleuca* species and coastal mangrove systems, are also predominant features within the Howard River region (see Figure 9 below). Rainforests, riparian vegetation (vegetation near waterways) and wetlands provide key habitats and watering points that support wildlife throughout the year. Monsoon vine forests, such as those at Holmes Jungle and Howard Springs, are associated with permanent creeks and springs. Research has shown that these monsoon vine forests, or rainforest patches, are 'island' habitats that provide important links in the preservation of flora and fauna biodiversity across the Top End (Holmes *et al.* 2005).



Figure 9 Coastal mangrove system on the Howard River

These rainforest patches support a dense concentration and diversity of plants despite their small and scattered nature; contributing 13% of the Northern Territory's known plant species (Liddle *et al.* 1994). Notable amongst these species are the yams *Dioscorea bulbifera* and *Dioscoera transversa* which are highly regraded by Larrakia as a food source (Wightman and Andrews 1989).

Many of these species are rare and found nowhere else but in Northern Territory rainforests. Large numbers of birds, mammals and reptiles breed and seek refuge in the dense vegetation that offers protection from heat and predators. Recent studies show that many patches are severely damaged by feral animals, weed invasion and contemporary fire regimes (Liddle *et al.* 2001; Liddle *et al.* 1992). For example, it has been suggested that the current decline of

*Ptychosperma bleeseri*<sup>2</sup> (Darwin Palm) populations in the Howard region might be in response to wildfire and feral animal activity (Liddle *et al.* 2006).



Figure 10 *Ptychosperma bleeseri* – Darwin Palm

The small size of most rainforest patches and their scattered distribution has a number of implications for their long term conservation (Wightman and Andrews 1989). Birds and fruit bats are vital for seed dispersal and pollination, so conserving habitat corridors, such as along creek lines and rivers, which connected isolated patches, is necessary for keeping populations and habitat size viable. The presence of native vegetation surrounding rainforests helps to protect them from fire and invading weeds.



Figure 11 Howard River south of Power Road

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<sup>2</sup> There has been some debate over the taxonomic status of this palm and is variously called *Ptychosperma bleeseri* and *Ptychosperma macarthurii*

Riparian vegetation, such as that found along the banks of the Howard River (see Figure 11), is important to keep the waterway healthy and to prevent erosion. Riparian areas also provide key habitat corridors that allow for the movement of vertebrate fauna. Wetlands also have flora quite distinct from the dominant woodland vegetation, and there is a corresponding distinctive fauna. Within the Howard region there are many types of wetlands, including permanent open water-bodies (such as lagoons) and seasonal swamps and floodplain areas with paperbarks or sedges (see Figures 12 and 13). Mangroves, beaches and salt marshes are also tidal wetlands. There are also some terrestrial habitats that are occasionally inundated, including sandy heathlands and pandanus woodlands.



Figure 12 Paperbark swamp

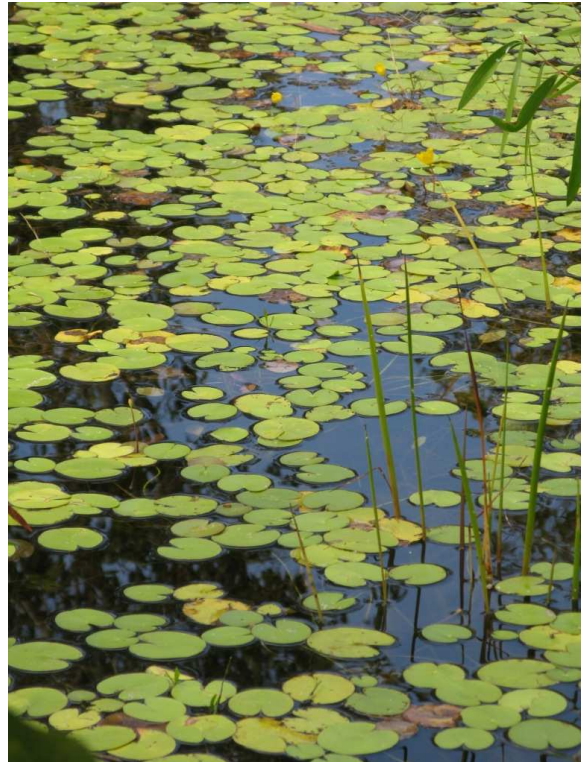


Figure 13 Swamp with lilies and sedges

The lagoons and billabongs support a wide range of wading birds. A significant proportion of the 132 bird species recorded at Fogg Dam are waterbirds, for example the Royal Spoonbill, Jacana, Jabiru and Egrets (Fogg Dam Friends 2006). Frogs, water pythons (*Liasis fuscus*), slatey-grey snakes (*Stegonotus cucullatus*) and keelbacks (*Tropidonophis mairii*) are common in the Fogg Dam area (Brown 2002), and are likely to be prevalent on the floodplain areas of the Howard River. One mammal, the Dusky Rat (*Rattus colletti*) has been identified as a floodplain specialist (Madsen *et al.* 2006) with a huge biomass, of 4.7 t km<sup>-2</sup> recorded for the Adelaide River floodplain. Wetlands also provide essential habitat for fish, turtles, crabs, prawns and other crustaceans, macro invertebrates and aquatic plants (Whitehead and Chatto 1996). The supra-littoral wetlands<sup>3</sup> on the floodplains of rivers draining into Shoal Bay have been identified as critical habitat for juvenile Barramundi.

<sup>3</sup> Guidelines for vegetation retention in the N.T. have specific provisions for these environments, and provide for retention of adequate buffers around them.

The Howard Region contains important sites used annually as staging points for migratory birds. These areas are subject to international agreements that aim to protect migratory birds in the East Asian Australasian Flyway. The *Partnership for the Conservation of Migratory Waterbirds and the Sustainable Use of their Habitats in the East Asian – Australasian Flyway* (Flyway Partnership), which was launched in 2006, represents a renewed effort to conserve migratory waterbirds and their habitats in the flyway.

Further, Australia is a partner in three bilateral agreements; JAMBA (Japan/Australia Migratory Bird Agreement), CAMBA (China/Australia Migratory Bird Agreement) and ROKAMBA (Republic of Korea/Australia Migratory Bird Agreement). In addition to bilateral agreements there are two multilateral agreements which are relevant to Flyway conservation of waders. The Ramsar Convention (Convention on Wetlands of International Importance especially as Waterfowl Habitat) promotes wetland conservation, and the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) provides a multinational framework for the conservation of migratory species. Key nesting sites for both migratory and local bird populations exist in and around the Shoal Bay area.

The Shoal Bay and Micket Creek wetland area (labelled ‘Shoal Bay’ in Figure 4) has been listed as a nationally important wetland based on two criteria:

1. It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex, and
2. The wetland is of outstanding historical or cultural significance.

There is educational value in the area, given its proximity to Darwin. The area has been identified as being of major recreational value to Darwin and also as a major food gathering area for Aboriginal people (Higson 1995).

The Micket Creek area is a significant bird habitat with over 200 species of birds recorded. It is also a dry season refuge for waterfowl and birds of prey (Australian Heritage Commission 1991). High numbers of migratory shorebirds regularly use the areas' mudflats with counts of more than 15,000 waders. The estuary creeks provide a significant nursery for Barramundi (*Lates calcarifer*). Twenty-five migratory birds, listed on international agreements with Japan and China (JAMBA/CAMBA), have been recorded from intertidal feeding sites, saline flats and local sewage ponds. The most common of these birds are the Little Whimbrel *Numenius minutus*, Greenshank *Tringa nebularia*, Sharp-tailed Sandpiper *Calidris acuminata*, Bar-tailed Godwit *Limosa lapponica*, Black-tailed Godwit *Limosa limosa*, Great Knot *Calidris tenuirostris*, Large Sand Plover *Charadrius leschenaultii*, Mongolian Plover *Charadrius mongolus* and Red-necked Stint *Calidris ruficollis*. The area is also notable for the nationally endangered Little Tern *Sterna albifrons* and two other uncommon species, the Eastern Grass Owl *Tyto longimembris* and Peregrine Falcon *Falco peregrinus*; and species considered to need protection, the Radjah Shelduck *Tadorna radjah*, Orange-footed Scrub Fowl *Megapodius reinwardt*, Bush Thick-knee *Burhinus magnirostris*, Yellow Chat *Epthianura albifrons* and the Australian Bustard *Ardeotis australis*. Sixteen further bird species are regionally uncommon and the nationally vulnerable Red Goshawk *Erythrotriorchis radiatus* is an occasional visitor to the area (AHC 1991).



Knuckey Lagoons and McMinns Lagoon have been listed in the Directory of Important Wetlands in Australia as a supplementary site for the NT, as part of the Darwin Peninsula Swamps (McMinns Lagoon Reserve Association 1999). Whilst not considered nationally important in their own right, as part of a supplementary site the Reserve supports and contributes to the values of other nationally important wetlands across the Top End (Parks and Wildlife Commission of the Northern Territory 2000).

### 3.2.2 Lagoons and other wetlands and waterbodies

The study area is characterised by extensive drainage systems, including the Howard River and its tributaries, springs, swamps, floodplain areas and lagoons. Surface water features include lakes, lagoons, wetlands and streams and can have multiple sources of water. These include direct rainfall, runoff from surrounding areas and groundwater. There are therefore important interactions between surface water features and underlying aquifers and water can flow between the ground and surface in multiple ways.

Streams can, for example, interact with groundwater systems by:

1. Gaining groundwater inflow;
2. Losing water to the underlying aquifer, or
3. Both by variably gaining and losing depending on the time of year.

An aquifer is the term used to describe an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted. Aquifers can occur at various depths.

A common misconception is that groundwater exists in underground rivers (e.g. caves where water flows freely underground). This is only sometimes true in eroded limestone areas known as karst topography which make up only a small percentage of earth's area. Limestone areas are found in the Katherine Water Control District, for example. It is more usual to find pore spaces of rocks in the subsurface that are simply saturated with water — like a sponge — which can be pumped out and used for agricultural, industrial or domestic water uses.

Lagoons, lakes and springs can also gain from or lose to the underlying aquifer. A through-flow situation can occur where parts of the lake receive groundwater and other parts lose water. Some wetlands can form where groundwater discharges to the land surface, and these tend to occur at breaks in slope or topographic depressions (Winter *et al.* 1998). However, other wetlands such as bogs are surface water dominated and arise where rapid drainage of water from the land surface is prevented.

The flow of water between a surface water feature and the underlying aquifer is largely controlled by:

- The difference between the surface water level and the groundwater level. If the stream level is higher than the groundwater level measured within the aquifer, then the stream has the potential to lose water to the aquifer, and/or

- The geological material separating the aquifer from the surface water feature. If a river has a coarse gravel bed, this would allow the easy movement of water between the river and the underlying aquifer. However, if the base of a lagoon consists of a thick layer of mud, organic material or clay, this is likely to restrict movement of water (Schult and Welch 2006).

Given the above, the surface water features of the Howard catchment, such as the Howard River and streams, lagoons, springs and swamp areas may be impacted upon differently from ground water extraction.

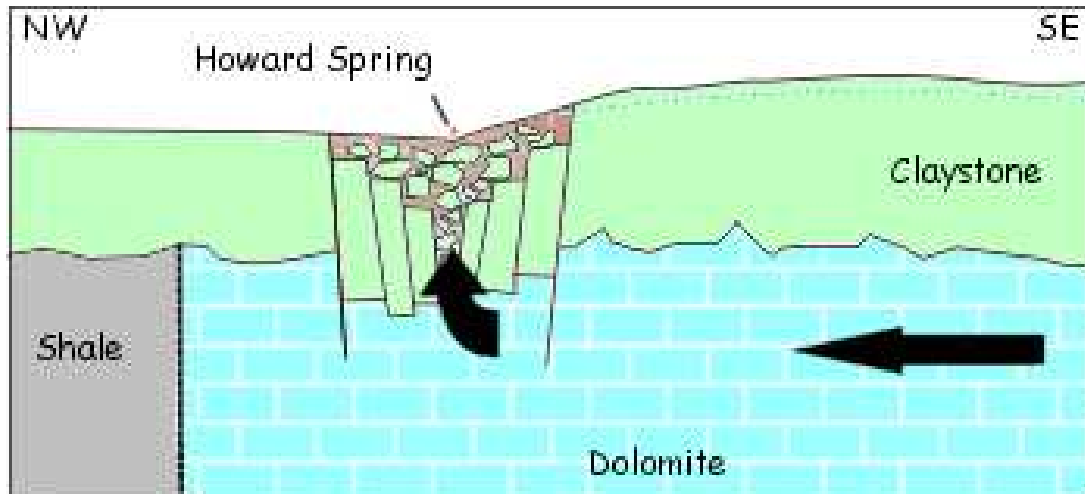


Figure 14 Diagram showing the connection between the Dolomite aquifer and Howard Spring. Source: Haig and Townsend (2003)

Perennial springs, which are fed from deeper dolomite aquifers, can be found at Howard Springs (Figure 14) while chemical analysis of the spring discharges at Black Jungle Swamp has shown that the source of the spring discharge is from the shallow, Cretaceous aquifer (Haig and Townsend 2003).

However, by the end of the dry season there is a change in water chemistry that indicates the discharge water at Black Jungle Swamp is sourced from both the shallow aquifer and from the deeper dolomite aquifer (Haig and Townsend 2003).

Connections between groundwater and surface water are a feature of tropical savanna environments and differ between the wet and dry seasons (Figures 15 and 16).

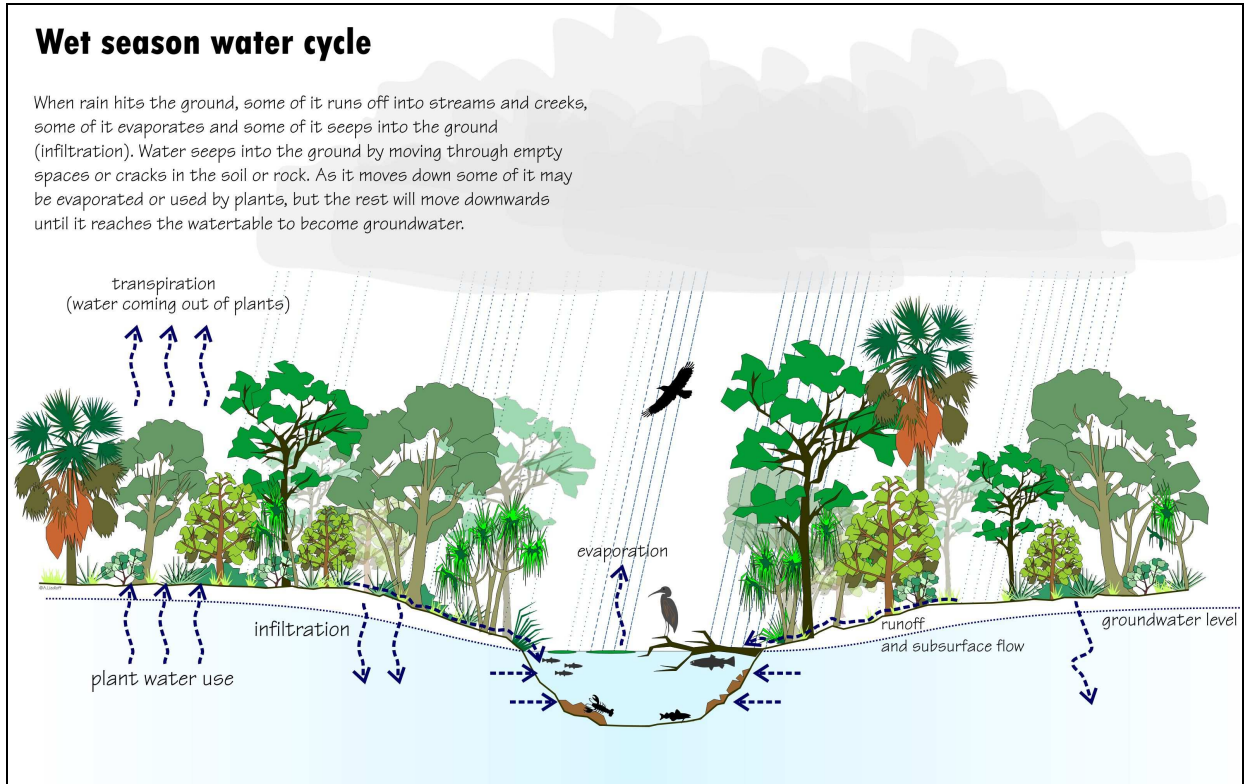


Figure 15 The Wet season water cycle showing infiltration and filling of the aquifer. Diagram by Adam Liedloff, CSIRO

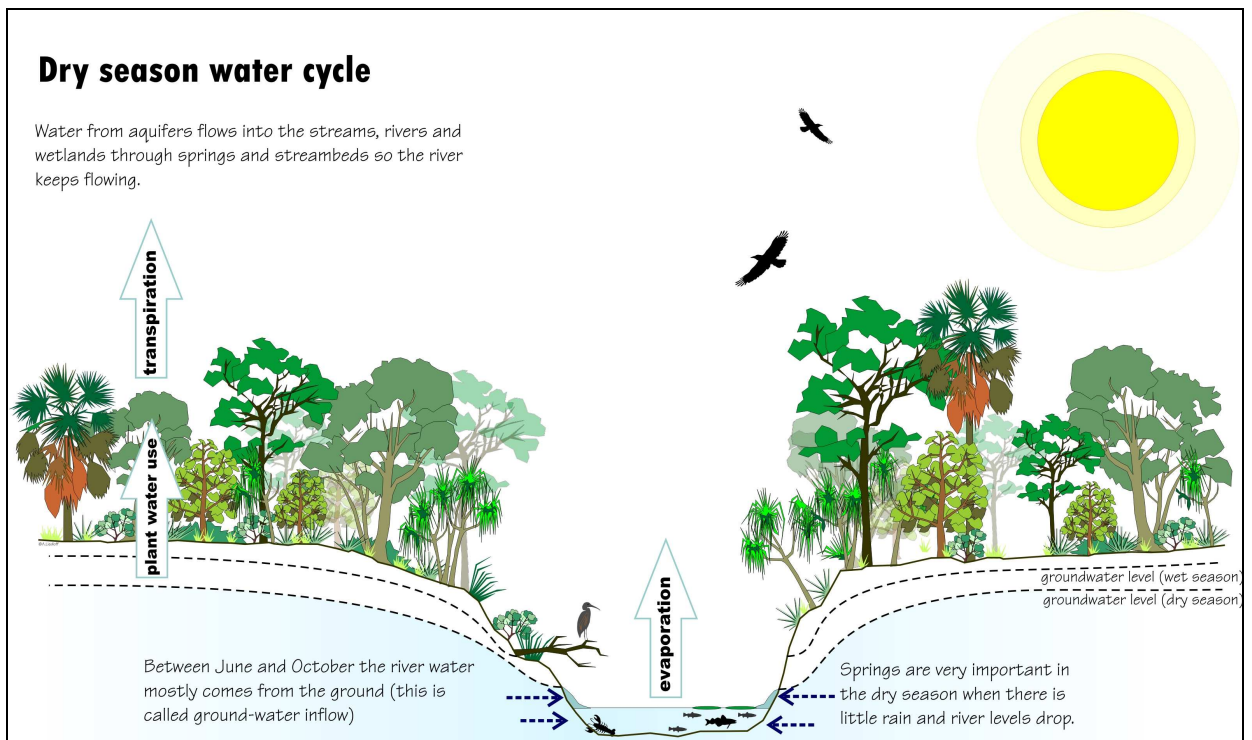


Figure 16 The Dry season water cycle showing the importance of springs and groundwater inflow to maintaining river flow. Diagram by Adam Liedloff, CSIRO

There are more than 130 lagoons in the study area which, during the wet season, cover close to 1500 ha (Schult and Welch 2006). However, very little is known about the factors that control their water levels or why some are perennial and others are seasonal. While direct rainfall probably contributes a large proportion of annual recharge to lagoons in the region, there is a substantial shortfall between rainfall and evaporation<sup>4</sup>, meaning that the lagoons must also be recharged by rainfall runoff from the surrounding catchment and groundwater. The relative contribution of recharge via runoff depends on a number of factors, such as the size of the catchment, development within the catchment (e.g. modified drainage patterns) and soil infiltration capacity (i.e. soils with low infiltration capacity produce high runoff). However at the end of the dry season, there are lagoons that persist after the surrounding region has been drained of shallow groundwater. This phenomenon is often seen as the formation of a “perched lagoon” in areas where depressions in the ground surface has caused the ponding of wet season rainfall (see Figure 17 below).

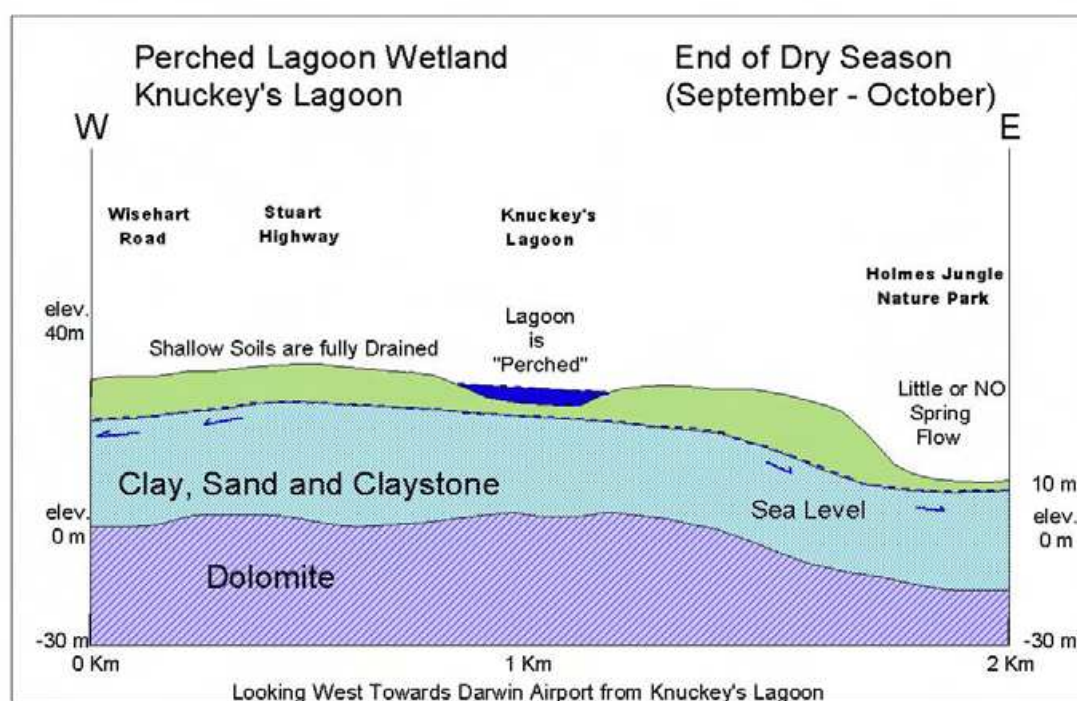


Figure 17 Cross-sectional schematic diagram showing 'Knuckey's Lagoon' perched at the end of the dry season. Source: Haig and Townsend (2003)

The bottom surface of the wetland consists of a layer of organic mud that acts as a semi-impermeable boundary, slowing the drainage of water out of the lagoon. The lagoons evaporate at a rate of approximately 2 metres per year, however there can be high variability in evaporation between lagoons as shown in Figure 18. In comparison, the regional water table drops from 8 to 10 metres from the peak of the wet season to the end of the dry season. As a result, the shallow depressions, which form the “perched lagoons”, are left above the water table (Schult and Welch 2006).

The rate and timing at which the groundwater level falls is likely to depend on local topographical features (e.g. slope, elevation) and the ability of the aquifer to transmit water

<sup>4</sup> Mean annual rainfall = 1.7 m, Mean annual pan evaporation = 2.6 m, Darwin Airport.

(e.g. porosity of soil/rock), which may in turn affect water levels of lagoons. It should be noted however that water levels in the shallow aquifer are highly variable during the wet season (D. Yinfoo, pers. comm.). There are numerous examples of this ‘perched lagoon’ phenomenon throughout the Howard River region. Some of the better-known occurrences are the lagoons known as McMinns, Lambells, Girraween and Knuckey<sup>5</sup>.

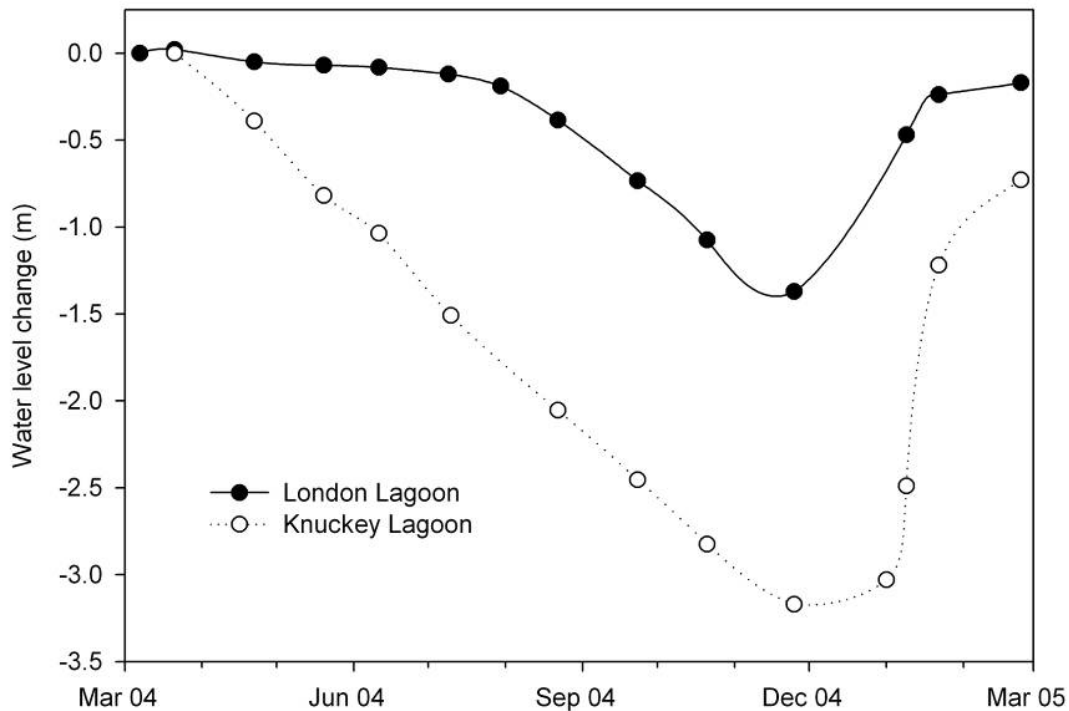


Figure 18 Water level changes during the dry season of 2004 in two contrasting lagoons: London and Knuckey's Lagoon which represent the two extremes of water level measured in the Study of Fifteen Lagoons by Schult and Welsh (2006)

In summary, as many of the lagoons in the Howard region are perched, once the groundwater table recedes with the onset of the dry season, the water bodies no longer recharge and continue to lose water to evaporation. If the water table recedes earlier in the dry season, the water body will lose water to evaporation without being recharged for a greater part of the year. In some cases this may lead to an early drop in lagoon water levels and a change in the ability of the wetland system to provide ecological services.

There is anecdotal evidence that surface water extraction is occurring from lagoons in the Howard region. Currently no permits have been issued by the NT Government for surface water extraction from lagoons in the Howard region. A permit for water extraction would be required if the water was to be used for commercial purposes and/or for watering areas greater than half a hectare (including household gardens). Under the current *Water Act 2004* (NT) landholders who either own land or who live immediately adjacent to a waterway have the right to take groundwater and surface water for domestic purposes, wandering stock, and for domestic

<sup>5</sup> Domestic water extraction from lagoons is not licensed and there is limited knowledge on current or historical unlicensed lagoon water extraction on few lagoons Lamche, G. 2008. *The Health of the Darwin Region Lagoons (Northern Territory): Trials of nationally proposed wetland condition indicators*. Aquatic Health Unit, Department of Natural Resources, Environment and the Arts, Darwin..

gardens of up to 0.5 hectares without a licence. There are currently no limits on the amount of water that can be extracted from the river or lagoons for these purposes. As there is no requirement for either a permit or a meter on bores pumping surface water from the river or lagoons, current surface water extraction is unknown.

Water licenses are also available for construction and road works, which may permit the pumping of water from a nearby lagoon, billabong, creek, river or bore over relatively short time periods. Those licenses require that pumping data be returned to the NT Government. No works requiring such a license have been undertaken in the study area over the last few years.

### 3.2.3 Hydrology

The average annual rainfall measured at Darwin Airport is 1,700 mm. The majority (80%) of this rainfall occurs between December and March. The dry season period extends from May to October, when little or no rainfall is recorded. Stream flows correspond with rainfall activity, and are seasonal in nature. Typically, flows commence in December and cease in June. With the exception of deep pools and occasional springs, the majority of waterways dry out completely (Padovan 2003).

#### *Aquifers in the Darwin region*

Within the study area, the Howard East Borefield is located within the Howard Groundwater System. The groundwater system comprises three aquifers:

- The uppermost aquifer developed in the lateritised profile of the Cretaceous sediments;
- An intervening aquifer developed in the sandstone unit at the base of the Cretaceous Darwin Member, and
- An aquifer developed in the weathered top of the Lower Proterozoic Koolpinyah Dolomite - this aquifer is the focus for most water source developments in the area because it has the potential to provide high yields and good quality water from individual bores.

The Koolpinyah Dolomite aquifer is semi-unconfined over the Howard East Borefield and confined to the north of Gunn Point Road by the overlying Cretaceous sediments. Dry season groundwater movement in the weathered Koolpinyah Dolomite, is directed towards the major discharge zones such as Howard Springs and Melacca Creek and a number of effluent streams in the region. If the water table within the shallow aquifer drops below the laterite subsoil layer, lateral flow ceases and water only moves vertically to lower aquifers (Schult and Welch 2006). Following the cycle of natural drainage and notwithstanding the extraction of groundwater, the aquifer system in the study region (especially the shallow aquifer) is fully recharged each wet season. During the wet season, water levels often reach the ground surface and then gradually decline during the dry season as water is lost to the deeper aquifer, transpiration by vegetation and discharge to streams.

Bore yields from the Koolpinyah Dolomite vary according to local lithological variations however investigations have since delineated a borefield capable of supplying 60ML per day.

The yield from the fully developed borefield in the McMinns/Howard East area is also subject to further consideration. The process by which this will be determined will be mapped under the proposed Darwin Region Water Allocation Plan. The plan considers the resource on a whole of catchment scale and will guide a public process of allocating available resources to designated users including public water supply (Power and Water Corporation 31/10/08).

In a study of the water balance of the tropical woodland ecosystem in the Howard River catchment it was discovered that the small patches of rainforest and Melaleuca swamp forests are sustained by groundwater through-flow from recharge areas dominated by Eucalypt savanna – the dominant vegetation type of the Howard catchment (see Figure 19 below). However increased development in the area since 1980 has resulted in a drop in end of dry season groundwater levels compared to groundwater levels not subject to the same intensity land use (Liddle *et al.* 2006).

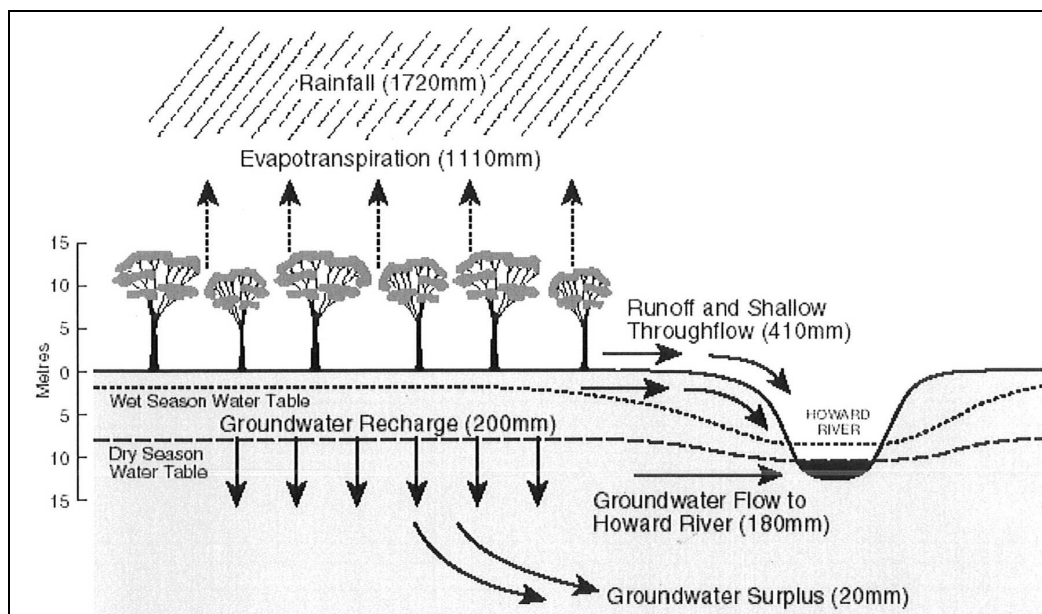


Figure 19 Annual water balance for the eucalypt savanna ecosystem. Source: Cook *et al.* (1998)

As an example, the endangered palm *Ptychosperma macarthurii* – of common name Darwin Palm – occurs in monsoonal rainforest patches in the Howard catchment. Figure 20 shows the distribution of rainforest patches within the Darwin region that support Darwin Palm populations. These patches include Bankers Jungle (BJ) on Koolpinyah Station, Whitewood Road (WR) rainforest, Daminmin (D) rainforest (Wulna managed) and Black Creek (BC), Crocodile Creek (CC) and Black Jungle (J3) within the Black Jungle Conservation Reserve, and each is dependent upon permanent sources of moisture (Liddle *et al.* 2006).

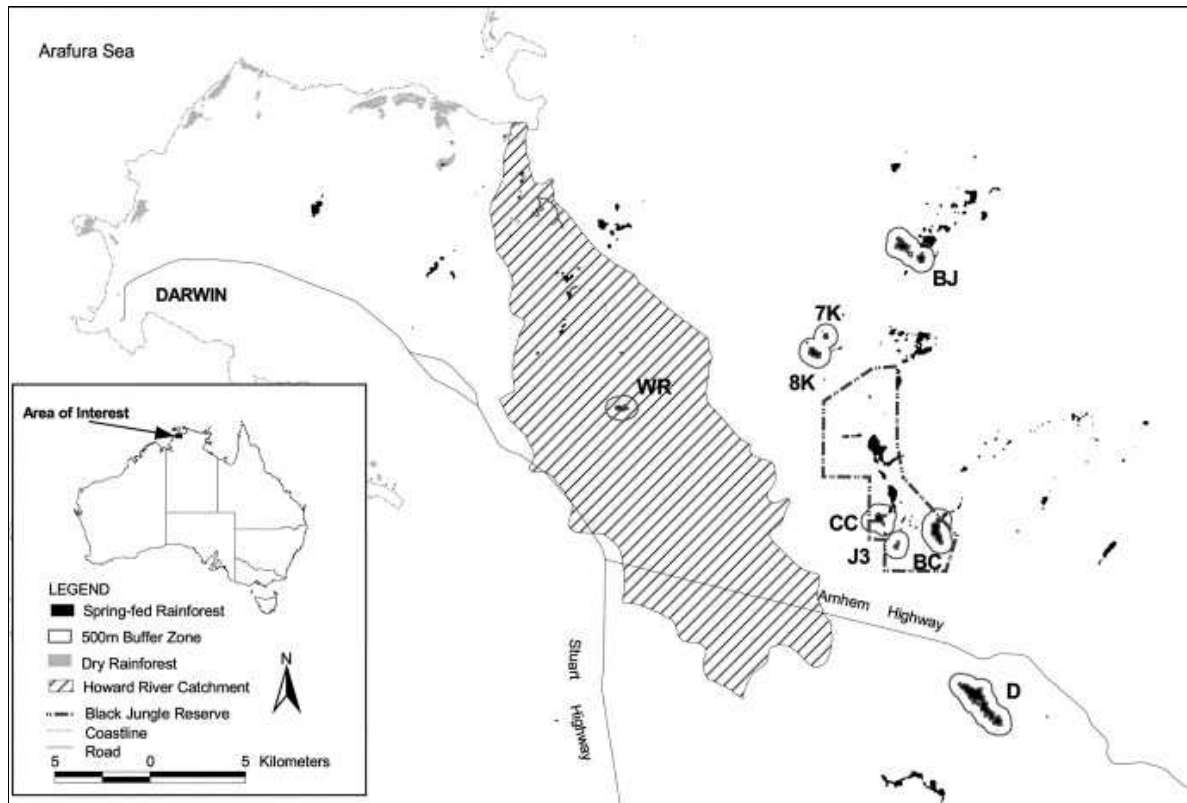


Figure 20 Distribution of rainforest patches containing populations of *Ptychosperma macarthurii*. Source: Liddle *et al.* (2006)

According to predictions by Liddle *et al.* (2006), who modelled groundwater drawdown due to rural development after a run of three consecutive average wet seasons, the water table at Whitewood Road rainforest is lowered an additional 3m, by the end of each dry season, because of existing rural development (drawn from Haig and Townsend 2003; See Figure 22). However, the impact of development and drawdown of the water table due to bore use seems quite localised. Using the same modelling scenario the predicted additional drawdown at the other rainforests in the Howard Catchment supporting the Darwin Palm located away from rural development floodplain is only <0.1m.

The number of adult palms at Whitewood Rd decreased by 60% between 1990 and 2000 (Liddle *et al.* 2006). This has been associated with occurrence of extensive wildfires thought to be exacerbated by the drying of the rainforest patch earlier in the dry season from increased drawing of water from bores in the area (see Figure 21). While major fires tended to correspond at times when seasonal rainfall has dropped, suggesting that the rainforests might dry out and become particularly vulnerable to fire in periods of lower than average rainfall. More extreme and lower rainfall periods in the 1950s and 60s did not result in the devastation of palms (Liddle *et al.* 2006). Also, the population collapse at Whitewood Rd that occurred in the 1990s has not been observed at other populations, indicating that the decline was not simply a result of regional rainfall (Liddle *et al.* 2006). According to Liddle *et al.* (2006) the vulnerability of the palms to fire appears to reflect a drying out of the habitat as a result of an underlying change in hydrology.



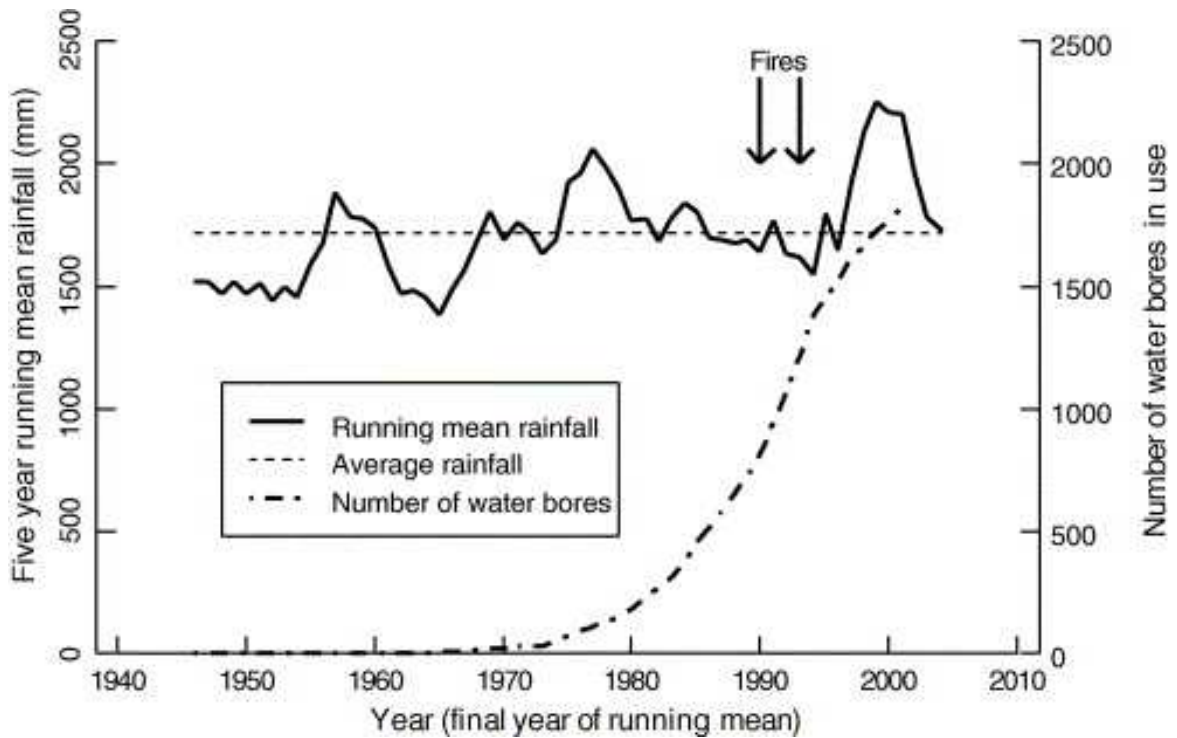


Figure 21 The potential relationship between the number of water bores in use in the Darwin rural area, rainfall and occurrence of fires in spring-fed rainforest at Whitewood Road. Source: Liddle *et al.* (2006)

Figure 22 shows the amount of groundwater drawdown in metres, at various points across McMinns dolomite aquifer at the end of the dry season. According to Haig and Townsend (2003) the Figure ‘is a plot of drawdown contours from the combined effects of the domestic, agricultural and municipal bores in the area around McMinns and Girraween Lagoons. For the analysis, the level of rural pumping and the recharge scenario were estimated. The situation shown accounts for a recharge scenario which represents three consecutive average seasons (D.Yin Foo pers. comm).

Figure 23 shows the approximate distribution of bores across the aquifer and their average annual pumping rates. In more developed areas where a high concentration of bores is present, such as the rural areas of Girraween, Humpty Doo and McMinns Lagoon, the groundwater levels at the end of the dry season have lowered more than surrounding areas – to between 6 and 10 metres each dry over the last 20 years. This localised lowering of the groundwater level at the end of the dry season is due to water extraction (D.Yin Foo pers. comm. 15/5/08).

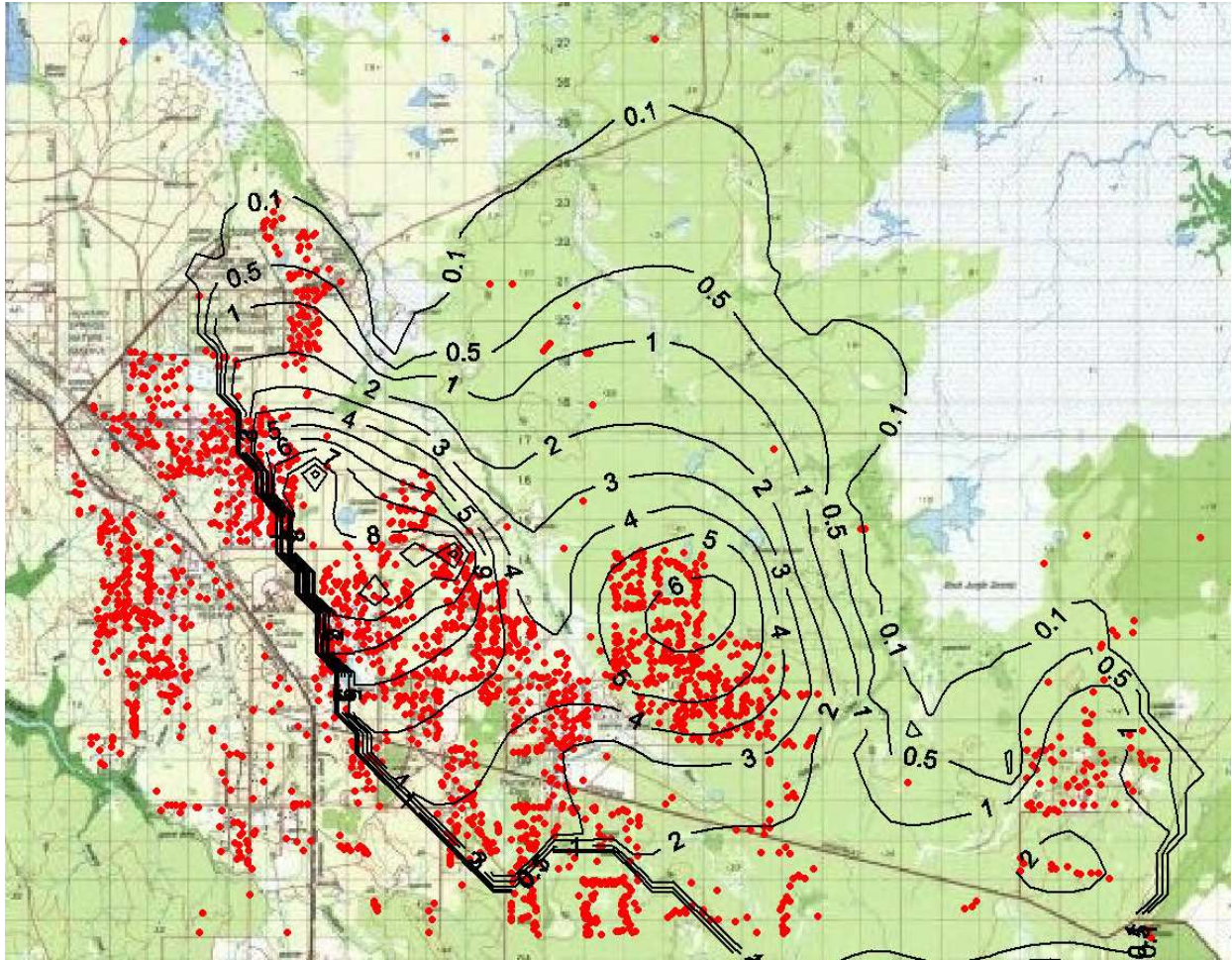


Figure 22 Map of Humpty-Doo, Howard Springs and Lambells Lagoon area showing location of drilled bores (in red) and localised drawdown on the aquifer (in metres) over the course of a Dry season. Source: Haig and Townsend (2003)

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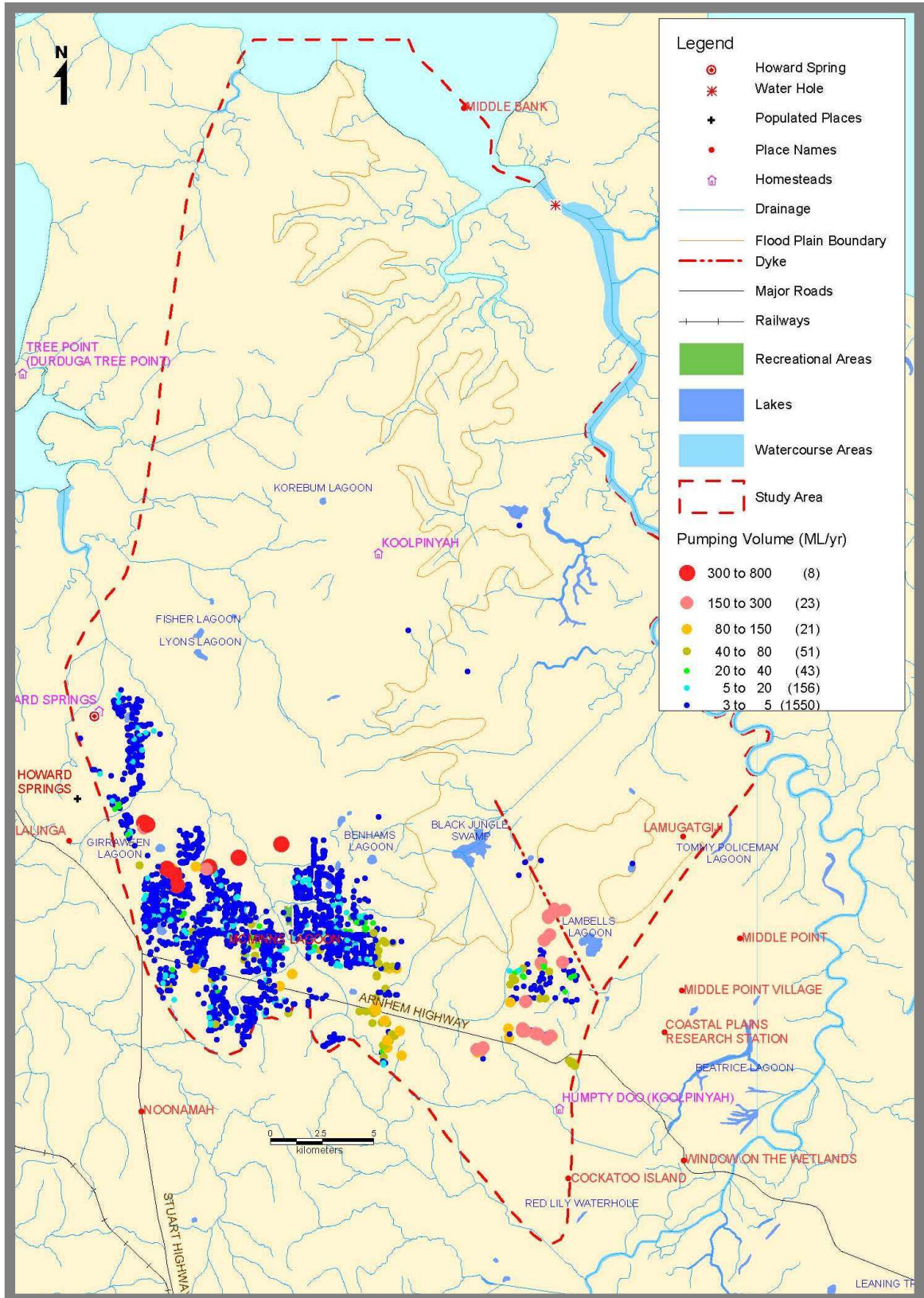


Figure 23 Map of the Dolomite aquifer and location of drilled bores of varied pumping volume. Source: NRETAS (2008)

### 3.3 Regional development context

#### 3.3.1 Population

According to the 2006 ABS Census data, approximately 12,000 people live within the study area (ABS 2007)<sup>6</sup>. The population of Litchfield Shire is expected to at least double, increasing from 15,400 in 1999 to between 29,400 and 59,500 in 2021 (ABS 2001). This is a result of several factors including the desire for rural living, expansion of the Darwin and Palmerston populations resulting in increased demand for land and property, subdivision of current bush blocks into higher density living, land releases offering town amenities such as connection to town water and the growth of the horticultural sector. The intensification of land use and increased diversity of such land use has accompanied population growth.

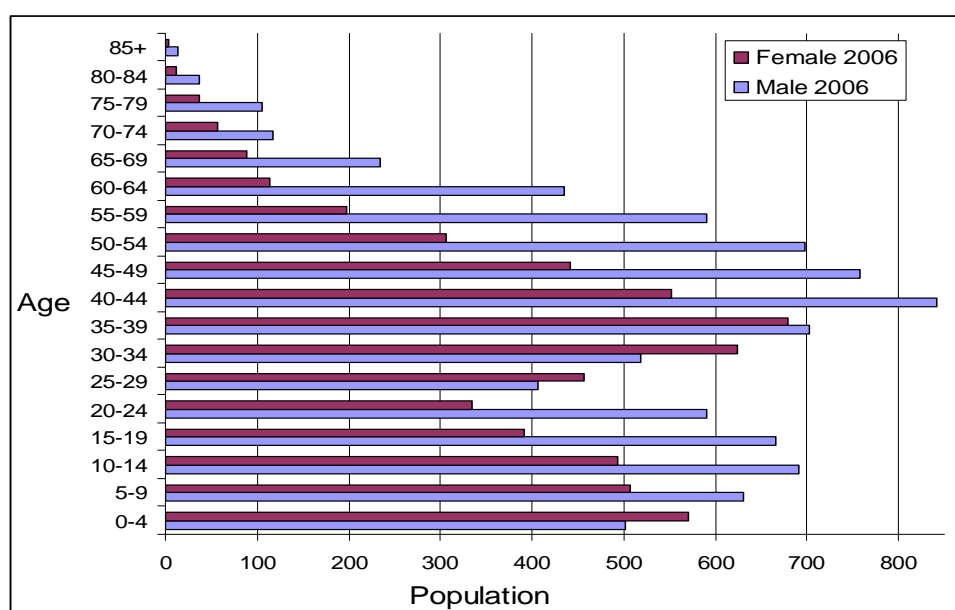


Figure 24 The Litchfield Shire population, by age and sex, according to ABS Census data 2006.

The population structure of Litchfield Shire is characterised by a significantly larger population of males, who outnumber females by nearly 18 percent (Figure 24).

#### 3.3.2 Land-use

##### *Customary use*

The original inhabitants of Litchfield Shire included the Larrakia and Wulna Aboriginal peoples. Larrakia are today the significant language group with customary associations with the Howard region – as their traditional lands include much of the Darwin rural and Gunn Point areas (Wells 2001). The Howard region provides ‘tidal mudflats and mangrove lined creeks, freshwater lagoons, floodplains, open woodland areas and the sea itself which contains a

<sup>6</sup> This includes those people living within postcode regions 0835 and 0836.

variety of plants, animals and marine resource which are managed, harvested, hunted and fished by Larrakia people' (Wells 2001: 7). The spring-fed jungles and rainforest patches provide important habitat for medicinal plants. Although plants and animals are not harvested as intensely today as prior to colonisation, the same areas that were historically important continue to be visited by Larrakia families. These include visits to culturally important sites: 'conception sites, birthing sites, burial sites, sites connected with men and women's ceremonial activity or 'business', and the landmarks which represent the movement and location of various Dreamings' (Wells, 2001 p 6). Archaeological sites, including significant shell middens, at Shoal Bay and Buffalo Creek, represent specific occupation sites where resource usage was particularly intense. These places exist as a reminder of the importance of coastal areas and creeks as food sources.

Certain lagoons, such as Knuckey Lagoons, have in the past provided an important meeting place for multiple Aboriginal tribes, whose members travelled between traditional home lands to the south and east and remote pastoral stations and other places of work. Other wetland areas provided important grounds for ceremony and initiation. In the Howard River area, it is plausible that the greatest land use change has been witnessed by the Larrakia in the very recent past. The following comments by David Mills attest to this:

*It was when I was working with Department of Works that I seen the damage at Shoal Bay, the bulldozers and gravel pits. They bulldozed all the old roads and there were gravel pits everywhere. We used to ride our bikes out there to get geese and fish and there were just gravel pits everywhere. We used to go anywhere. Leanyer, there was a swamp. Shooting geese. At Humpty Doo we used to go out there to get geese or water birds. We'd ride out there. Nearly forty miles when you think of it! Used to get a feed of geese... We'd carry them home around our necks on a bit of rope. They were heavy! We had to walk through the swamp and the grass was so high and just full of leeches and snakes and you name it (Wells 2001; p70).*

The values associated with Aboriginal use and association with the region will be more fully discussed in section 4.1 below.

### *Agricultural and pastoral use*

European settlement in the Litchfield Shire dates from 1864 when the area was first surveyed, although initial settlement was slow, with land use being mainly agricultural and pastoral. Some growth took place in the 1870s and 1880s, following the construction of the Overland Telegraph Line.

Governments of this time sought to encourage agriculture across the Top End believing that because of its tropical location, the region would be well suited to crops such as sugar, rubber, coffee, tobacco, hemp, maize, rice, arrowroot, peanuts, tea and cotton (Courtenay 1982; Jones 1980). Sugar was thought a good prospect and, in 1875, the government offered a 5,000 pound reward for the first 500 tons of sugar to be grown and milled in the Territory. The first Sugar Grant was issued to A.W Sergison for plots on the Adelaide River but the property was abandoned by 1884 after unsuccessful attempts to grow sugar (Wilson and Estbergs 1984).

Otto Brandt set up within what is now known as the Litchfield Shire, at Shoal Bay. He was the most persistent of the planters, planting a trial crop of 20 acres of cane in 1883, which he doubled the following year. Early results were encouraging, so Brandt brought sugar refining equipment from Queensland in 1885 and employed about 80 men. The Government Resident inspected the 1885 crop and wrote:

*None amongst us was prepared for the fine luxuriant crop we saw ... we looked down upon about 40 acres of perfect growth, leaving little for the planter to desire. The average height of the cane was nine feet* (Litchfield Council 2008).

However Brandt's sugar production was subsequently plagued by bad luck. He produced 15 tons of low grade sugar before his machinery broke down in 1886 and the rest of his crop was lost before the mill could be repaired. Most of the sugar he had been able to mill was subsequently ruined when the boat that was carrying it to Darwin was caught in a squall. Long term however, the low lying land which Brandt had chosen was salt impregnated and its productivity declined over successive seasons. A man named Moore also attempted to grow sugar at Shoal Bay but abandoned the venture after two years.

More substantial horticultural growth took place in the post-war years, with the most significant development from the 1970s. Since 1996, Litchfield Shire has experienced a marked increase in population, a result of new residential development and increased interest in horticulture and other land uses.

Today, production from the Litchfield Shire makes an important contribution to the Northern Territory's agricultural output. Eighty-five per cent of the \$26.8 million of vegetables grown in the NT in 2007 were from the Litchfield region (ABS 2007). The total value of the fruit crops grown in the NT in 2007 was \$51.1 million, with 50.4% grown in the Litchfield Shire region. The main fruit crop grown is mangoes. Between 1993 and 2004 the growth of mango plantings in the Howard Springs/Virginia, Humpy Doo/Bees Creek and Lambells Lagoon/Middle Point areas increased from approximately 46 300 trees to 274 500 – nearly a six-fold increase (ABS 2007).

The growth in market gardens since 2004 has supported a significant increase in the production of cucumbers and Asian vegetables. There are now around 100 growers and 65 established Asian farms operating in the Darwin rural area. They produce a range of Asian and traditional vegetables for local and capital city markets. According to a report by the NT Government (White 2004) the mango industry has recently and rapidly transformed from an industry dominated by small enterprises managed by semi-retirees or part-time growers to more commercially focussed productions 'increasingly concentrated on a small number of medium to large-scale commercial farms, located in the outer rural areas of Darwin and Katherine' (White 2004 p iv) and while some growers have significantly expanded their productions, by increasing their tree numbers, other producers have removed trees, chosen not to pick fruit or sold the property (White 2004) it has been suggested that the sharp spike in bores drilled in the Darwin rural area in the mid 1990s, as shown in Figure 26, is in part a response to changes in mango production.

### *Mining*

The study site is also an important one for the provision of minerals, sands and other construction materials. Specifically, low value materials such as fine sand and gravel are extracted from shallow mines in the Howard region. At present, mining for fine sand in the Darwin region removes approximately 41 ha of native vegetation per year, but this is expected to rise by 70% by the year 2020 (Doyle 2001). Fine sand is mined from shallow sandsheets, which mostly occur in the immediate vicinity of rivers and creeks or associated with palaeo-drainage lines (Price *et al.* 2005). There are approximately 250 extractive mining tenements within the outer Darwin area, including granted leases and those under application. Other extractive minerals used around Darwin include fine and coarse sand, natural gravel, crushed rock, porcellanite, clay, soil and dimension stone. The average consumption of extractive minerals (crushed rock, gravel and sand) in the Darwin region over the last 4 years was 1.3 million tonnes, estimated to be half the Territory average of 2.6 million tonnes. The estimated demand for extractive minerals in the year 2020 for the Darwin region is 2.2 million tonnes. Figure 25 and 26 are Google images of two sand mines on the Howard River: The mine in Figure 26 is operational.



Figure 25 Sand mine on a Howard River tributary. Photo: © Google Images



Figure 26 Operational sand mine on the Howard River. Photo: © Google Images

Mining is exempt from groundwater and surface water licensing under the current *Water Act 2004* (NT) but is subject to licensing for discharge, waste management and pollution under the *Waste Management and Pollution Control Act 1998* (NT). There is no limit on water extraction for mining, however there are avenues for mining proposals to be subjected to either a Notice of Intention and Public Environmental Report/Environmental Impact Statement process. These processes require proponents to detail water extraction rates, discharge and usage and show how they intend to ameliorate impacts. Few extractives mines have undergone this kind of environmental assessment however. They are instead approved and regulated under the *Mining Act and Mine Management Act*. There is a Memorandum of Understanding between the Mines Department and NRETAS through which developments above a certain threshold are referred to NRETAS for environmental assessment.

A Bore Construction Permit is only required if the bore is drilled outside the mining lease and within a water control district i.e., on the adjacent parcel of land to the mining lease where the miner's accommodation is located.

### *Rural residential*

While the early history of agriculture in the study region is not notable for successes, as the population increased, mainly on lots of 8 ha or less, there was an upsurge of interest in agriculture on both a commercial and semi-commercial or hobby farm basis. Litchfield Shire also continued to develop as an alternative place to live, emerging as a separate identifiable entity with its own development pressures and opportunities (Northern Territory Government 2002).

The concepts for future residential development in Litchfield Shire, taken from the Litchfield Shire Planning Concepts and Land Use Objectives 2002 (Northern Territory Government 2002) accommodate future population growth, maintain minimum lot sizes within existing subdivisions in established rural living areas and create opportunities to cater for various aspirations in relation to rural lifestyle.

The concepts incorporate:

- Continuation of 2 ha subdivision predominantly for residential purposes generally in the Howard Springs, Bees Creek and Humpty Doo locality;
- Continuation of 8 ha subdivision for a range of uses including rural living and agriculture (includes horticulture and aquaculture) in the southern part of the shire;
- Provision for future rural residential subdivision of lots less than 2 ha in specific localities;
- The creation of opportunities for alternative rural living lifestyles, and
- Further provision of urban sized lots within appropriately serviced district centres.

A new high density rural living zoning is also proposed within the Land Use Objectives and described as 'estate development':



*Estate development provides opportunities for an alternative communal rural lifestyle and may provide opportunities to protect areas of natural vegetation or of environmental significance (Northern Territory Government 2007).*

Such development could include areas held in common title such as units. At the same time there is concern for maintaining the 'existing rural living amenity' and an awareness of the impacts of high density housing and the need for appropriate buffers. The provision of communal water supply and sewage waste disposal for such development may also reduce the impacts of development on natural resources (Northern Territory Government 2007).

Recently, there has been a trend away from larger 8 ha subdivisions to predominantly 2 ha or smaller lots, creating a higher density of living, and also increased provision of services such as reticulated water to a larger proportion of the population living within the Shire. It is likely that an increasing regional population, increased demand for rural living and vacant land more generally, has stimulated the move to provide more options for living, including higher density to accommodate demand. Regulations requiring new subdivisions to provide reticulated water and septic systems for blocks smaller than 2 hectares have been passed in response to increasing pressure on groundwater supply from local bores, as well as health considerations. It is necessary to position bores (particularly bores that are to supply water for drinking and other household use) a sufficient distance from septic systems to prevent leaching and contamination (Northern Territory Government 2007). Power and Water has completed significant studies into the risks to groundwater, e.g. from domestic septage and extractives mining in the rural area.

### **3.3.3 Water use**

It is difficult to accurately describe current water use within the Darwin region because of the limitations of water monitoring and regulation systems. It is known that demand for groundwater in the Darwin rural area has been increasing, as reflected in the number of bores that have been drilled in the area, as shown in Figure 27. According to Power and Water Corporation some areas (e.g. Girraween) were originally put onto reticulated water because drilling conditions and geological issues created difficulties in achieving a reliable bore supply (Power and Water Corporation 31/10/08).

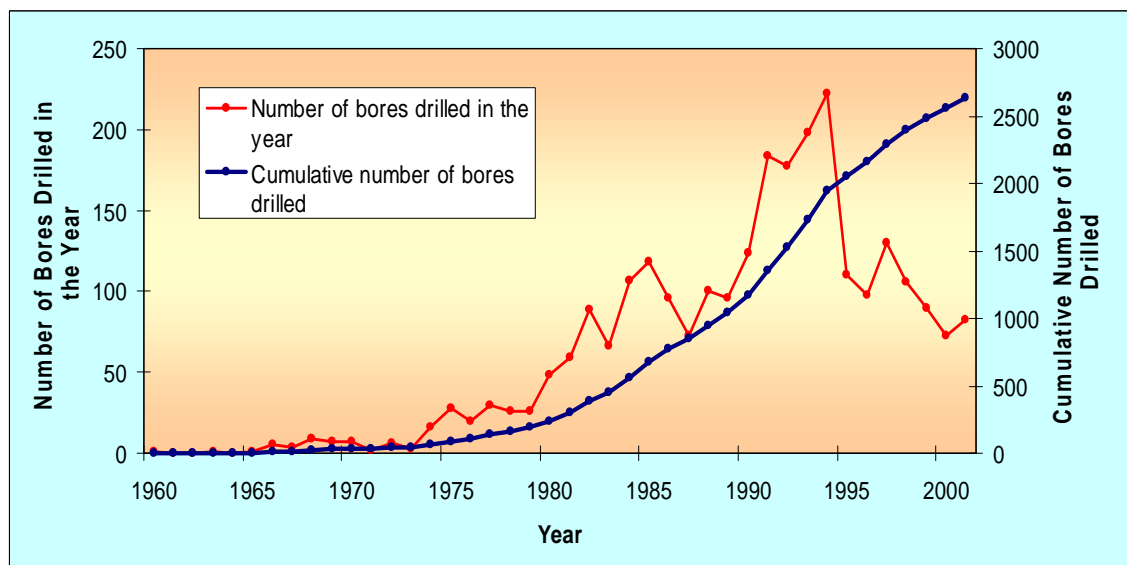


Figure 27 Number of bores drilled each year and cumulatively in the Darwin rural area. Source NRETAS (2008)

Water agencies have developed estimates based on certain assumptions about consumption rates. Table 1 below shows the Department of Natural Resources, Environmental and the Arts estimates for annual water consumption from domestic, horticultural and town water supply bores (operated by Power and Water Corporation) in the Darwin rural area.. The figures provided for the town water supply bores are not estimates as these bores are metered. However at present, stock and rural domestic bores are neither metered (except those in the Darwin Daly Bore Metering Project) nor licensed, nor do they have a capped rate within or outside the water control district in the Darwin region. This applies for both groundwater and surface water extraction (from the river, lagoons etc).

<b>Rural Residential Bores</b>	
—	<b>Annual pumping ~ Estimated in 2005 at 1ML per bore (one Olympic size swimming pool)</b>
—	<b>Estimated total 2005 pumping – 1800ML</b>
—	<b>Re-estimated in 2008 to be between 3.5ML and 8ML pumped each year per residential bore</b>
<b>Horticultural Bores</b>	
—	<b>Annual pumping per bore ~ 1.5ML</b>
—	<b>Estimated total 2005 pumping –3600 ML</b>
<b>Town Water Supply Bores</b>	
—	<b>Currently 6 TWS bores in operation</b>
—	<b>Metered 2005 TWS pumping 1100ML</b>

Table 1 Estimated and actual water use from rural residential, horticultural and town water supply bores in the Darwin rural area. Adapted from NRETAS (2008)

Currently, large groundwater users (land owners with bores that pump more than 15 litres per second), require a licence under the *Water Act 2004* (NT) if not pumping for stock and domestic purposes. Small water users (land owners with bores that pump less than 15 litres per second) are not legally required to have a meter in the Darwin Rural Water Control District under an exemption from the Northern Territory Water Act. There is currently insufficient information to identify the proportion of bores that do or don't have meters. Surface water extraction for commercial purposes is also licensed across the NT. Water Licensees are given an entitlement to extract water from a water source (ground or surface, such as a river), including maximum monthly usage 'caps' to which they must adhere, as well as ensuring that they only extract their allocation of 20% of the given flow at the time of extraction for Ground Water Extraction Licences or 20% of Maximum Extractable Yield in the case of Ground Water Extraction Licenses. This allows for 80% of the resource to be available to the environment.

Metering is a mandatory condition under the extraction licence and they are audited by Water Management Board staff on a regular basis. Licensees are also required to submit monthly pumpage results regarding extraction amounts. Breaches in entitlement and usage will result in revocation of the licence. These large users are required to meter, record and report their water use. However, there are no standards for such meters, meaning that the information the NT Government collects from these water users is not always reliable. There is, therefore, no information on overall water use. A trial voluntary metering project is currently underway to refine estimates of how much water is being used by private bore owners (2007)

### *Horticulture*

There are a number of crops grown in the study area. The water demand and pattern of usage for each crop varies. For bananas the irrigation applied per day must be at least equivalent to the evaporative loss (Diczbalis and Toohill 1993). For bananas grown near Darwin, the month in which there is the greatest difference between available rainfall and evaporative loss is October. The maximum pumping requirement during this month (where watering efficiency is 85%) is estimated to be 3.17 ML/ha to make up the shortfall between rainfall and evaporative loss (Diczbalis and Toohill 1993).

Mangos are another common crop grown within the study area. In a new planting, trees must be irrigated throughout the year for the first 2 years (Diczbalis *et al.* 2006). According to advice published by the NT Government for prospective mango producers – a figure of 100 L/tree/week is deemed sufficient for the first two years (Diczbalis *et al.* 2006). After the second wet season trees are generally only irrigated during the flowering and fruit development period; the 5 month period between July and November in the dry season. The following table shows the average mango tree water requirements in litres per tree based on tree density and canopy cover. The water use rate for each mango tree, where the tree density is 140 trees per hectare and the canopy cover is 5000m<sup>2</sup> per hectare, is 1400 Litres per day (Diczbalis *et al.* 2006) or about 0.4ML per tree per month. Watering of 200 trees under these conditions for 5 months would require 42ML of water (200 trees x 1400L/day x 150days).

Canopy cover m <sup>2</sup> /ha	Trees per hectare						
	80	100	130	140	160	180	200
1000	490	390	330	280	250	220	200
2000	980	780	650	560	490	440	390
3000	1470	1180	980	840	740	650	590
4000	1960	1570	1310	1120	980	870	780
5000	2450	1960	1630	1400	1230	1090	980
6000	2940	2350	1960	1680	1470	1310	1180
7000	3430	2740	2290	1960	1720	1520	1370
8000	3920	3140	2610	2240	1960	1740	1570

Figure 28 Average mango tree water requirements (Darwin and Katherine areas) in litres per tree per week, based on canopy cover and tree density. Source: Diczbalis *et al.* (2006)

Cucumbers are now the major vegetable crop of the Top End, which is the result of greater water availability than growers face in the southern states. The amount of Asian vegetables produced between 2004 and 2005 more than doubled to a production of around 6000 tons. In 2006/07 these farms contributed about \$30 million dollars in sales to the wholesale markets. Tropical fruit growing, cut flowers and nurseries are also popular. Each of these industries relies on the availability of water for irrigation with some requiring significant amounts of water (Diczbalis 1999).

Annual vegetable and melon crops are particularly high users of water. These crops require irrigating at critical points during their relatively short life span (10-20 weeks). Perennial tree crops tend to require less water and management than annual crops, although water is still a critical requirement. Some tree crops (mango and cashew) require little or no water for their survival during non-flowering and non-fruiting growth periods; whereas, fruit trees (e.g. carambola, mangosteen, jackfruit and banana) from wetter tropical environments require continuous irrigation throughout the year. Crop type influences rooting depth which determines how much available soil water the plant is able to tap into. Effective root depths vary from 15-30 cm for vegetable crops to 80-100 cm for many tree crops (e.g. mango, citrus).

In estimating irrigation usage per bore in the McMinns/Howard East, Yin Foo (2004) determined that the average horticultural block size is 3ha. In developing an applicable pumping rate per bore for horticulture in the rural area, an estimate of 15ML/bore/annum was derived based on the average block (3ha) applying the maximum watering rate (10ML/ha) for 6 months of the year (Yin Foo 2004). A daily estimation of bore use on a monthly basis for horticultural irrigation in the study area is shown in Table 2.

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<b>Month</b>	<b>Irrigation Usage per bore (kL/day)</b>
Jan	1.3
Feb	1.3
Mar	1.3
Apr	12.7
May	50.9
Jun	63.6
Jul	63.6
Aug	63.6
Sep	63.6
Oct	63.6
Nov	63.6
Dec	50.9

Table 2 Estimated Irrigation Usage per bore from the Howard region (McMinns/Howard-East Groundwater System) Source: Yin Foo (2004)

*Rural domestic*

Riparian use is considered to be the public right to take water for domestic and stock purposes. In the Darwin rural area this is considered to be the groundwater extracted from private bores for personal use and the irrigation of approximately 0.5 hectare of garden and the watering of stock *Water Act 2004* (NT).

The sub-division of existing rural house blocks has contributed to a substantial growth in the sinking of new bores in the rural area for stock and domestic purposes. There are also a significant number of rural residential blocks running ‘hobby farms’, with estimated high water use, including cut flowers and mangos. The total number of production bores in the Darwin catchment area, which is larger than the Howard River study area, is estimated to be 2,700. Of these bores, about 600 are considered to be used for irrigation purposes (Haig and Townsend 2003). The growth in total bore development for the Darwin rural area can be seen in the time series maps prepared by the Power and Water Corporation (see Figures 28 to 32 below).

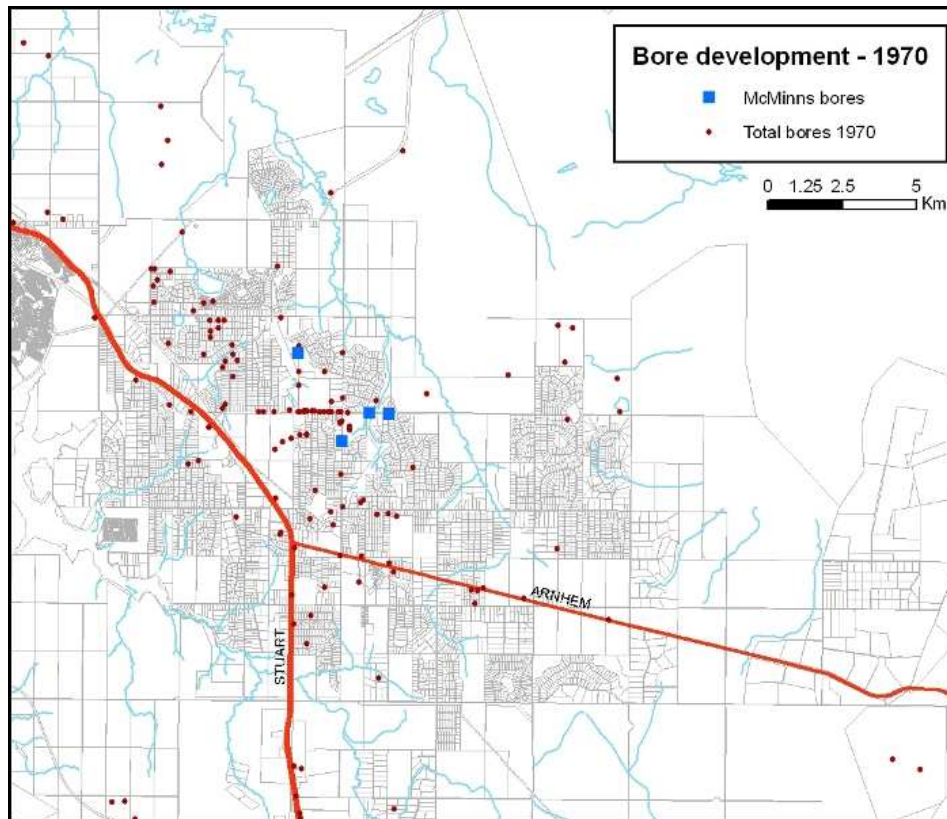


Figure 29 The total number of bores in the Darwin rural area in 1970

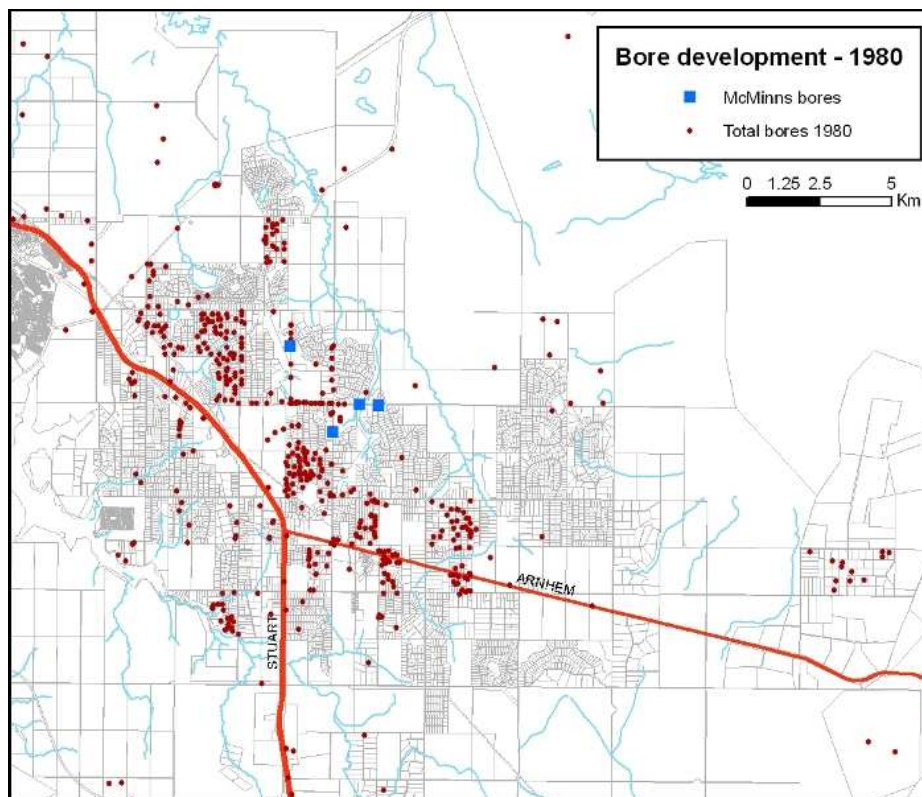


Figure 30 The total number of bores in the Darwin rural area in 1980

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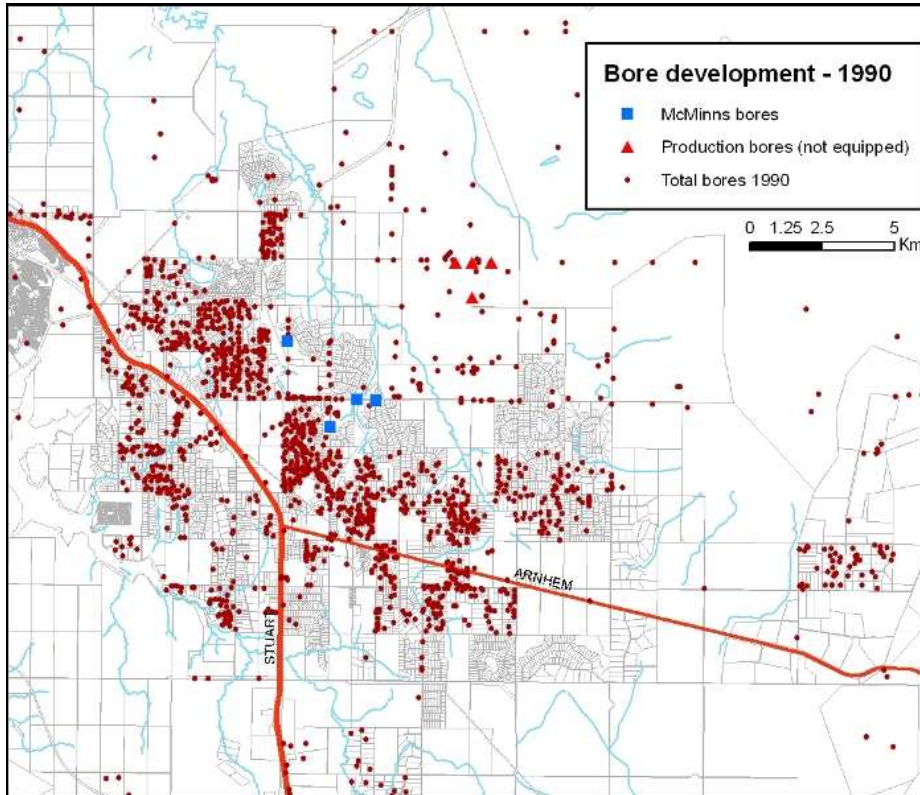


Figure 31 The total number of bores in the Darwin rural area in 1990

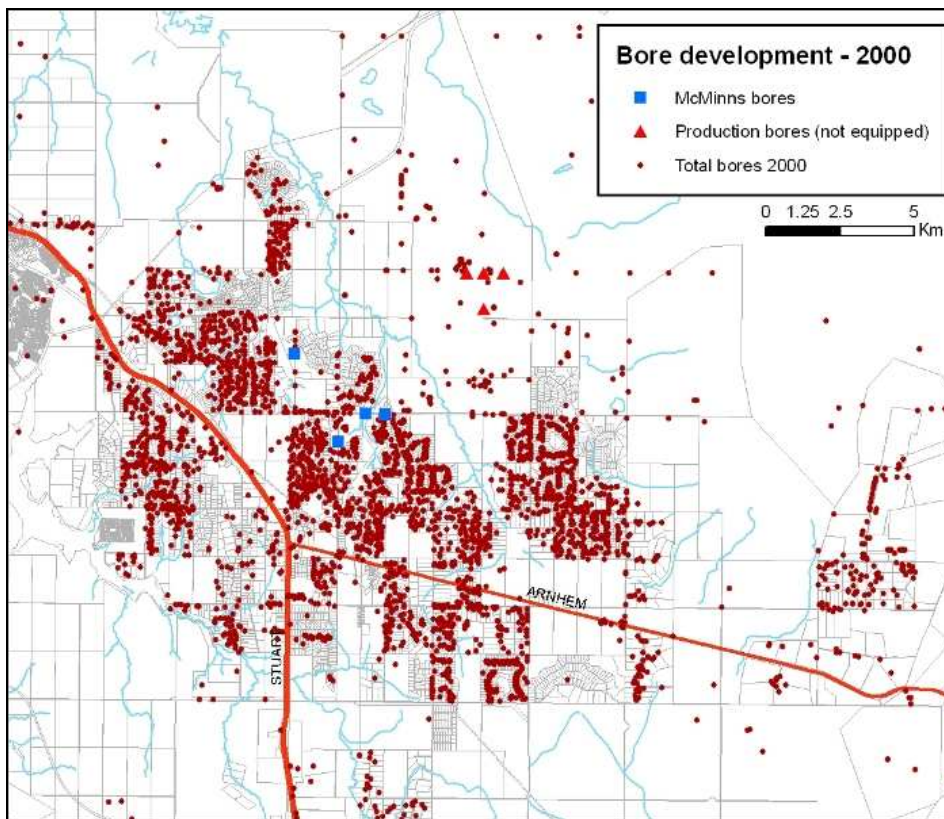


Figure 32 The total number of bores in the Darwin rural area in 2000

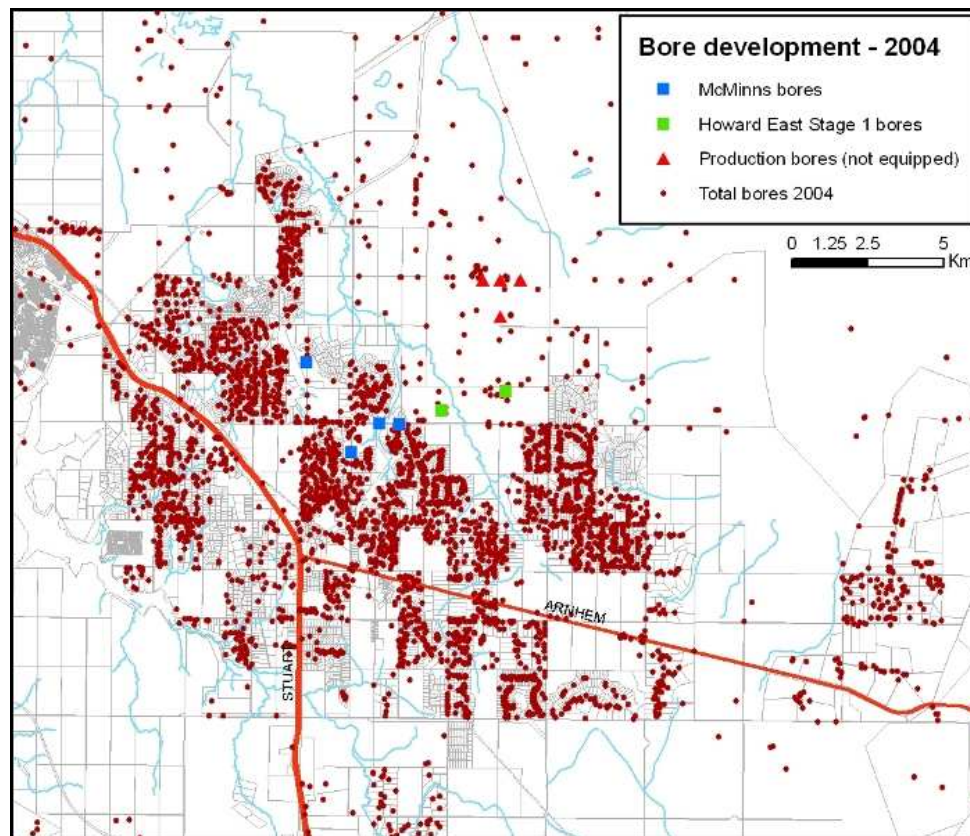


Figure 33 The total number of bores in the Darwin rural area in 2004

A conservative estimate of the number of bores in the catchment area designated as being used for riparian use would be about 2,100 (Haig and Townsend 2003). An estimate of rural domestic rate of use is approximately 7 ML annually for each bore. This estimate is based on a “return to sewer”<sup>7</sup> of 380 litres/day/person for a family of four and the irrigation of 0.5 ha of garden at a rate of 50 mm per week for 6 months out of 12. The total amount of groundwater extracted from the 2,100 domestic bores within the boundary of the Darwin Harbour catchment is about 14,700 ML/Yr.

If land owners choose to connect to the Darwin water supply network at least some of the costs will be borne by the individual, and there is a perception at least that these charges are very high (Straton *et al.* 2008). There is a contribution scheme that means that Power and Water/Northern Territory Government may pay for the infrastructure and each landowner that wishes to connect pays a contribution or proportion of costs. This is called the Water and Sewerage Services Extension Policy (WASSEP). Costs are related to the number of customers on the new line, the length of property frontage, the costs of pipeline and the benefit/impact on the overall water supply system (Power and Water Corporation 31/10/08).

According to some current rural bore owners living in the Howard region, the combination of initial connection costs and the ongoing cost of water, results in little incentive to convert to town water supply and relinquish their bore. The Litchfield Planning Concepts and Land Use

<sup>7</sup> This term refers to the amount of water that is discharged into the sewer system (or similar) for collection and treatment and does not include storm, surface, and groundwater not intentionally admitted in to the sewer system.



Objectives (Northern Territory Government 2002) state that to minimise impacts on both the amenity of existing rural living areas and the environment, rural lots less than 2 ha should be connected with both reticulated water and sewerage as well as other waste disposal. Currently, cost of connection to sewerage is prohibitive and Alternative Septic Systems (individual tertiary treated systems) are preferred (Power and Water Corporation 31/10/08). Consequently the new rural residential developments are connected to Darwin's reticulated water supply system and are charged for the use of water.

### *Darwin's water supply*

Borefields in the Howard Region have been supplementing Darwin's public water supply for decades. The municipal water supply for the greater Darwin region is derived from a blend of approximately 90% surface water with 10% groundwater. The surface water is sourced from the Darwin River Dam and is mixed with water pumped from the McMinns and Howard East Borefields (Power and Water Corporation 2006b).

The McMinns and Howard East borefields, located approximately 25km southeast of Darwin, consist of a total of 6 production bores in the dolomite aquifer. The bores are around 60m deep, with pumping yields of between 35 and 80 Litres per second.

Bores in the McMinns area have been used for public water supply since 1966, with four bores now operational. Stage 1 of the Howard East Borefield, consisting of two additional production bores, was completed in December 2001 at a cost of \$7.3 million (Power and Water Corporation 2003).

Total extraction from the borefields is approximately 4-5000 ML/year, with a total licenced entitlement of 8420 ML/year (David George, pers com)

Further stages of development of Howard East Borefield to meet Darwin's growth demand were first proposed in the early 1980s. In the mid 1980s the bores for Stage 2 were drilled (D. George pers comm.). A report by Power and Water in 2002 flagged the borefield for development in 3 additional stages over the following 15 to 20 years, at which point it was thought it could supply up to 24 percent of Darwin's water (Power and Water Corporation 2002). The proposed Howard East Borefield Stage 2 is located within the Water Management Zone (WMZ), in an undeveloped area. Bores for this stage were drilled in the 1980s and four were prepared (by NRETAS) for use as production bores in 2005. These bores can produce approximately 4000 ML/year. The estimated cost of developing this borefield is approximately \$8 million (Power and Water Corporation 2006a). An application to increase overall groundwater extraction from the aquifer, using these bores, has been stalled since 2006 pending the Water Allocation Process.



Figure 34 Darwin's water and sewerage infrastructure showing the relative amounts of water pumped from Darwin River Dam and McMinns/Howard East Borefields to supply Darwin with water. Quantities shown are from 2006. Source: Power and Water Corporation (2006a)

The Howard East Borefield is zoned a Water Management Zone under the NT Planning Scheme, with the intent of protecting future public water supply from this area through the control of certain activities and developments. Two of the existing bores, and all proposed future bores, fall inside the WMZ, however the 4 McMinns bores do not.

In 2004-2005 a risk assessment was undertaken to determine the impact of septic tank systems contaminating groundwater in the McMinns / Howard East area.(Power and Water Corporation 2005). The study found that an exclusion zone of 400 metres is required to achieve an attenuating travel time in excess of 100 days at a pumping rate of 4 ML/d (million litres per day). It was also recommended that the Exclusion Zone (EZ) be accompanied by a complementary Active Management Zone (AMZ) of a further 200 metres around all Power and Water bores.

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These buffer zones are now being applied to all affected new developments and subdivisions, through the *Planning Act*, with Alternative Septic Tank Systems being required within the AMZ. Assessment and approval of effluent disposal systems within the AMZ is jointly carried out by Power and Water and the Department of Health and Families. Existing developments within the AMZ and EZ are not affected. Development around one of Power and Water’s existing production bores has caused contamination, and the bore is currently not used for public water supply, pending the installation of an additional ultraviolet disinfection system at the wellhead.

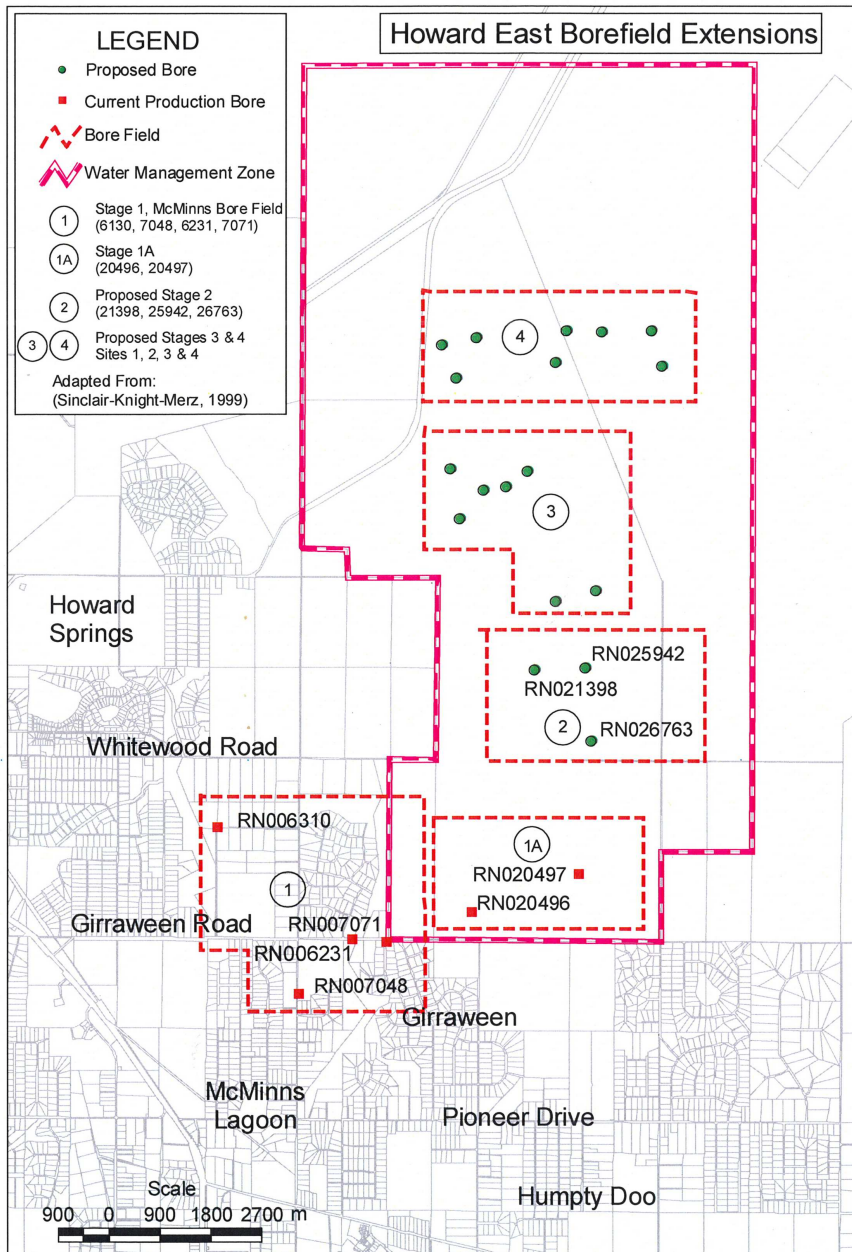


Figure 35 McMinns and Howard East Borefields showing current and proposed bores. Source: Haig and Townsend (2003)

### *Projected future demand*

The Darwin region is currently experiencing high growth, with significant increases in water demand predicted due to potentially large increases in industrial demand and the associated population growth.

The Northern Territory's Power and Water Corporation is currently embarking on a number of major projects in order to meet predicted future growth in water demands. Longer term options include the development of a new major dam. Three potential future damsites have been identified by the NT Government; Marrakai and Warrai on the Adelaide River and Mount Bennett on the Finnis River (Department of Lands Planning and Environment 2000). These dams will require significant lead time due to the extensive engineering and environmental assessment requirements of constructing dams on major waterways.

As a consequence of the uncertainty over future water allocations, in particular the delay and uncertainty in future use of Stage 2 of the Howard East Borefield Stage 2, Power and Water has brought forward alternative options for meeting short to medium term increasing water demand in the greater Darwin region. This includes bringing Manton Dam back into production and also raising the height of Darwin River Dam to provide additional water to meet increased demand in the Darwin, Palmerston and rural areas. Studies have indicated that raising the main Darwin River Dam embankment and spillway by 1.3m would increase yield by up to 20 per cent (Power and Water Corporation 2007). Power and Water have said that they require diverse and independent water supplies to provide security in emergencies (Power and Water Corporation 2006a). Independent water sources are critical to maintaining a safe and secure public water supply system (D. George pers com).

Across the Australian capital cities, total consumption per capita for urban water use varies from a low of around 120 kilolitres per annum for Melbourne to a substantial 350 kilolitres per annum for Darwin urban customers (Marsden and Pickering 2006). As shown in Figure 34, per capita water use for residential purposes in Darwin is more uniform. Water conservation is now a key strategy to address the water supply demand balance in Australia and targets for reductions in per capita use vary across Australia. The capital cities with the highest per capita consumption – Darwin and Hobart – have not proposed any water use reduction targets, possibly because of the ongoing perception that these cities have access to almost limitless amounts of water. Brisbane, Perth, Adelaide and Canberra have all proposed reductions of around 20 per cent from pre-restriction levels because of the dire and critical water shortages they are currently facing.

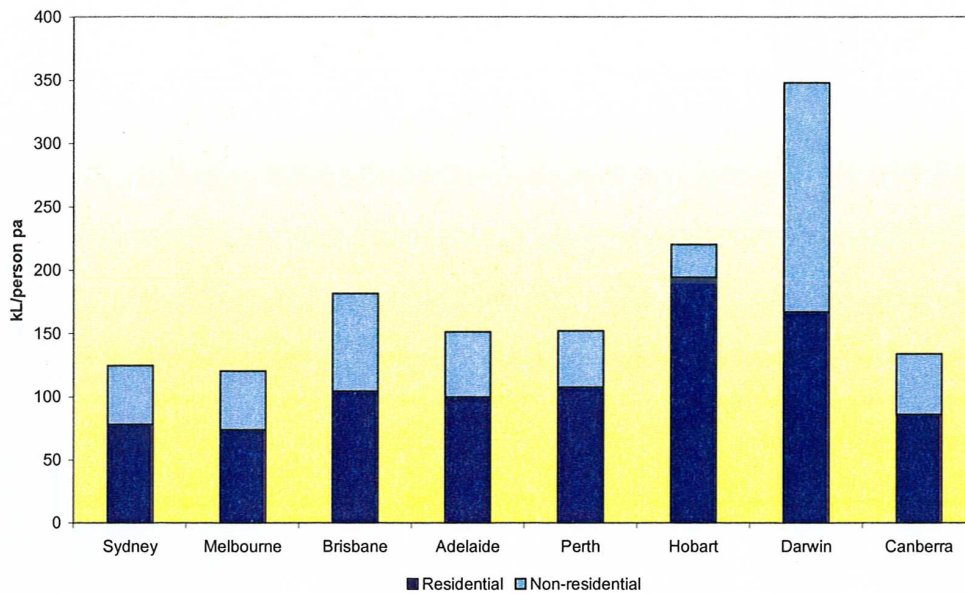


Figure 36 Consumption of water per capita in Australia's cities. Source: Water Services Association of Australia (2006)

### 3.3.4 The NT's statutory framework for water allocation planning

The management, administration and protection of regional water resources are controlled under the *Water Act 2004* (NT). The Minister for Natural Resources, Environment and Heritage and the Controller of Water Resources exercise power under the Act. The Department of Natural Resources, Environment, the Arts and Sport (NRETAS) administers the Act. The Power and Water Authority is the sole service provider for urban and rural water and NRETAS is the resource manager.

The Act provides for sustainable management of water by specifying the outputs and outcomes of the plan: s 22B(5) specifies that 'a water allocation plan is to ensure in the water control district that:

- (a) Water is allocated within the estimated sustainable yield to beneficial uses;
- (b) The total water use for all beneficial uses (including those provided through rural stock and domestic use and licenses granted under sections 45 and 60) is less than the sum of the allocations to each beneficial use, and
- (c) As far as possible, the full cost for water resources management is to be recovered through administrative charges to licensees and operational contributions from licensees'.

An allocation under subsection (5)(a) is to include an allocation to the environment (s 22B(6)).

Through the public declaration of beneficial uses, management goals are set for a water control district<sup>8</sup> to determine how and why the community and government want to protect, manage and use the water resource.

Beneficial uses include agriculture, aquaculture, public water supply, riparian and industry. Current NRETAS policy states that adequate provision is to be made to maintain cultural and environmental requirements (referred to as aquatic ecosystem and cultural beneficial uses).

- The Minister has wide discretion in relation to the making, format and content of Water Allocation Plans (WAPs).

A water allocation plan outlines the vision, objectives, strategies and performance indicators for the particular water source/s encompassed by the plan. It also sets limits to the availability of water assigned to each beneficial use, rules for managing licences and water trading. Monitoring is required to assess the performance of a plan and to inform reviews.

A review of the NT water legislation undertaken by the NSW Environmental Defenders Office in 2005 (Environmental Defenders Office 2005) was critical of the absence of a clear relationship between the *Water Act 2004* (NT) and other environmental or planning laws in the Territory. There is no formal requirement for consultation between different Departments or agencies, nor are plans made under the *Water Act 2004* (NT) integrated with other natural resource plans. This insight is of particular relevance to the Howard River region which has seen marked land use change and a consequent dramatic growth in bore construction, as shown above.

At the time of writing, NRETAS is establishing a Top End Water Advisory Committee to oversee the development of a regional water resource strategy. This strategy will guide the production of water allocation plans for specific water resources within the greater Darwin region (Chris Wicks, pers comm.). At the time of writing the composition of that group had not been finalised.

If you would like to read more about the NT Water Act including water planning processes, the declaration of beneficial uses; Water Advisory Committees and other issues that affect water planning and availability including land use planning and zoning in the NT, please refer to Appendix D 'Land and Water Management in the Darwin region'.

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<sup>8</sup> Water control districts are geographical areas declared under the *Water Act 1992* (NT) by the Northern Territory Minister to allow for intensive management of water resources. These districts are established in locations where there are competing water requirements and the declaration of a water allocation plan is required. To date, there are six declared water control districts.

#### **4. SOCIAL AND CULTURAL VALUES OF HOWARD RIVER WATERWAYS AND WETLANDS**

In this section we document the importance and use of wetlands and waterways to Indigenous and non-Indigenous groups. The following section will then identify the most popular locations and describe their history, current management arrangements and the environmental changes and other pressures identified by stakeholders during the course of the study.

Through interviews a range of social and cultural values have been identified that are linked to surface water features and their immediate environments in the Howard region. These are listed below.

- a) Education, teaching and transfer of knowledge
- b) Aesthetics – appreciating ‘nature’
- c) Bird watching
- d) Exercise areas for people, pets, horses etc
- e) Orienteering and rogaining
- f) Mountain-biking
- g) Fishing
- h) Hunting
- i) Swimming, snorkelling
- j) Bushwalking
- k) Exploring
- l) Quad biking/dirtbiking/4WD-ing and other ‘off-road’ specific activities
- m) Gathering (Seed collecting)
- n) Picnicking/BBQing
- o) Camping
- p) Boating/canoeing/kayaking
- q) Historical and archaeological appreciation
- r) Cultural obligation
- s) Inspiration for art and craft, photography
- t) Research interest

## 4.1 Indigenous use, cultural values and heritage

I have come across a few old places where countrymen years ago have sat down and made spear heads. The ones they don't want they've left there and the ones they want they've kept. And grooves in the stone where they've sharpened them up and that. I know several of them areas around the place (Interview, Larrakia Elder; 28/1/08)

The Larrakia people interviewed nominated a specific set of social and cultural values that they associate with the Howard region, including:

- a) Hunting and collecting a wide variety of foods e.g. long-neck turtle, goose, milky plum, freshwater prawns, water lilies, barramundi, catfish, yabbies, file snake, goanna, cockles, crabs, stingray, wallaby, kangaroo, possum, bandicoot;
- b) Sharing the food collected; sharing with family;
- c) Visiting jungles which are important places for fruit, other foods and medicines;
- d) Maintaining historical connections – visiting places that have connections with the past – Tamarind trees and Macassans, for example;
- e) To share and pass on knowledge, name places and stories;
- f) To remember the activities of forebears – for example, old people singing with clapsticks and didgeridoo at Whitestone 50 years ago;
- g) Visiting places in order to observe change and care for country;
- h) As inspiration for painting and other artistic and cultural expression.

The Howard study region constitutes a part of the Larrakia traditional lands that have for centuries provided a homeland with a great variety of plant and animal resources. The land rights struggle of the Larrakia is notable in the history of the NT land rights movement; particularly for the length of time it has taken the Larrakia to achieve legal recognition of their systems of customary land tenure.

The historical section of the Northern Land Council's claim book for the Kenbi claim to the Cox Peninsula documents past debates about land rights, the need for land for resident Aboriginal people, and early references to Larrakia ownership of the Darwin region in official records of Darwin's settlement (Brandl, Haritos and Walsh 1979). This material testifies to the strength, depth and duration of Larrakia connection to their traditional lands.

In the past, Larrakia people moved constantly about their country, hunting and fishing in accordance with cultural requirements, seasonal patterns of resource use, and the availability of fresh water. Aboriginal people have utilised the plants and animals of the region as significant sources of food, medicine and tools, and which have been hunted and gathered as part of a



strong social tradition. Larrakia country consists of both the land and the sea. The tidal mudflats and mangrove lined creeks, freshwater lagoons, open woodland areas and the sea itself contain a variety of plants, animals and marine resources (Wells 2001). Historical sources, as well as current accounts, report that Aboriginal people in the Darwin region depended heavily on fish and shellfish from coastal areas as well as fish, duck, geese and waterlilies from permanent water holes (e.g. Wells 2001). These resources were sustained by Larrakia people who harvested, hunted and fished them. One Larrakia Elder, interviewed for this study, describes the bountiful supply of bush tucker found in the region:

*There used to be a lot of food around there in the old days, we never bought anything! We did hunting, shooting or whatever ... A lot of buffalo was around. And Koolpinyah Station was closed off to everybody else, only me and one man was running it. We used to have free range of everything, the bullocks, the whole lot. (That was) before, when them two old brothers, Oscar and Evan Herbert, when the Herbert Brothers were there (Interview; 1/2/08).*

Food resources included long yam (*mariyenggwa*), green plum, wild passionfruit, fan (*binbirrimba*) and cabbage palm, lily root, pandanus nut, bush potato (*boetwitjba*), billygoat plum (*damiyumba*), bush peanut (*duldinbar*), bush apples (*mindimilma* and *mindilima*), goanna, wallaby, python, file snake, possum, bandicoot, quoll, jungle fowl (*kulkurka*), magpie goose (*gakingga*) and various kinds of duck. In the coastal creeks sting-ray (*Muli'babi-la*), shark (*Malaguijn-ba*), mud crab, periwinkle (*Damu'gu-la*), longbum and saltwater mud mussel (*Gunart'barrwa*) could be harvested.

Native vegetation was not used solely for food. Numerous jungle vines provided the Larrakia with decorative armbands and the fibrous leaves from sand or cabbage palms or pandanus (*biyamarrmar*) were stripped, cured and rolled on the thigh to produce string for weaving string bags (*denela*), mats, baskets, necklaces and bracelets. Leaves from the pandanus were also boiled and placed on sores to help them heal. During the dry season the Larrakia obtained shelter from the sun and the cool night-time winds by using strategically placed sheets of paperbark (Wells 2001).

As well as the uses described above, the Larrakia also used native plants to make weapons and musical instruments and for ceremonial purposes. Bamboo (*gwarigwa*) was also used for a *mamilima* (*didjeridu*) or for the shafts on large spears. The hard timber from the ironwood tree (*delenyggwa*) was used by the Larrakia for flat fighting sticks and poisonous spearheads. The *mamilima* was also made from the trunks of Eucalyptus like woollybutt (*maminyjuma*) or stringybark (*manigurrrma*) which had been hollowed out by termites. The leaves from the ironwood tree were burnt and used in the final stages of a funeral ceremony. Native vegetation was also used to treat ailments.

Permanent sources of freshwater were important camping places for inhabitants of the region (Foelsche 1882). Kangaroos and wallabies could be ambushed along well-used paths to waterholes, and ducks, geese and many other birds, along with swamp plants such as waterlilies could be obtained. Reports describe Larrakia people gathering plant foods such as yams, cycad palm nuts, wild rice and water lilies (seeds) in the late dry from freshwater swamps and processing them by grinding with mortars and pestles and cooking them in earth ovens (as reported in Bourke 2005).

The importance of maintained connection between wetland areas comes through in a description by Hodgson (1997) of the mosquito dreaming story:

*The mosquito dreaming story goes from Noogoo Swamp to Leanyer to Black Jungle to a big swamp the other side of Humpty Doo known for its huge and numerous leeches, then to Whitestone (the quartz ridge). It was indicated that in areas backing the beaches to the east of Micket Creek there is a sacred site called Gundalu and a ceremonial ground, burial ground and pukamani site. Pockets of rainforest can be found throughout the woodland in this area (p23).*

Traditions, such as initiation rites, have been carried out in the area, bringing together Larrakia people in important ceremonies. One Larrakia respondent describes how important it is that these traditions continue:

*We used to walk all that country through the swamp and everything, but now when I'm old man and I know what's in that swamp there, I'm not going to walk anywhere through that swamp ... we have to get them young fellas to walk through that ... 'cause that was part of being initiated (Interview, 7/2/08).*

The role of feral animals in hunting and gathering was spoken about by another respondent:

*I found that we used to do a lot of pig-shooting out in that area too, and with the feral animals that have been introduced into the area, also remembering that they have destroyed a lot of the areas where the original inhabitants of the area used to gather. The women used to gather yams, transversa and bulbifera. The cheeky yam is bulbifera..and the long yam is transversa. (Interview, 8/2/08).*

4.1.1 Sacred Sites – map and description

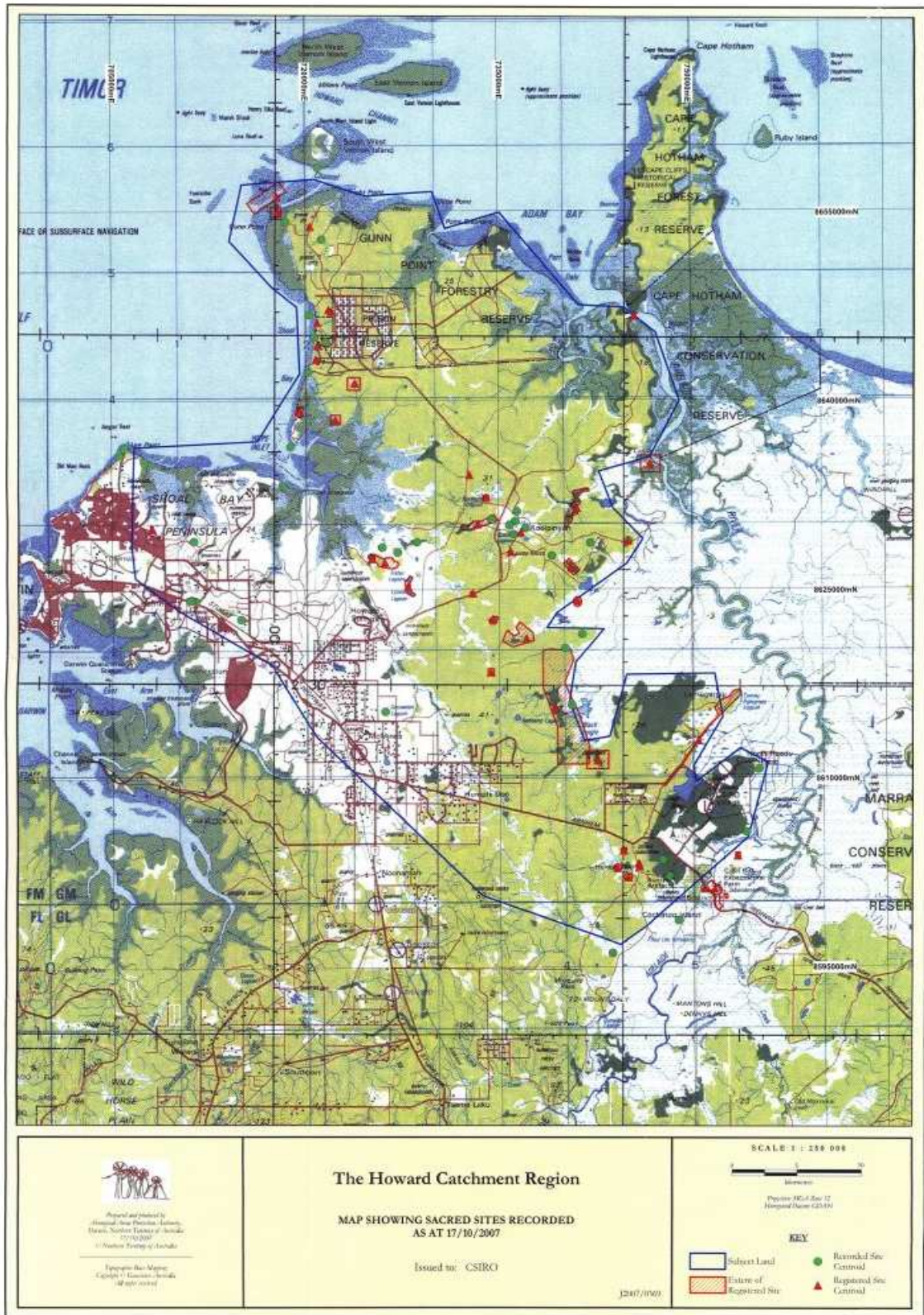


Figure 37 Map showing Aboriginal sacred sites within the Howard Catchment Region. Source: Aboriginal Areas Protection Authority (2007)

Figure 36 shows the location of Aboriginal sacred sites, recorded under the Northern Territory Aboriginal Sacred Sites Act 1989 (NT), and listed on the Aboriginal Areas Protection Authority's (AAPA) Register of Aboriginal Sites. As the map shows, many sites are associated with groundwater features. As at 17/10/2007 the Howard River study area contained 30 Recorded Sites and 33 Registered Sites. Many of these places are themselves groundwater features of cultural significance such as river systems, lakes, wetlands and springs and included the sites within the Fischer and Lyons Lagoon complex, Black Jungle, Salt Water Arm and the lagoons near Koolpinyah homestead including Korebum Lagoon. Others, such as camping areas, hunting places and artefact scatters, are indirectly associated with the presence of water although the water source itself may have since disappeared. Sites recorded in the Hope Inlet/Shoal Bay area are associated with the important shell midden archaeological sites.

The Melacca Swamp Conservation Area Indigenous Land Use Agreement (ILUA) was made between the Northern Land Council, the Northern Territory of Australia and the Native Title Parties to clarify the future title and management of the Melacca Swamp Conservation Area which contains several sacred sites (Agreements Treaties and Negotiated Settlements Project (ATNS) 2005). Likewise, The Black Jungle/ Lambells Lagoon Conservation Reserve Indigenous Land Use Agreement (ILUA) was made between the Northern Land Council, the Northern Territory of Australia and the Native Title Parties to clarify the future title and management of the Black Jungle/Lambells Lagoon Conservation Reserve. Several sites have also been registered and recorded in this area.

#### **4.1.2 Archaeological sites of significance**

Information on the archaeological significance of sites within the study area has been drawn from key studies by Bourke (2004) and Bourke and Williams (2006).

The Hope Inlet shell mounds rise 7 metres above the coastal plains just 25km from Darwin and are thousands of years old. Archaeological surveys conducted in the Hope Inlet area in the 1990s found a high density of archaeological places, the high significance of which prompted the application for a NT Heritage listing for the site (Bourke 2004). The approximate location of archaeological sites within the Hope Inlet area is shown in Figure 37.

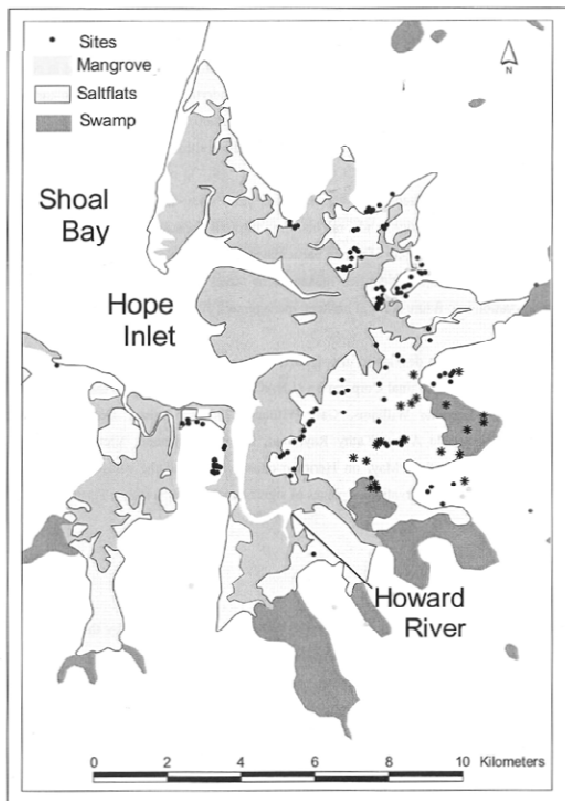


Figure 38 Approximate location of archaeological sites within the Hope Inlet area. Source: Bourke (2004)

Burns (1999) carried out survey and excavation work on prehistoric middens across the broader Hope Inlet region. Burns recorded more than 200 prehistoric archaeological sites during a survey of the region, including the coast and immediate hinterland from Howard Peninsula in the southwest to approximately the southern boundary of the Gunn Point Prison Reserve. Shell deposits were the most common type of site recorded, with smaller numbers of earth mounds, surface scatters (of shell and/or stone artefacts) (Burns 1999). The largest shell mound site was 7m in height (see Figure 38). Most middens (76%) were found on the salt flats, generally concentrated close to the boundary of the mangroves fringing the Howard River or adjacent to tidal creeks. All of the middens identified during this study were of great archaeological interest because the dominant shell species at each site, *A. Granosa*, inhabits open sandy mudflats. This species is uncommon or absent from the mangrove flats that now line the Howard River and other tributaries at Hope Inlet.

Other foods remain preserved in the alkaline mounds as well as shellfish which give insight into the other food hunted in the area at this time. These include mammal bone, macropod teeth and incisors, snake, bird, fish bone and otoliths and crab. Also present is charcoal, and laterite rocks used as hearth material, stone artefacts and ochre, indicating that cooking, stone working and decorating activities took place on these sites (Bourke and Williams 2006).

The Hope Inlet scatters contain many small sharp, flaked artefacts and pieces of flaked local and imported stone, but also large formal artefact types of ground exotic stone (Figure 39). These include many pestles/pounders and less numerous portable grinding stones (mortars) made from sandstone, quartz and quartzite, edge ground axes made from dolerite, and exotic

orange striped and white quartzite large flakes, of the type called 'leilira' blades by McCarthy and Setzler in Arnhem Land.

As reported in Bourke and Williams (2006) sharp flaked stone artefacts could have been used for activities such as scraping or cutting meat and plant materials, as well as implement manufacture, spear heads and body scarification. Large blades were used as shafted spearheads, knives and fighting picks. Edge ground axes, grindstones and pestles could have been used for a variety of activities, including woodworking, breaking up animal bones for marrow, and grinding ochre for pigment to decorate implements or bodies for ceremonies. Stone axes were used for fashioning goose-felling sticks, chopping open logs and branches in search of the native honey – “sugar bag”, animals or eggs, or notching trees for climbing, and hollowing out canoes. It is suggested that one of the main uses of the pestles and grindstones as found at Hope Inlet was to process plant foods such as cycad palm nuts and swamp plants such as spike rush (*Eliocharis dulcis*) waterlilies (*Nymphaea spp.*) and wild rice.

Within Darwin Harbour the deposition of middens and mounds dominated by this species appears to have begun 2500 years ago and ceased approximately 500-700 years ago. Artefacts of modern origin including a cannon shell from a World War II aircraft and bullet cartridges were also uncovered.

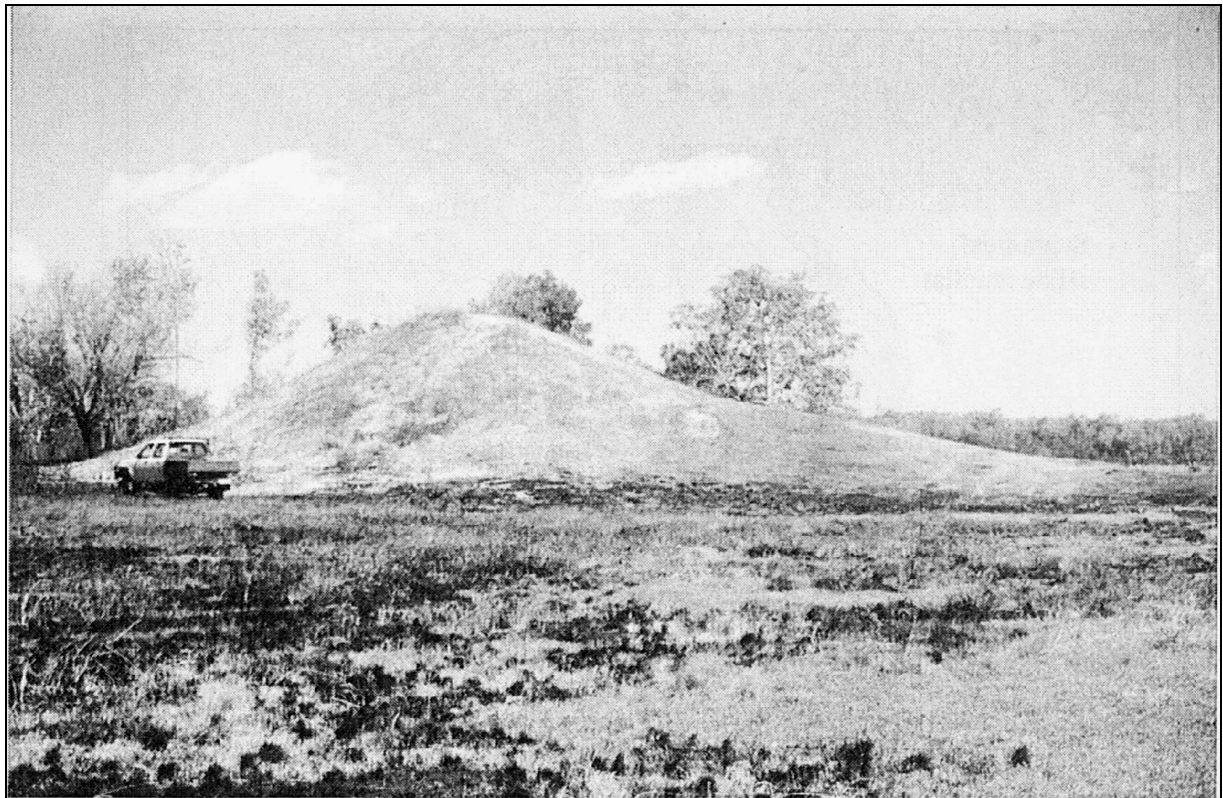


Figure 39 View of largest 7 metre high Aboriginal mound in complex at Hope Inlet. Source: Bourke and Williams (2006)



Figure 40 Edge ground axes made from grey quartzite. Source: Bourke and Williams (2006)

The authors identify inadequate management of these sites as a threat to their conservation. For instance, even though sites are generally only accessible via four wheel drive tracks, collectors appear to be removing artefacts leading to degradation of sites. Protection from collectors is afforded at inaccessible sites – particularly those located within mudflats and tidally inundated areas. The Hope Inlet complex is situated on the outskirts of the existing suburb of Howard Springs and adjoins the Howard Springs recreational hunting reserve:

*Unfortunately there is evidence that urban spread and increasing numbers of recreational visitors on trail bikes, dune buggies and four wheel drives are impacting on sites close to Darwin (some shell mounds near Darwin are intersected by 4WD tracks). Expanding development of rural residential blocks in the area and improved access routes and associated increased levels of casual visitation pose a serious threat to these sites, particularly in terms of a current lack of a management strategy to prevent further illegal removal of artefacts (Bourke and Williams 2006 p.41).*

According to these authors, attempts at preventing access or conserving fragile site elements are unlikely to be successful, and a fully developed scheme of public site interpretation and public access is the only feasible long term management strategy (Bourke and Williams 2006).

### 4.1.3 Military heritage

World War II relic collectors have been fossicking in the Howard region for many decades. At the Knuckey Lagoons Recreation Reserve, a World War II dump has been promoted as an attraction along a path that twists through the bushland. Unfortunately in recent years visitors to the area have removed various items (Interview, 14/12/07). In places through the Howard region military infrastructure still remains as a reminder of this significant part of Darwin's history. Many of these sites are currently offered some level of protection as they are located within Parks and Reserves. These include the 132 Radar Station located within Knuckey Lagoons Reserve and the weir at Howard Springs, built by Australian and American Servicemen during World War II.

The Shoal Bay Strong Point at Lee Point is listed on the Register of the National Estate as an Australia Heritage Site for historic reasons. The significance of the strong point is the reminder of the possibility of the Japanese landing in Darwin, and Darwin's involvement in World War Two. The strong point was constructed from in situ concrete and was built as a freestanding structure on the beach with a square rear section and two curved gun posts at the front which are slightly separated. The strong point was built as an observation post with two openings for machine guns. It has been unused since the end of World War Two.

#### 4.1.4 Register of the National Estate listings – Australian natural heritage sites

The following sites within the study region have been listed on the Register of the National Estate due to their natural heritage values.

##### *Black Jungle*

Black Jungle contains diverse and representative patches of the type of monsoon vine forest that occurs on spring fed areas adjacent to coastal floodplains in the Northern Territory. The vine forest at Black Jungle is fragmented from other similar forests and contains several species of plants whose distributions are largely limited to widely disjunct monsoon habitat. Such relic species include the nationally endangered palm *Ptychosperma bleeseri*, the nationally rare orchid *Malaxis acuminata* and the Whitewood tree *Endospermum medullosum* which is rare in the Northern Territory (Australian Government 2008).

##### *Black Jungle orchid site*

This area is one of only two (possibly now three) recorded sites in Australia of the orchid species *Malaxis acuminata* which is considered vulnerable on a national basis (Figure 40). The nearly rectangular area includes a 1.7km section of a creek draining into Black Jungle Swamp. This creek is bordered by a 300m-500m belt of low lying, almost swampy, country supporting pockets of rainforest and paperbark forest. The vulnerable orchid *Malaxis acuminata* grows in dense shade on the forest floor in humus enriched sandy soil just above semipermanent standing water (Australian Government 2008).



Figure 41 *Malaxis acuminata*

##### *Black Jungle palm site*

This area is one of only two known sites of the endangered Australian endemic palm species *Ptychosperma bleeseri* burret. The listed area includes a 1.2km stretch of two creeks which drain into Black Jungle Swamp. These creeks are fringed by rainforest in which the endangered



palm *Ptychosperma bleeseri* is sparsely scattered through the understorey. The major rainforest species include *Carpentaria acuminata*, *Livistona benthamii*, *Syzygium operculatum*, *Vavaea australiana* and *Terminalia sericocarpa*.

### *Holmes Jungle & swamp & Micket Creek complex*

The Holmes Jungle, Holmes Jungle Swamp and Micket Creek complex form a small spring fed coastal wetland system on the eastern edge of Darwin that creates a significant bird habitat. It is a regionally important dry season refuge for waterfowl and birds of prey. During the wet season the area is used by migratory birds, mainly waders and swifts. Twenty of these species are listed under the Japan Australia Migratory Birds Agreement (JAMBA). The area is a habitat of two nationally rare species, the eastern grass owl (*Tyto longimembris*) and the peregrine falcon (*Falco peregrinus*). The area also contains resident or seasonal populations of five bird species which are considered likely to become nationally rare or threatened in the near future. These species are the radjah shelduck (*Tadorna radjah*), orange footed scrub fowl (*Megapodius reinwardt*), bush thick knee (*Burhinus magnirostris*), yellow chat (*Epthianura albifrons*) and the Australian bustard (*Ardeotis australis*).

Part of the Holmes Jungle area is associated with Maurice and Nicholas Holtze, pioneering Top End nurserymen, who used it as an experimental or trial plot to determine which exotic plant species were best suited to the Territory. Holmes Jungle and the associated wetlands are frequently visited and studied by students and field naturalists, and retain National Estate significance, largely as an educational resource (Australian Government 2008).

### *Howard River site*

This area is one of only two known sites of the endangered Australian endemic palm species *Ptychosperma bleeseri burret*. The area encompasses a narrow belt of rainforest about 100m wide along the Howard River. The endangered palm *Ptychosperma bleeseri* is sparsely scattered through the understorey where only twenty to thirty individuals were known in 1983.

## **4.1.5 Recreational fishing**

### **Fishing the Howard River – Interview with long-time Howard River fisher**

The fish that come out of there are very healthy, for saltwater fish they're actually a bit fatter than most fish you'll get. Like compared with what you get in the Harbour – the harbour fish are very lean, and whereas for a fish of the same size they weigh quite a bit more – even though they're proper salt water fish not freshwater fish. There's a lot of bait in the River, that saltwater stretch is just full of prawns and mullet. There's definitely no shortage of food for the Barra and it's one place I've never seen any fish kills even up in the fresh water. Whether they happen I don't know but I've never seen them (Interview, 3/12/07).

Due its proximity to Darwin, and reliable barramundi and mud crab fishing, many sites within the Howard region are popular with recreational fishers, including at permanent coastal and

riverine environs as well as seasonally flooded inland sites (see Figure 41). Utilising ramp facilities at Buffalo Creek, Howard River, Leaders Creek and Shoal Bay, the river, creeks and inlets of the area are easily accessible by boat, with consideration of tidal movement. The Howard, Little Howard, Hope Inlet, Kings Creek, Micket Creek and Leaders Creek are all popular with boats – much of the inundated Shoal Bay region is only accessible by boat for much of the year. Fishing on the Howard River at the ‘Rockbar’ is popular - access to this point is through the Howard Springs Hunting Reserve. Locals commonly fish the wet set season runoff in culverts and from bridges along the Howard River and its tributaries.

The Chief Executive Officer of the representative recreational fishers body, the Amateur Fishermen’s Association of the Northern Territory (AFANT), emphasised the region’s importance to recreational fishers:

*The area is an extremely important area to recreational fishing partly because this is where we all live (referring to Darwin on map), 200,000 of us... so obviously the areas that we can access are going to be the ones that are most heavily fished...that’s been backed up by the removal of commercial effort (Interview, 22/10/07).*

Shoal Bay is a valued fishery. It consists of an extensive network of freshwater swamps backing up its tidal creeks. The area is a valuable barramundi nursery. The Northern Territory Government banned net fishing in Shoal Bay in 1997 and most of the area is also closed to commercial fishing. However the area is renowned for its barramundi fishing, and large 15kg-plus fish that are caught in the creeks and at ‘the Rock’ on the Howard River by recreational fishers.

Buffalo Creek is particularly popular due to it’s proximity to Darwin, ease of access via a concrete public ramp, and consistently large barramundi caught each year. King and Micket Creeks are also popular but can be accessed only via boat, as the area is under Defence tenure and permits for access are no longer available. Leaders Creek is described as a good fishing and crabbing spot and its popularity is increased by it being the closest public launch site to the Vernon Islands.



Figure 42 Crabbing on the Howard River

Each of the respondents who spoke about fishing had been involved in this activity since a young age and had continued to fish throughout their lives. Howard River and its many tributaries were the focus of discussion. According to one long-term fisherman:

*A spot called the Landing on the Howard River...we used to go there in the early 70s. There was this log road, they just used them as a border with fill and gravel so you could drive across the mudflats at all tides. I'm just guessing that it was probably done by the Army...around 1972 it was there. That was an area we used to go a lot and still go there now... (Interview, 3/12/07).*

*Yeh love fishing. We use fishing line, we don't use drag net or anything like that (Interview Larrakia man, 4/2/08).*

#### **4.1.6 Motorbike and quad-bike riding**

The popularity of motorsports in the Darwin region has increased significantly in recent years (Interview, 25/3/08). The most popular areas for use of off-road bikes and quads are the Shoal Bay Coastal Reserve area and surrounding floodplains and swamps. Anecdotal evidence suggests that the majority of these users are not engaging in hunting or other pursuits concurrently. Some organised activities occur through the Darwin Motorcycle Club, including the Kamfari - a five hour endurance event which has been going for 37 years and is advertised as 'one of the toughest mud races in Australia.' This event has previously been held at Fisher and Lyons Lagoon (see Section 5.2.4). The Gunn Point area more broadly is also a popular place for events.

This is a growing user group. Respondents believe that growth is driven predominantly by an increasing young male population with expendable incomes. The growth of this user group is contributing significantly to the intensity of land use in the Shoal Bay and Gunn Point areas. Limited resources within the Parks and Wildlife Service combined with a myriad of tracks and the ability of the vehicles to go off-road, is preventing the effective control of this activity in the area. Because of the nature of this recreational activity - the noise levels, its persistence throughout the year and potential destruction to the environment through the creation of new tracks - when uncontrolled it has the ability to significantly impact on other users as well as the environment.

#### **4.1.7 Orienteering and rogaining**

Orienteering and rogaining are recreational pursuits that require participants to find their way through unfamiliar territory with the aid of a map and compass. Darwin has an active orienteering club that supports regular activities. Some of these activities occur in the Holmes Jungle and Howard Springs areas. Holmes Jungle is topographically interesting so provides an added element to an orienteering course, whilst the rainforest patches and Palm Creek, which is spring fed, provide both cool shady areas and an aesthetically pleasing course - the deciding factors for some participants. The image below is an orienteering course map for a Top End Orienteer's event in Holmes Jungle, September 2008 (Figure 42).

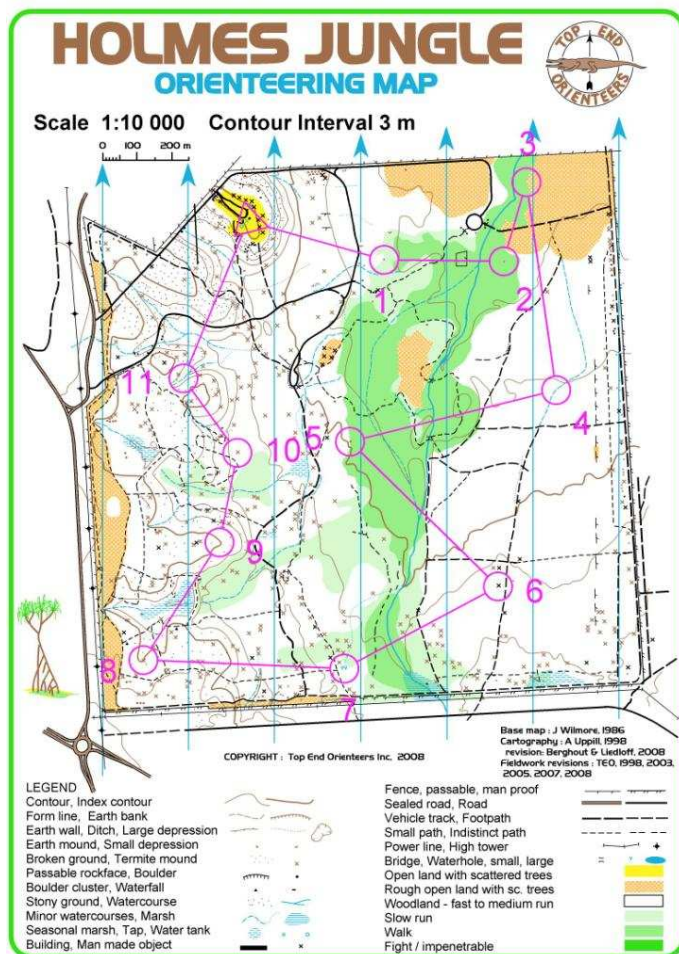


Figure 43 Holmes Jungle orienteering map. Source: Top End Orienteers

#### 4.1.8 Off-road biking (mountain bikers)

Mountain bikers frequently seek diverse undeveloped terrain for testing their skills and challenging their endurance, usually with a group of like minded riders. Holmes Jungle is a popular site for some – the rainforest patches and stream being particularly attractive features of the course, providing cool relief. The local representative group for off-road cyclists frequently use a course in the Howard Springs pine plantation and, less often, the Shoal Bay area. Stream crossings, swamps and floodplains provide an added diversity to an off-road course.

#### 4.1.9 Hunting

Waterfowl hunting is a popular recreational activity in the Northern Territory, attracting local, interstate and international interest during an open season of up to four months. In the past hunting was less regulated in regards to target species, catch numbers and hunting areas. The old photo below shows a hunting party on Koolpinyah station in the 1920s (Figure 43).



Figure 44 Hunting party with catch at Limul-limul Lagoon, Koolpinyah Station 1920s.  
Source: Roy Edwards Collection, Northern Territory Collection

At present eight species may be hunted: magpie goose, *Anseranas semipalmata*; grass whistling-duck, *Dendrocygna eytoni*; water whistling-duck, *Dendrocygna arcuata*; Pacific black duck, *Anas superciliosa*; grey teal, *Anas gibberifrons*; pink-eared duck, *Malacorhynchus membranaceus*; hardhead, *Aythya australis*; and the maned duck, *Chenonetta jubata*. Length of season and bag limits are determined each year following a systematic aerial survey of major waterfowl habitats (Whitehead *et al.* 1988). In 2007 the waterfowl hunting season opened on Monday 3 September and closed on Sunday 30 December.

Hunting is prohibited in parks, reserves, wilderness areas and sanctuaries or areas nominated under the *Firearms Act*, except in Shoal Bay Coastal Reserve, Howard Springs Hunting Reserve, Lambells Lagoon Conservation Reserve and Harrison Dam Conservation Reserve.

Limits are placed on the number of birds shot: seven ducks and seven geese each day per licence (Figure 45 shows the numbers of bird taken in 2001 to 2005). Shotguns and bows are allowed, but for safety reasons rifles, pistols or crossbows are not. Lead and zinc shot are also prohibited at the above reserves.

There have been issues regarding the illegal use of (cheaper) lead shot and subsequent consumption and poisoning of magpie geese. There have also been isolated instances of large numbers of geese and ducks being shot and not removed from where they have fallen.

Permits to hunt pigs are issued for a period of one year from 1 August to 31 July each year. The permit is issued to allow hunting of pigs within the NT hunting reserves of Shoal Bay and Harrison Dam. The number of hunting licenses issued by the Parks and Wildlife Commission in recent years has steadily increased.

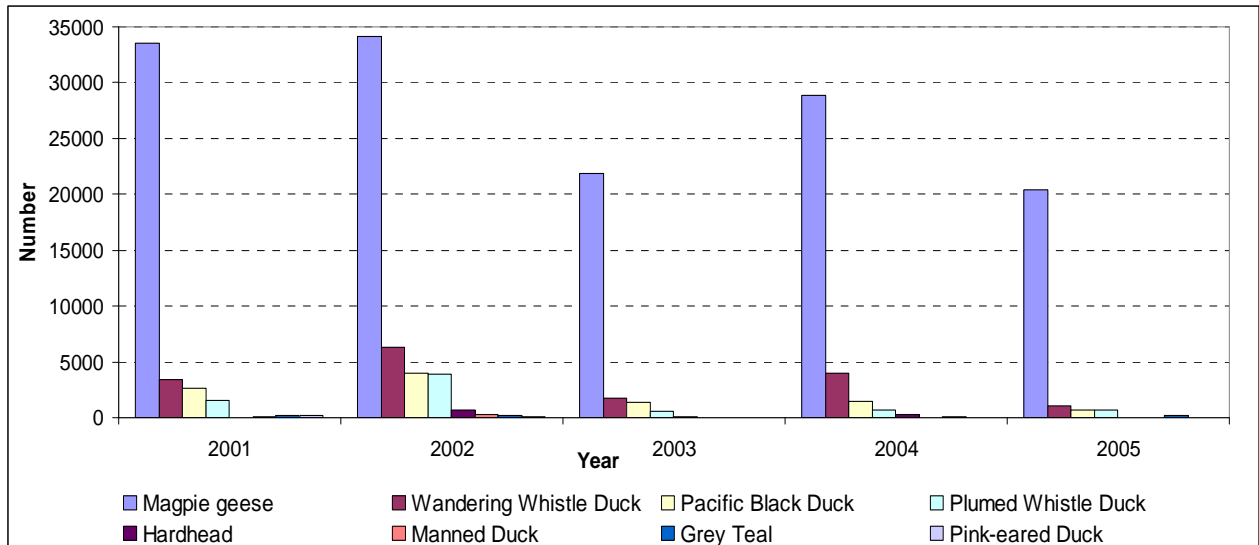


Figure 45 Approximate number of key birds taken 2001-2005

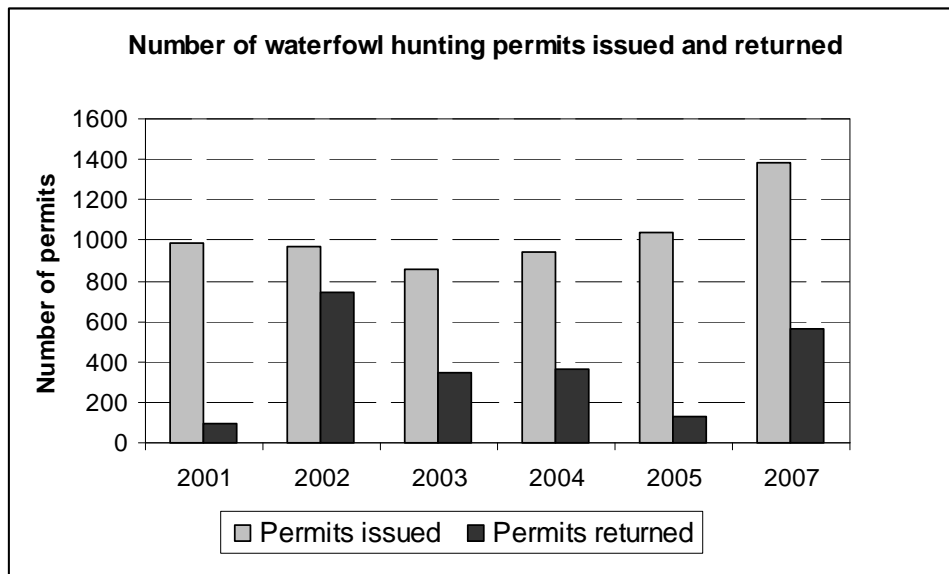


Figure 46 Waterfowl hunting permits issued by Parks and Wildlife, and returns received

Some stakeholders expressed the view that waterfowl hunting is gaining in popularity, a view supported by the increase in number of permits issued for recreational waterfowl hunting, as shown in Figure 46 above. Concern was expressed about the increasing numbers of hunters using what is perceived to be limited hunting areas within the Howard region. One member of the NT Field and Game Association expressed his concern in the following way:

*You buy a permit to hunt these areas and we are now getting crowded out there. It's becoming quite difficult, the etiquette that goes with it (hunting) isn't there...we made an approach to the Environment Minister to have more hunting areas because water fowl hunting is growing now to nearly 1400 permit hunters plus there's kids under that (Interviewee 1, 5/2/08).*

Another person commented:

*I've never seen hunting concentration like it. On any swamp, and given that I live on Howard Swamp, I can hear the shooting every morning and every night and judge, like when the water is there, whether it's worth going down. And I can travel to Lambells or Harrison or Shoal Bay and there will always be other shooters there, every morning and night. I would say that there would be 200-300 shooters total across all four reserves every day of the season, morning and night and that's a four month season. It is relentless, I've never quite seen such an effort (Interviewee 2, 5/2/08).*

Interviewees from both Government and the public believed that the numbers of permits issued over the next few years will continue to increase:

*We're now nearly 1400 (permit holders) and that doesn't include the kids we're nominating; we're allowed to have two kids per adult. What I can see is that very soon we might have another three or 400 come in as they become old enough to get their own permits...could be 1800 (Interviewee 2, 5/2/08)*

Pressure on hunting areas from increasing numbers of hunters was a concern expressed by one Larrakia man, who felt that areas available to hunt were getting 'less and less' but 'there's more and more hunters.' Concern was also raised about not having enough 'to share with our families, especially extended families.' There was also some confusion raised about hunting areas and what was permitted where:

*We've all got our licenses and all that and abiding by the law but it just seems as that the government is getting less and less shooting spots for us and as I said we don't know whether we're breaching or breaking the law 'cause there's all the signs going up (Interview, 6/2/08)*

### ***Indigenous hunting and gathering***

Both Indigenous and non-Indigenous hunters spoke passionately about hunting and their ability to continue to pursue this social and cultural pastime. For Larrakia people, hunting is intrinsically connected with providing for the family and, whilst socially enjoyable in its undertaking, is not considered a sport. Non-indigenous hunters appeared to place less value on the product they obtained from hunting (the catch) and more value on the process of hunting, such as the use of decoys and hunting dogs. Only Indigenous respondents referred to collecting plants and gathering other bush foods.

The following comments were made by Larrakia and other Aboriginal hunters:

*There was one place in that old Shoal Bay place –they used to call it Cooliago – just opposite Tree Point, there's one good spot there –I think the Army looking after it, that be good. There's one place there, that this old bloke showed me, there's prawns everywhere all year round prawns, fish everywhere. It was like a Garden of Eden (Interview, 31/1/08)*

*I only saw two kangaroos there the other day, a mother and a little baby, but I won't hunt them, 'cause I only hunt if I have no tucker. That's the only time I go hunting, even fishing – I'll only go fishing if I've got no food. Or no money to buy I'll go and catch it,*

*but that's about all. There's still a lot of bush plants there, like wild grapes, billy-goat plum – there's lot's still there. But I've been clearing it around, so they don't get burnt (Interview, 1/2/08).*

*I love it (water lilies) too, I eat it when I go bush.. It's all over the country. You can always get a feed I reckon, if you treat and hunt in the right manner (Interview, 31/1/08).*

This respondent added:

*I have been a hunter all my life, 'cause I grew up in the bush. I've had Aboriginal people to teach me how to do things you know...I've been hunting every year, because I love shooting, hunting...I love to shoot and share my food with others you know... that's the best part of Aboriginal people (Interview, 31/1/08).*

Those interviewed revealed that one's sense of connection and affiliation to an area is strengthened through historical events or more personally, historical family connection. This was a central theme that emerged through interviews with Larrakia respondents. When asked about the importance of an area people spoke of events in the past as frequently as they spoke of the present. This was common within discussions relating to hunting activities with family. The following comment from Victor Williams is indicative of the social identity forged through customary activities such as hunting. Social identity is reinforced by a sense of common tradition, a shared lifestyle and shared beliefs relating to responsibility to country:

*I can remember and recall when I was a young, really young lad, some five year old to six year old ... I used to go out with my Uncle and the rest of the family ... We used to go out to Humpty Doo, we used to call into the camp there where everybody used to stay ... family, and all the old people you know? And I remember a lot of those old people used to speak Larrakeyah language and you know we used to go in this truck ...I don't know what type of truck it was ... It was an old army, ex-army military truck during the war era, and we used to go out at Humpty Doo, out through where the old rice fields are, and my uncle used to shoot all the goose ... I remember when the old people used to pluck goose and singe them, then cook the goose on the fire and not fully cooked but the way we eat it ... and they use to make the old goose wing feather, and we use to fan ourselves with the old goose winged-fan, especially in the dry season...that was 46 years ago when I went out there, I was only a young lad. You know I could remember those old people singing with didgeridoos and clap-sticks at Humpty Doo (Interview, 8/2/08).*

Some concern was expressed at restrictions on hunting, including decision making around the determination of open season on waterfowl hunting:

*I think they're wrong sometimes (fences), and yet preservation is a good thing. ... should open up at a certain time some swamps and ... open up areas that they can shoot before the right time you know? Because it's better to eat a bird when it's beautiful and fat, and some years they'd been skinny, hardly any fat on them (Interview, 31/1/08)*

Hunting in accordance with Aboriginal tradition is a legal right protected by the *Native Title Act 1993* (Cth), and by NT statute such as the *Pastoral Land Act 1992* (NT). Section 211 of the *Native Title Act* ensures that activities such as hunting and fishing can be continue without a



licence or permit. A reservation in the *Pastoral Land Act* includes the right to enter onto land, the right to take and use water and the right to take wild animals and vegetation for food and ceremony (Dawson 1996).

#### 4.1.10 Aesthetics, nature study and appreciation

Several groups, including the Top End Native Plant Society and NT Field Naturalist's Club (Darwin) draw together people with an interest in the appreciation of local flora and fauna. These groups include people who have specific interests, for example in the observation and documenting of sightings of different birds, butterflies, unusual or rare plant species, as well as people who like to participate in group guided walks to learn more about the natural environment. Locations within the Howard region are regularly used by both organised groups and individuals for the appreciation of nature. These include Howard Springs, Shoal Bay, the Gunn Point region and many of the lagoons including McMinns and Knuckey.

The aesthetic value of lagoons in particular was mentioned by several of the interviewees. The attraction was attributed more to the overall enjoyment derived from the water feature rather than any one component. An aesthetic value is also reflected in peoples' choices for visiting areas, for instance the popularity of McMinns Lagoon for wedding parties as well as a place to sit and watch the sun set. The following quotes refer to the affective value of particular wetlands in the region:

*I know people that come from town to McMinns Lagoon on a Sunday afternoon ... and sit there and watch the sun set and the birds... The dry season is booked out with wedding parties, they book with the president. People choose to get married down there at sunset, so it's very versatile in that way (Interview, 29/11/07).*

*We go out on the boat for water quality monitoring; that's a rather peaceful thing to do on a Saturday morning. I guess it's aesthetics – its that its in beautiful condition as well...like coming from Sydney, to have a near pristine lagoon just a kilometre or two down the road - it's pretty special (Interview,15/11/07 )*

*The beauty, the nature of a natural spring is very important (Interview, 4/2/08).*

#### 4.1.11 Bird watching

We've got quite a good habitat here, varied habitats, cause we've got the shore with shore birds, and we've good monsoon forest that comes right down to the shore, so you've got different birds in the monsoon forest and then you've got woodlands ... It's very good for bird watching ... you don't have to travel great distances around Darwin cause you've got all the habitats here (Interview, 11/12/07).

The Howard region retains a diversity of habitat that in turn supports a diversity of bird species (described above in section 3.2.1). Bird enthusiasts from around the world visit Darwin specifically to view local birds as well as migratory species at specific times of the years.

As reported by Niven McCrie, a local birding identity, ‘There are some excellent wetlands just outside Darwin and these are particularly good for birdwatching from about June to December. Small reserves such as at Howard Springs and Holmes Jungle provide good areas of spring-fed monsoon forest, where Rainbow Pitta, Rose-crowned Fruit-Dove and other monsoon forest birds can be seen’ (<http://ntbirds.net/>).

#### 4.1.12 Educational value

When I was doing Scouts for 5 years we monitored the water quality; we did the macroinvertebrates, kept a record. That record has been given to Parks and Wildlife and we’re going to try to continue that now. And it could even give them (children) a direction in life. You know they might think, ‘oh science is for me’ and study science. So it’s very, very valuable (Interview, 3/12/07)

The lagoons and other surface water features of the Howard region have consistently provided the setting for community groups, school groups, non-government organisations and government agencies, amongst others, to provide and facilitate educational and learning opportunities for school children and the broader public. Examples include:

- Scout groups undertaking water monitoring exercises in conjunction with Government agencies and learning how to catch and trap cane toads with representatives of the community-based organisation, Frogwatch, at Knuckey Lagoons;
- The local promotion of World Wetlands Day including activities supported by Federal and State Government agencies that focus on engaging the community in such things as weeding, tree-planting and bird watching. These have included field trips to Fogg Dam, McMinns and Knuckey Lagoons;
- Community-based organisations including the Northern Territory (NT) Field Naturalists Club, Darwin and the Top End Native Plants Society both holding regular field trips around the local area, for instance to the Howard’s spring-fed rainforests and Howard Springs which encourage community participation and education and allow for the transfer of information from specialist guides, and
- Local schools including Kormilda College using Knuckey Lagoons and Girraween Primary using local wetlands as an outdoor class room for science subjects, including learning about water quality monitoring.

One respondent enthusiastically relayed their plans for incorporating the local wetlands in the Science curriculum:

*In three more weeks we’re having a sleepover at the school... and we’re doing a toad bust, and we’re having the toad busting guru from Frogwatch coming to join us and teaching us the difference between frog calls, toads verses native frogs. Then we’re going to also listen for the native frogs and see if we can spot any of the native frogs in the wetland (Interview, 22/10/07).*

The respondent added:

*We have had a couple of downpours and a couple of storms that the kids have just been enthralled in and talking more about, in terms of wetlands, and what the water means for the wetlands, and of course because there are the more permanent waterholes over there, we have still been able to access the water (in the dry) and find waterbugs in them (Interview, 22/10/07).*

#### **4.1.13 Community cohesion arising from sense of place**

The role that the Howard River, various lagoons and other surface water features have in not only providing focal points for social and cultural activity, but for providing an opportunity for community cohesion and subsequent capacity building, was a strong common theme to emerge from interviews. This appeared to be a result of a drive by community members to protect or preserve particular areas in support of their social and cultural values. This drive to be actively involved in management included the desire to promote the potential value of an area to other members of the community. In some instances, a strong connection to place has driven people to seek an active management role; for instance through participation in a Landcare group. A sense of ownership or custodianship was common for many of those who were interviewed, largely driven by their need to maintain their favourite places so they can continue to derive the same amount of enjoyment from them in the future.

Several of the more formalised user groups, including AFANT and NT Field and Game, promote active management of the area through their member networks. Other land management groups have aimed to create community cohesion by hosting days where local residents can meet within the shared space of the local lagoon or wetland. The following comments reflect the intentions behind these initiatives:

*We used to do breakfast with the birds, we'd invite everyone from the community or the Darwin area to come and have breakfast with the scouts, and then we'd have pancakes or scones and billy tea. Then we'd usually do a walk to the radar station...(World War II listed relic) so that the community would realise what a valuable area this is (Interview, 3/12/07).*

*There's the wetlands that are behind the Knuckey Lagoon Recreation Reserve...what we are trying to do is...lock that into a green belt so that is protected, and then we wouldn't lock out the motorbikes.. 'cause you can't do that, you can't lock out the horses, cause everyone has a right in public open space to have access to the area. But we could determine an area for the motorbikes, determine an area for the horse riders, and determine an area for the walkers... horses and motorbikes don't mix. (Interview 12/07).*

*We want to preserve habitat ... that's our future (Interviewee 1, 5/2/08).*

#### 4.1.14 An 'escape' from Darwin

Whilst the entire Howard River region is within close travelling distance from Darwin city and many of the popular river places, lagoons and creeks exist within peri urban and more developed hinterland, respondents still spoke of water features in the region as valuable places to 'escape' to. Indeed the proximity of these surface water features means they are readily accessible to Darwin city and rural residents after work and on weekends. Respondents appreciated wetlands for their quiet atmosphere, sense of refuge, sanctuary and relief from city life, as this comment from a Larrakia man indicates:

*Good place for camping in the dry season (Whitestone) and getting away from the city and all that, and wet season its hunting time for goose. It's when all the grass grows, new grass grow ... and bush tucker and wallaby everywhere (Interview, 7/2/08)*

## 5. IDENTIFICATION OF WATER BODIES AND WETLANDS OF SOCIAL AND CULTURAL SIGNIFICANCE

### 5.1 Introduction

Many of the Howard Region's coastal reserves, lagoons and other wetland areas are popular for recreational pursuits and other social and cultural reasons. From interviews with stakeholders we have identified several geographical areas that were repeatedly referred to in the interview process, as well as many other sites that were mentioned less frequently. These sites have been mapped and are inserted in the back of this document, and are also available online at <http://www.terc.csiro.au>.

The following list contains key sites that were each mentioned by four or more interviewees when asked to nominate the wetland sites visited (Table 3). The activities undertaken at each of these key sites are also included.

Place	Social and cultural activities undertaken at site
1. Black Jungle Swamp/Conservation Reserve	Indigenous hunting, hunting, rainforest patches
2. Girraween Lagoon	Boating, fishing, exercising, quad-biking, horse-riding, aesthetic appreciation
3. Holmes Jungle	Mountain biking, orienteering, exercising, traditional hunting
4. Howard River	Fishing, crabbing
5. Howard Springs	Bird-watching, aesthetic appreciation, swimming, picnicking, historical
6. Howard Swamp/Howard Springs Hunting Reserve	Hunting
7. Knuckey Lagoons	Historical appreciation, educational, birdwatching, aesthetic appreciation, horseriding
8. Lambells Lagoon	Indigenous hunting, hunting, birdwatching
9. McMinns Lagoon	Birdwatching, pet exercising, aesthetic appreciation, quadbiking
10. Noogoo Swamp area	Indigenous hunting, hunting
11. Shoal Bay Coastal Reserve	Indigenous hunting, hunting, birdwatching, mountain biking

Table 3 Table showing most popular wetland sites and their corresponding uses

SOCIAL AND CULTURAL VALUES OF WATER IN THE HOWARD RIVER REGION

The following places were also mentioned, but less frequently (less than four occasions) (Table 4). Some of these places were referred to or nominated when discussing issues of concern, arising from environmental pressure for example, rather than being nominated solely as sites or places frequently visited.

Place	Activities or concerns raised about each place
1. Benhams Lagoon	Close proximity of surrounding housing development
2. Dutchies Lagoon	Swimming; hunting and gathering
3. Edwin Creek	Subdivision of this Howard River feeder creek
4. Fischer and Lyons Lagoons (Mentioned together)	Kamfari – motorcycle competition, habitat preservation
5. Hole in the Road	Landcare/management activities, swimming
6. Kings Creek	Fishing
7. Korebum Lagoon and Koolpinyah Station	Waterfowl hunting; Indigenous hunting
8. Leaders Creek	Fishing
9. Leanyer Swamp	Indigenous hunting
10. Limul-Limul Lagoons	Waterfowl hunting
11. Little Howard River	Fishing
12. Micket Creek	Fishing
13. Quambi Lagoon	Waterfowl hunting
14. Saltwater Arm	Fishing
15. Tree Point	Community living area, fishing, habitat

Table 4 Table showing other locations visited or the subject of concern

## 5.2 Popular sites – their use and management

The literature revealed that a number of the key wetland areas within the Howard River region mentioned consistently in the interviews have a rich and interesting history. In the section to follow, historical information, where available is combined with excerpts from management plans and other literature to provide deeper insight into current and past uses and values and the nature of changes observed by respondents. The extent of information available for each site varies considerably depending on the existence of specific studies and other published literature.

Each of the places identified in the tables above are managed under quite varied arrangements. Knuckey Lagoons, Holmes Jungle, Howard Springs, Shoal Bay, Black Jungle and Buffalo Creek are declared Parks or Reserves by the NT Government and managed by the Parks and Wildlife Commission under the provisions of the *Territory Parks and Wildlife Conservation Act 1976* (NT). Other lagoons in the region, including Girraween Lagoon, Benham's Lagoon, Dutchies Lagoon and McMinns Lagoon, are not protected under this Act and are variously owned by private estates, or managed by the Litchfield Shire, or informally through custodial arrangements with community management groups. Other areas include those excised from subdivisions such as 'Hole in the Road' and Churcher Wetlands. In the case of McMinns Lagoon, the Litchfield Shire Council is the present owner of the freehold land known as McMinns Lagoon Wildlife Reserve. Management is undertaken by the McMinns Lagoon Reserve Association, the landowner and the Litchfield Shire Council.

### 5.2.1 Black Jungle Swamp/Lambells Lagoon Conservation Reserve

The Black Jungle Conservation Reserve contains significant pockets of spring-fed rainforest that are inhabited by the endangered palm, *Ptychosperma bleeseri*. These populations and the integrity of the rainforest patches are threatened by weeds and feral animals including mission grass, pigs and buffalo. Fire is also a threatening process occurring within the Reserve.

The Black Jungle / Lambells Lagoon Conservation Reserve is listed under Schedule 3 of the Parks and Reserves (Framework for the Future) Act 2003 (NT). Under this Act an Indigenous Land Use Agreement has been signed between the Northern Territory Government and the Northern Land Council. The two parties consent to the execution of a joint management agreement for the Reserve. A joint management plan for the Black Jungle / Lambells Lagoon Conservation Reserve is currently being drafted.

Lambells Lagoon is one of four wetlands available in the greater Darwin area for seasonal waterfowl hunting, and according to NT Field and Game, is intensely visited for hunting each wet season. Part of the lagoon dries up by the end of the dry season before refilling through surface flow in the wet season. Freshwater turtle shells were evident on visiting the area which suggests that people are continuing to visit the area and hunt there (see Figure 46).



Figure 47 Freshwater turtle shells at Lambells Lagoon

### 5.2.2 Buffalo Creek

Buffalo Creek is a very popular spot with recreational fishermen and Aboriginal people, particularly those visiting from bush communities. The latter have at times collected and cooked shellfish on the middens behind the beach area on the south side of the creek. The use of the north side of the creek is gradually being hampered by the extension of land for special purposes to the creek edge, specifically by the Department of Defence. The area to the south west at the termination of the creek was in the past used as a bombing range. It has largely retained its natural configuration, the only structural additions being a dirt access road and a cement boat ramp.

A sewerage treatment pond and waste release point is located on the creek approximately two kilometres from the mouth at Leanyer. The quality of the water from the pond is of concern to Aboriginal people interviewed, as they have noticed a reduction in the quantities of shellfish at the mouth of the creek and wonder whether there is a correlation with the presence of the pond. According to a newspaper report, sewerage effluent contributed to a fish kill episode in Buffalo Creek: in 1994. The fish were thought to have been killed by oxygen starvation, as a result of a combination of tides, high water temperature and the high nutrient levels from sewerage effluent (Northern Territory News 28/10/94).

*In the dry season Buffalo Creek water quality is impacted by wastewater effluent and in the wet season by both urban run-off as well as wastewater effluent. The concentration of total phosphorus and chlorophyll in the creek is approximately ten times higher than that measured elsewhere, and total nitrogen four times higher (Water Monitoring Branch 2005).*

The longevity of the use of Buffalo Creek is demonstrated by the presence of middens along the southern foreshore facing the beach. Wave action has exposed the layers of deposit in some places. The present use is evident in the many fresh piles of shellfish adjacent to hearths all along the midden areas. The mouth of Buffalo Creek is used for collecting crab, shellfish and fish (Hodgson 1997).



### 5.2.3 Dutchies Lagoon

Dutchies Lagoon lies directly south of Howard Springs and Gunn Point Rd (see Figure 48 below). It is one of the smaller lagoons of the Darwin region with a catchment of 32 ha compared to Girraween Lagoon's 917ha catchment (Schult and Welch 2006). It is surrounded by a housing subdivision with limited set backs. Very little information has been recorded about the history of use of the Lagoon; however one Larrakia respondent had fond memories of visiting the Lagoon as a youngster:

*I used to go there a lot as a young girl, particularly the small pool upstream which had a lot of leaves in it ...good for catching yabbies ...by dangling a little bit of meat in the water. Really sweet yabby meat ... like the green king prawns ... (also caught them) down stream from Howard Spring. That's the sweetest meat that I've eaten around here (Interview, 4/2/08).*

The same respondent recalled witnessing the movement of turtles between lagoons in the area, including Dutchies, and the increased use of the area for hunting and gathering:

*Back then, used to see turtles wandering (on the road)...used to go and take them and put them in the lagoon opposite the post office (Wadham Lagoon?). Don't see them any more as fences have gone up around the place...turtles can't travel between lagoons to breed...and pets probably bail them up. Those fences might be right down into the lagoon. People used to hunt for magpie goose there...probably not anymore. People use to fish and get turtles in the lagoon. That's when everything used to run into each other. Used to be lots of lilies, now there's lots of reeds and the lagoon is full of grass; since they put culverts in the lagoon has been dry more often. The fire brigade burns the grass now (Interview, 4/2/08)*



Figure 48 Google Image of Dutchies Lagoon © Google (2008)

## 5.2.4 Fisher and Lyons Lagoons

Fisher and Lyons Lagoons are situated off Gunn Point Rd to the south east of the Shoal Bay Reserve. The area is managed by the NT Parks and Wildlife Commission, and the area covering both lagoons is registered as a sacred site under the *Northern Territory Aboriginal Sacred Sites Act* (2004).

The lagoons were named after local farmers whose interests included coffee and rubber at Beatrice Hills in the early 1880s and later held large and numerous pastoral leases across the Top End. Compared to the other areas discussed, Fisher and Lyons Lagoons are relatively remote from populated areas; however they are still visited and valued as areas for recreation.

One respondent selected Fisher and Lyons as one of their favourites place to visit within the Howard region because of its ‘great water lilies’ and the fact that it is ‘away from the crowds’. This person was concerned for the Lagoons however because of the ‘activity of the Kamfari race impacting on the ecology of the area’ (Mini questionnaire respondent 2).

The Kamfari is described by the Darwin Motorcycle Club as ‘a four hour endurance event in trying conditions that does not allow any outside assistance. It is one of the toughest mud races in Australia. The track is usually 10-15km long and is made up of wet muddy terrain’ (Figure 49a and 49b) (<http://www.darwinmotorcycleclub.org/>). The Club applies for a permit from the NT Government to hold the event each year and for the fast few years the event has been held in the Gunn Point region.

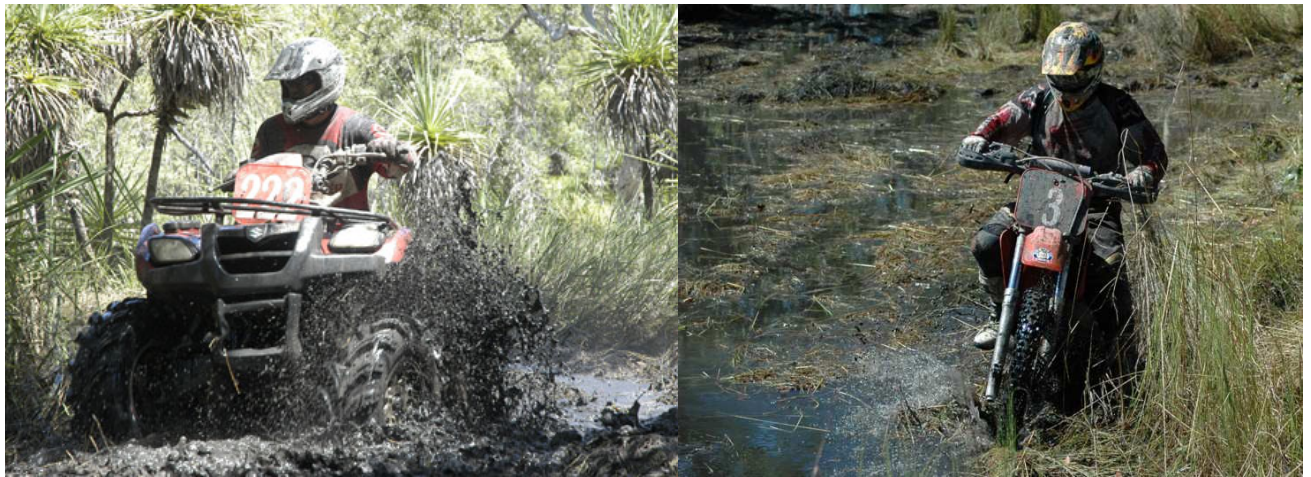


Figure 49a and 49b Photos from the Kamfari: left; 2008, right; 2006. Source: <http://www.darwinmotorcycleclub.org>

## 5.2.5 Girraween Lagoon

Girraween Lagoon, as shown in Figure 50, is a permanent freshwater lagoon located approximately 24 km south east of Darwin. It is one of the largest in the region, encompassing 45.3 hectares with a maximum depth of approximately 5 metres (Schult & Welch 2006). While many of the lagoons in the Darwin region episodically dry out, Girraween Lagoon has been

## IDENTIFICATION OF WATER BODIES AND WETLANDS OF SOCIAL AND CULTURAL SIGNIFICANCE

shown to maintain relatively stable water levels throughout the year (Schult and Welch 2006). The lagoons are generally discrete bodies during the dry season, but they link up along drainage channels during wet season flooding. Water levels in Girraween Lagoon are influenced by direct rainfall, surface water runoff and groundwater recharge. The relative contribution of these inputs is not well understood.



Figure 50 Girraween Lagoon

Despite the fact that Girraween Lagoon is privately owned by the Churcher Estate, it has been used by the local community as an unrestricted recreational area for many years. Activities such as horse, bicycle, trail and quad bike riding and walking are commonly undertaken on the tracks surrounding the lagoon, while the lagoon itself is used for boating and fishing. The lagoon and its surrounding woodlands boast a diverse bird community that is attractive to birdwatchers. The open grassy area near the boat ramp is popular with campers, and the views from the eastern side of the lagoon are particularly good at sunset.

There are a number of processes that potentially threaten wetlands such as Girraween Lagoon. For example, the accumulation of contaminants from surrounding areas, changes to drainage which influence the lagoon's hydrology, and introduced aquatic weed species and feral animals have detrimental effects on the biodiversity of lagoons and their value for native animals and humans alike (Girraween Landcare Group 2007).

The Girraween Landcare group began as an informal group of residents with an interest or concern in Girraween Lagoon. The group became incorporated in August 2006, with a focus on raising awareness of the Lagoon. They have been active in monitoring the health of the lagoon and are currently in discussion with The Litchfield Shire Council, NRETAS and members of the Churcher Estate in attempts to preserve the environmental and social values of Girraween Lagoon throughout the development of the Lagoon vicinity.

Respondents expressed frustration at the perceived lack of Government planning to afford some protection to the Lagoon throughout the current subdivision of the surrounding land:

*The thing that annoys me about the subdivision plans that have already gone through, they don't have to give any of their drainage plans...they've wacked a big drain into the lagoon already...it's just a big open cut drain at the end of the lagoon, and we were thinking well that's just from one road on one side of the lagoon...what happens if they subdivide all the way round? That's something really strange about NT planning processes. I think at this point we should be talking drainage, not after all the approvals have been given (Interview, 15/11/07 )*

*(Girraween) is one of the best lagoons you get in the area and there should be some sort of identification of what's the minimum amount of land that should be left aside around it...I think they were talking 20m, but we're not talking about a minor little lagoon here, we're talking a major lagoon... people use it for boating (Interview, 23/10/07)*

### 5.2.6 Holmes Jungle

Holmes Jungle is an area of mixed woodland bordering a patch of monsoon vine forest to the north east of Darwin. A freshwater spring-fed stream – Palm Creek - runs through the rainforest but tends to stop flowing in the dry season. The area is a declared Nature Park.

Holmes Jungle Nature Park contains one of the few remaining areas of monsoon rainforest in the greater Darwin area, and as such, provides a refuge and breeding area for numerous bird species, some of which are considered vulnerable and are subject to international treaties (see section 3.2.1 above). The Park was established to conserve the patch of monsoon rainforest which exists on Palm Creek. According to the Holmes Jungle Plan of Management 'walking along its many trails underneath the eucalypt woodland or Carpentaria palm forest gives the visitor an appreciation of the flora, fauna and landforms which naturally occur in the Darwin area' (Parks and Wildlife Commission of the Northern Territory 1997).

Mountain bike riding, walking dogs, horse riding and orienteering are also enjoyed at Holmes Jungle. The area is important for education and interpretation because of the diversity of habitats it contains and its proximity to Darwin. The Jungle has long been part of the Darwin recreational setting. It was an often visited picnic spot from the 1870s when it was a long twelve mile horse ride from the then small outpost on the shores of Darwin Harbour (Parks and Wildlife Commission of the Northern Territory 1997). It was also used for 'R&R' by armed forces personnel during World War II. In the early days (1870s), the site was also used for 'collection of flowers and ferns, and shooting or hunting' and later, also for grazing and agricultural pursuits (Parks and Wildlife Commission of the Northern Territory 1997).

Hodgson (1997), in her report on Aboriginal use of natural resources in the Darwin region (past and present), draws on information from Aboriginal consultants to build a picture of current and past use of the stretch of flood plain to the northwest of Holmes Jungle Nature Reserve:

*This (area) was said to have been swampy and covered in reeds in the past. It was once considered a good area for goose and duck hunting. Disturbance by buffalo and other agents has changed this environment making it no longer suitable for waterbirds and associated flora and fauna (Hodgson 1997 p 11).*

Holmes Jungle was described by one respondent as having an ‘amazing rainforesty feel to it’ with an ‘amazing canopy’ (Interview with mountain-bike user of Holmes Jungle, 3/12/07).

One member of the Top End Native Plant Society chose Holmes Jungle as their favourite place to visit within the Study area because of its ‘accessibility’, ‘lovely walking tracks’ and ‘great diversity of vegetation types’ (Mini-questionnaire respondent 1).

### 5.2.7 Howard River

On the bottom side of the Howard River, bottom end of the freshwater side is very good hunting. You can get beautiful freshwater prawns, also long-necked tortoise and also barramundi, and various other freshwater species. Catfish and Yabbies, and also if you have a good look around you might find the odd file snake’ (Interview Larrakia man: 15/2/08)

W. P. Auld of Finnis’s exploration party named the Howard River after Frederick Howard in 1865. Captain Howard was the master of the small topsail schooner HMS Beatrice which carried out exploration work from the Escape Cliffs settlement in 1864. He charted, as a hydrographer, the mouth of the Liverpool River and the coastline between Cape Stewart and Port Essington (Northern Territory Government, 2008b)

The Howard River is one of only a couple of rivers within the Darwin Harbour that flows all year around (Figure 51). It incorporates a catchment size of 497km<sup>2</sup> and has broad coastal plains and low-lying terrain inland of Shoal Bay. This terrain has formed in relatively recent geological times during the Quaternary and consists of flat, poorly drained saline muds and clay plains. Each wet season these plains are flooded by fresh water to depths of up to 2 metres for 6 to 8 months (Darwin Harbour Advisory Committee 2003).

*My boys used to go up there too (spot on the Howard River south of Gunn Point Rd), ride their push-bikes up there, stay overnight, catch a heap of red-claw and come home again. A lot of the places now, you can’t go in, not from this side of the River because this has become private lease and private access. There’s a lot of companies that have got leases there (Interview, 3/12/07).*



Figure 51 Howard River creek line

One local recreational fisherman lamented the growth in use of the Howard River area over the past three decades. He states that *'in the earlier days we could go in there and be there on our own.'* They may have seen another car *'but that would be on the weekend.'* Use of the area has changed and according to the interviewee: *'now if you went out there on a Saturday or Sunday, especially now being a bit wet, you would see utes and trailers and quadbikes...'* (Interview, 3/12/07)

As is evident from the photo below, the Howard River has been a site for social activity for many years (see Figure 52).



Figure 52 Picnicking at the Howard River, 1923. Source: Roy Edwards Collection, Northern Territory Library

### 5.2.8 Howard Springs

Howard Springs was developed as Darwin’s water supply in 1939 when water from the springs was piped to railway dams, overhead tanks in Darwin, and Vesty’s meat works. It was intended as a short-term solution to Darwin’s water shortages pending the completion of Manton Dam in 1942 (Northern Territory Department of Infrastructure Planning and Environment 2002). Following the connection of Manton Dam to Darwin, it became a backup source of water in case of enemy attack on the main pipeline. During the Second World War, rest and recreation camps for up to 120 men were set up here for servicemen from the USA and Australia. The American 148<sup>th</sup> Field Artillery Regiment established a camp at the junction of the North-South Rd and the Howard Springs Rd in January 1942 (Northern Territory Department of Infrastructure Planning and Environment 2002). The RAAF’s No. 9 Airfield Construction Squadron, the AWC and 1<sup>st</sup> Australian Field Company Royal Australian Engineers were responsible for large scale developmental works which included construction and installation of a larger weir, improved pipeline and pumping station during the period 1943-44. A large hospital facility was also constructed at Howard Springs but was not utilised to any extent (Northern Territory Department of Infrastructure Planning and Environment 2002).

The issues influencing the development of what we know today as Howard Springs Recreational Reserve are revealed through the following correspondence sourced from the Australian National Archives (Table 5; NT Reserves Board- Howard Springs Reserve Folio 1: 1970/1330, p1,36,40,104,57).

Date	Comment
12 January 1950 Municipal Inspector to The Chief Clerk:	‘The area around the pool is very untidy and littered with broken bottles, rusty tins and lengths of water pipe. I noticed a 44-gallon drum which was full of goose feathers and intestines. This area has no sanitary conveniences or dressing sheds, and the area around the pool is at the present time being used as an open-air latrine. At the present time the retaining wall of the pool is being badly damaged by vandals using it for target practice for .303 rifles and a lot of the broken bottles have been used for the same purpose. This is one of the few areas near Darwin where ferns and other native plants etc. grow in large numbers. This natural plant life is fast becoming destroyed by vandals.’
13 January 1950 Municipal officer to Chief Clerk:	‘Complaints have been made about the indiscriminate use of firearms in the vicinity and I recommend that steps be taken to have an area defined and proclaimed a sanctuary for bird, animal and plant life and that the use of firearms within that area be prohibited’.
31 January 1950 Acting Chief Clerk	‘The site is used periodically by school and Sunday school children, and other parties, and for Union picnics, when the attendances reach a maximum of probably 500-700 people. There are no facilities for picnic or camping parties, with the result that camps are set up discriminately, and one shack built of scrap material, and other structures, are left standing near the pool and attract undesirable campers.’
21 September 1950 Municipal Officer to Chief Clerk	It was recommended that a minimum radius of 1 mile from the springs be defined “If a shorter radius than one mile were fixed, there is a probability that shooting parties would remain just outside the area, and one or two

	unarmed members could enter the sanctuary area and disturb the game birds (geese and ducks) therein, and while the birds were circling around they would come within range of the shooters waiting outside.”
<p>In 1952 a one mile radius from the centre of the Dam at Howard Springs (area of 2011 acres) was declared to be a Bird Protection District under the Birds Protection Ordinance 1928-1940. Following this declaration the Howard Springs Recreational Reserve (containing 700 acres) was ‘reserved by proclamation dated 22<sup>nd</sup> May 1952’</p> <p>In 1956 proposals for the development of Howard Springs were raised by the Town Management Board. Septic Tanks, dressing sheds, children’s pool, diving board and pontoon, picnic shelters, fencing and beautification were recommended.</p>	
5 March 1957 The Curator of Parks and Gardens, James Worland	“From the outset it must be appreciated that this pool should only be utilised during the wet season when the water is on the move and that once the water ceases to flow it could not be recommended from a health angle’
18 December 1962 Northern Territory Reserves Board to the NT Administrator	‘As you may be aware, the Reserves Board, in conjunction with the Northern Territory Zoological Society, is making plans to establish a Fauna Park within the boundaries of its Howard Springs Recreation Reserve. Briefly the objectives are to stock the “Park” with all species of Northern territory fauna, and attract wildlife to constantly inhabit the place”.
<p>In 1977 the camping ground in the Park was closed because of the excessive demands the facility placed on Park Management.</p> <p>In 1981 there estimated visitor numbers of 200 000.</p>	
1982 Department of Transport and Works letter to Conservation Commission NT; in response to Draft plan of Management for Howard Springs	“Pump tests on the two bores indicate that there should be no effect on the springs if they are pumped at the recommended level. The effect of development of the Benhams Lagoon borefield is presently being investigated with respect to effect on Howard Springs flow and the Commission will be notified of the results’

Table 5 Historical issues in the development of Howard Springs as a Recreational Reserve

The groundwater spring in Howard Springs Nature Park supports highly water dependent vegetation communities (spring fed and riparian monsoon forest) and aquatic flora and fauna (Figure 53). The spring is also the main water source for the waterhole that is the focus of most recreational use (swimming and aquatic wildlife viewing). The spring flow decreases progressively from about 300 litres/second at the height of the wet season in February to an average of about 20 litres/second at the end of the dry season in November. After a series of years with below average rainfall the spring may stop flowing (Northern Territory Government 2006). At the end of the wet season water quality is high because the waterhole and its catchment have been flushed out by increased surface runoff and continuous spring flow. During the dry season water quality progressively deteriorates as the spring flow decreases (or ceases) and the concentration of organic material (organisms, sediment, dissolved solids, leaf



lifter etc.) In recent years the pool has been closed to swimming due to unacceptably high levels of bacteria thought to be a result of decaying organic matter combined with low flows.



Figure 53 The main spring at Howard Springs

One respondent chose Howard Springs as their favourite place to visit within the Howard region because it was an ‘area to swim with small children’ (Mini Questionnaire respondent 10). Those consulted revealed mixed feelings towards the closure of the swimming pool (Figure 54).

One respondent expressed concern about the Government decision to allow landowners in the Howard River Park development, within close proximity of Howard Springs, to drill bores for watering their gardens and other non-consumptive purposes when they were already connected to reticulated (town) water:

*Howard Springs has been in the news lately, it appears as though it's not getting enough flow. They're saying that it could be because the government allowed bores in the Howard River area. They gave them permission to have bores in this area, which normally you wouldn't be allowed to have (because the properties are 2 hectare blocks which are on town water). Then they put a moratorium on it, because the people in this area...south, who probably drink out of this same aquifer, are at risk 'cause they only have bore water. These people in Howard Park have town water and are pumping for their garden within 100 metres of their septic tanks. That to me seems like a very poor sited policy from the government and of course... it still exists (Interview, 23/10/07).*

Larrakia respondents were also concerned about Howard Springs:

*Howard Springs, we used to swim all in that area – no one used to worry about what was going on there – you can't swim there that Howard Springs...don't know what's going on there. I don't know what it is, but before we used to swim all the time. They reckon there's some sort of disease in the water. We never used to worry about things like that, we would just swim (Interview, 1/2/08)*

*Larrakia people have always enjoyed Howard Springs. Over the years that has turned into a stagnant pool (Interview, 30/1/08)*



Figure 54 Howard Springs swimming pool

The picnic areas, walk tracks, aquatic and other wildlife viewing opportunities also attract visitors to Howard Springs. According to the collection of visitor numbers between 2003 and 2005, the dry season months of June, July and August were the most popular for visitors with an obvious drop in overall visitor number in 2005 compared with 2003 and 2004 (Figure 55). Interestingly, this coincides with the closure of the swimming pool in early 2005 due to drying of the spring and the resultant poor water quality.

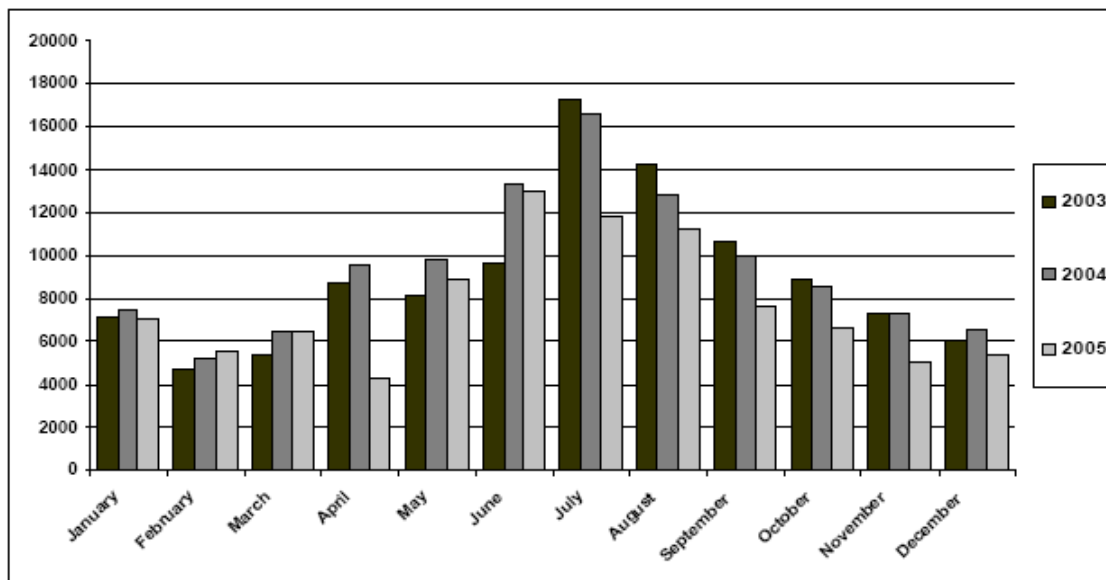


Figure 55 Monthly visitor numbers for Howard Springs Nature Park 2003-2005. Source: Howard Springs Nature Park Draft Plan of Management, Northern Territory Government (2006)

Howard Springs is also popular place for birdwatching. One respondent felt that the lack of recent swimming due to the pool's closure was not necessarily a negative outcome and they should 'keep the no swimming ban' and turn the area into a 'wildlife viewing area' (Mini-

questionnaire Respondent 2). Another selected Howard Springs as their favourite place to visit because it is an 'easily accessible pocket of rainforest with [a] wide variety of birds' (Mini-questionnaire Respondent 3).

According to the NT Government's Draft Plan of Management for Howard Springs Park (2006), the cultural heritage values of the park derive from the spring fed pool that was originally built during WWII and used to supply water for Darwin, and then later used as a rest and recreation area for servicemen based in Darwin during the war. Indeed one respondent selected Howard Springs as their favourite place to visit in the Howard region because of its 'rich history' (Mini Questionnaire Respondent 2). The Park was also the first in the Territory to come under the Northern Territory Reserves Board and as such is considered to be the first park in the Territory in the modern era of park and reserve management (Northern Territory Government 2006).

The Park also has considerable value for education and interpretation derived from the variety of ecosystems and wildlife and cultural values easily accessible to school groups, as well as the general public. Woorabinda Youth Camp provides the opportunity for environmental study groups to camp within the Park, for example (Northern Territory Government 2006).

Since 1992 there has been considerable development in and around the Park and the Litchfield Shire Land Use Objectives provide for further development. Increased development and clearing of land to the south of the Park is likely to result in further increases of sediment and pollutants in the runoff entering the spring and waterhole (Northern Territory Government 2006).

As a consequence of this development, a large number of domestic and other types of bores have become active in the surrounding area, resulting in considerable public debate about the impacts on the springs. In normal rainfall years the spring flow is unaffected by the drawdown from these bores. In low rainfall years the spring may cease to flow because the groundwater level in the aquifer drops. The springs are likely to cease flowing earlier than normal in low rainfall years because of the additional draw down from surrounding bores (Northern Territory Government 2006). In low rainfall years it is likely that the springs cease flowing earlier in the dry season than under normal conditions because of the drawdown from surrounding bores.

Other management issues, such as feral animal pressures, are reported on in the Draft Management Plan for Nature Park (Northern Territory Government 2006).

### **5.2.9 Howard Swamp and Hunting Reserve**

Howard Springs Hunting Reserve was declared in 1984 for the conservation of flora and fauna and as a game reserve for duck and geese shooting. It is north of the Howard Springs Nature Park and covers an area of 1,605 hectares (Conservation Commission of the Northern Territory 1992). During the wildfowl hunting season, shooting of approved game is permitted in the Hunting Reserve. The Reserve is Darwin's closest approved waterfowl hunting area. This factor, combined with the closure of Noogoo Swamp to hunting, has put the Reserve under increased hunting pressure. All hunters are required to hold a valid permit to hunt approved species from the Conservation Commission. For safety reasons no shooting is permitted in that part of the Reserve closest to the Park, shown as the Buffer Area in Figure 56.

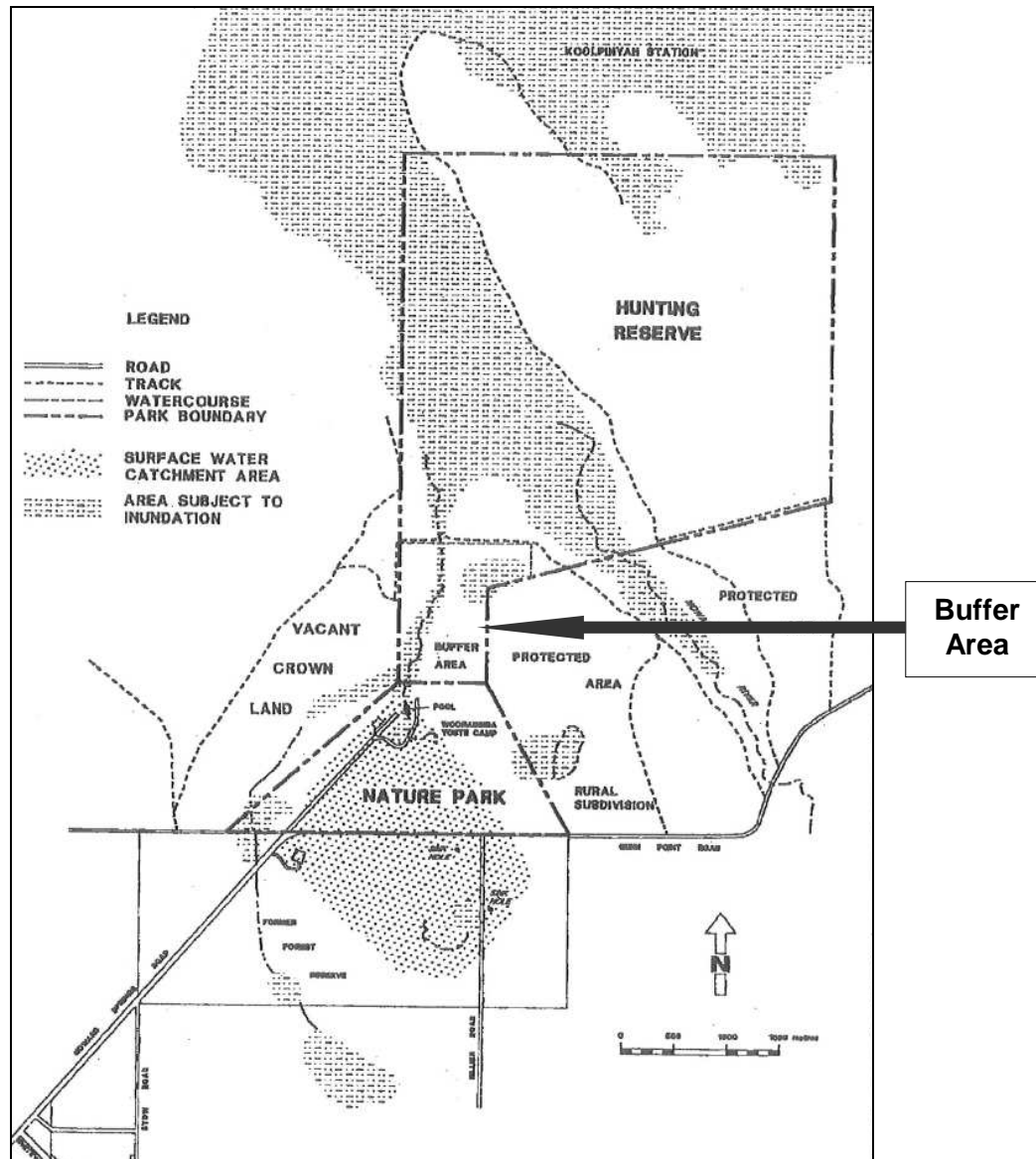


Figure 56 Map showing the Howard Springs Nature Park, Hunting Reserve and Buffer Area. Source: Conservation Commission of the Northern Territory (1992)

### 5.2.10 Knuckey Lagoons

Knuckey Lagoons Reserve is named after the well-known bushman R.R. Knuckey, who was in charge of a section of the Overland Telegraph (Barr 1978). Management of the Conservation Reserve is the responsibility of the NT Parks and Wildlife Commission under the provisions of the *Territory Parks and Wildlife Conservation Act*. All mammals, birds, reptiles and amphibians in the Reserve are protected. As a declared protected area the use of firearms and traps is prohibited. Aquatic life is protected under the *Fisheries Act* (NT). Under section 122 of the *Territory Parks and Wildlife Conservation Act* traditional hunting and collecting by Aboriginal people may be carried out on the Reserve. It is zoned Open Space-Conservation under the Litchfield Shire Zoning established under the Northern Territory *Planning Act*.

Presently, no sacred sites have been recorded or registered with the Aboriginal Areas Protection Authority for Knuckey Lagoons Conservation Reserve, however, any Aboriginal artefacts

within the Reserve are protected as 'Prescribed Archaeological Objects' under the *Heritage Conservation Act*. Sacred Sites are protected under *Northern Territory Sacred Sites Act* whether or not they are recorded.

Knuckey Lagoons Conservation Reserve contains perennial, temporary and intermittent lagoons which are connected to the groundwater table. Consequently the lagoons reflect the fluctuations in the level of the water table (Parks and Wildlife Commission of the Northern Territory 2000). The Reserve's Lagoons contain water long after the wet season has passed, providing an important habitat for native wildlife particularly Magpie Geese (*Anseranas semipalmata*), the Little Curlew (*Numenius minutus*), Egrets (*Ardea ibis*, *Ardea alba*, *Egretta intermedia*, *Egretta garzetta*), and the Long-necked Turtle (*Chelodina rugosa*), as they wait out the dry season (Parks and Wildlife Commission of the Northern Territory 2000).

Knuckey Lagoons has a rich history. Knuckey Lagoons was used as a market garden to grow vegetables to supply to both servicemen and the Darwin population during World War II and an old well can still be found today that was used to water crops (Interview, 3/12/07; Figure 57). There is evidence that 'rice gardens' were also maintained by Chinese farmers in the Knuckey Lagoons area at 'Milners Lagoon' at the end of the 1800s and into the early 1900s. There is one old photo in the Northern Territory archives that attests to this (Photo No. PH0001/0022 in the Tracey Collection). Other photos in the Territory Archives show horse racing occurring at the racecourse adjacent to the north-east of the main lagoon on picnic days, and motorcycle racing – thought to have occurred around the boundary of the lagoons in the dry season. Knuckey Lagoons was known to be a popular site for picnic and race days during the war era, when towns folk from Darwin would take the train to Knuckey Lagoons siding (Interview, 3/12/07). The remnants of the train track can still be seen to the south of the Lagoon complex adjacent to the Stuart Highway.

The Lagoons were used in historic times as a meeting and camping place by Aboriginal people, particularly those visiting Darwin (Hodgson 1997). Eylmann (1908) as translated by Hubel (1994) camped there in the wet season with Aboriginal people as long ago as 1896, sharing a shack with Chinese railway workers. He commented on the steady stream of Aboriginal people in transit who used the camp. In the mid 1970s, about 50-60 Aboriginal people were living around Knuckey Lagoons, and during the wet season when Aboriginal people from outlying cattle properties would come and stay at Knuckey Lagoons, the population would rise to between 150-200 people (Hodgson 1997).

Marjie Pan Que of the Kamu language group lived in a home on acres to the east of the lagoon, about 500 metres from the waters edge. Marjie recalled Aboriginal people visiting her from the camp with gifts of food from the lagoon (Hodgson 1997).



Figure 57 The old well at Knuckey Lagoons that was used by market gardeners during World War II

Aboriginal people persisted in living in the Knuckey Lagoons area as development encroached upon them in the 1960s and 70s. They had little access to basic shelter and no amenities such as running water and sanitation. In particular the old people were finding it a struggle to continue living in this place which had become their home. Historically many had travelled to the Knuckey Lagoons area to meet up with family during the pastoral off-season over the Wet. This brief snapshot provides some context within which a group of Knuckey Lagoons residents began to push for acknowledgement of Knuckey Lagoons as their preferred living area and attempt to secure some basic services to ensure they could remain living there with their families into their future. The following information provides some insight into the connection that Aboriginal people living in the region had and have with Knuckey Lagoons.

According to documentation sourced from the Australian National Archives, correspondence about the living situation of Aboriginal people at Knuckey lagoons began with a letter, sent from the Cities Commission to the Department of Aboriginal Affairs in 1974. The letter was in regards to planned developments of an area close to where Aboriginal people were ‘encamped’ around Knuckey’s (sic) Lagoon. They highlight two Aboriginal sites of significance relevant to the Howard Springs study area. These were the Murdak Ground at Howard Springs and the area surrounding Knuckey’s Lagoon known as the Barrumundi Dreaming area (Australian National Archives 1974).

*It is understood to be currently used as a camping area and the lagoon is used both as a drinking water source and swimming/bathing place. The vegetation in and around the Lagoon – specifically the stems of water lilies and reeds – are used as food by the inhabitants of the area (1974: p6-7).*

Within the same letter, ‘formalisation’ of Knuckey Lagoons was proposed ‘in order to eliminate the mosquito breeding areas in the Lagoon.’ By formalisation it was implied that ‘the water feature would be of sufficient depth of water to eliminate mosquito breeding areas and have sharp banks clear of vegetation’ (1974: p6). The Aboriginal Development Foundation held a meeting at Knuckey Lagoons Camping Area shortly after to address the needs of the people living there including better accommodation and the availability of some key services, including for ablutions. The residents outlined their reasons for wanting to stay there including:

## IDENTIFICATION OF WATER BODIES AND WETLANDS OF SOCIAL AND CULTURAL SIGNIFICANCE

- That the old age pensioners who are living there are ex-cattle station workers and that they are keeping a place for their relatives who work on cattle properties in the dry season and come to Darwin in the wet season.
- That these people come in from at least four cattle properties as well as Missions and Settlements.
- With the ever increasing number of Aboriginal people employed on cattle properties, places like Knuckey's Lagoon [*sic*] is where they are setting up their camps (1974: p12).

According to the minutes of the meeting 'Discussions with the family groups revealed that they had no wish to live anywhere in Darwin. Also as they have been here for so long, there was the feeling that the lagoons belonged to them' (1974: p10). And that further,

'Discussions of future land development around the lagoons brought out requests that they submit a Land Claim for the area. It was voiced that the lagoons held meaning for Aboriginal people and that it should be Aboriginal people who live around them' (1974: p10).

In 1980 an area of land adjacent to the Reserve was granted to the Aboriginal Development Foundation to provide hostel type accommodation for Aboriginal people. This Aboriginal Community is known as Knuckey's Lagoon Community.

Although management of the Reserve is the responsibility of the Parks and Wildlife Commission, local residents have formed a community group, *Knuckey Lagoons Wildlife Sanctuary Incorporated* and executed a formal agreement with the Parks and Wildlife Commission to assist with the planning and management of the Reserve.

Since then, the group has developed a meeting hall, walking tracks and carried out revegetation and weed control activities. The 1st Berrimah Joey Scouts are based at the reserve and have won national awards for their Weedbuster Week activities. The group is continuing to improve the management of the reserve with assistance from the Parks and Wildlife Commission, Greening Australia and Landcare.

Both Knuckey Lagoons and McMinns Lagoon have been listed in the Directory of Important Wetlands in Australia. The Reserve's natural values are related primarily to its importance as a wetland habitat for a variety of birds and other wildlife. Several of the birds that use the area are listed on the bilateral agreements with the Governments of Japan and China for the protection of migratory birds and their habitats. Knuckey Lagoons and McMinns Lagoon have been listed in the Directory of Important Wetlands in Australia as a supplementary site for the NT as part of the Darwin Peninsula Swamps. Whilst not considered nationally important in its own right, as part of a supplementary site the Reserve supports and contributes to the values of other nationally important wetlands across the Top End.

The Plan of Management reports on the aesthetic values of the Reserve: they derive from the views provided of water and waterlilies during the wet season and the congregation of bird life around the lagoons when other water bodies subside during the dry season (Parks and Wildlife Commission of the Northern Territory 2000). Due to its location and ease of access it is a popular site for birdwatchers. Historical and contemporary use of the Reserve by Aboriginal

people is noted for its importance on the Plan of Management. The historical values of the Reserve relate to its use as a recreational area and use by the defence forces during WWII. Chinese gardeners, including rice growers, also used the area during the early development of Darwin. The educational and interpretative values of the Reserve relate to its habitats and wildlife, its use by Aboriginal people and its historic values.

The Reserve's scientific and educational values relate to the opportunity to study a wetland habitat and its importance to wildlife, particularly waterfowl, migratory birds and freshwater turtles within a semi-urban environment. The contribution of the Reserve's wildlife and their habitats to the conservation of biological diversity within the Darwin Region also gives the Reserve scientific value (Parks and Wildlife Commission of the Northern Territory 2000).

Residents living directly adjacent to the main lagoon have observed changes in the hydrology of the area since significant open drains were constructed on Agostini and Thorak Roads to prevent seasonal flooding of surrounding property. One resident who has lived across from the lagoon for over 20 years stated that while 'even in the early years sometimes the Lagoon would dry up completely, it wouldn't on a regular basis.' The resident has noticed that 'there's usually a little bit of water in the lagoon' however 'since the drains have gone in, it year by year has drained out completely.' They have heard that 'this is because the big drains take too much water out of the lagoon... not enough water to be retained'. But they also felt that this artificial change to the hydrology of the lagoon 'doesn't really affect the Lagoons that much in that the turtles just dig themselves down into the ground, the fish species as well stay from year to year' (Interview, 3/12/07).

One respondent chose Knuckey Lagoons as their favourite place to visit within the Howard region because 'I enjoy seeing the waterlilies and birdlife during the wet season'. The only thing preventing them from enjoying the Lagoon more was having 'no time to stop' (Mini questionnaire respondent 8). Another respondent also chose Knuckey Lagoons as their favourite place because of the 'variety of birds that congregate' as well as the waterlilies, however they felt that their enjoyment was hampered by evidence of 'wild dogs roaming free', 'weeds encroaching on the lagoon' and 'fires almost annually' (Mini questionnaire respondent 9).

There have been some suggestions made about increasing the amenities available at Knuckey Lagoons which one respondent reflected on:

*I think the school groups that come in and appreciate the birds are wonderful, but it's another issue putting in toilet facilities. We'd wanted to put a bird hide in so you don't disturb the birds...and that way, it could be used as an educating tool as well, but of course as the money dries up it's harder to get money to do these things as well. I would really love to put a table and chairs in there so that you can take a bottle of wine and sit there on a Sunday night and just watch the birds. I think that would be wonderful. But, big changes ... I don't know... we like it to be as it is... and yet we like people to come and appreciate the beauty as well! It's a hard one (Interview, 12/07/07).*



### 5.2.11 Koolpinyah Station and its lagoons

The area encompassed by Koolpinyah Station was once more extensive than the area it covers today. It formerly reached closer to Darwin and extended further south over what is now Humpty Doo, Howard Springs and the Shoal Bay Coastal Reserve.

Sugar growing was attempted in the Shoal Bay region (Wilson and Estbergs 1984), and persisted until 1889 when the planter, Brandt, admitted defeat. He later experimented in growing tobacco. The Chinese had greater success at agriculture, seeking out areas of good soil and growing a range of tropical and sub-tropical fruits and vegetables. Substantial areas were also planted with rice with good results. Cotton was also grown in the early 1920s around Shoal Bay, as were coconuts.

Koolpinyah Station was taken up as a mixed farming lease by the Herbert brothers in 1908 and it included buffalo, goats, tropical fruits as well as cattle (McGrath 1987) From its inception many Larrakia, Wulna, Limilngan and Tiwi people worked on the station. The diaries from Koolpinyah Station, written by the brothers, 'give the distinct impression of two economies and cultures meeting at the point of labour and commodity exchange, though they also intersected on a social level' (McGrath 1987). It has been recorded that Larrakia and other Aboriginal people collected goose eggs annually at Koolpinyah Station, on the boundary of Larrakia country, and close to extensive floodplains during at the end of the wet season (Wells 2003).

Koolpinyah Station holds Korebum and Limul-Limul Lagoons which have been favourite hunting places for Indigenous and non-indigenous hunters, past and present. Until recently people still shot waterfowl on Koolpinyah Station which was tolerated to some degree by the manager and owner of the Station.

*We also patrol that area with police – the Limul-Limul and other lagoons on Koolpinyah that border our country. So there's Korebum...we patrol these with the police for illegal hunting 'cause that's private land. He's got 'No Trespass' signs on all of his Gunn Point roads there, they're pushed over or still standing some of them. But you'll also see new tracks starting off that Gunn Point Rd that have got no signs up, so people just bypass the signs and push their way into that country (Koolpinyah) (Parks and Wildlife Officer)*

In discussion with shooters who were interviewed for the project, there was appreciation for why a decision was made to exclude hunters from the Koolpinyah area given that:

*...30 or 40 hunters would turn up there every night (to the fence line adjacent to Quambi Lagoon where Koolpinyah Homestead is located), especially Thursday night onwards, and just shoot at passing birds going from here back toward the coast. And it was a phenomenon that I've never seen. But the rubbish was just unbelievable. You know there were nappies, just everything and you know in the end I suppose the din of these shots just going off every night...(Interviewee 1, 5/2/08)*

*And people going over the fences (into Koolpinyah Station) after birds...they were actually warned and disregarded the warnings so it was closed off (Interviewee 2, 5/2/08).*

The respondent continued:

*Koolpinyah used to be an area we were able to access once... it's closed off now, it's private now. Yeh, Korebum and Limul Limul (Lagoons) (Interviewee 2, 5/2/08).*

### **5.2.12 Leaders Creek**

Leaders Creek is the major focus of recreational activity on the Gunn Peninsula. The freshwater creek provides the only reliable wet season swimming hole on the peninsula. The freshwater creek crossing is used for overnight camping and as a day use picnic area (Conservation Commission Northern Territory nd.). Boat owners use the ramp on Leaders Creek to access the major recreational fishing locations of the Vernon Islands and the Adelaide River delta.

One respondent highlighted the importance of Leaders Creek as providing a launching point to the Vernon Islands as well as being a good river to fish in its own right (Interview, 22/10/07).

### **5.2.13 McMinns Lagoon**

South east of Darwin is a reserve known as McMinns Lagoon (Figure 57). The Reserve is established under the NT Parks and Wildlife Act.

The McMinns Lagoons Reserve Association (MLRA) has taken responsibility for much of the day to day management of the Lagoon Reserve. Strategic management decisions are made by the McMinns Lagoon Reserve Management Board: a board set up under Litchfield Shire Council which has representation from the Reserve Association. The MLRA receives annual funding from Litchfield Shire Council for things like the bore, maintenance of the fire shed and other equipment. Funding for capital items such as their small tractor with slasher and bucket comes from the Litchfield Shire Council's Reserves Board funding. So for ongoing operations they are covered with some funds from the Litchfield Shire Council, but if they wish to take on any specific projects then they have to seek funding through another organisation or program such as Envirofund.

The lagoon is very popular for recreation activities and passive activities such as walking, horse-riding, picnicking, canoeing and birdwatching (Figure 58) are promoted and encouraged in the reserve. Management of the reserve also recognises the native title rights of the Larrakia people to utilise the resources of the reserve in a sustainable manner (McMinns Lagoon Reserve Association 1999).



Figure 58 McMinn's Lagoon

McMinn's Lagoon, as seen in Figures 58 and 59, becomes a perched water body in the dry season, being several metres higher than the surrounding groundwater level. It is almost a separate hydrological unit, the base material of the lagoon is not totally impermeable although downwards loss or leakage is slow (Schult and Welch 2006).

Changes to the environmental condition of the lagoon have been witnessed by local residents and have been documented in the record of the Association (McMinn's Lagoon Reserve Association 1999).

- For the first time since the 1930s, the lagoon dried up completely in the 1970s. Not much else is known by local residents about this event.
- It is assumed that the dead or dying paperbarks on the south side of the lagoon are as a result of Cyclone Tracy (Brian McWilliam, MLRA as cited in McMinn's Lagoon Reserve Association 1999).
- In the 1990 dry season an almost complete drawdown of the lagoon occurred with a resultant emigration of Northern long-necked turtles from the lagoon.
- Very high rainfall during the Wet Season of 1994/95, and again during the Wet Season of 1996/97, resulted in much higher than normal water levels in the lagoon. Around the beginning of May 1995 the lagoon overflowed into the eastern drainage channel and flooded surrounding properties.
- During the 1970s waterskiing occurred in the lagoon (McMinn's Lagoon Reserve Association 1999). Today both fishing and boating (other than canoeing) are discouraged, as is set out in the McMinn's Lagoon Plan of Management.



Figure 59 McMinn's Lagoon with magpie geese in flight

Relatively complex custodial and management arrangements exist for McMinn's Lagoon as described by the following respondent:

*The sub-division around the Lagoon actually happened long before there was a Council (Litchfield Shire Council). That's probably the reason now why you see the way it's cut in so close to the lagoon, but the land is owned by Litchfield Shire Council. The McMinn's Lagoon Reserve Management Board is actually a board set up under Litchfield Shire Council (LSC). The same as Knuckey's Lagoon, Fred's Pass Reserve; there's 7 of them across the current Litchfield Shire, and so we receive a certain amount of funding from LSC every year and then for capital items, like we have a small tractor with a slasher and a bucket, those sorts of things actually come from Litchfield Shire Council from their Reserves Board funding. So it's more the natural resource management work that we get the funding for, from Envirofund, or those sorts of things. We kind of operate down the middle, we have the Reserves Board funding and that's really for things like the bore, maintaining the fire shed that was handed over, things like that, and maintenance of equipment. Whereas any new projects or any particular equipment that the group decides they want to get, for the Lagoon, then that's done actually through us seeking funding from another organisation (Interview, 29/11/07).*

One respondent nominated McMinn's Lagoon as their favourite place to visit within the Howard region due to being 'easy to access, very aesthetically appealing, well-cared for and good infrastructure and facilities – e.g. walking path, picnic area.' However they felt their enjoyment of the area was compromised by 'motorbike riders' who also use the area (Mini questionnaire respondent 4). A second respondent liked McMinn's lagoon because of the feeling of 'familiarity', its 'natural environment' and the 'critters' that lived there. They believed there was some 'very occasional engine intrusions' but not enough to cause conflict with their use 'at present' (Mini questionnaire respondent 6).

### **5.2.14 Micket Creek**

Micket Creek is described as a muddy estuarine creek. In the past, freshwater wells along the backswale could be used for drinking water (Hodgson 1997). Runnels seen across the mangrove flats are usually created by freshwater springs. After Cyclone Tracy in 1974, the oyster beds on the east side of the creek were depleted and the mangroves severely damaged. The site was used by Aboriginal people in all seasons in the past, but particularly to target mud crab in the late wet. It is rarely used by Aboriginal people now as it is enclosed by Commonwealth land and the area is controlled by the navy. The creek is still frequently used by fishers (Interview: 22/10/08).

### **5.2.15 Noogoo Swamp**

During interviews, Noogoo was repeatedly highlighted as a swamp that was favoured in the past for hunting, particularly of geese. Access to the Noogoo swamp area has been increasingly restricted due to the Department of Defence's Shoal Bay receiving station, and has now ceased in the area. A member of the NT Field and Game Association explains that the hunting experience has been degraded by the poor condition of the wetlands and the consequent low numbers of birds:

*I used to shoot on Noogoo Swamp, what I call the rice gardens (Milner Swamp), Howard Swamp and I only went out to Harrison Dam 6 or 7 years ago, because the shooting at Howard Swamp and those areas had dropped off, birds weren't there, the wetlands weren't what they used to be (Interviewee 1, 5/2/08).*

### **5.2.16 Shoal Bay Coastal Reserve**

Shoal Bay is a shallow embayment comprising sand and mud flats, with much of the bay exposed at low tide (Figure 60). The maximum depth of the bay is approximately 15 metres near Gunn Point. Sandy beaches are a prominent feature of the shoreline. The Howard River, which has a catchment size of 497km<sup>2</sup>, flows into Shoal Bay. Buffalo Creek, Mickett Creek and King Creek also feed into Shoal Bay (Darwin Harbour Advisory Committee 2003).

The dune systems that run along the eastern edge of Shoal Bay are regionally significant for the occurrence of ammonite fossils. The Beneficial Uses Declaration made in 1998 (NRETAS 2005) recognised the values of the Shoal Bay-Vernon Islands area as an aquatic ecosystem, a recreational water body and aesthetically valuable to the community. In 2001, the development of a prawn farm at the base of Shoal Bay was halted by local opposition to the destruction of large areas of mangrove forest and the risk that proposed effluent levels posed to the barramundi breeding environment of Shoal Bay.



Figure 60 Howard River, lined with mangroves, and a flooded Shoal Bay plain

The Coastal Reserve is managed by the NT Government through the Parks and Wildlife Commission. It is recognised for its importance to migratory birds (Northern Territory Government 2005, 2008). The Coastal Reserve is incorporated within the Darwin Harbour Regional Plan of Management (Darwin Harbour Advisory Committee 2003). Weeds, feral animals and fire are major problems for this conservation reserve (Northern Territory Government 2008). Permits to hunt pigs are issued for a period of one year from 1 August to 31 July each year. The permit is issued to allow hunting of pigs within the NT hunting reserves of Shoal Bay and Harrison Dam. This Coastal Reserve is also used as an extension to the Howard Springs Hunting Reserve with magpie geese being the main target during hunting season. The Coastal Reserve has important wildlife habitats particularly for magpie geese and whistling ducks. At certain times of the year Brolgas congregate on the drying swamps. Rainbow Pitas and Orange Footed Scrub Fowl can also be seen in various locations. One respondent felt that:

*one thing that's going to become more popular around Shoal Bay... is bird-watching. Particularly as it dries off, and people realise that it's one place to see all sort of birds' (Interview, 25/3/08).*

Another respondent saw potential in the future use of the Shoal Bay area given its 'magnificent views' and because it is 'so close to Darwin':

*Some parts of that Shoal Bay floodplain, when you come off from the woodland onto the floodplain it's really magnificent views and it's just so close to Darwin... you'd probably have to go to Kakadu or Djukbinj to see the next set of just big open floodplains... so yeh it's probably a viewing area, but you've got shooters and hunters and other people in there.. But in reality in the future if you've got Darwin here and Shoal Bay there, look at the attraction. If you get rid of one sort of group in there... then you could actually have that as a quite nice area (Interview, 25/3/08).*

Such an idea is not a current consideration for another respondent:

*Yes, if you put decent roads in there (Shoal Bay) you would give greater access to just the general public and then that would impact hugely on the hunting... ducks, pigs and geese. But at the moment anyone that goes in there has got to, I wouldn't say dodge the bullets, but there's the possibility that people are hunting – all year round. And that's a conflict, so we don't put in decent roads (Interview, 25/3/08).*

### **5.2.17 Tree Point Conservation Area**

The Tree Point Conservation Area protects a coastal area on the Tree Point Peninsula and a large mangrove habitat with a tidal creek that runs back in towards the Shoal Bay Coastal Reserve. The mangroves support a large variety of birds that use the mangroves for cover and the tidal mudflats for feeding. A fringe of coastal vine thicket occurs along the beach for part of the Conservation area and migratory waders congregate on the beach at certain times of the year. Management of the area is the responsibility of the Parks and Wildlife Commission.

The Jampalampi Tiwi (Aboriginal) group claim traditional rights of access and affiliation with the area, and have secured freehold tenure on the northern tip of Hope Inlet known as Tree Point (Calnan 2006). They have established a community here, known as Tree Point or Durduga Community.

In the past members of the Jampalampi Tiwi group travelled from the Tiwi Islands to the mainland via the Vernon Islands to Gunn Point. Members of this group are associated with the southernmost tip of Melville Island and assert traditional interests in the Shoal Bay/Gunn Point area. The group base their interests in the Tiwi tradition of use of the area, their solid knowledge and long occupation of the area and the Tiwi custom that the duty to look after gravesites of deceased ancestors confers rights and responsibilities in relation to the land. The Jampalampi Tiwi assert that interests in land are, in part, derived from the existence of burial sites. The souls of the deceased are said to become a part of the area of the burial. This places an obligation on the descendants and relatives of the deceased to care for, and maintain, the area (National Native Title Tribunal 2001).

There are approximately 57 Aboriginal sites recorded at Gunn Point and approximately 11 of these sites are associated with burial areas. There are approximately seven registered sites that have large exclusion zones defined by the Aboriginal Areas Protection Authority. Interests in these sites are shared between Larrakia and Jampalampi Tiwi interests (National Native Title Tribunal 2001).

Some members of the Jampalampi Tiwi have lived all their lives at Gunn Point and know and appreciate the area intimately. A large number of Larrakia and Jampalampi Tiwi were resident at Koolpinyah Station in the early days and were involved in a wide range of traditional practices including the conduct of ceremony and subsistence activities and this has been noted in the Koolpinyah Station records (National Native Title Tribunal 2001).

Tree Point is also a known roosting area for migratory birds.

### 5.3 Threats and risks to social and cultural values

Increased development in the Howard catchment area has the potential to affect current and future social and cultural use of water. Some of these development issues are outlined here.

#### 5.3.1 Land clearing

Based on NRETAS estimates from satellite data, clearing rates in the study area were steady between 1977-1990, with clearing at an average rate of 460 ha/yr, decreasing over 1990-95 to 210 ha/yr, and increasing to 1145 ha/yr from 1995-2000. Increased clearing between 1995 and 2000 is directly correlated with horticultural productivity. For the same time period production increased from \$21.4 to \$55.7 million in the Darwin region (Hosking 2002). A recent investigation suggests that figures have since returned to pre-1990 levels (Water Monitoring Branch 2005). The NT Planning Scheme includes control provisions which require native vegetation clearing consent for proposals to clear areas that exceed one hectare in area (Northern Territory Government Department of Natural Resources Environment and the Arts (NRETAS) 2005). Consent must also be obtained for areas that have already been cleared.

There are certain areas identified in the 2006 Northern Territory Planning Scheme land clearing guidelines which should not be cleared at all or which should only be cleared if advice has been sought relating to how impacts can be minimised. The no clear areas include:

- Drainage Lines, watercourses, wetlands or seepage zones, and
- Sensitive or significant vegetation communities such as rainforest, vine thicket or closed forest.

According to Gerry Wood, former Mayor of Litchfield Shire Council and now a current Member of the Northern Territory's Legislative Assembly, 'the policy of the council is trying to make sure that the Howard River and its tributaries and lagoons remain free of sub-division and are retained in public hands where possible' (pers comm., 23/10/07). Gerry Wood explains how the Council has managed to achieve a change in land use practice when it comes to waterways within the Shire:

*The River of course is used for such things as drainage ... So to some extent the river is not just something important environmentally, it's actually a drainage reserve. It might be a technical name but sometimes (it's) the only way the Councillors have been able to obtain land under the Planning Act. If you claimed it under conservation they'd say 'well that isn't your role'. Drainage Reserve is a legitimate request. In many cases the council has been able to claim land – it's patchy but at least there's some hope that most of the River will stay out of subdivision (Interview, 23/10/07).*

Northern Territory pastoralists have a legal obligation to formally apply to the Pastoral Land Board before clearing land for any purpose where specific guidelines have not been set. The guidelines reflect the requirements of section 38(1)(h) of the *Pastoral Land Act 1992* which states: 'The lessee will not clear any pastoral land except in accordance with the written consent of the Board or guidelines, if any, published by the Board'.



Litchfield Shire, within which the Howard region is situated, is one of the most intensely developed rural areas in the Northern Territory (Hosking 2002). Under the Litchfield Shire Area Plan 1992, 50% of any freehold portion can be cleared without any formal approval process. Under this control plan clearing in excess of 50% requires the approval of the Development Consent Authority (DCA), which includes a public appeal process (Hosking 2002). On 4 December 2002, the Interim Development Control Order No. 12 was declared and now requires landholders to obtain consent for clearing on all freehold land, outside of the existing control plan areas on land 2 hectares or greater in size. Under the new Native Vegetation Clearing Controls landholders can only have a total of 1 hectare of native vegetation cleared without consent (Hosking 2002).

Limitations or constraints on clearing also apply to where there is waterlogging and seasonal inundation (wetlands). Further, there are minimum widths of riparian vegetation that should be retained when adjacent areas are being cleared. This width is variable and dependent on whether the water body in question is a drainage line, intermittent stream, creek, river or wetland (Department of Natural Resources Environment and the Arts 2006)

Extensive areas, particularly to the north on the Gunn Point region are largely uncleared, whilst other areas are increasingly being cleared for intensive land use, including horticulture (see Figure 60) and residential developments. There are no accurate figures for clearing within the Howard River region, but an indication of rates and levels of clearing can be established through data covering the entire Darwin region (Water Monitoring Branch 2005). Approximately 19% or 46,000 ha of native vegetation has been cleared in the Darwin region. It has been estimated that the Darwin and Palmerston urban centres account for 10,000 ha of total cleared land in the catchment, and that in the last 25 years just under 19,000 ha has been cleared (Water Monitoring Branch 2005). Outside of the major urban areas, the tenure most affected by clearing is freehold land where rural residential, agricultural and horticultural land-uses predominate.

If the urban area of Darwin or the agricultural industry continues to expand, this figure can be expected to rise steadily. Land clearing reduces the habitat for wildlife, causes the remaining habitat to become fragmented and contributes to pollution via soil erosion. Changed surface run-off may affect wetlands by altering the pattern of drying-out.



Figure 61 Land cleared for horticulture near Lambells Lagoon

### 5.3.2 Pollution

Wetland pollutants may derive from agriculture, industry or domestic sources (Figure 61).

Concern was raised by one workshop attendee about the NT Government's planned development of an industrial hub next to the Holtz Landcare area. According to the attendee it is proposed that this industrial area will service and maintain Abram (Defence) tanks. The major concern is that any chemicals found in paints and other substances used in maintenance, including dioxins and heavy metals, will be washed into a proposed 10 acre catchment pond before draining into Milners Creek, Noogoo Swamp and the Darwin Harbour.

Domestic pollutants include those from septic systems, particularly where bores have been drilled in close proximity to waste systems, as already discussed.



Figure 62 Whitegoods dumped at Girraween Lagoon

A new rubbish disposal facility is also planned to be constructed within close proximity of Howard Springs, which has also created some concern for future water quality in the area.

The Northern Territory Horticultural Association (NTHA) has been working with its constituents to strengthen awareness about agrochemicals but in a submission to the Australian Government Productivity Commission 'Annual Review of Regulatory Burdens on Business – Primary Sector' (2007) wrote that the application and data collection process for the use of agrochemicals is resulting in chemical users working outside of the regulation and has fostered a reliance on single broad spectrum chemicals, rather than moving to a suite of "softer" targeted chemicals that may be used in an integrated pest management strategy. In the same submission, minor (agrochemical) use coordinator Peter Dal Santo of the NTHA identifies that the horticulture industry '*frequently suffers from a lack of legal access to crop protection products to effectively manage pests and disease. Whilst crops are valuable, they are too small individually for agrochemical companies to bear the high cost of registering pesticides for use on them.* (Northern Territory Horticultural Association 2007 p.5)'

With increasing horticultural development in the Howard region the potential impact of farm chemicals on water sources may have to be given greater consideration.

### 5.3.3 Fire

Management of fire in the Litchfield shire is destined to become an increasingly significant challenge due to increased fuel loads arising from the invasion of exotic grasses, including high fuel-load weeds such as Gamba grass. There are areas that are burnt every year and others that are never burnt: neither of these is ideal for maintaining wildlife habitat, including wetland areas.

### 5.3.4 Weeds

Several serious weeds affect terrestrial ecosystems, and many more are associated with freshwater wetlands. Mission and Gamba grasses are probably the most serious problems in the catchment because they are spreading very quickly and can increase the intensity of bushfires. Mimosa is established in isolated areas of the catchment near the Adelaide River. It is a major problem in nearby catchments because it completely alters floodplain ecosystems and often renders them useless for hunting and cattle grazing. Para grass is an exotic wetland species that is widespread in the Mary and Finnis floodplains and the potential exists for it to affect the Howard catchment. It is thought to replace native plants that are valuable food sources for waterbirds. NT Field and Game have expressed concern over weeds such as olive hymenachne:

*cause that will choke the swamp out, and when that happens the habitat's gone, the birds are gone (Interviewee 1, 5/2/08).*

One respondent was concerned about the combined issues of fire, weeds and erosion in the Shoal Bay area:

*Weed control, erosion just destroys the area. There's some illegal fires, some illegal burns going on there. We do a lot of the burning ourselves, but there's a lot of late season burns...and either people over at Koolpinyah or goose hunters start them...to clear the grass up in there (Interview, 25/3/08).*

### 5.3.5 Feral animals

Pigs are common throughout the catchment, particularly around Shoal Bay, Howard swamp and the Howard Springs area. While they appear to have a significant impact on vegetation and habitat through rooting, this has never been properly investigated.

Cane toads are expected to cause a reduction in populations of predators such as quolls and snakes. This is a particular concern because there are already signs that mammal populations are declining (at least in parts of the catchment). It is possible, but not certain, that predator populations can recover from the initial decline once they learn to avoid the toads.

Dogs and cats are common, but very little is known about their impact on native animals. Black rats and house mice are common in some bushland areas, and it is possible that they have spread diseases causing the decline of native mammals.

### 5.3.6 Changes to flow regime

One of the project aims was to identify and assess the relative significance of resource impacts possible under different water resource use scenarios, including stakeholder perspectives on the means of protecting or enhancing social and cultural values through water resource management. This was to include consideration of the preliminary cultural water requirements. The following chapter addresses the first part of the impact assessment aim outlined above. With respect to consideration of preliminary cultural water requirements, we offer the following comments on some potential impacts. It is worth emphasising, however, that accurately relating changes to flow regime to impacts on values is a very complex task that requires more empirical information than is currently available.

The notion of a cultural water requirement also requires more consideration. Recent use of the term 'cultural flow' in water planning discourse suggests that the idea is predicated on the assumption that environmental flows are insufficient in volume and distributed according to criteria that do not meet Indigenous, and perhaps, non-Indigenous social and cultural needs. There is no doubt that there is a close relationship between water required to meet the needs of aquatic ecosystems and the social and cultural values associated with those same ecosystems. Without a comprehensive understanding of the environmental water requirements it is, however, difficult to contribute to the determination of the so-called cultural water requirements.

Recent publications by Jackson (2006; 2008) and by Jackson *et al* (2008) have emphasised the importance of the intangible and symbolic values to Indigenous and non-Indigenous identity, norms and environmental philosophy. There are many values referred to throughout this report that defy measurement and evaluation in conventional terms, and even in cases where a value may be measured, there are remaining challenges inherent in the task of quantifying and incorporating such values in flow assessment. Not least of these challenges is the degree of dependency between the value and flow and the factors that control it. The problem is compounded by the interaction of a range of non-flow related factors controlling the suitability of a given water body for human use or valuation. In the case of recreational instream uses for example, there may be some optimal condition for each human use, but actual usage will be heavily dependent on some factors other than environmental condition (Mosley 1983). For

example, access and associated transport issues will have a considerable bearing on hunting and fishing activity.

Elsewhere Jackson (2006) argues that, in the context of Indigenous water requirements at least, a volumetric allocation of water can not be relied upon to address Aboriginal requirements for water. Because Aboriginal people wish to maintain a relationship with their rivers and water-bodies, direct Indigenous participation in water resource management, including monitoring, is considered the most effective mechanism for addressing cultural requirements for water. Through direct participation in adaptive management processes, Aboriginal people can perhaps more effectively participate in water allocation planning and contribute to determining the flow regimes that meet their needs. NRETAS' intention to establish a water advisory committee may assist in meeting this need and the needs of other groups in the wider community to contribute to management. There is little doubt that more attention will need to be given to ensuring that social and cultural values associated with water and water bodies in the region are fully considered in the water allocation plan.

In the following section information from Cook *et al* (1998) on groundwater and surface water levels and the resultant ecological relationships is used to speculate on potential impacts of water extraction on social and cultural values. Several 'hypotheses' are suggested and the potential impacts on environmental values are discussed. This section is imprecise and general because the dynamic and complex relationships between aquifer levels and environmental flows are poorly understood.

*Hypothesis 1: If groundwater extraction takes place within the wet season, then it is likely that the wet season discharge to the Howard River would be reduced.*

Result: The environmental consequences of this would probably be limited, because this discharge is a relatively minor component of the river flow at this time (total wet season flow is 570mm). There is also a possibility that groundwater extraction during the wet season will increase aquifer recharge. Currently water tables rise within 2-3 metres of the land surface, usually within 2-3 months of the onset of the wet season. It is not until this time that large volumes of runoff are generated. It is possible that groundwater pumping during the wet season will simply slow the rate of rise of water tables, and the onset of significant runoff. If this were the case, then it might be possible to extract more than 200mm per year from the groundwater during the wet season, with consequent reduction in surface runoff and shallow through flow (currently 410mm)

Potential impact on values: Difficult to determine but likely to be limited.

*Hypothesis 2: If groundwater extraction takes place during the dry season, then it is likely that dry season discharge to the Howard River would be reduced.*

Result: The environmental consequences of this may be considerable because of the significance of base flow to the Howard River at this time of year. Dry season pumping may also reduce the groundwater surplus, with as yet unknown consequences. On the other hand, it may be possible to reduce the impact of dry season pumping on river baseflow if pumping was

concentrated in areas remote from the river. Thus a local cone of depression may be created, which would be filled the following wet season.

Potential impacts on values: If an accelerated drop in wetland water levels and earlier dry season dry-up occurs this could severely impact on wetland habitat for waterbirds – and have serious implications for hunting values. Already anecdotal evidence suggests earlier drying of the Howard swamp area, creating more dense hunting effort on the two remaining hunting areas – Lambells Lagoon and Shoal Bay. If swamps and lagoons were to dry significantly earlier in the year for consecutive years there may be impacts on fish and turtles which would impact on both aesthetic and Indigenous hunting values.

*Hypothesis 3: Any groundwater extraction represents a loss to the environment, but different parts of the environment have a different reliance on groundwater.*

Result: Based on estimates of their average annual water balance, it appears that neither the eucalypt savanna nor the paperbark swamp ecosystems are dependent on groundwater for transpiration. Provided that wet season rainfall wets the soil to field capacity each year, there appears to be enough available soil water to sustain the transpiration needs over the dry season. Thus groundwater extraction should not impact these systems.

Potential Impact on Values: Should be limited.

*Hypothesis 4: If soil water storage is not replenished due to lower than average rains during one wet season then, in the absence of a backup groundwater system, the vegetation may undergo water stress in the following dry season.*

Result 1: Groundwater extraction that lowers the water table may increase the susceptibility of vegetation to droughts.

Potential impact on Values 1: It is likely that rainforest patches are reliant upon groundwater through-flow from the Eucalypt savanna during the dry season. Ongoing monitoring of the Endangered Darwin palm, *Ptychosperma macarthurii*, has revealed a substantial population decline at a rainforest in the Howard River Catchment following a series of wildfires in the 1990s (Liddle *et al.* 1996; Liddle *et al.* 2001).

Result 2: A decrease in the available volume of water may conceivably lead to rainforest patches drying out during the late dry season, becoming more susceptible to fire and weed invasion and to changes in species composition.

Potential impact on Values 2: Adverse effect on values related to aesthetics, education, cultural, hunting and collection as rainforest patches shrink and lose viability from increased drying and subsequent increases in fire and feral disturbance. Loss of species would diminish the existence values associated with rare plants.

It should also be considered whether there would be any implications of consistent annual drying of lagoons. If wetlands were to become temporary or seasonal would this impact on the future existence of current Reserves? Might they be filled in and become subdivisions as their

## IDENTIFICATION OF WATER BODIES AND WETLANDS OF SOCIAL AND CULTURAL SIGNIFICANCE

social and cultural values become diminished? What impact might this have on the existence of community open space and community cohesion that has been demonstrated through the existence of management group's networks?

## 6. SCENARIO EVALUATION

### 6.1 Introduction and aims

As discussed in chapter two, the NT Government is turning to statutory water planning processes to regulate, share and sustain local water resources, driven and guided also by the national program of water reform introduced by the Council of Australian Governments (COAG), the National Water Initiative (NWI). However, water planning in the NT is in its infancy. Managers, planners and members of the community are grappling with a low knowledge-base about how river systems function, high variability in water supply, complex social and cultural dynamics, and limited capacity within stakeholder and management organisations.

The overarching objective of this project required that we gain an understanding of the way in which potential changes to water use in the greater Darwin area might affect the social and cultural values of the Howard River catchment. To this end we employed a socio-economic decision support tool that can help reveal and explore trade-offs between competing outcomes, a tool that has not previously been used in water planning in the Northern Territory. This process built on the understanding of values and issues gained through the consultations described above and used several workshops to:

- Share information about the values and issues for the Howard catchment;
- Explore the conflicts and potential trade-offs, and
- Evaluate several scenarios for the future.

The following sections briefly discuss the workshops and summarises key findings from the application of the decision-support tool. Section 6.2 describes the first workshop held in April 2008 and introduces the method: deliberative multi-criteria evaluation. Section 6.3 describes the second workshop held in May 2008, including a summary of key discussion points, and discusses the results of the evaluation performed at that workshop. Section 6.4 talks about some implications and future research directions.

### 6.2 Workshop 1: Setting up the evaluation

#### 6.2.1 Workshop setting and participation

The first workshop was held on April 22<sup>nd</sup> 2008 at CSIRO's Tropical Ecosystems Research Centre. Letters of invitation were initially sent to an inclusive sample of the stakeholders interviewed for the consultation stage of the research. Eight people attended, representing a range of groups and interests (Table 6).



Organisation	Interests
Holtze Landcare Group	Local environmental interests
McMinns Lagoon Reserve Association	Local environmental interests
Northern Territory Firearms Council	Recreational interests
Northern Territory Field and Game	Recreational and environmental interests
Amateur Fishermen's Association of the Northern Territory	Recreational interests
Top End Native Plant Society	Local environmental interests
Larrakia Nation	Indigenous interests

Table 6 Organisations and interests represented at the first workshop

The interests represented didn't cover the full range relevant to the Howard catchment. In particular, horticultural, mining and pastoral interests were not represented. This signalled to the researchers that further attempts needed to be made to engage these sectors. Such attempts were made in organising the second workshop and are described in Section 6.2.4.

On arrival to the first workshop, participants were given background information on the project, the water planning process for the Northern Territory, and how the research project and workshops relate to this process. The findings of stakeholder consultations were presented in order to get some feedback and ratification of this part of the research. Participants were asked if they had any issues they wanted to add to the findings, and a set of maps were used to help focus discussion around particular places of interest (See Figures 63, 64a and b). The substance of these discussions was incorporated into findings of the first stage of the research and is described in the full report.



Figure 63 Participants of Workshop 1 identifying areas of value in the study area.

## 6.2.2 The method: deliberative multi-criteria evaluation

Participants were then introduced to the method, called deliberative multi-criteria evaluation (DMCE). This method is a combination of two techniques: multi-criteria analysis and the citizens' jury. Multi-criteria analysis is a body of techniques that structure decision problems in ways that improve their auditability and transparency (Dunning *et al.* 2000; Romero and Rehman 1987). MCA has its origins in military planning (Eckenrode 1965) and operations research but is today used in a variety of fields and disciplines including natural resource management (Hajkowicz and Collins 2007).

In a MCA a set of alternatives, for example, investment portfolios, scenarios, or programs/projects, are described using the same set of criteria. The criteria represent the key factors that indicate how well the different alternatives perform towards the achievement of an overall goal, for example, to ensure a sustainable water allocation. Criteria are represented in the most appropriate unit and may be of multiple types, describing multiple components/facets of each alternative, for example, economic, social, cultural, technical and ecological. The values that each criterion will take under each alternative are set out in an evaluation matrix. Stakeholders then weight the criteria in terms of how important they are to a particular goal or outcome. The values criteria take in the evaluation matrix and their weights are then aggregated in a utility function that returns a utility or benefit score for each alternative; the higher the score, the better the performance of an alternative. The utility score can therefore be used to distinguish between superior/inferior and more preferable/less preferable alternatives or to establish a ranking of alternatives.

There are a few shortcomings of the MCA process as it is often applied. One is that while different stakeholders may, and often do, weight the criteria differently, the process of aggregating different stakeholder's weightings into one set of average weights means that a range of information about different attitudes and preferences is lost (Proctor and Drechsler 2006)). Instead, individual weightings can be used to evaluate alternatives, and then the weightings and evaluation results compared across stakeholders.

To assist the discussion and negotiation of individuals' different weightings, group deliberation/decision making approaches can be introduced. Such deliberative processes also enable subsequent weightings after information has been shared and positions negotiated. The influence of information sharing and deliberation on weightings can thus be explored.

The citizens' jury is one such an approach. Emerging from concurrent but independent research in Germany<sup>9</sup> and the United States<sup>10</sup>, the citizens' jury is now being used in various parts of the world as a viable framework for public participation in community-relevant decision-making. Similar to a Western-style court of law, a citizens' jury involves a small, randomly selected group (representative or inclusive of interests of the broader public) – the 'jury' – coming together to 'hear evidence' from 'witnesses' on a particular issue, about which they will deliberate in order to answer a pre-specified 'charge', or question. The citizens' jury is moderated by an impartial facilitator and usually meets over two to four days.

Proctor and Drechsler (2006) have combined the multi-criteria analysis with a citizens' jury into the DMCE method, which brings together the benefits of the multi-criteria analysis approach to structuring problems and integrating multiple criteria into decision problems, and the benefits of interaction and deliberation between stakeholders, thus making up for some shortcomings of each method when used on its own. The 'charge' for the jury in the DMCE process can be to come to consensus on the criteria weightings. With jury members almost always having different weightings and priorities, this charge begins the deliberation process as those with widely varying weights are asked to support their positions through facilitated deliberation and discussion. For this DMCE, participants were not asked to come to a consensus on the weights, rather to share information and discuss the issues arising around their weightings.

To date, the DMCE method has been applied to complex issues around tourism management in the Goulburn-Broken catchment in Australia (Proctor and Drechsler 2006) and managing environmental and health risks from a lead and zinc smelter in South Australia (Proctor *et al.* 2006). This is the first time it has been applied in Australia in a water management context.

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<sup>9</sup> Research Institute for Citizen Participation and Planning Methods, University of Wuppertal.

<sup>10</sup> Jefferson Centre, Minneapolis (see <http://www.jefferson-center.org/>).



Figure 64a and b Participants identifying places of value on maps at the first workshop

### 6.2.3 Developing the scenarios and criteria

Once the method had been described and discussed, participants were involved in setting up the DMCE, first by envisioning some potential scenarios for the Howard catchment. They were asked to describe how the catchment would look in 20 years if the best possible outcome was reached, and similarly, if the worst possible outcome was reached. These formed the basis for the scenarios in the evaluation matrix and are summarised in Table 7.

“Best case” scenario	“Worst case” scenario (seen as the situation if business continues as usual)
<ul style="list-style-type: none"> <li>• Maintain population and density of living at current levels</li> <li>• Maintain or improve environmental quality (e.g. water quality and levels, populations of barramundi and magpie geese, decrease weeds, ferals and vegetation clearing)</li> <li>• Decrease agriculture</li> <li>• Improve access to favourite recreation sites</li> <li>• Stop water extraction from Power and</li> </ul>	<ul style="list-style-type: none"> <li>• Population and density continues to increase</li> <li>• Environmental health continues to decrease (e.g. Howard Springs stop flowing more frequently, populations of birds and fish decrease, vegetation clearing, weeds and ferals populations increase)</li> <li>• Agriculture increases</li> <li>• Subdivision continue and increase</li> <li>• Power and Water Corporation extracts</li> </ul>

Water Corporation bores	more water for Darwin households
<ul style="list-style-type: none"> <li>• Improve planning and consultation</li> <li>• Develop small-scale, non-water-intensive economic activity</li> <li>• Decrease daily water use rate in Darwin</li> <li>• Increase passive tourism</li> <li>• Limit further development of mines</li> </ul>	<ul style="list-style-type: none"> <li>• Planning continues uncoordinated and without consultation</li> <li>• Access to favourite sites continues to decrease</li> <li>• Darwin households don't reduce their consumption of water</li> <li>• More land leased for mines</li> </ul>

Table 7 Scenarios developed by workshop participants

The ways in which each scenario was described, for example, the words and indicators used, formed the basis for the set of criteria by which each scenario would be evaluated. Participants were also asked directly what they look for in their surroundings to assess how things are going. These responses were used to fill out the list of criteria (Table 8).

Hectares of wetlands	“Naturalness”
Hectares of weeds	Water levels
Openness of consultation and planning process	Amount and rate of water used by Darwin residents
Water quality	Crowding at favourite sites
Population of barramundi	Population of frogs
Population of magpie geese	Number of mines
Population of people	Sediment in creeks making them shallower
Hectares of land zoned for dense suburban living	Number of places that can no longer be accessed
Hectares of land zoned for industry	Coordination of planning process
Hectares of land cleared	Extent of extractive economic activity
Extent of non-extractive economic activity	Number of motorbikes and quad bikes
Amount of water extracted from bore fields	

Table 8 List of criteria developed by workshop participants

Participants were then asked to do an initial weighting of this preliminary list of criteria. For this they were told, “You have 100 points to allocate across all of the criteria according to how important you think they are. Give more points to the criteria that you think are most important in terms of the future of the catchment and less to those you think are less important. You may give some criteria zero points if they are not at all important to you. The total for all criteria must add up to 100 points.” The initial weightings were collected by the researchers<sup>11</sup>.

<sup>11</sup> As the set of criteria was modified between the first and second workshop, this initial set of weightings was not further used and so is not reported here.

Finally, participants were asked what kind of information they would need to be able to adequately evaluate the different scenarios. This was used to guide the choice of which ‘experts’ to ask to present for the citizens’ jury at the second workshop.

#### 6.2.4 Workshop follow-up

Following this initial workshop, several tasks were undertaken in preparation for the second workshop. First, the participants were contacted a few days after the workshop to ask if they had any further comments and whether they thought others should be invited to the second workshop. As previously mentioned, the participants at the first workshop did not represent or raise the full range of interests in the catchment, so it was decided to invite people with other, predominantly commercial, interests along to the second workshop, in particular horticultural and land-owner interests. Suggestions were also made to invite members from the local government authority and the Northern Territory Parliament. As such, representatives of the Litchfield Shire Council and the Northern Territory Horticultural Association were approached and invited to attend the workshop, as were the local Member of Parliament for the Darwin rural area and the Leader of the Opposition of the Northern Territory Government. Most of these stakeholders had already been contacted and/or interviewed for the stakeholder interviews.

Second, the scenarios identified by participants in the first workshop were written up into ‘narratives’ or stories describing each of the visions for the future of the catchment. Two other scenarios were constructed based on some issues that had been raised in the stakeholder consultations. All scenarios were reviewed by NT Government staff and members of the research team before being used to develop the evaluation matrix. The scenarios were:

- (a) development mix;
- (b) environmental and passive recreation haven;
- (c) rural living haven; and
- (d) development mix plus more intensive rainfall and a longer dry season.

The development mix describes a scenario of increased population, similar rates of water consumption, increased water extraction from borefields in the Howard region, continued sub-division and rural residential development of land, relatively stable horticultural production, increased industrial development and negative impacts on recreation, Indigenous interests and environmental quality. This is one vision of the ‘worst case’ scenario described by participants at the first workshop (see Table 7).

The environmental and passive recreation haven is one vision of the ‘best case’ scenario described by participants in the first workshop. This scenario involves the same population increase but decreased daily water use and extraction from the Howard borefields. There are limitations on further sub-division, horticultural activity and industrial development, and also on active, noise-creating recreational activities. There has been expansion of recreation and tourism sites and residents and Indigenous people are generally happy with the level of consultation and planning.

The rural living haven sees the same population increase, a slight decrease in daily water use, but stable extraction from the Howard borefields. Sub-division and residential development has increased substantially and the build up in population has increased demand for services and retail outlets and has also increased pressure on and risks to the groundwater system through increased numbers of septic systems. Horticulture has decreased and there is increased pressure on recreation sites through over-crowding, although some pressures are managed.

The development mix plus more intensive rainfall and a longer dry season adds a climate change scenario to the development mix scenario, resulting in lower water levels at the end of the dry season and increased pressure on recreation sites and habitat. The narratives are included in full in Appendix E.

Third, the initial list of criteria was consolidated into a second list that was more complete, operational, independent, non-redundant and minimal than the first (Table 9). Some initial criteria were combined into one final criterion and one was separated into two.

Initial criteria	Final criteria
<i>Environmental</i>	
Hectares of wetlands	
Population of barramundi	
Population of magpie geese	Condition of aquatic habitat and populations of aquatic species
Population of frogs	
Sediment in creeks making them shallower	
Hectares of weeds	Condition of terrestrial habitat and populations of terrestrial species
Hectares of land cleared	
Water quality	Risks to water quality
Water levels	ML of water pumped from horticultural bores/year
	ML of water pumped from residential bores/year
Amount of water extracted from bore fields	ML of water pumped from Power and Water Corporation borefield Stage 1
<i>Social</i>	
	Number of times per dry season that stock and domestic bores 'fail'
Hectares of land zoned for dense suburban living	Increase in number of rural residential and rural living blocks

Number of places that can no longer be accessed	Number of sites accessible for hunting, fishing and shooting
Crowding at favourite sites	Crowding at favourite sites
Openness of consultation and planning process	Openness of consultation and planning process
Coordination of planning process	Coordination of planning process
Number of motorbikes and quad bikes	Number of motorbikes and quad bikes
<hr/>	
<i>Economic</i>	
Extent of non-extractive economic activity	Extent of new commercial/retail businesses
Gross value of Primary Industries production in the catchment	Gross value of Primary Industries production in the catchment
Hectares of land zoned for industry	
Extent of extractive economic activity	New industry in the catchment
Number of mines	
<hr/>	

Table 9 Relationship between initial and final criteria

Fourth, the evaluation matrix was developed for the scenarios and new list of criteria using a range of source material, guesstimates and expert opinion (Table 10). Estimates of the total number of megalitres of water that would be pumped from the Power and Water Corporation's Stage 1 borefield under different scenarios were based on current and potential daily water use figures and volumes of water reported in *The Darwin Water Story* (Power and Water Corporation 2006). Estimates of the numbers of horticultural and residential bores were based on current figures and garnered from discussions with NT Government staff about what was reasonable given current trends. Estimates of the total number of ML of water that would be pumped from each type of bore were based on the NT Government's figures of 5ML/ha/year for horticultural bores and 3.5ML/year for residential bores. Estimates of the number of rural residential and rural living blocks were based on discussions with NT Government staff. Levels for all other criteria were based on guesstimates of what might happen under different scenarios based on general trends reported in existing research where available (for example, Cook *et al.* 1998; Schult and Welch 2006). The final evaluation matrix was reviewed by Government staff and members of the research team. The DMCE process allows for the scenarios, criteria and matrix to be modified by participants in the citizen's jury, so these were all seen as starting points rather than final, fixed versions.



No	Criteria	Scenarios			
		A	B	C	D
1	Condition of aquatic habitat and populations of aquatic species	2 (degraded)	5 (close to natural)	3 (degraded)	1 (very degraded)
2	Condition of terrestrial habitat and populations of terrestrial species	2 (degraded)	4 (close to natural)	2 (degraded)	1 (very degraded)
3	Risks to water quality	2 (medium)	1 (low)	4 (high)	3 (medium-high)
4	ML of water pumped from horticultural bores/year	12800	6250	2500	12800
5	ML of water pumped from residential bores/year	8750	7000	12250	8750
6	ML of water pumped from Power and Water Corporation borefield Stage 1	8420	0	3000	8420
7	Number of times per dry season that stock and domestic bores 'fail'	3 (often)	1 (very seldom)	4 (regularly)	4 (regularly)
8	Increase in number of rural residential and rural living blocks	750	0	2000	750
9	Number of sites accessible for hunting, fishing and shooting	3 (less than now)	1 (much less than now)	1 (much less than now)	3 (less than now)
10	Crowding at favourite sites	2 (large increase)	1 (medium increase)	2 (large increase)	2 (large increase)
11	Openness of consultation and planning process	1 (little consultation)	3 (extensive consultation)	2 (some consultation)	1 (little consultation)
12	Coordination of planning process	1 (piecemeal)	3 (very coordinated)	2 (coordinated)	1 (piecemeal)
13	Number of motorbikes and quad bikes	2 (more than now)	1 (less than now)	2 (more than now)	2 (more than now)

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14	Extent of new commercial/retail businesses	1 (more than now)	1 (more than now)	3 (many more than now, centralised hubs)	1 (more than now)
15	Gross value of Primary Industries production in the catchment	\$55 million	\$24 million	\$10 million	\$40 million
16	New industry in the catchment	4 (rubbish dump, transport corridor, defence support hub, sand and gravel mines/pits)	1 (none)	2 (rubbish dump)	4 (rubbish dump, transport corridor, defence support hub, sand and gravel mines/pits)

Note:

A – development mix

B – environmental and passive recreation haven

C – rural living haven

D – development mix plus more intensive rainfall and a longer dry season

Table 10 Evaluation matrix

Finally, experts able to provide the information identified at the first workshop were approached and invited to attend and present at the second workshop.

## 6.3 Workshop 2: Scenario evaluation

### 6.3.1 Workshop setting and participation

The second workshop was held on May 15<sup>th</sup> 2008 at Charles Darwin University and was run as a citizen's jury structured around two multi-criteria analysis evaluations of the evaluation matrix. Nine people attended (see Table 11 for the list of organisations and interests represented by participants) and five experts were called as witnesses (see Table 12 for a list of expertise and topics presented).

Organisation	Interests
Holtze Landcare Group	Local environmental interests
McMinns Lagoon Reserve Association	Local environmental interests
Northern Territory Firearms Council	Recreational interests
Northern Territory Field and Game	Recreational and environmental interests
Amateur Fishermen's Association of the Northern Territory	Recreational interests
Top End Native Plant Society	Local environmental interests
Larrakia Nation	Indigenous interests
Girraween Landcare Group	Local environmental interests
Local Member of Parliament	General public interests

Table 11 Organisations and interests represented by participants at the second workshop

Attempts were made to secure the attendance of a representative of the Northern Territory Horticultural Association (NTHA), however, due to miscommunication and competing commitments they could not attend. Instead, a researcher visited the President of the NTHA to talk about the project, the workshops and his opinions for inclusion in the write-up of the stakeholder consultation stage of the research. A pastoral representative was also confirmed to attend, however did not make it to the workshop on the day.

### 6.3.2 The deliberative multi-criteria evaluation process

The citizen's jury workshop started with an introduction and a description of the project, how it might inform water planning for the Howard catchment, and what had happened to date (including the original stakeholder interviews and the first workshop). The scenario narratives, criteria and evaluation matrix were presented to participants for their feedback and were approved as a starting point for the process. As the set of criteria was slightly different to the preliminary list, participants were shown how the two lists corresponded (Table 9), and were

asked to weight the new set. Researchers found it challenging to communicate the weighting process and some participants expressed frustration with some ambiguities at this stage. These participants found it difficult to assess the ‘importance’ of criteria without having a distinct end goal to assess them against. This challenge is acknowledged by the researchers, but on further consideration was believed to not compromise the results and as the process continued most participants became more comfortable.



Figure 65 Participants at the second workshop listening to presentations from invited experts

The charge for the citizens’ jury was for the participants to share information about and negotiate the criteria and their importance in moving towards a position of greater understanding and agreement about a desired scenario for the catchment. Total consensus on the weights is very rarely reached and is not always necessary as stakeholders will always have differing views and perspectives with regards to decision criteria and what is important. However, the charge to move towards greater understanding and agreement is a natural way to begin the deliberations and discussions as those with widely differing weights are asked to defend and explain their positions. An initial assumption of this process is that a possible reason for widely varying weights is lack of information and knowledge, so a starting point for the process is to bring in experts that can give factual information and answer questions relating to those criteria with widely varying weights.

The group heard presentations from the first three experts before lunch (Fig. 65 and 66; Table 12 summarises the expertise and topics presented). The first weightings of the new set of criteria were entered into software called the Multi-Criteria Analysis Tool (MCAT) and on reconvening after lunch participants were shown all nine sets of weightings, and what each of their individual weightings meant in terms of the performance of each scenario. All results are presented in Section 6.4.

Expertise	Topic
Ecohydrologist	Summary and recommendations from a hydrological investigation at Howard East
Rural Planner	Land use planning for the Howard region
Water Modeller	Groundwater in the Darwin rural area and groundwater modelling
Environmental Geochemist	Bio-physical impacts of mining
Water Utility Services Manager	Providing water for Darwin and the rural area: current and future trends and issues

Table 12 Expertise and topics presented at the second workshop

This was followed by presentations from the final two experts and a facilitated discussion on some of the criteria, particularly those that participants had weighted significantly differently. Participants were asked to provide a final weighting of the set of criteria once all presentations had been heard and discussed. It was decided that, based on the results of the first weighting showing that one particular scenario was strongly preferred by all participants and on the fact that there had been substantial discussion already, asking for one agreed weighting would not yield further benefits. Hence, participants were asked to re-weight the criteria on their own. Finally, participants were asked to suggest another scenario that was both desirable and realistic.



Figure 66 Participants of the second workshop

## 6.4 Findings and discussion

### 6.4.1 Results of the deliberative multi-criteria evaluation

#### *Multi-criteria analysis round 1*

A multi-criteria analysis (MCA) was performed for each of the 9 participants’ sets of weights before the information sharing and discussion. The results of the associated individual evaluations were then combined and visualised. Figure 67 shows the utility or benefit scores showing how desirable each scenario was to each participant according to their weighting of the criteria (participants are here identified by a letter from A to I to protect anonymity).

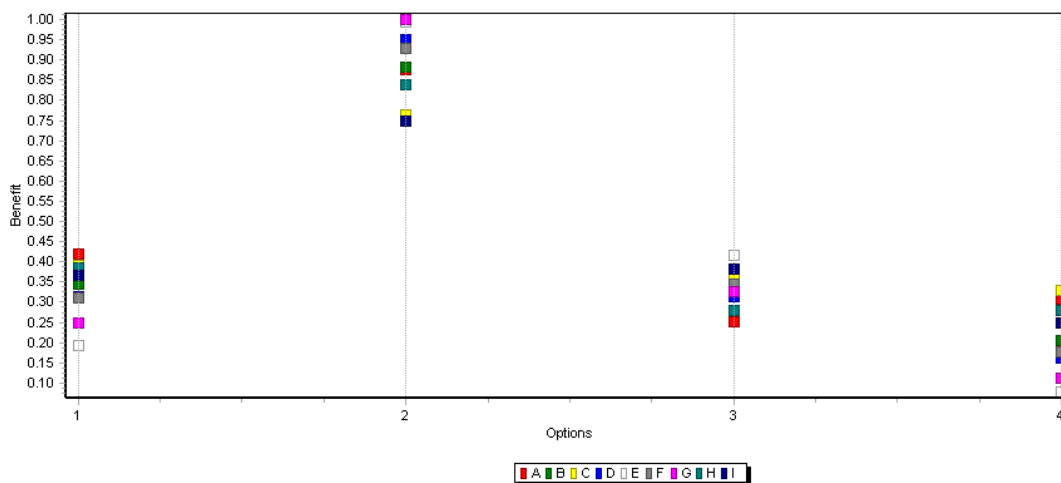


Figure 67 Utility/Benefit scores as computed for each participant’s set of criteria weights; round 1

SCENARIO EVALUATION

Figure 67 shows that Option 2 (Scenario B) is the most preferable development scenario as it obtains the highest score from all participants. This scenario is an ‘environmental and passive recreation haven’ that corresponds to the ‘best-case’ scenario described by participants at the first workshop (see Table 7, left-hand column) and is described briefly above and in Appendix E. In short, this scenario is one of minimal development and significant protection for environmental and recreational interests. It also includes a situation where Power and Water Corporation are no longer extracting water from their borefields in the region.

The MCAT also plots the weights that each participant gave to each criterion (Figure 68). As some participants assigned some criteria an identical weight, these points overlay each other and are not visible, however all participants assigned a weight to all criteria.

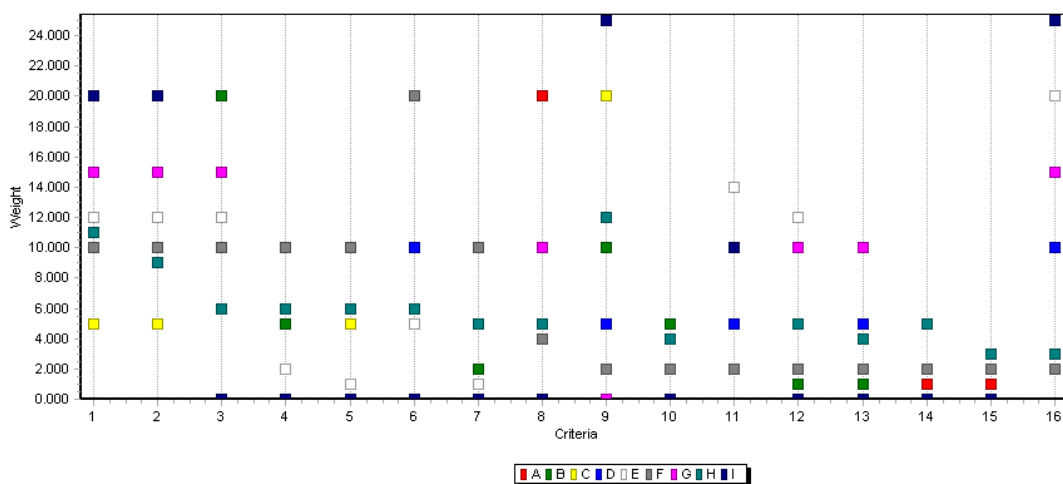


Figure 68 Criteria weights as assigned by the participants in round 1

These weightings provide initial insight into what the representatives of different interest groups think is important in reaching their desired future scenario. For example, a participant from a group representing recreational interests places their highest weight on Criterion 9 (the number of sites accessible for hunting, fishing and shooting), while a participant from a group representing local environmental interests places their highest weight on Criterion 8 (increase in number of rural residential and rural living blocks). The weightings also show where there are widely ranging opinions as to the importance of criteria. For example, one participant gave the number of sites accessible for hunting, fishing and shooting (Criterion 9) a ranking of 24, while others gave it zero, two and five. This points to criteria that are very important to some and not so to others. For those stakeholders to whom these criteria are very important, the extent to which they can be traded off against others may be less than for stakeholders who do not see them as particularly important.

Table 13 summarises the mean, median, standard deviation (in brackets) and the maximum and minimum numbers for each criterion weight. The table also ranks criteria in terms of importance based on their mean.

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No.	Criterion	Mean (std. dev.)	Median	Min	Max	Ranking
1	Condition of aquatic habitat and populations of aquatic species	13.67 (5.41)	12.00	5.00	20.00	1
2	Condition of terrestrial habitat and populations of terrestrial species	10.67 (4.69)	10.00	5.00	20.00	4
3	Risks to water quality	10.89 (5.73)	10.00	0.00	20.00	3
4	ML of water pumped from horticultural bores/year	4.22 (4.02)	5.00	0.00	10.00	10
5	ML of water pumped from residential bores/year	3.11 (3.55)	1.00	0.00	10.00	11
6	ML of water pumped from Power and Water Corporation borefield Stage 1	6.22 (6.00)	5.00	0.00	20.00	8
7	Number of times per dry season that stock and domestic bores 'fail'	3.11 (3.41)	2.00	0.00	10.00	11
8	Increase in number of rural residential and rural living blocks	7.67 (5.72)	5.00	0.00	20.00	6
9	Number of sites accessible for hunting, fishing and shooting	9.33 (8.76)	10.00	0.00	25.00	5
10	Crowding at favourite sites	1.44 (1.94)	0.00	0.00	5.00	12
11	Openness of consultation and planning process	7.00 (4.15)	5.00	2.00	14.00	7
12	Coordination of planning process	4.67 (4.06)	5.00	0.00	12.00	9
13	Number of motorbikes and quad bikes	3.11 (3.14)	2.00	0.00	10.00	11
14	Extent of new commercial/retail businesses	0.89 (1.69)	0.00	0.00	5.00	13
15	Gross value of Primary Industries production in the catchment	0.67 (1.12)	0.00	0.00	3.00	14
16	New industry in the catchment	13.33 (7.81)	15.00	2.00	25.00	2

Table 13 Mean, standard deviation, median, minimum and maximum values of the criteria weights and ranking by mean for round 1 (number of participants is 9)



## SCENARIO EVALUATION

The four criteria that are the most important to participants based on their mean values are:

1. Criterion 1: Condition of aquatic habitat and populations of aquatic species;
2. Criterion 16: New industry in the catchment;
3. Criterion 3: Risks to water quality; and
4. Criterion 2: Condition of terrestrial habitat and populations of terrestrial species.

This indicates that these criteria are those that people may be looking to when they evaluate how things are going in the catchment and it may be worthwhile for water planners to focus on them when providing more information to stakeholders and the community about different water allocation scenarios and their potential impacts.

The four least important criteria are:

1. Criterion 15: Gross value of Primary Industries production in the catchment;
2. Criterion 14: Extent of new commercial/retail businesses;
3. Criterion 10: Crowding at favourite sites; and
4. A tie between Criterion 13: Number of motorbikes and quad bikes, Criterion 5: ML of water pumped from residential bores/year, and Criterion 7: Number of times per dry season that stock and domestic bores 'fail'.

We acknowledge that these results may have been different had there been some representation from primary industry, commercial or retail groups or motor/quad bike riders. We now turn to the nature of the discussions had during the workshop as stimulated by the expert presentations and question and answer sessions.

### *Key points of discussion in Workshop 2*

The discussions during the workshop arose in response to the expert presentations, question and answer sessions with each expert, and discussion amongst workshop participants. These summaries are based on notes taken by researchers at the workshop and are yet to be ratified by workshop participants. Where there is a corresponding criterion from the MCA, this is noted to enable assessment of criteria for which the discussion may have influenced the second round weightings. This summary also provides insight into some of the key issues and factors that may not have been captured through the multi-criteria analyses.

Participants all acknowledged and expressed concern about the impacts of changes in Darwin's rural zone on the quality of life and lifestyle of residents, as well as on the resource base and environmental condition of the area. They noted the fragmentation of landscapes, privatisation of some wetlands and stress on groundwater resources resulting from rapid development of rural lifestyle blocks and small horticultural holdings.

Participants discussed the major stresses on groundwater quantity as coming from PWC's extraction (Criterion 6), the increase in number of bores sunk in the passed few decades, the increasing rate of sub-division of properties into rural living blocks (Criteria 5 and 8), and demand from small horticultural holdings (Criterion 4). PWC's extraction of water from the catchment for predominantly urban users was a source of great concern as some participants believed that use by urban users was less legitimate than that of rural users living and working in the Howard catchment. The discussion thus began with a belief that rural use should not be traded against urban use based on an argument for citizen rights to water. Further, participants expressed distrust in the PWC's reporting of water extraction from their borefields in the region.

The presentation by the Water Utility Services Manager was able to dispel concern about PWC's reporting and further, to clarify the critical role of borefields in the Howard region in the future water supply strategy for the Darwin region. This was important in light of the fact that extraction by PWC was a significant factor in the definition of best and worst case scenarios. By the end of the discussion participants recognised that managing water use and quality is a shared responsibility. One participant said, *"I think we all have to take responsibility for the water we are using. Power and Water are only using 16%."*

Participants discussed the current rates of consumption by users in the NT, which are significantly higher than for anywhere else in Australia. They raised the fact that there is a common perception that water is never scarce in the Top End of the NT because of the significant rainfall during the wet season. This perception was acknowledged as being incorrect due to the long dry seasons experienced every year and the increasing pressure on groundwater resources as surface water dries up, particularly towards the end of the dry season. Demand by households and many horticultural enterprises is often highest at this time of year. Participants recognised that demand management may need to be implemented as part of a water management strategy, acknowledging that current daily water consumption could be traded to achieve better outcomes for the environment and recreational users. If this meant that extraction by PWC from borefields in the Howard catchment would not need to increase significantly and may even decrease, then many current pressures on the groundwater resource may decrease.

The key impacts of increased pressure on groundwater quantity were seen in reduction or cessation of flow at certain places (springs) and from bores (Criterion 7) and corresponding impacts on people's ability to swim, native vegetation and habitat for species such as birds and fish (Criteria 1 and 2). Discussion about the stress on groundwater quality (Criterion 3) focussed on the impacts of increasing numbers of septic systems in the region, use of pollutants by horticultural enterprises, and current and potential industry in the catchment (Criterion 16). The inclusion of Criteria 1, 2, 3 and 16 in the list of most important criteria suggests that stakeholders are not likely to support any major trade-off of these criteria against other benefits.

Water quantity and quality issues were seen as impacting on recreational uses such as hunting and fishing. The many lagoons of the area sustain bird life favoured by hunters. Larrakia traditional owners use the area for hunting, gathering and cultural activities. The quality of fishing in the catchment is also affected by water quantity and quality (Criterion 3). Representatives of these groups also stressed that they are impacted significantly by increasing limits to access that come about through: (a) changes in land tenure that concentrate multiple and sometimes competing recreational activities (e.g. passive bushwalking and bird watching

are combined in areas where motorbiking is allowed) (Criterion 10 and 13); (b) reduction in available land due to housing and industry developments (Criterion 9); and (c) changes in management structures (e.g. when land is designated a protected area or is privatised and this then excludes certain activities) (Criterion 9).

Participants acknowledged that a challenge that sits behind all of these issues and conflicts is the need for coordination between land and water use planning (Criterion 12). They stated that the zoning of land determines water use and impacts on groundwater recharge rates and water quality to a large extent. Participants spent some time discussing specific development proposals and the management instruments available to planners (land and water) to regulate resource use.

Participants concluded that continuation of the status quo was a risky strategy that would likely generate more severe environmental, social and cultural impacts. One participant said, “*We can’t keep subdividing as we have in the past.*” There is a belief that if all horticultural and rural blocks are developed to capacity there is likely to be a ‘system collapse’. Alongside this, participants also stressed the need to know precisely how much water is available, how the hydrological system works, and how much water can be extracted without negative impacts.

Participants were asked if they had any concerns about two of the criteria that had not been discussed – Criteria 14 and 15. They responded that environmental and recreational outcomes were more important to them. This confirms the bias in representation of our participant group and indicates that engagement with these other interests will be required in the next phase of community consultation.

Following the discussion, participants were asked to return to the scenarios, criteria and evaluation matrix. Participants commented that, based on the issues just discussed, their preferred scenario was unlikely given current trends of development. They were asked to re-weight the criteria and then to suggest another scenario that was both desirable and realistic.

### *Multi-criteria analysis round 2*

Following the presentations by experts and the discussion as summarised above, the participants were again asked to weight the criteria. As with round 1, the assigned weights were entered into the MCAT and visualised on a chart. One participant (G) was not present for the second weighting due to a previous commitment. We used the set of weights that this participant used in round 1 for their round 2 result. Figure 69 shows that Scenario B, environmental and passive recreation haven, again obtained the highest benefit scores across all participants.

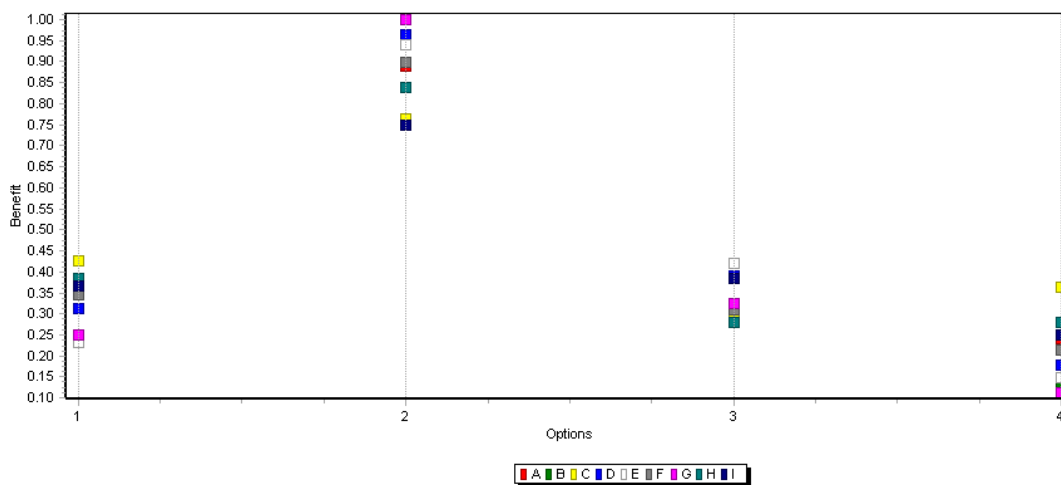


Figure 69 Utility/Benefit scores as computed for each participant's set of criteria weights; round 2

A sensitivity analysis of this result to different weightings of the criteria was undertaken. Scenario B consistently receives the highest benefit score for changes in weightings of all criteria except Criteria 4, 9 and 15; as the weights of these criteria increase, the benefit score for Scenario B decreases. This reveals that Scenario B does not perform as well when ML of water pumped from horticultural bores/year, number of sites accessible for hunting, fishing and shooting and gross value of primary industries production in the catchment receive higher weights. Assuming that horticultural interests would have weighted at least the first and last of these relatively highly, the overall result may have been quite different had these interests been present.

As with the sets of weights for round 1, the round 2 raw criteria weights show a range of opinions about criteria importance (Fig. 70).

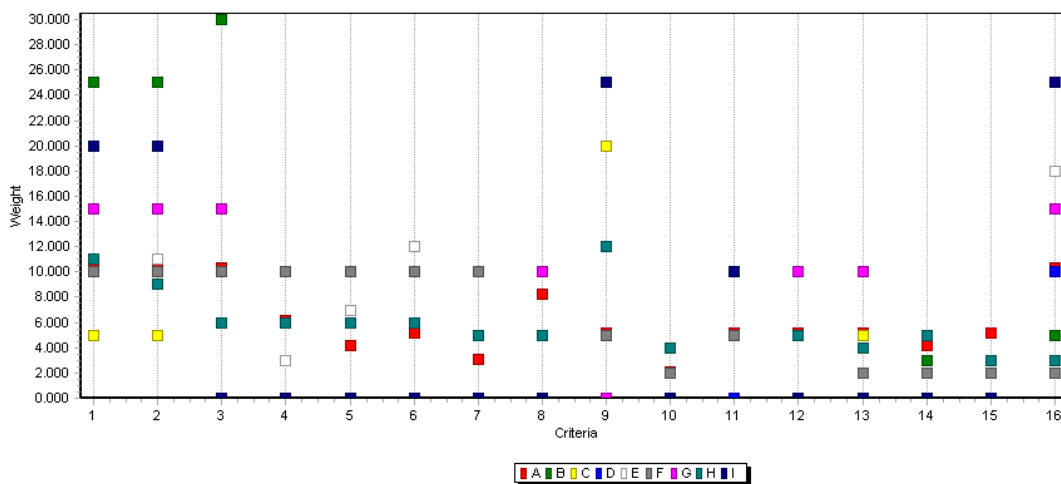


Figure 70 Criteria weights as assigned by the stakeholders in round 2

## SCENARIO EVALUATION

Overall, participants reduced the number of criteria that they gave high weights to, focussing in this second round on the condition of aquatic habitat and populations of aquatic species, condition of terrestrial habitat and populations of terrestrial species, risks to water quality, number of sites accessible for hunting, fishing and shooting, and new industry in the catchment. The criteria, ML of water pumped from Power and Water Corporation borefield Stage 1, increase in number of rural residential and rural living blocks and openness of consultation and planning process didn't receive such high weightings as in round 1.

Table 14 summarises the mean, median, standard deviation (in brackets) and the maximum and minimum numbers for each criterion weight. The table also ranks criteria in terms of importance based on their mean.

No.	Criterion	Mean	Median	Min	Max	Ranking
1	Condition of aquatic habitat and populations of aquatic species	14.15 (6.35)	11.0	5.00	25.00	1
2	Condition of terrestrial habitat and populations of terrestrial species	12.81 (6.18)	10.3	5.00	25.00	2
3	Risks to water quality	11.37 (8.41)	10.0	0.00	30.00	3
4	ML of water pumped from horticultural bores/year	5.02 (4.42)	6.0	0.00	10.00	11
5	ML of water pumped from residential bores/year	5.24 (4.41)	6.0	0.00	10.00	10
6	ML of water pumped from Power and Water Corporation borefield Stage 1	5.91 (4.91)	6.0	0.00	12.00	8
7	Number of times per dry season that stock and domestic bores 'fail'	2.01 (3.50)	0.0	0.00	10.00	13
8	Increase in number of rural residential and rural living blocks	5.92 (4.00)	5.0	0.00	10.00	7
9	Number of sites accessible for hunting, fishing and shooting	8.02 (9.13)	5.0	0.00	25.00	5
10	Crowding at favourite sites	0.90 (1.46)	0.0	0.00	4.00	16
11	Openness of consultation and	6.13 (4.16)	5.2	0.00	10.00	6

	planning process					
12	Coordination of planning process	5.57 (3.00)	5.0	0.00	10.00	9
13	Number of motorbikes and quad bikes	3.35 (3.13)	2.0	0.00	10.00	12
14	Extent of new commercial/retail businesses	1.57 (2.03)	0.0	0.00	5.00	14
15	Gross value of Primary Industries production in the catchment	1.13 (1.87)	0.0	0.00	5.15	15
16	New industry in the catchment	10.92 (7.45)	10.0	2.00	25.00	4

Table 14 Mean, standard deviation (in brackets), median, minimum and maximum values of the criteria weights and ranking by mean for round 2 (number of participants is 9)

Criteria 1, 2, 3 and 16 are again the highest ranked in terms of importance on average although the order of ranking is slightly different. As stated for the results for round 1, from this we can surmise that Criteria 1, 2, 3 and 16 are those that people may be looking to when they evaluate how things are going in the catchment. Participants care about impacts on these criteria and will look to these criteria to know how things are going (more likely for Criteria 1, 2 and 3) or perhaps they believe that these criteria will be significant in driving outcomes in the catchment (more likely for Criterion 16). This result indicates that more planning and/or research are required for these criteria, including monitoring and evaluation systems and regulation of impacts, and it indicates that participants may be less willing to trade-off desirable conditions for these criteria against other benefits.

Criteria 10, 15, 14 and 7 are again considered the least important although again, their standard deviations are large relative to their means so the notion of an ‘average’ weighting is meaningless.

To explore how the spread of opinion has changed for each criterion between rounds 1 and 2, we need to compare each criterion in terms of their coefficient of variation (CoV) in rounds 1 and 2. The CoV is defined as the standard deviation divided by the mean value and as such it measures the spread of opinion but standardises it across the values of the weights so that any differences in the actual numbers participants used to weight criteria between rounds are accounted for. Table 15 summarises the CoV for all criteria across rounds 1 and 2. If the CoV has increased (decreased) between rounds, there has been an increase (decrease) in the spread of opinion. Where the mean is equal or close to zero, the CoV is not defined and may be high even though the spread may not actually be that large (criteria 10, 14 and 15 have means close to zero in either the first or second rounds and so are not included in the ranking of change in spread of opinion).

SCENARIO EVALUATION

No	Criterion	CoV (Round 1)	CoV (Round 2)	Change in spread of opinion	Change in CoV [%]	Increase spread ranking	Decrease spread ranking
1	Condition of aquatic habitat and populations of aquatic species	0.40	0.45	Inc	12.50	5	
2	Condition of terrestrial habitat and populations of terrestrial species	0.44	0.48	Inc	9.09	6	
3	Risks to water quality	0.53	0.74	Inc	39.62	2	
4	ML of water pumped from horticultural bores/year	0.95	0.88	Dec	-7.37		5
5	ML of water pumped from residential bores/year	1.14	0.84	Dec	-26.32		2
6	ML of water pumped from Power and Water Corporation borefield Stage 1	0.96	0.83	Dec	-13.54		3
7	Number of times per dry season that stock and domestic bores 'fail'	1.10	1.74	Inc	58.18	1	
8	Increase in number of rural residential and rural living blocks	0.75	0.68	Dec	-9.33		4
9	Number of sites accessible for hunting, fishing and shooting	0.94	1.14	Inc	21.28	3	
10	Crowding at favourite sites	1.35	1.63	Inc	20.74		
11	Openness of consultation and planning process	0.59	0.68	Inc	15.25	4	
12	Coordination of planning process	0.87	0.54	Dec	-37.93		1
13	Number of motorbikes and quad bikes	1.01	0.94	Dec	-6.93		6
14	Extent of new commercial/retail businesses	1.90	1.29	Dec	-32.11		
15	Gross value of Primary	1.68	1.66	Dec	-1.19		

Industries production in the catchment						
16	New industry in the catchment	0.59	0.68	Inc	15.25	4

**Note:**

Criteria shaded in grey have means close to 0 for round 1.

Criteria shaded in pink have means close to 0 for round 2.

Criteria shaded in green were chosen as the most important criteria in both rounds 1 and 2.

Table 15 Coefficient of variation for rounds 1 and 2 (number of participants is 9)

The four criteria for which there was the greatest increase in the spread of opinion (increase in disagreement about importance) are:

1. Criterion 7: Number of times per dry season that stock and domestic bores 'fail'
2. Criterion 3: Risks to water quality
3. Criterion 9: Number of sites accessible for hunting, fishing and shooting
4. Criterion 10: Crowding at favourite sites

There could be a number of reasons why the spread of opinion about these criteria has increased. Participants' weighting strategies may have changed, or the information sharing and discussion may have created more uncertainty than clarity about these criteria, all of which were discussed during the citizens' jury except for Criterion 11. This could reflect that little is currently known about these criteria and that either more information is required about these criteria generally or that more expertise was required at the workshops to explain the role of these criteria in the catchment and how they could change under different scenarios. Importantly, the increase in spread of opinion indicates also that these criteria are very important to some, and hence less negotiable or able to be traded-off against other benefits, while others believe that they can be traded-off against other outcomes. There is likely to be debate and contention around these criteria in the future.

The four criteria for which there was the greatest decrease in the spread of opinion (increase in agreement about importance) are:

1. Criterion 12: Coordination of planning process
2. Criterion 14: Extent of new commercial/retail businesses
3. Criterion 5: ML of water pumped from residential bores/year
4. Criterion 6: ML of water pumped from Power and Water Corporation borefield Stage 1

This result suggests that the process of information sharing and discussion had some impact in terms of bringing participants closer together in their assessment of the importance of these criteria to outcomes in the catchment. There was substantial discussion about the need for a



coordinated planning process, the potential for demand management strategies to decrease household use of water, PWC's extraction and the impacts of sub-division during the citizens' jury. The coalescence of opinion about the importance of these criteria may be due to the extent of this discussion. It could also have been affected by the presentation style of presenters, and group dynamics, for example, coalition building. Even though the rankings of the perceived importance of these criteria didn't change significantly from rounds 1 and 2, and we cannot assess exactly which information or discussion influenced opinion, this result provides support for the assumption that information sharing and discussion can contribute to increased agreement about the importance of some criteria.

However, agreement decreased for one more criterion than it increased and these criteria were also discussed during the jury. As suggested above, the nature of the discussion may have increased uncertainty for those criteria for which there is an increase in the spread of opinion, whereas it stimulated a coalescence of positions for those criteria for which there is a decrease in this spread. It is difficult to assess this based on the record of discussions during the workshop and there may have been a number of other factors at play, however, we assume that positions coalesced for criteria where the information provided and discussion provided more clarity and certainty.

For example, the Water Utility Services Manager provided participants with up-to-date information on the state of water extraction from PWC bores. This was a criterion around which there had been some concern expressed previously in terms of the accuracy of these figures. We can say with some degree of confidence based on stakeholder comments that the information presented about these figures and subsequent discussion contributed to increased agreement among participants about the weighted importance of this criterion.

### *'Most realistic' desired scenario*

At the end of the workshop, participants spoke about the most realistic scenario given current development trends and that would also be likely to maintain environmental and recreational values. This was seen as a combination of Scenarios A (development mix) and B (environmental and passive recreation haven) in recognition of the opinion of some participants that development can be done in a way that limits negative impacts, especially if it is not based on substantial water extraction. This scenario would require clear knowledge and enforcement of limits on water extraction. However, some participants expressed a lack of confidence in the NT Government's decision-making about industry and managing risks to water supplies and other users, and did not believe that development would be undertaken in a way that minimised risks, even despite the best intentions.

Participants generally agreed that there is an amount of water that would need to remain in the hydrological system to maintain certain values, and that this water would need to be of a certain quality. These requirements should then define what is available for extraction and how much impact on water quality is acceptable. Some participants appeared more willing to trade-off other developmental or recreational benefits up to these levels than others, who believed that further declines in environmental quality were not desirable under any circumstance.

### 6.4.2 Discussion

While there is a range of opinions about the importance of certain criteria to the outcome, there is overwhelming agreement among participants in wanting to see the catchment's environmental and recreational values maintained and improved. The list of the four most important criteria to participants reflects this with three of them describing aspects of environmental condition. The fact that these four criteria remain the most important after the citizens' jury suggests that community members will be watching them closely. Information sharing and discussion in the citizens' jury served to both increase and decrease agreement about criteria importance. This could be due to a number of reasons not tested for during the DMCE. The four criteria for which there was the greatest increase in the spread of opinion are those about which there may be future contention within the community. Finally, participants acknowledged that Scenario B is unlikely if current trends for water use, land sub-division and uncoordinated planning are to continue, and they expressed that the reality would more likely be a combination of Scenarios A and B, although there were some reservations about the propensity or capacity of the Government to guide development in a way that minimises negative impacts.

The deliberative multi-criteria evaluation provided a structure for organising values, uses, preferences and scenarios and for participants to hear information from local experts on a range of issues. This information input and the ability to ask questions of presenters and deliberate with the other participants dissolved some myths around water use and management in the catchment and from this emerged a new appreciation (a) for the complexity of water planning and management and (b) that responsibility must be shared by all. This kind of outcome, while not easily measurable, may serve to improve stakeholder consultations around future water planning in the NT. Several of the participants in this process are likely to be invited by the NT Government to sit on a committee to consider water allocation plans for the Greater Darwin region. Their participation in this DMCE has likely contributed to building their capacity to engage with that process. Also, the results of the MCAs and citizens' jury discussion will provide the NT Government's water planners with significant background knowledge and an awareness of where attention may need to be focussed to bring stakeholders and the community along with any decision-making.

There were a few issues that arose in the implementation of the DMCE. First, there did seem to be a slight disconnect between the MCA evaluation matrix and the citizens' jury discussions. Even though presenters were selected based on information needs identified by the participants at the first workshop, a general lack of evidence about ecological, socio-economic and institutional interactions in the catchment meant that they could not always present information that could guide discussion or support conclusions about the scenarios described in the evaluation matrix. Second, this lack of available information also meant that the values of each criterion in the matrix were largely estimates and weren't developed based on scientific modelling. Third, it may also be that the final list of criteria was not as complete or well-specified as it could have been. Despite this, the discussions during the citizens' jury were lively and useful in clarifying some criteria and enabling participants to explore a wide range of issues.

Fourth, the lack of representation from the full range of interest groups has already been identified as an issue to be rectified in future such consultations. Fifth, the difficulties

experienced with the weighting process have also been mentioned and this part of the process can be improved upon. An application of this method in the same water planning context that is planned for the near future will establish an evaluation matrix based on alternative water allocation scenarios and will ask participants to weight sectors according to their preferred allocation of a sustainable yield of water. This demonstrates that the tool can be modified to suit the stage of planning and engagement and the level of information available.

A deliberative multi-criteria evaluation is a useful tool in water planning. It can be designed to suit the level of information available and the stage of water planning. For example, this application at an early stage of the planning process performed well in stimulating information sharing and assessing the current state of opinion and understanding. The MCAT software is particularly useful because it allows rapid calculation and visualisation of the results of each MCA round. The deliberative aspect of a DMCE is highly beneficial as it enables information to be shared and for people to be engaged and ‘brought along’ in the planning process. In this case the research team witnessed an increase in participant awareness of the need for sound hydrological knowledge of the limits to water use scenarios. Greater acceptance of the need for government regulation and long term water planning and monitoring resulted. The MCA provides a useful structure and enabled the identification of criteria that are important to participants in their decision-making. The DMCE method has been identified for use in the next iteration of the water planning process, which will likely see further discussion around some of the important trade-offs identified through this exercise.

### **6.4.3 Where to from here?**

Several of the participants in this research process, either the consultations and/or the workshops, are likely to be invited by the NT Government to sit on a committee to consider water allocation plans for the Greater Darwin region. Members of the research team have funding through the Tropical Rivers and Coastal Knowledge (TRaCK) research program to provide research support to the Government’s process in the form of water planning tools, including deliberative multi-criteria evaluation. This study for the Howard catchment has provided the researchers, stakeholders and participants with an opportunity to learn about some of the issues, trial the methods and learn where improvements can be made for future iterations and applications.

Improvements around the explanation of the weighting process have been noted. The method could also be usefully applied in the NT Government’s water planning process such that distinct options for the allocation of water between multiple uses are the scenarios that are evaluated.

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# Feelings about Howard River

By Simon Flavell  
**CSIRO's newest study of Howard River has nothing to do with bacteria... counts and algae samples - it's all about how Territorians feel.**  
 Dr Sue Jackson wants to know why the creeks, lagoons and springs around Howard



*Dr Sue Jackson (above) from CSIRO is finding out what the Howard River region means to Territorians.*

*And at right, locals picnicking at Howard River in 1923.*

River are so important to Northern Territorians. "This includes the ways residents and tourists use water in the Howard River region, such as for fishing, hunting camping and picnicking," said the CSIRO researcher.

"Some places may be of cultural significance to locals, and we're keen to hear their stories." Ms Jackson will be interviewing different groups and members of the public. The project is part of the National Heritage Trust's plan to assess the social impact of increased water use.

Charles Darwin University is also conducting environmental research in the area. The joint project between the university and CSIRO will determine the water needs of both aquatic ecosystems and nearby community groups.

Water requirements will be determined for aquatic algae and plants, which are the basis of river food webs, and for fish. The project will also document the use and importance of water resources to various Indigenous and non-Indigenous groups, and assess social impacts of increased water use in the Howard River.

A statement from CDU said the demand for water is putting pressure on and non-Indigenous groups," the statement said. "It will assess the and importance of social impacts of increased water use in various Indigenous the Howard River."



## What can you tell us about the Howard River?

- Are you a long-time resident or visitor to the Howard River region?
- Have you enjoyed fishing, picnicking, hunting, appreciating nature or other activities in the region over the years?
- Are some places in the region culturally significant to you?
- Do you have some old photos?
- Have you noticed changes since you first started going to your favourite places?

### If so, we'd love to hear from you!

CSIRO is undertaking a project to identify the social values of water in the Howard River region near Darwin. As part of the project we'd like to talk with people who have enjoyed using the region going back several decades. We are also keen in seeing old photos showing how water bodies and their uses might have changed over time.

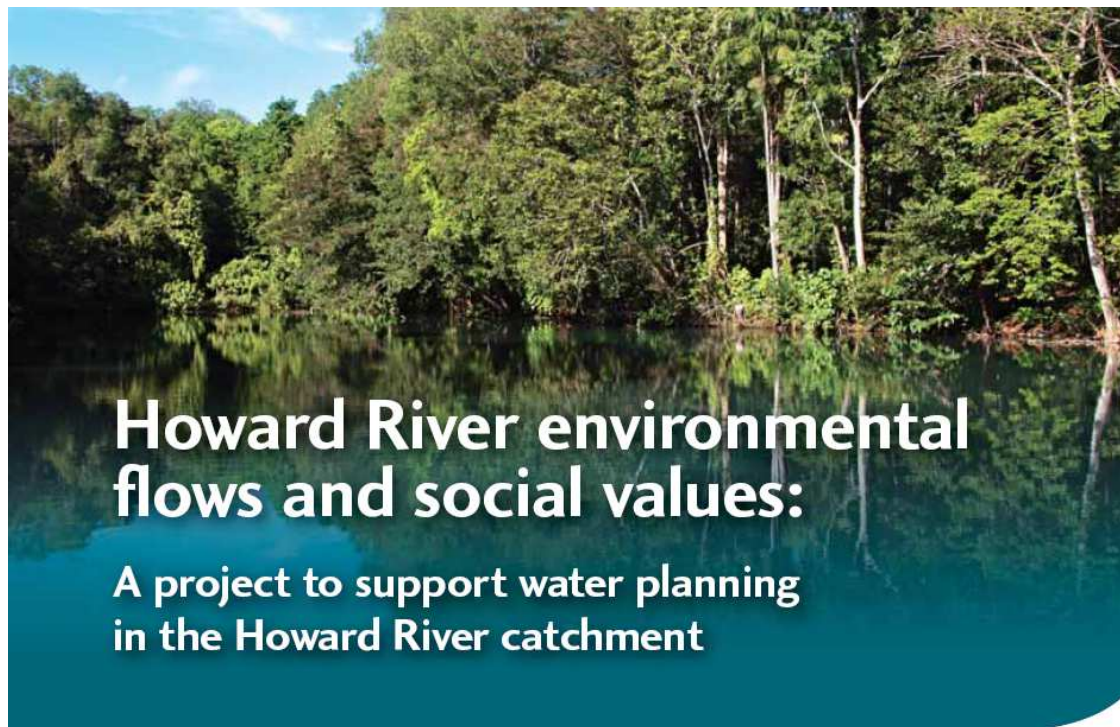
If you think you can help us with our research, we'd love to hear from you. Please call Barbara McKelvie at CSIRO on ph. 8944 8411.



CSIRO

TRACK  
 Traditional Values and Cultural Knowledge

## APPENDIX B Project pamphlet



### Background to the project

Next year the NT Department of Natural Resources, Environment and the Arts will be preparing a water allocation plan that includes the Howard River area. This plan will need to be built on knowledge of:

- environmental and social values (including cultural values);
- how much water is required for different uses and when; and
- current and potential effects of groundwater use.

The plan will state how groundwater in the Howard River area is to be shared between current uses and to protect all values. The public will be involved in this planning process.

### What are the project's aims?

The project aims to support the water allocation plan by recommending 'cultural and environmental water requirements for wetlands and surface and groundwater resources within the Howard River sub-catchment'.



This project seeks to fully understand how much water is needed for the social values and environmental requirements of water bodies (rivers, creeks, springs, wetlands and groundwater).

Social values refer to the features of water and water bodies that people consider to be important. This includes the ways in which each of the many groups and cultures in the region use water, such as for fishing, hunting, camping or picnicking, or appreciate water bodies for their beauty and inspiration.



## APPENDIX C Stakeholder groups and individual groups contacted

1. Amateur Fishermen's Association of the NT
2. Churcher Wetlands Reserve Landcare group
3. Darwin Bushwalking Club
4. Darwin Motorcycle Club
5. Darwin Off Road Cyclists Club
6. Darwin Top End Bow Hunters
7. Howard Springs Scout Group
8. Environment Centre
9. Gerry Wood - MLA
10. Girraween Landcare Group
11. Girraween Primary School
12. Graeme Sawyer - Frogwatch
13. Greening Australia
14. Historical Society of the NT
15. Holtze Landcare Group
16. Jasmine Jan – Artist
17. Knuckey Lagoons Conservation Group
18. Koolpinyah Station
19. Lambells Lagoon Landcare Group
20. Landcare Coordinator - NRETA
21. Litchfield Horse and Pony Club
22. McMinns Lagoons Landcare Group
23. Noel Padgham-Purich – Former MLA
24. NT Birds
25. NT Field and Game
26. NT Field Naturalists Club
27. NT Firearms Council
28. NT Writer's Centre
29. Parks and Wildlife Commission
30. Planning Division - NRETA
31. Shoal Bay Boat Hire
32. Top End Orienteers
33. Top End Gun Club
34. Top End Native Plant Society
35. Woodside Reserve – Taminmin High School

## APPENDIX D Land and water management in the Darwin region

### The NT's statutory framework for water allocation planning

The management, administration and protection of regional water resources are controlled under the *Water Act 2004* (NT). The Minister for Natural Resources, Environment and Heritage and the Controller of Water Resources exercise power under the Act. The Department of Natural Resources, Environment and the Arts (NRETAS) administers the Act. The Power and Water Authority is the sole service provide for urban and rural water and NRETAS is the resource manager.

Tan (2008) notes that the *Water Act 2004* (NT) is different from all other water legislation in Australia in three main respects:

1. The Act declares 'property in and the rights to the use, flow and control of all water in the Territory is vested in the Territory and those rights are exercisable by the Minister': s 9(2).
2. There is no statement of objectives in the Act. Although there is no standard model for objects to be stated in legislation, increasingly a statement is directed to all persons and institutions responsible for the legislation.
3. Water quality and pollution controls are also found in the Act. All other jurisdiction have separate regulatory regime against pollution.

The NT's regulatory regime classifies water into surface water and groundwater, and has separate controls in place for each. According to Tan's legal analysis (2008), controls placed on groundwater are by far the more exacting. Given the NT's reliance on groundwater, this is to be expected. Unless an exemption is declared for a particular class or description of bores or drainage water or waste, the default position is that the controls described below apply for all groundwater. Tan argues that the following are important points to note regarding regulation of groundwater:

- Construction of bores is regulated. Drillers for bores are licensed, and no one is to drill, construct, deepen, enlarge or otherwise work on parts of a bore unless she or he has a licence (s 48);
- Taking of groundwater requires a licence;
- A licence may be granted by the Controller to dispose of water underground by way of a bore (s 63);
- Otherwise disposal of water underground through a bore is prohibited and depending on the intention of the offender, is a serious environmental offence (s 62);

## APPENDICIES

- A licence may be granted by the Controller to recharge water in an aquifer (s 67) (Tan 2008).

Tan notes that in relation to surface water, the controls are simpler:

- No one is to take and use water (presumably from a waterway) unless permitted by a licence (s 44(1));
- No one is to construct or alter a dam, storage or other structure in a waterway so as to affect the flow or likely flow of water in a water way (s 40);
- An owner or occupier of land may drain the land in accordance with the *Soil Conservation and Land Utilization Act* (s 40(2)(a));
- An owner or occupier of land may construct a water storage away from a waterway if the flow or likely flow of water into or in a water way is not materially affected (s 40(2)(b)) (Tan 2008).

Deficiencies in the legislation have been identified (NSW EDO 2005) and amendments in 2000 provided more explicitly for the declaration of water allocation plans and for trading in water entitlements. Following this, the National Competition Council found that the NT legislation was consistent with the 1994 COAG water reform framework. The NT Government, in its most recent submission on the implementation of the NWI, committed to a comprehensive review of legislation by the end of 2006. At the time of writing a review was underway.

Further amendments to the *Water Act 2004* (NT) were made in December 2007 however at time of print the commence date was still pending. A new Part 6A requires compulsory advertising of all licence applications and consequential decisions. Section 95 now provides for the Controller to keep a publicly available register of water extraction licences as required by the NWI.

The Act provides for sustainable management of water by specifying the outputs and outcomes of the plan: s 22B(5) specifies that ‘a water allocation plan is to ensure in the water control district that:

- (a) water is allocated within the estimated sustainable yield to beneficial uses;
- (b) the total water use for all beneficial uses (including those provided through rural stock and domestic use and licenses granted under sections 45 and 60) is less than the sum of the allocations to each beneficial use;
- (c) as far as possible, the full cost for water resources management is to be recovered through administrative charges to licensees and operational contributions from licensees’.

An allocation under subsection (5)(a) is to include an allocation to the environment (s 22B(6)).

The Act has no objects or principles to guide the development or content of a water allocation plan (Tan 2008). Sustainability is introduced through the concept of ‘beneficial use’. Through

the public declaration of beneficial uses, management goals are set for a water control district<sup>12</sup> to determine how and why the community and government want to protect, manage and use the water resource.

The concept of beneficial uses is important in the *Water Act 2004* (NT), as it provides the context in which decisions relating to management planning and the issuance of licences and approvals are made. As mentioned previously, citizens have the opportunity to nominate the uses to which a water-body is to be put and the values they wish to see protected by water management activity. There is, however, no prioritisation in the list of beneficial uses, and the environment is just one of a number of uses for which water can be allocated (NSW EDO, 2005). Beneficial uses include agriculture, aquaculture, public water supply, riparian and industry. Current NRETAS policy states that adequate provision is to be made to maintain cultural and environmental requirements (referred to as aquatic ecosystem and cultural beneficial uses).

The Minister has wide discretion in relation to the making, format and content of Water Allocation Plans (WAP). No detailed water planning policy currently exists, however this is being developed at time of print. Only key elements of the WAP framework appear in the Act, such that a WAP must:

- be in a water control district;
- exist not longer than 10 year period;
- be reviewed every 5 years or less;
- allocate water within sustainable yield to beneficial uses;
- allocate water for the environment;
- allow for trade of licences (s 22).

A water allocation plan outlines the vision, objectives, strategies and performance indicators for the particular water source/s encompassed by the plan. It also sets limits to the availability of water assigned to each beneficial use, rules for managing licences and water trading. Monitoring is required to assess the performance of a plan and to inform reviews. Water plans detail the area and water resource to which the plan applies as well as the vision, objectives, strategies and performance indicators of the plan. Also included in these plans are:

- The basis for water allocation planning, climatic variability and methods for making available water determinations;

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<sup>12</sup> Water control districts are geographical areas declared under the *Water Act 1992* (NT) by the Northern Territory Minister to allow for intensive management of water resources. These districts are established in locations where there are competing water requirements and the declaration of a water allocation plan is required. To date, there are six declared water control districts.



## APPENDICIES

- Rules for the assessment of licences to take water assigned to various beneficial uses;
- Limits to the availability of water;
- Rules to enable water licences to be adjusted during times of severe climate variability;
- Rules for managing licences to take water assigned to various beneficial use;
- Rules for water trading;
- Mandatory conditions for licences and permits issued under the *Water Act 2004* (NT); and
- Monitoring programs to evaluate the performance of the plan and to inform a review.

According to NRETA, the benefits of this water allocation planning process are:

- A transparent stakeholder driven plan that will protect environmental and human interests;
- Secure water extraction licences for the duration of the water allocation plan;
- An assurance that licences to extract water (from a source defined within the plan) will not be issued if they are deemed to have unacceptable repercussions on other beneficial uses, especially the environment;
- Establishment of a basis for the permanent trade of water from one location to another (within the area defined by the plan) subject to various rules;
- Protection of water related cultural values within the region; and
- Protection of water dependent ecosystems within the region ([www.nt.gov.au](http://www.nt.gov.au)).

Water allocation plans are developed following technical and scientific assessment as well as extensive community consultation to seek the right balance between competing requirements for water. The *Water Act 2004* (NT) does not stipulate how communities or government agencies are to settle the trade-offs between competing outcomes. Water use is required to be sustainable and balanced between the environment and all other users. There is, however, an informal policy that establishes a default allocation to the environment, referred to the 80/20 rule (see Appendix D).

Under that 'rule', in the Top End, environmental water provisions are to be given the first priority. In rivers, 80% of the flow is to be allocated to the environment, whereas, for aquifers, at least, 80% of annual recharge must be allocated to the environment. These are default or contingent allocations to guide any decisions in the absence of scientific knowledge.

A review of the NT water legislation undertaken by the NSW Environmental Defenders Office in 2005 (EDO 2005) was critical of the absence of a clear relationship between the *Water Act 2004* (NT) and other environmental or planning laws in the Territory. There is no formal requirement for consultation between different Departments or agencies, nor are plans made

under the *Water Act 2004* (NT) integrated with other natural resource plans. This insight is of particular relevance to the Howard River region which has seen marked land use change and a consequent dramatic growth in bore construction, as shown above.

## **Water management in the Darwin rural area**

### **Beneficial use framework**

Darwin's rural area falls within the Darwin Water Control District.

As mentioned previously, the *Water Act 2004* (NT) establishes a number of beneficial uses which are nominated through a consultative transparent process. Once agreed upon, these values or uses guide the preparation of management strategies and allocation decisions.

In 1999 the following beneficial uses were declared for the Darwin Water Control District:

#### *1. Public water supply*

As mentioned above, the municipal water supply for the greater Darwin region is derived from a blend of 90% surface water with 10% groundwater. The surface water is sourced from the Darwin River Dam and is mixed with water pumped from the McMinns and Howard East Borefields. The McMinns Borefield has been in production as a public water supply since 1971.

#### *2. Riparian use*

Riparian use is considered to be the public right to take water for domestic household use and stock.

In the Darwin rural area this includes the groundwater extracted from private bores for personal use, the irrigation of approximately 0.5 hectare of garden and the watering of stock (NTG 2003). A conservative estimate of the number of bores in the catchment area designated as being used for riparian use would be about 2,100.

#### *3. Cultural*

According to the *Water Act 2004* (NT), cultural beneficial uses are defined as aesthetic, recreational and cultural needs. It is assumed that these beneficial uses are to be met by instream flow and that they are of a non-consumptive nature i.e. their satisfaction does not require water extraction.

#### *4. Aquatic ecosystems*

According to the *Water Act 2004* (NT), this is defined as water to maintain the health of rivers waterways, wetlands, and other ecosystems that rely on groundwater or surface water. Again, water for aquatic ecosystems is to be 'left' in the non-consumptive pool.

## Public input to water use decisions in the Darwin region

The Act also allows for, but does not mandate, the establishment of a Water Advisory Committee (WAC) for a water control district for which a management plan is being prepared (Tan 2008). There is no requirement that the WAC is to be representative of interests within the water control district. Appointments and the number of members are all at the discretion of the Minister. It is standard practice in NT water planning procedure, however, to establish a water advisory committee comprising representatives from the many stakeholder groups with an interest in, or affected by, water use decisions.

Eight water advisory committees have been appointed at various times:

- Rapid Creek Catchment Water Advisory Committee
- Katherine Tindall Water Advisory Committee<sup>13</sup>
- Darwin Harbour Advisory Committee
- Daly River Management Advisory Committee
- Ti Tree Water Advisory Committee
- The NT Artesian Water Advisory Committee
- Alice Springs Water Advisory Committee
- Mataranka Water Advisory Committee

Each advisory committee is to consider and advise the Controller on such matters within its jurisdiction as are referred to it by the Controller: s 24(3). In addition it is to advise on the effectiveness of the water plan in maximising economic and social benefits within ecological restraints: s 24(1B)(a). Terms of reference are furnished to each advisory committee. Members of each WAC are appointed at the discretion of the Minister.

There is no statutory requirement of public notice of draft plans, and no right for the public to make public submissions. Recent planning exercises undertaken in the Katherine and Alice Springs water control districts have provided opportunity for public comment upon release of a draft plan. Furthermore, although no specific policy or statutory provisions exist to require planning information to be made publicly available (Tan 2008), as a matter of practice, this information is available online at the NRETAS website.

At the time of writing, NRETAS is establishing a Top End Water Advisory Committee to oversee the development of a regional water resource strategy. This strategy will guide the production of water allocation plans for specific water resources within the greater Darwin

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<sup>13</sup> The Katherine Water Advisory Committee functions as a sub-committee of the Daly River Management Advisory Committee.

region (Chris Wicks, pers comm.). At the time of writing the composition of that group had not been finalised.

### **Current land-use planning, zoning and regulation**

The *Planning Act* provides for a single integrated NT Planning Scheme which now incorporates the Litchfield Planning Concepts and Land Use Objectives. The consolidated plan commenced on February 2007. The Scheme describes a set of “planning principles”. They are broad expressions of the Northern Territory Government’s commitment to outcomes of land use planning and development control. The Scheme requires a Consent Authority to make determinations of development applications in a manner consistent with the planning principles. A Consent Authority cannot make a determination that is demonstrably inconsistent with or would frustrate achievement of those principles (<http://www.nt.gov.au>).

Area Plans are frequently constructed for towns and more densely populated areas including Litchfield Shire. The Plans show the intended land use outcome for the particular location for the guidance of the community and the Consent Authority. Although not binding on the Consent Authority, it should not make determinations that are demonstrably inconsistent with or would frustrate the achievement of the outcomes (<http://www.nt.gov.au>). The different planning zones reflect the proposed objectives of land use and are subject to change by the Lands and Planning Minister.

The Scheme establishes certain standards for subdivision including minimum lot sizes, general layout, the provision of open space etc. Some of the zonings particularly relevant to the study area include the following:

- Rural Living (zone RL) is to provide for low-density rural living and a range of rural land uses including agriculture and horticulture. The minimum lot size for new subdivisions that occur within the Rural Living zone is 2ha with a minimum of 1ha of unconstrained land<sup>14</sup>. If lots are unsewered, provision for the disposal of effluent must be made on-site so that the effluent does not pollute ground or surface waters.
- The primary purpose of zone RR – Rural Residential – is to provide for rural residential use. Proposals for rural residential development are expected to demonstrate the relationship of the proposal to existing and proposed future land uses identifying potential impacts on facilities and services and the amenity of the locality. Again if lots are unsewered, provision for the disposal of effluent must be made on-site. Subclause 3 states that ‘Each lot in a rural residential subdivision is to be connected to reticulated water’. The NT Planning Scheme includes a specific clause stating ‘The consent authority must not consent to a subdivision that is not in accordance with sub-clause 3’. The minimum lot size for new sub-divisions within the Litchfield Shire is 1 hectare which must all be unconstrained land.
- Zone R – Rural – is to provide for a range of activities including residential, agricultural and other rural activities. The larger lot sizes in this zone, 8ha with a minimum of 1ha of unconstrained land, facilitate the separation between potentially

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<sup>14</sup> Area of land available for development and not restricted by environmental sensitivities.

incompatible uses and restrict closer settlement. The same consideration applies to sewerage disposal.

- The purpose of water management zoning (WM) is to restrict development within a water catchment area or other area providing surface or ground water for public water supplies. The minimum permitted size of a subdivision within this zoning is 50ha.
- A key consideration in the development of the Litchfield Shire Plan was the identification and protection of areas with high horticultural potential. Areas identified as having soils with high capability for horticulture, in association with available water have been zoned HP (Horticultural Protection). The purpose of this zone is to preserve suitable land for horticultural use and the minimum lot size is intended to maintain parcels for viable horticultural production. Horticulture is growing in the Howard Catchment, particularly in the Lambells Lagoon region, and this stakeholder group are significant groundwater users.

## APPENDIX E SCENARIO NARRATIVES

### Scenario A – development-mix

The population of Darwin and the rural area has increased by about 50,000. Daily water use doesn't decrease significantly, so Power and Water Corporation (PWC) needs to supply more water. As part of their solution, they decided to use the Howard Stage 1 borefields to the full extent of their license, which means 8,420 ML/year (as compared to the 3,000 ML/year extracted currently).

There is continued sub-division of land and the building of houses on blocks zoned 'rural living' (2 hectares) and 'rural residential' (1 hectare). The overall number of these blocks increases by 750. Some of the water needs for these new properties are supplied by PWC, but some are supplied by private bores, so the overall number of private residential bores increases from 2,000 to 2,500.

Rural horticulture has not developed significantly because of increasing land prices, although 12 additional horticultural bores have come on line pumping an average of 5 ML/hectare/year. At an average crop size of 5 hectares, that's an additional 300 ML/year to water and an additional 60 hectares of crops in the catchment.

There has been an increase in industrial development in the catchment, with a new rubbish dump, transport corridor and defence support hub being built as well as some new sand and gravel mines/pits. These new uses place additional demands on water and there are some concerns about their release of pollutants back into the environment. Several new commercial and retail businesses have been established to service the needs of the increased number of residents in the catchment.

The use of the catchment as a place for recreation has been affected. Those engaged in active, noise-creating recreation such as trail and quad bike riding are still able to find places to undertake their activity although this is now more intensive in some areas due to expanding housing developments. Activities that are more passive, such as picnicking and bird watching are still undertaken but the quality of the experience has diminished. A decline in water quality due to insufficient spring flow/flushing has meant that people no longer swim. Habitat for birds and animals outside of conservation reserves has been damaged and reduced by increased development. This is impacting negatively on people who enjoy the Howard for its natural features and on people who fish recreationally and hunt in the area as access to some sites is now further limited by expanding housing developments. The increased population means that more people now visit spots like Howard Springs, so they are often over-crowded.

The Larrakia traditional owners have found it difficult to find the peace, quiet and space they once enjoyed when Darwin was smaller. Greater use of their estates by other groups has pushed them out. While recreational groups might move on to a less congested site, the Larrakia want to maintain connections with specific places they have known all their lives and feel obligated to care for under their law.

Long term residents of the Howard catchment are frustrated by the seeming lack of planning for development – to them it looks like ‘death by a thousand cuts’ – and a lack of consultation and transparency in the decisions that have been made.

### **Scenario B – environmental and passive recreational haven**

The population of Darwin and the rural area has increased by about 50,000. Daily water use has decreased steadily and is now equivalent to other Australian cities, so overall PWC doesn’t need to supply more water than in 2008. In planning for the future, however, they have decided to invest in another source of water for Darwin, so the Howard Stage 1 borefields have been turned off and the 3,000 ML/year that did come from them is no longer extracted.

The Dept of Planning and Infrastructure has put a limit on further sub-division of the Howard catchment, so the number of private residential bores stays constant at 2,000.

Of the 500 horticultural bores, 250 are turned off as significant limitations have been put on some horticultural activity due to crop disease outbreaks. This means approximately 6,250 ML/year is no longer extracted. People once in horticulture have diversified into other forms of business activity that do not rely so intensively on water use.

Limitations have been placed on industrial and mining development in the catchment in response to concerns raised about impacts on water quality in the catchment and in Darwin Harbour.

Limitations have also been placed on active, noise-creating recreation such as trail and quad bike riding. Only more passive forms of recreation are allowed, including recreational fishing. Some restrictions have also been placed on hunters and shooters, in that the sites available have decreased. The decrease in water extraction and the limit on further residential and industrial development has meant that it is possible to swim in the Howard Springs more often. Even though there are more people living in Darwin now and more people visiting the region for recreation, effort has been put into the appropriate development of more recreation sites and eco-tourism operations, so impact has been managed and over-crowding is not too bad. The Larrakia have had a strong say in this management approach and in some places their preferences are given priority. Habitat for birds and animals is managed as part of this.

Residents of the Howard catchment are pleased at how well coordinated the planning process has been and about the good environmental and recreational outcomes this has brought about. They have found the Government to be very open and willing to talk about how decisions have and are being made. Developers are not so happy, however, as they’ve been restricted from activity in the catchment.

### **Scenario C – rural living haven**

The population of Darwin and the rural area has increased by about 50,000. Daily water use decreases a little, but PWC still needs to supply more water. They invest in another source, but decide to maintain the Howard Stage 1 borefields at their current levels of extraction, being 3,000 ML/year.

The catchment has been opened to residential developers. There is extensive sub-division of land and the building of houses on blocks zoned 'rural living' (2 hectares) and 'rural residential' (1 hectare). Some of the water needs for these new properties are supplied by PWC, but some are supplied by more private bores, so the overall number of private residential bores increases from 2,000 to 3,500, each of the additional 1,500 pumping 3.5 ML/year making it an additional 12,250 ML extracted per year. The build up of higher density housing in certain areas has driven demand for more commercial and retail outlets, schools and other services, most of which also have water demands. The increase in septic systems increases pressure on the groundwater system of the catchment and increases the costs of water treatment and management.

Rural horticulture has ceased to be a dominant industry in the catchment. There are still some nurseries, cut flower farms and vegetable farms, but the number of horticultural bores has decreased from 500 to 100. This means that approximately 2,500 ML/year is extracted for horticultural use as opposed to 12,500 ML/year when there were 500 bores.

There has been only a slight increase in industrial development in the catchment, mainly in the form of a new rubbish dump.

People still visit the area for recreation, now even more so as there are more people living in the area. There are many more quad bikes and motorbikes out on the weekends and this activity is now more intensive in some areas due to expanding housing developments. With the increased number of people living in the catchment, effort has been put into the appropriate development of more recreation sites and eco-tourism operations, so impact has been managed. Many sites are still quite over-crowded despite this. Some places are suffering from lower water levels and water quality due to increased residential bores and septic systems in the catchment. Bird-watching and hunting aren't as good as they used to be and there are fewer sites now due to expanded housing developments. Habitat for some fish species has been impaired and populations of some species fished recreationally have decreased.

Original residents of the catchment are frustrated at the decline in the peacefulness of the area and the change in landscape with so many more houses. Some like the additional shopping opportunities, services and job opportunities that are now close by.

### **Scenario D – scenario A plus more intensive rainfall and longer dry season**

At the same time as Scenario A has been rolling out, climate patterns have changed to involve more intensive rainfall and a longer dry season. This means that water levels are lower by the end of the dry season, increasing pressure on recreation sites and habitat for aquatic and terrestrial vegetation and species. Some places are no longer accessible for recreational fishing at certain times of year.

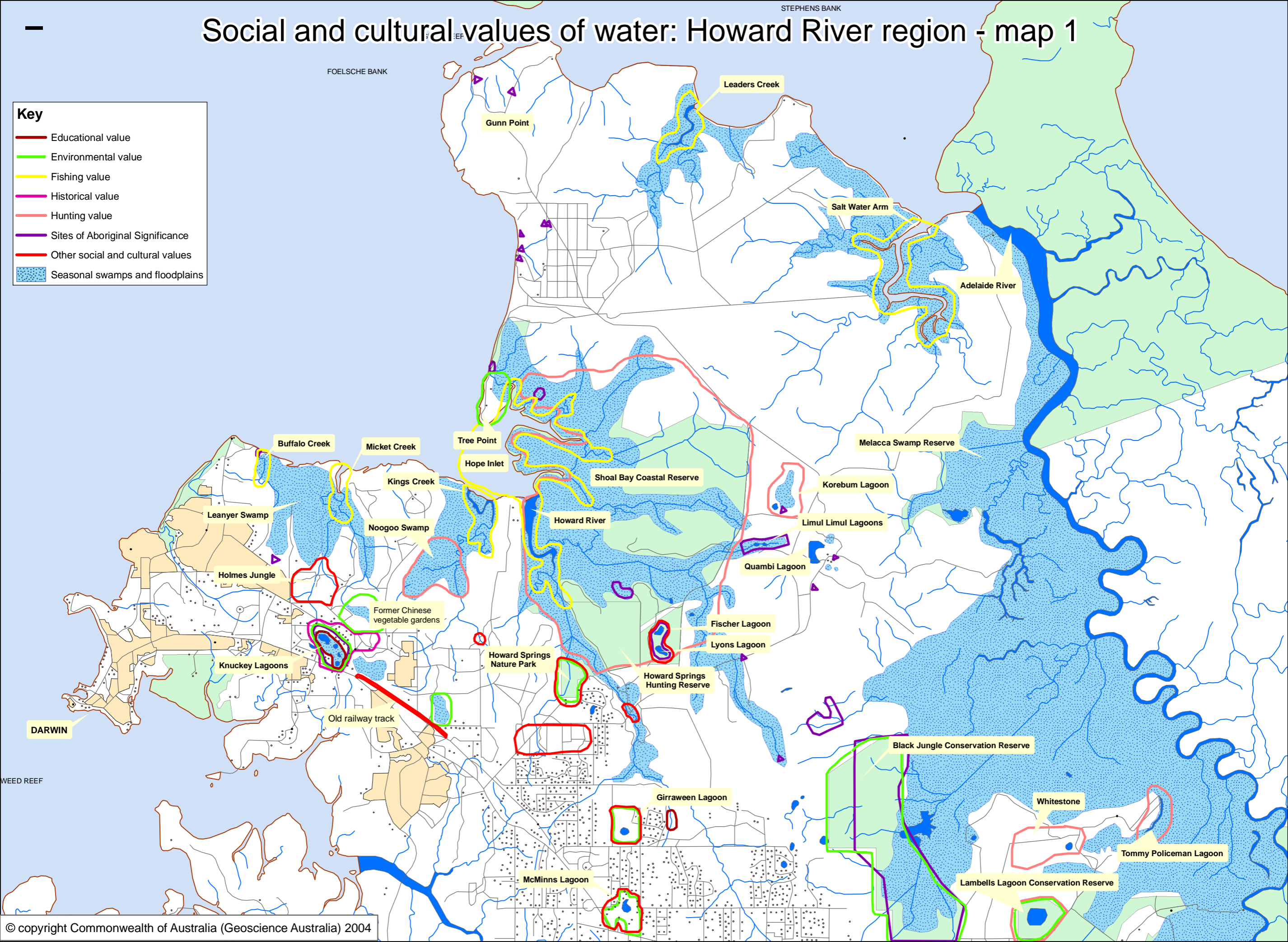




# Social and cultural values of water: Howard River region - map 1

**Key**

- Educational value
- Environmental value
- Fishing value
- Historical value
- Hunting value
- ▲ Sites of Aboriginal Significance
- Other social and cultural values
- Seasonal swamps and floodplains

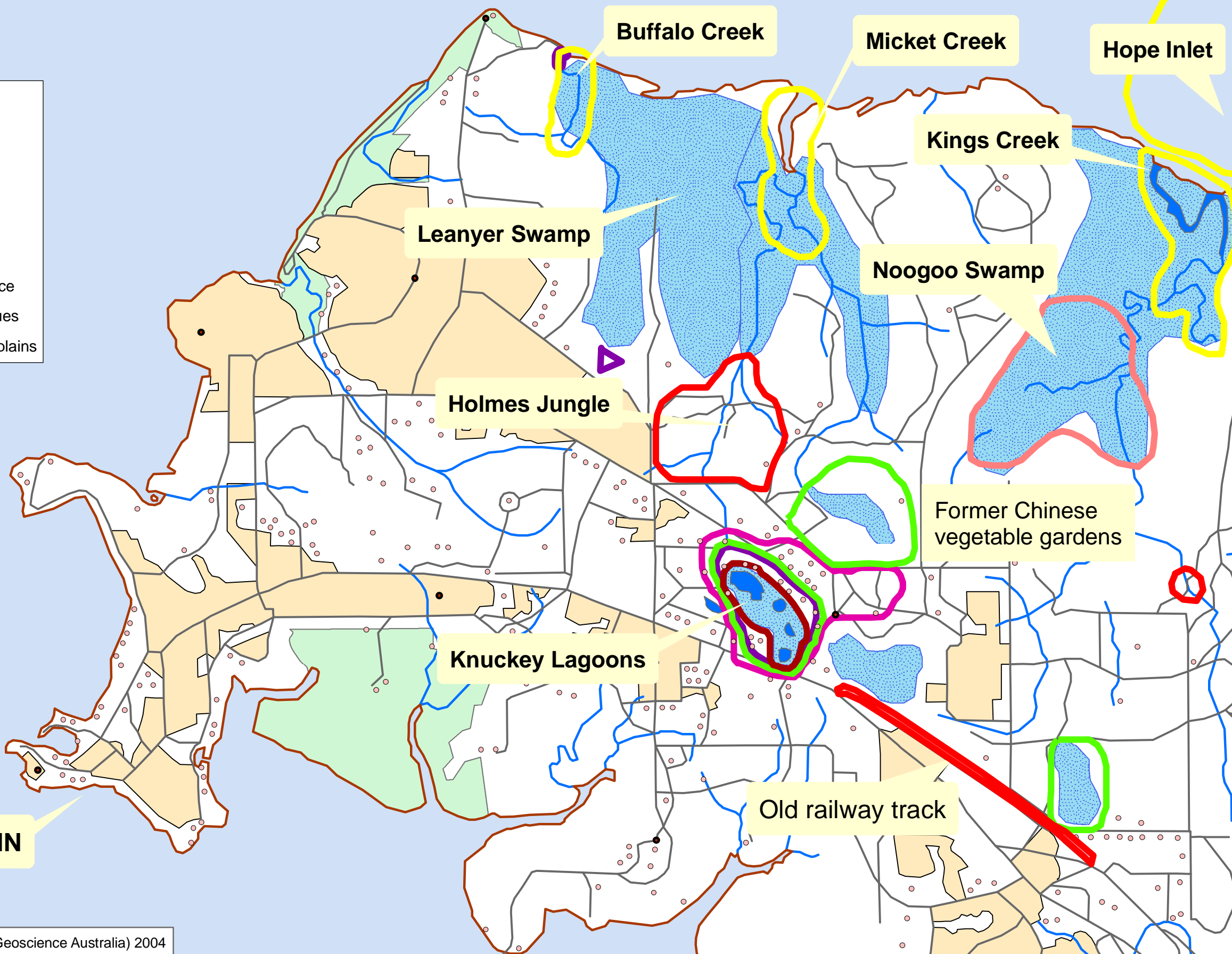


# Social and cultural values of water: Howard River region - map 2

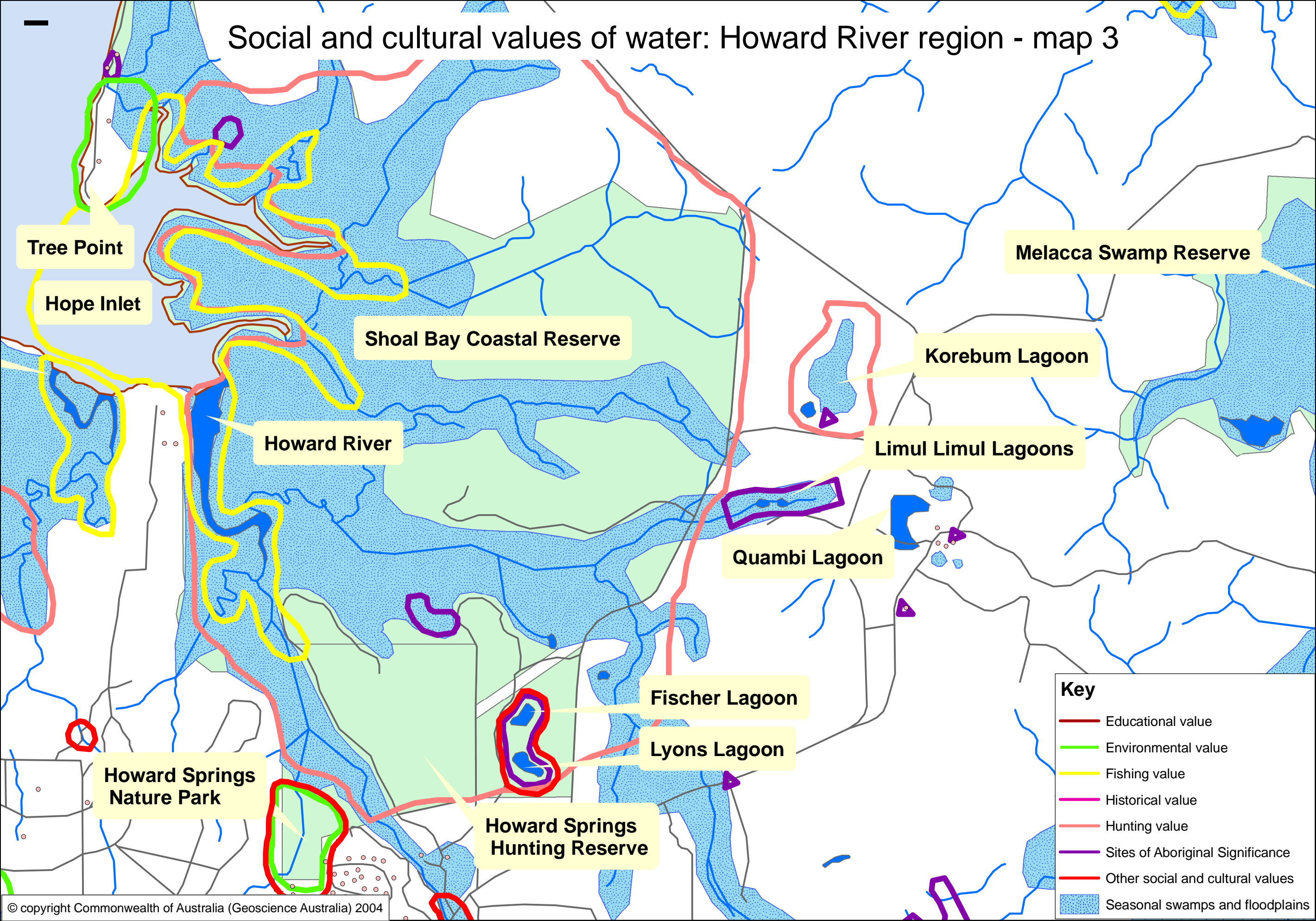
**Key**

- Educational value
- Environmental value
- Fishing value
- Historical value
- Hunting value
- Sites of Aboriginal Significance
- Other social and cultural values
- Seasonal swamps and floodplains

**DARWIN**



# Social and cultural values of water: Howard River region - map 3



Tree Point

Hope Inlet

Shoal Bay Coastal Reserve

Howard River

Melacca Swamp Reserve

Korebum Lagoon

Limul Limul Lagoons

Quambi Lagoon

Fischer Lagoon

Lyons Lagoon

Howard Springs Nature Park

Howard Springs Hunting Reserve

## Key

- Educational value
- Environmental value
- Fishing value
- Historical value
- Hunting value
- Sites of Aboriginal Significance
- Other social and cultural values
- Seasonal swamps and floodplains

# Social and cultural values of water: Howard River region - map 4

