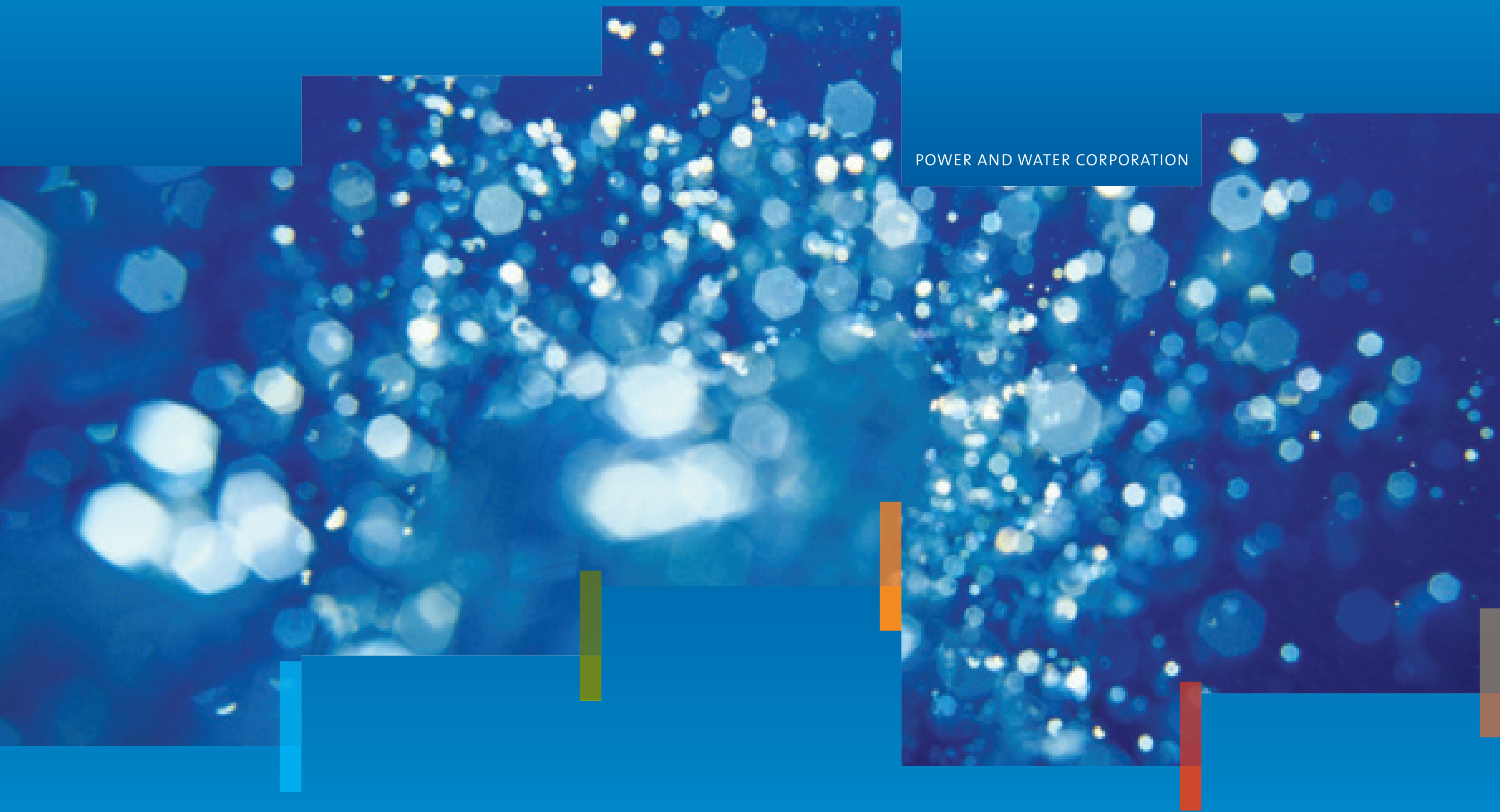
POWER AND WATER CORPORATION



DARWIN REGION WATER SUPPLY STRATEGY 2013

PowerWater

#1080991/04-2015

Contents

LIST OF FIGURES

LIST OF TABLES

1 Executive summary

1.1 Introduction

The Darwin Region Water Supply Strategy – hereafter called the Strategy – details the Power and Water Corporation's plan to balance demand for water with the capability of supply to a planning horizon of 2030. The Strategy covers the capacity and make-up of the current water supply system, forecast growth in demand, existing and proposed initiatives for demand management, future water source options, and a programme for the development of new water sources.

The Darwin region water supply system currently sources water from the Darwin River Dam (85 per cent) and the McMinns and Howard East Borefields (15 per cent). Water is not currently sourced from Manton Dam owing to infrastructure constraints, water quality challenges and recreation on the reservoir.

1.2 Water Supply Security and Sustainability

Darwin region water supply is strongly influenced by climate, including the seasonal nature of rainfall in the wet/dry tropics, the variability of rainfall from year to year (which affects annual water demand and inflows to Darwin River Dam), and the forecast impacts of climate change, particularly a likely increase in evapotranspiration.

1.2.1 Risk – Sustainability of Supply

A sustained series of poor wet seasons could mean insufficient recharge to Darwin River Dam, causing water levels to fall steadily in the region's principal water supply source. This would place the continuity of supply at risk.

1.2.2 Mitigation – Sustainability of Supply

To ensure appropriate water security, planning and management objectives that define a level of service for the Darwin region water supply have been developed. The level-of-service objectives provide for two levels of reliability of water supply: 95 per cent unrestricted demand reliability (water restrictions 1 in 20 years), and 99 per cent restricted demand reliability (severe water restrictions 1 in 100 years). The Strategy incorporates a drought-response plan, which manages periods of low inflows to the system, and an emergency-response plan, to deal with prolonged severe drought.

The level-of-service objectives include a four-stage regime of water restrictions. The regime provides Power and Water with a way to manage demand during periods of low inflows to the region's reservoirs owing to drought, or in the event of a delay in the programmed development of new water sources.

Using Power and Water's water resource modelling, the yields of the existing water sources have been calculated for each of the level-of service objectives. In this way, the total system yield is determined, in turn informing the programmed development of water sources.

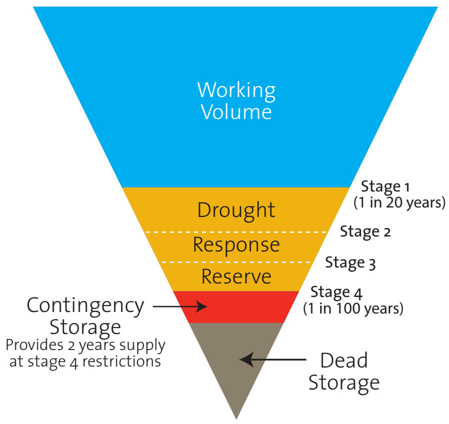
The target system yield incorporates 10 per cent headroom between annual demand for water and capability of supply. The headroom provision buffers large annual fluctuations in observed (historical) demand (+/- 10 per cent), which are being driven by variable annual rainfall and wet season periods in the Darwin region. The headroom also caters for any significant and unplanned step increases in demand arising from potential rapid industrial development in the region.

Figure 1 (below) illustrates the application of the level of service objectives to Darwin River Dam.

1.2.3 Risk – Security of Supply

In the event of an unexpected loss of supply from the region's principal water resource, Darwin River Dam, water supply to the Darwin region would be greatly affected. Loss of supply could be caused by, for example, contamination, equipment failure or terrorism.

Figure 1:
Application of Level of Service Objectives to Darwin River Dam



Relative level (m AHD)	Volume (GL)	Volume (%)	Description	Demand (%)	Reliability (%)	Frequency of trigger (1 in X years)
45.86	320	100	FSL	100		
39	100	31	Stage 1	90	95	20
37	65	20	Stage 2	80	not defined	not defined
35.5	44.5	14	Stage 3	65	not defined	not defined
34	28	9	Stage 4	50	99	100
32	15	5	Dead Storage			
28	0	0	Empty			

FSL = Full Supply Level

1.2.4 Mitigation – Security of Supply

In the event that supply from Darwin River Dam becomes unavailable, Power and Water aims to provide an alternate supply from a source independent of Darwin River Dam. Such a source would supply the region over the short term and during the emergency. Groundwater from the McMinns and Howard East Borefields could be used to diversify sources of supply in this way. Furthermore, and in the absence of an alternative supply that is independent of Darwin River Dam, the groundwater supply at the borefields must have adequate redundancy. This means the borefields should meet an 'n-2' reliability criterion, whereby the groundwater supply would continue to meet the supply diversity objective even in the event that the two highest-yielding bores fail.

1.3 Immediate Supply Risks – by 2015

1.3.1 Risk

The existing groundwater supply fails to meet the requirement for borefield redundancy. Consequently the supply fails to meet Power and Water's supply diversity objective for the current demand. Further, the lack of redundancy means Power and Water is unable to make full use of the groundwater allocation for which it is licensed.

The water supply system's yield is equal to the combined yields from connected water sources, taking into account infrastructure and licensing constraints. The current water supply system yield is 42,780 ML/yr, compared with a total system demand in 2012/13 of 42,805 ML.

Table 1 (below) shows how Darwin region water supply's existing sources of water contribute to the current total system yield.

The current target system yield, which incorporates the 10 per cent headroom requirement, is 47,864 ML/yr, representing an immediate shortfall of 5,084 ML/yr.

Table 1:
Summary of Source Availability

Source	Licenced extraction (ML/yr)	Available extraction [limited by infrastructure or yield] (ML/yr)
McMinns and Howard East Borefields	8,420	6,000
Darwin River Dam	49,100	36,780
Manton Dam	7,300	0
TOTAL	**64,820**	**42,780**

1.3.2 Mitigation

Planned further development of the Howard East Borefield in 2014/15 is designed to address the lack of redundancy, enabling the borefield to provide sufficient emergency supply capacity for a 2030 planning horizon. The connection of Manton Dam, planned for 2025 will further augment the emergency supply at that time.

Enhancing the redundancy of the Howard East Borefield will also allow Power and Water to reliably access its existing licensed groundwater allocation. This will increase the total amount of water available for extraction from connected sources to 45,200 ML/yr, again reducing the shortfall in the water supply system.

1.4 Short Term Supply Risks – by 2020

1.4.1 Risk

Population-driven growth in demand, as well as incremental increases associated with large industrial developments in the Darwin region, is driving the planning for additional sources of water in the short term.

1.4.2 Mitigation

To support continued growth in the region while deferring the need for significant capital investment in new water sources, Power and Water has developed an accelerated and expanded demand management programme called 'Living Water Smart'.

Living Water Smart aims to reduce water demand by 10,000 ML/yr by 2018. The programme will do this by improving asset management (reducing water losses and managing system pressure) and through a comprehensive programme of water conservation.

Achieving Living Water Smart's savings targets will defer the need to connect new sources of water in the Darwin region by up to seven years (to 2025).

The next step in Power and Water's water source development programme is the return to service of Manton Dam, which will provide additional supply of 7,400 ML/yr to the Darwin region. Reconnecting Manton Dam to the system will also significantly enhance the emergency supply capacity.

Planning and design for the return to service of Manton Dam is continuing, and can be fast-tracked should Living Water Smart's water demand savings targets not be achieved. Additionally, Power and Water could introduce low-level water restrictions to achieve the targeted reduction in demand.

1.5 Medium Term Supply Risks – Beyond 2020

1.5.1 Risk

Further organic demand growth and continued industrial expansion will require the development of additional sources of water in the medium term. Climate change is forecast to impact on supply by increasing evapotranspiration, which will lead to reduced inflows to reservoirs and decreasing yields.

1.5.2 Mitigation

Power and Water's demand management strategy provides for further water conservation initiatives beyond 2020.

Beyond the return to service of Manton Dam, planning and investigations are underway for an additional major source of water for the Darwin region water supply. Options currently being considered include:

- An in-stream dam (on the upper Adelaide River);
- An off-stream storage (in the Marrakai region), filled with water harvested from flood flows in the Adelaide River;
- Augmentation of Manton Dam's storage;
- Desalination; and/or
- A range of decentralised integrated water management solutions, including rainwater tanks, greywater reuse and wastewater recycling to reduce the reliance on the potable water system for non-potable uses.

1.6 Planning Uncertainties

1.6.1 Risk

There are a number of inherent uncertainties associated with water supply planning for a 20-year period:

- Water demand growth is subject to a range of influences, including population growth, economic activity and the impact of major projects;
- Climate change is forecast to have a significant impact on yields available from the region's water supply sources, including increasing evapotranspiration and reducing runoff and recharge, however a great deal of uncertainty remains as to the rate of change and the level of impact; and
- Regulation of water extraction/abstraction is an area of uncertainty, as contemporary approaches to water management in the Northern Territory are currently being developed and implemented.

1.6.2 Mitigation

Forecasting growth in water demand requires analysing a number of factors, including: Historical trends, population growth forecasts from the Department of Treasury and Finance and the Australian Bureau of Statistics, and forecasts of major urban and industry development from the Department of Business and the Land Development Corporation.

Power and Water's water demand/supply model is 'reset' every year after the end of the financial year, so that demand is forecast from the most recent demand data. Demand modelling and forecasting are being improved through interrogation of water consumption data by customer type, and by analysing impacts on demand from seasonal and annual weather fluctuations.

Five-yearly reviews of yield are undertaken for the sources comprising the Darwin region's water supply. The reviews use updated local and regional meteorological information and data, and factor in the latest information on climate change. Climate change adaptation strategies for water agencies are being developed at a National level, and Power and Water is monitoring developments in this area.

The Northern Territory Government manages the sustainable use of the region's water resources through a water allocation planning process. Power and Water is a member of a number of water allocation advisory committees, and also actively consults with the Department of Land Resource Management in its planning for the development of new water sources.

1.7 Catchment Risks

1.7.1 Risk

A number of significant catchment-related risks have the potential to impact on the sources of Darwin region's water supply.

In the McMinns Borefield, land adjacent to Power and Water's water supply bores has been developed for rural residential and horticultural land uses. These land uses pose a risk of contamination to the public water supply.

Conditions in the region's surface water catchments also pose a number of significant risks to water quality in reservoirs. These risks include illegal access to the catchment, erosion and flood damage, bush fires, feral animals and weeds.

1.7.2 Mitigation

Power and Water has developed a Catchments and Water Source Protection Strategy to support the proactive management and protection of its water supply catchments.

Wellhead protection zones have been established around production bores to help reduce the risk of contamination. In areas where rural residential development has occurred adjacent to existing bores, Power and Water works with the Department of Health to ensure the installation of site-appropriate wastewater treatment and disposal systems.

There may be an opportunity to partially shift Power and Water's regular extraction of water from the McMinn's Borefield to Howard East Borefield, further reducing the risk of contamination. The shift could accompany the planned further development of the Howard East Borefileld, which aims to enhance redundancy in Power and Water's groundwater supply. However, the McMinn's Borefield will remain a critical component of Power and Water's groundwater supply capability.

Power and Water regularly reviews its catchment management activities to protect source water quality. Some of the most important activities include managing fire, weeds and feral animals, and catchment security and surveillance.

A water treatment plant will be developed as part of returning Manton Dam to service. In time, the water treatment plant could be expanded to also treat water from Darwin River Dam, providing additional measures to reduce risk where undertaken in support of Power and Water's drinking water management objectives.

1.8 Summary of Key Activities

Figure 2 (below) represents the current water source development programme, and is an output from Power and Water's demand/supply modelling. The programme reflects key planning assumptions, including achieving water demand targets set down under Living Water Smart.

As shown, returning Manton Dam to service significantly augments the capacity of the water supply system. Before this time however, the modelling suggests water restrictions may be required in some years. On occasion, the demand for water will approach the capacity of the system to supply it, and will encroach upon the 10 per cent headroom requirement.

Power and Water recognises the reductions in water demand targeted under Living Water Smart are ambitious, and contingent upon sustained community and Government support. As a prudent way to manage this risk, Power and Water is continuing the planning and design work for Manton Dam's return to service and for future sources of water so this programme can be fast-tracked should growth in demand outpace demand management efforts.

Figure 2:
Current Water Source Development Programme

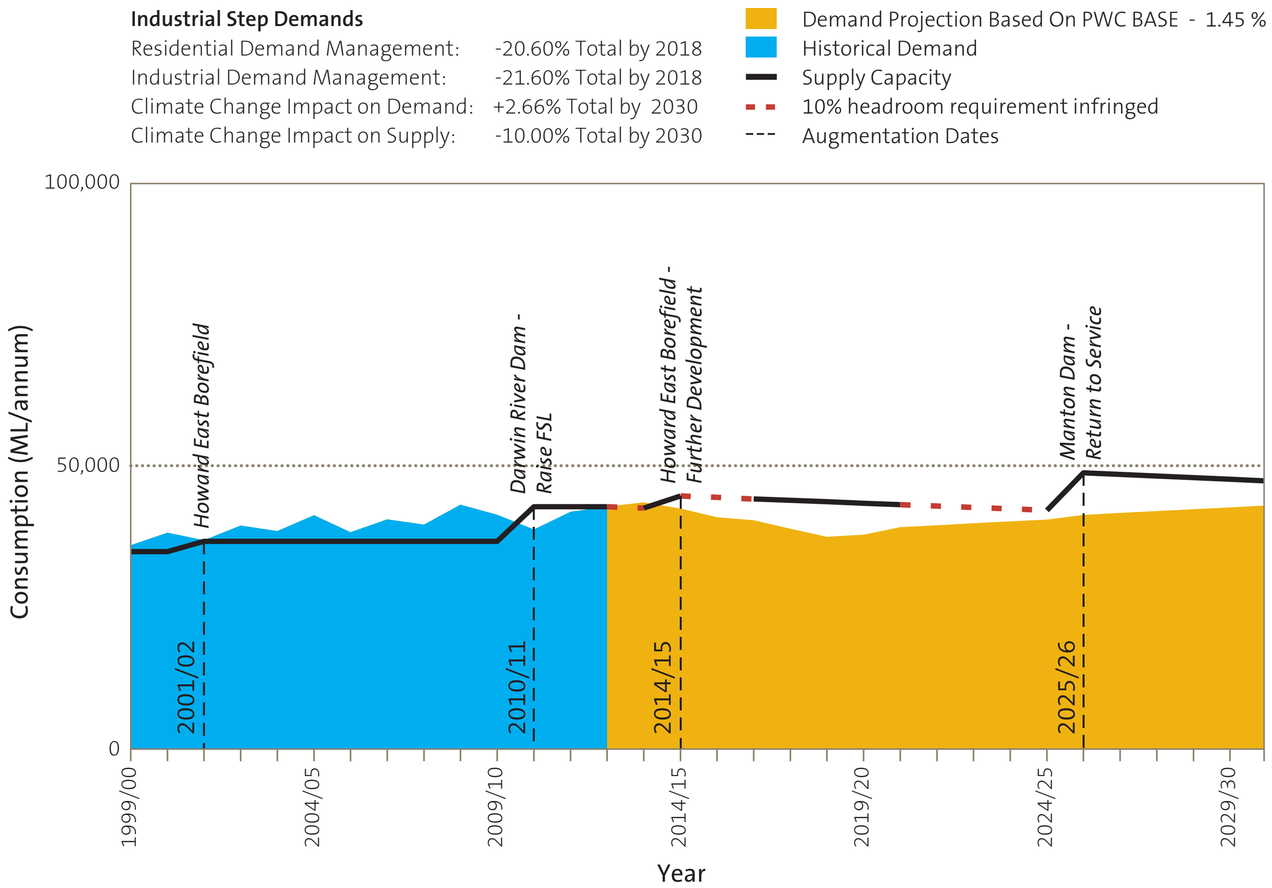


Figure 3 (on the following page) shows an alternative programme, which has been prepared assuming 50 per cent of the Living Water Smart demand-management targets are achieved. This represents the earliest achievable programme, considering the significant number of engineering and environmental studies and approvals that are required, and making allowance for construction times.

Table 2 (on the following page) summarises the key activities to be delivered under the Strategy to a 2030 planning horizon. The activities include providing additional supply capacity to manage demand for water and to engage with the community around issues of water supply and demand management. It is intended that the Strategy be reviewed annually, with a formal update and public release every five years.

Power and Water will review the initial results of Living Water Smart in late 2015. The review will determine when Manton Dam should be returned to service and whether low level water restrictions are needed to achieve water demand savings targets.

Figure 3:
Alternative Programme – For Planning and Design Purposes

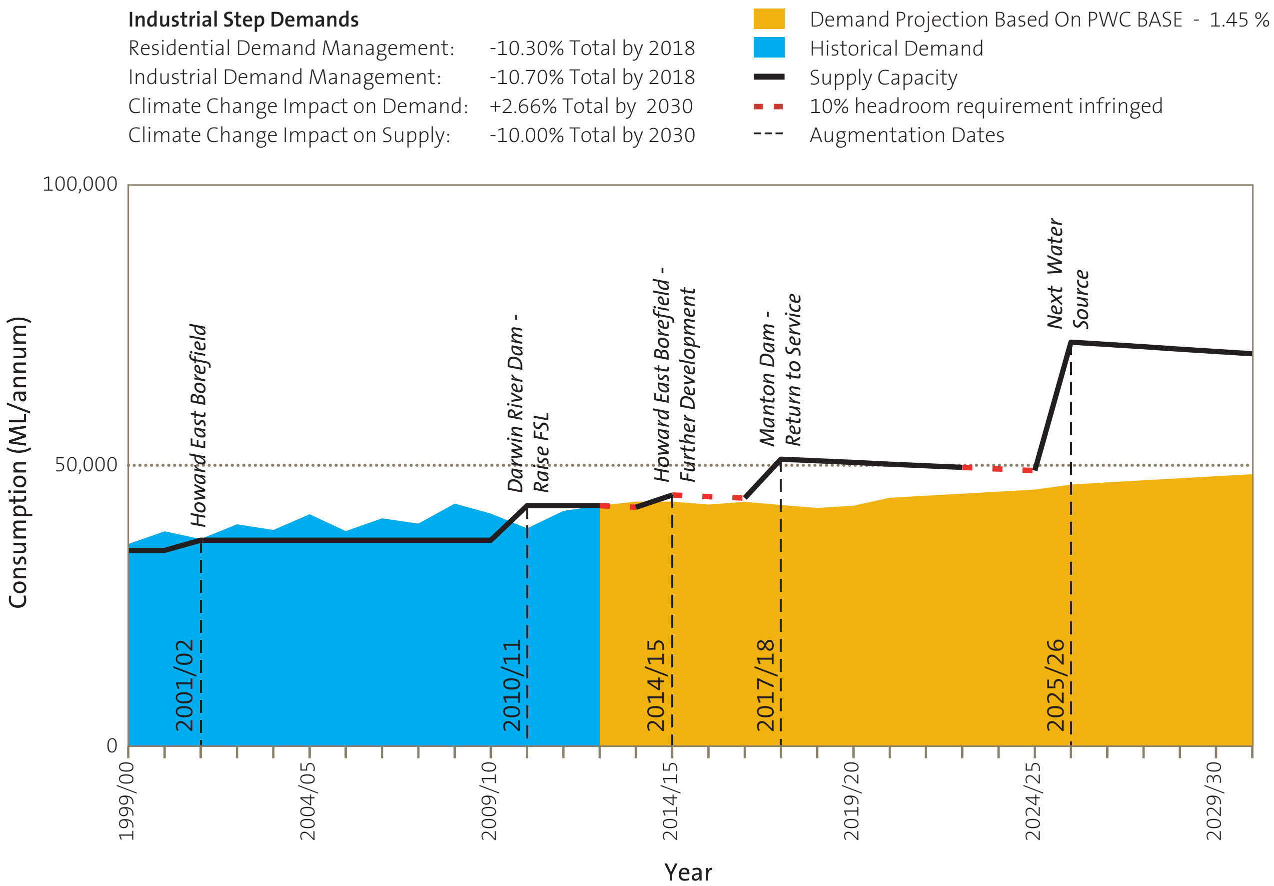


Table 2:
Summary of Key Activities - Darwin Region Water Supply Strategy

Timeframe	Key Activities	Outcomes
By 2015	Implement Living Water Smart	Reduce per capita water consumption Embed water conservative community culture
	Engage with community around water supply and demand issues	Community input to next issue of Darwin Region Water Supply Strategy
	Further development of the Howard East Borefield	Increased emergency supply capability Increased reliability of extracting existing licensed groundwater allocation
	Undertake environmental and engineering studies on a range of medium-term water supply options for the Darwin region	Identify preferred medium-term water supply option for the Darwin region
By 2016	Review initial results of Living Water Smart and refine demand management initiatives	Review timing for return to service of Manton Dam and assess the need for water restrictions to achieve water demand savings
By 2020	Review and refine demand management strategy	Reduce per capita water consumption Sustain water conservative community culture
	Publish next issue of the Darwin Region Water Supply Strategy	Darwin Region Water Supply Strategy responds to community expectations
By 2025	Return Manton Dam to service	Increased supply capability Enhanced emergency supply capability Improved diversity of supply
Beyond 2025	Continue to implement demand management action plan	Reduce per capita water consumption
	Develop medium term water supply source	Increased supply capability Enhanced emergency supply capability Improved diversity of supply

GLOSSARY OF TERMS

Augmentation
Works required to increase water supply

Aquifer
An underground layer of water-bearing rock or materials from which groundwater may be extracted.

Catchment
An area of land where run-off enters a particular river system or reservoir

Demand management
Initiatives that endeavour to reduce water consumption and encourage more efficient water use and reduce water losses from the system

Drought Response Plans
Short term action plans that provide effective responses to deal with the occurrence of droughts

Groundwater
All subsurface water, generally occupying pore spaces and fractures in rock and soil

Megalitre (ML)
1,000,000 litres

Potable
Suitable for drinking

Recycled water
Water from sewage or industrial processes that is treated to appropriate standards for its intended use

Level of service objectives
An adopted standard of water supply that endeavours to achieve supply outcomes expected by the community, by using a range of measures including the desirable maximum frequency, duration and severity of water restrictions

Surface water
Water stored or transported above ground (i.e. in lakes, rivers, dams)

System yield
A figure derived from models that refers to the volume of water that can be harvested from a water supply system in order to achieve the adopted standard of service

Unrestricted water demand
The total volume of water used by consumers during periods without water restrictions

Water demand
The average annual water demand based on water consumption and population projections

2 Introduction

2.1 Background Information

The development of the Darwin Region Water Supply Strategy demonstrates the commitment of Power and Water to more efficient urban water use, and to identifying supply options that will maintain an appropriate balance between urban water supply and demand for the next 20 years.

The strategy identifies programmed water source development projects for the Darwin region, as well as exploring options for the development of future water sources.

2.2 Key Objectives

The strategy aims to achieve sustainable urban water management in the short and long term through a range of measures focussed on:

- Securing water supplies
- Reducing water demand
- Balancing water supply with growth in demand
- Supplying water in a financially responsible manner.

Table 3:
Darwin Region Water Strategy Key Objectives

Key Objectives:	
1.	Providing sustainable and economical long term water resource planning for the Darwin Region;
2.	Establishing a balance between sustainable supply options and demand management initiatives;
3.	Reducing bulk raw water demand, and per capita water consumption;
4.	Maximising the utilisation of existing infrastructure and already disturbed natural water systems prior to developing new water sources;
5.	Assessing climate change impacts in the development of future supply and demand scenarios;
6.	Identifying new and alternative local water resource options for consideration;
7.	Integrating alternative water supply options into future water supply planning;
8.	Ensuring water resource planning is undertaken in a transparent and auditable framework; and
9.	Engaging local communities in planning for long term sustainability of their water resources.

2.3 Previous Long-term Planning

Long-term water supply planning is an ongoing process requiring regular review. This document will be reviewed and updated every five years.

Previous long-term planning reports that were used to develop this strategy include:

- *Darwin Water Story, 2005*
- *Darwin Bulk Water Strategy, 2004*
- *Water Resources for the Greater Darwin Area - Darwin Water Resources Strategy, 1999*
- *Darwin Rural Area South - Water Supply Development Master Plan, 1996*
- *Darwin Regional Water Supply and Land Management Strategy, 1988*

Further information on references is provided in Section 11 REFERENCES.

2.4 Strategy Development

The development and presentation of the Strategy is informed by a number of documents, including:

- *Planning Guidelines for Water Supply and Sewerage,* Queensland Department of Environment and Resource Management, 2010.
- *Power and Water Corporation Supplements for the Planning Guidelines for Water Supply and Sewerage,* Power and Water Corporation, 2010.
- *Survey outcomes, Community Attitudes to Water Use,* Power and Water Corporation, 2006.
- *Framework for Urban Water Resource Planning,* Water Services Association of Australia (WSAA), 2005.
- *Guidelines for the Development of a Water Supply Demand Strategy,* Department of Sustainability and Environment (DSE), Victoria, 2005.
- *Darwin Water Story,* Power and Water Corporation, 2005.

Further information on references is provided in Section 11 REFERENCES.

2.5 Regulatory Environment

Power and Water is a Government Owned Corporation. The multi-utility is responsible for the provision of water supply, sewerage and electricity services and a five-member Board steers the organisation.

The Northern Territory Treasurer is the Shareholding Minister, and Power and Water reports to the Minister for Essential Services (as the portfolio Minister). A three-member Utilities Commission acts as regulator for Government. The Northern Territory Government sets utility tariffs in consultation with Power and Water.

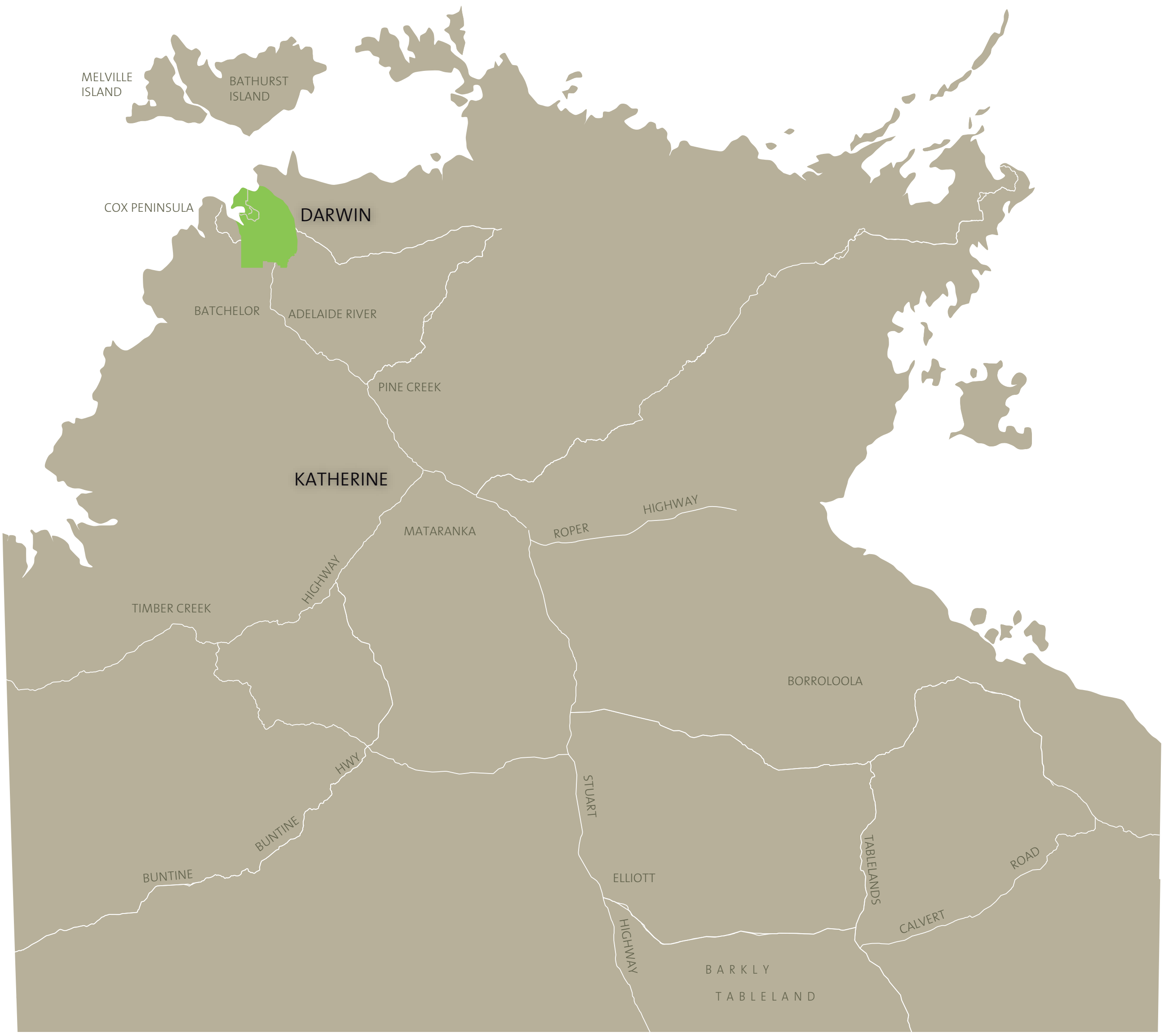
Water resources in the Northern Territory are regulated by the Department of Land Resources and Management (DLRM). Extraction from surface or groundwater resources for Public Water Supply requires licensing under the *Water Act*. Extraction licenses are granted by the Controller of Water Resources, who must take a number of factors into account when issuing a licence, including environmental and cultural needs. The Department of Health regulates the public health aspects of public drinking water supplies.

Water allocations, or entitlements, are provided through Water Allocation Plans, which are developed by DLRM, in accordance with the National Water Initiative and the NT *Water Act*. Water Allocation Plans have been created, or are underway or proposed, in places where current or potential water use could pose a risk to the ongoing availability and health of the resource.

The *Water Act* specifies that extraction licenses are to be issued for a maximum of 10 years and can be varied at any time. Upon the Minister's advice, a licence can be granted for a longer period and a number of current Power and Water licenses, including those for Darwin, have been granted for 50 years. However where Water Allocation Plans are in place, the licenses have been issued for 10 years.

The water allocation planning process has commenced in the Koolpinyah (Howard East) Aquifer. The groundwater resource is considered to be under stress and extraction may be exceeding sustainable levels. The Water Allocation Planning process is expected to limit extraction to sustainable levels and achieve an equitable share of the resource between consumptive users, whilst providing for environmental and cultural water requirements.

Figure 4:
Locality Plan of the Darwin Region



3 Current water system review

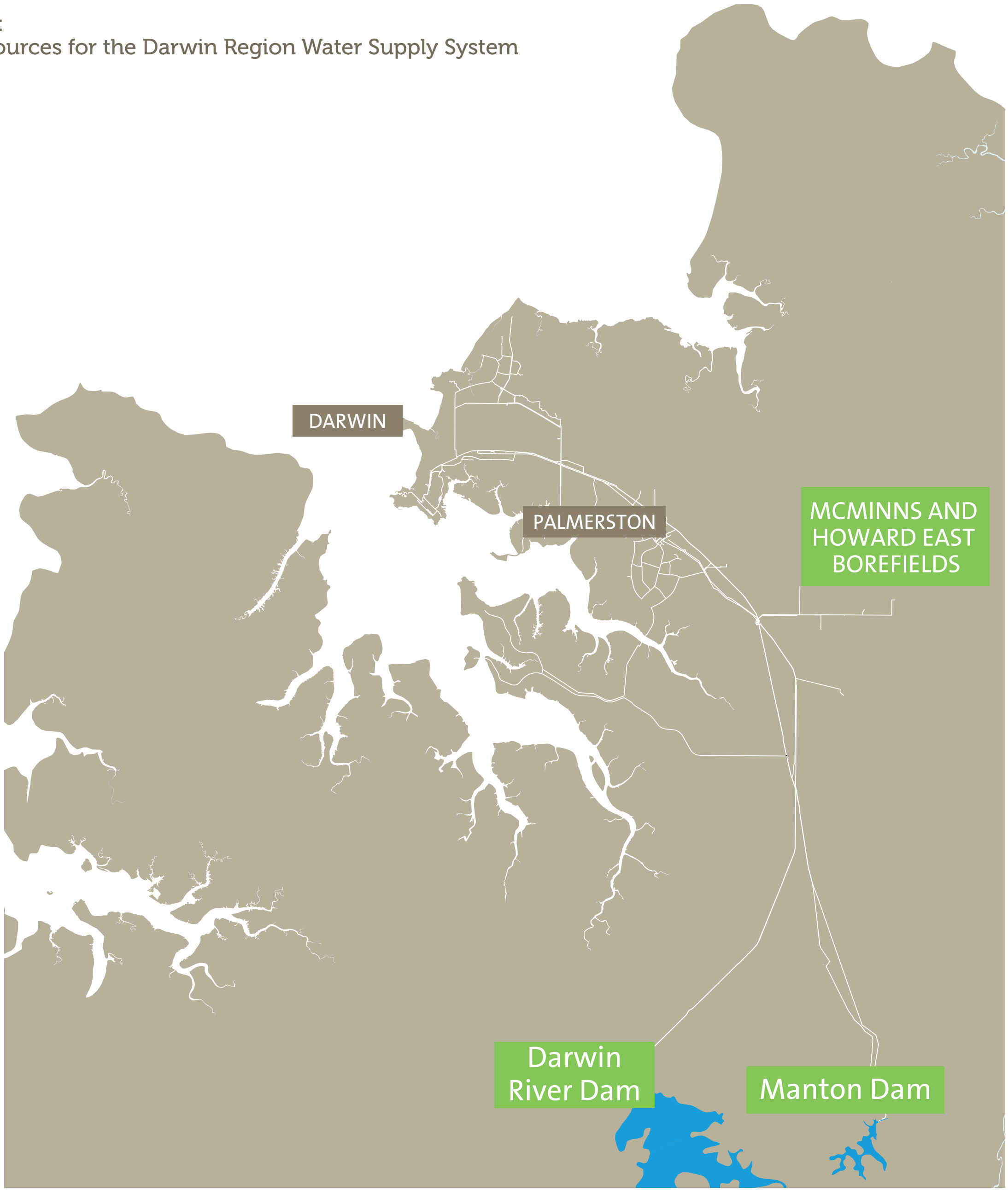
3.1 Water Sources

Darwin is located in the wet-dry tropics of Northern Australia, with high average temperatures and high year-round evapotranspiration, a monsoonal wet season lasting four to five months, and a largely rain-free dry season lasting seven to eight months on average.

The Darwin region's water supply system obtains its water from both surface water sources (via dams) and groundwater (via bores). The great proportion (approximately 85 per cent) of the Darwin region's water is currently sourced from Darwin River Dam, with an important supplementary supply extracted from the McMinns and Howard East Borefields. These two sources are piped to McMinns Storage and Transfer Station, where the water is blended and piped to Darwin, Palmerston and the outer Darwin area.

Power and Water has developed a Water Source Protection Strategy to support the proactive management and protection of its water supply catchments.

Figure 5:
Water Sources for the Darwin Region Water Supply System



3.1.1 Darwin River Dam

Darwin River Dam was constructed in 1972 about 50 km south of Darwin. Darwin River Dam is a 518m-long earth embankment dam, with an unregulated 265m wide spillway.

In 2010, Power and Water completed an upgrade of the embankment and raised the spillway at Darwin River Dam to increase the full supply level by 1.3m. The augmentation increased the yield of the dam by approximately 20 per cent and resulted in a storage capacity of 320,000 ML.

Power and Water is currently licensed to extract 49,100 ML/yr from Darwin River Dam, however its yield has recently been assessed as 36,780 ML/yr, after the latest of a series of regular five-yearly reviews of yield. Extraction beyond the yield is possible, but this will reduce the level of service offered, resulting in an increased likelihood of water restrictions for the community. This issue is further explored in Section 3.6 Level of Service.

3.1.1.1 Darwin River Dam Catchment

Darwin River Dam catchment is operated as a closed catchment, being predominantly undeveloped and with restricted public access. The catchment management plan aims to control environmental threats, including wild fires and weeds, and recognises the catchment's environmental values, being a refuge for native flora and fauna, including migratory and local bird species, as well as its role as a public water supply source.

The majority of the land is freehold and owned by Power and Water with most of the balance falling within the Finniss River Land Trust. The Northern portion of the catchment is zoned Water Management under the NT Planning Scheme, identified in the Litchfield area zone plan. The Southern portion of the catchment is contained within the Coomalie area and identified in the Coomalie Planning Concepts and Land Use Objectives (2000), on unzoned land.

Land tenure and land zoning plans for Darwin River Dam are at Appendix 1: Land Tenure And Land Zoning Maps For Darwin Region Water Supply Catchments.

3.1.2 Manton Dam

Manton Dam was constructed in the early 1940s by the Department of Defence to provide a reliable source of water for Darwin during World War II. Located approximately 50km southeast of Darwin, Manton Dam, with a storage capacity of 14,000 ML, was the city's primary source of water until the commissioning of Darwin River Dam in 1972. Since that time Manton Dam has been maintained as an emergency water supply source for the Darwin Region water supply system.

Power and Water is licensed to extract 7,300 ML/yr from Manton Dam. The supply from Manton is not currently used as an operational source of water due to infrastructure constraints and water quality challenges, including recreational use of the dam. Manton Dam's yield has recently been assessed as able to provide a 7,400 ML/yr net contribution to the Darwin Region's water supply.

In an emergency, Power and Water could deliver up to 10 ML/day from Manton Dam to the McMinns Transfer Station to supplement the water supply system. However the water quality would not comply with the Australian Drinking Water Guidelines without treatment. Therefore the use of Manton Dam as a limited short-term emergency supply during a crisis such as a cyclone event or failure of the Darwin River Dam supply system is possible, but undesirable in the absence of water treatment facilities.

3.1.2.1 Manton Dam Catchment

Manton Dam catchment was operated as a closed catchment until the late 1980s when Government directed it be opened up for recreational use by the community. Today water skiers, anglers, picnickers and day trippers visit the dam on a regular basis and it has become a popular freshwater recreation destination for the local populace.

The recreational use of the dam is managed by the Parks and Wildlife Commission, who are also responsible for catchment management. Power and Water remains responsible for the maintenance of the water supply infrastructure.

The majority of the catchment is freehold land owned by Power and Water and leased to the Conservation Land Corporation. The catchment is contained within the Coomalie area and identified in the Coomalie Planning Concepts and Land Use Objectives (2000), on unzoned land.

Land tenure and land zoning plans for Manton Dam are at Appendix 1: Land Tenure And Land Zoning Maps For Darwin Region Water Supply Catchments.

3.1.3 McMinns and Howard East Borefields

The McMinns Borefield, 30km East South East of Darwin in Howard Springs, was established in the 1960s on the Koolpinyah dolomite aquifer.

Stage 1 of the Howard East Borefield, the first of four planned stages, was commissioned in 2001 to supplement the existing supply from the McMinns Borefield.

The Howard East and McMinns Borefields can theoretically provide up to 20 per cent of the Darwin region's current demand requirements, but, due to infrastructure constraints including a lack of redundancy in the borefields, current supply is limited to around 15 per cent of Darwin's water supply. Importantly, the Howard East and McMinns Borefields are an integral part of the diversification, security and emergency supply aspects of the Darwin Region Water Supply Strategy.

Power and Water is currently licenced to extract 8,420 ML/yr from the six production bores in the Howard East and McMinns Borefields as detailed in Table 4 (on the following page).

Table 4:
Howard East and McMinns Borefield Production Bore Details and Extraction Limits

Location	Power and Water Bore Reference	NTG Bore Number	Equipped Extraction Rate (L/s)	Annual Extraction License Volume (ML)
McMinns	M54	RN6310	54	2,150
McMinns	M55	RN6231	44*	1,020
McMinns	M62	RN7048	64	1,020
McMinns	M64	RN7071	51	1,550
Howard East	HEP1	RN20496	28*	1,300
Howard East	HEP2	RN20497	32	1,380
Total			**273**	**8,420**

* Not available at the end of the dry season due to declining water levels

The annual licensed extraction limits reflect the theoretical maximum bore extraction volumes at the time of granting of the licenses. Seasonal variability in groundwater levels, individual bore pump limits and a lack of redundancy in the borefields means that the licensed annual extraction volume is not reliably achieved with the current infrastructure.

3.1.3.1McMinns and Howard East Catchments

When McMinns Borefield was first established in outer Darwin, its location was relatively remote. Since the 1980s however, the area has been extensively developed as a rural living area and property owners use private bores to extract water from the same groundwater resource for household and irrigation needs, and in a relatively unregulated manner.

Whilst DLRM continues to study and model the groundwater resources in the area, it is estimated that Power and Water's annual extraction from its six production bores represents less than 20 per cent of the total annual extraction from the aquifer, with the majority of extraction from the approximately 3000 largely unmetered private horticultural and rural residential bores.

Of the four operational bores in McMinns Borefield, one is located within the road reserve, two are on freehold land owned by Power and Water, and one is located on a private freehold land zoned Rural Living. All of the four bores are adjacent to Rural Living zoned developments.

The existing Howard East Borefield is on Crown Land leased to Power and Water. The bores are 1km from the nearest residential development, on land zoned Water Management under the NT Planning Scheme, identified in the Darwin Region zone plan. An area identified for expansion of the Howard East Borefield to the north of the existing borefield is on Vacant Crown Land, planned for transfer to Power and Water following resolution of Native Title issues.

The open and developed nature of the catchment represents a number of risks for Power and Water including potential contamination of and unsustainable extraction from the groundwater source. DLRM is currently developing a Water Allocation Plan for the Koolpinyah aquifer and it is considered unlikely that any further allocation will be available to Power and Water through that process beyond the current license limits. However, Power and Water is planning to develop additional extraction capacity within the Howard East borefield to improve the reliability of extraction within the current license limits.

Power and Water remains vigilant to the pressures of development, increased human occupation and recreation in the area and risks from extractive minerals mining. To address these risks, Power and Water has identified wellhead protection zones around the bores in the McMinns Borefield to support development control and to protect the integrity of the public water supply system. Power and Water liaises closely with the Department of Mines and Energy to manage potential impacts from extractive minerals and energy exploration and development.

In 2009, an ultraviolet disinfection system was installed at the bore head of one of the McMinns bores to provide an additional barrier to contamination of the public water supply. This bore has been historically impacted by contamination linked to nearby residential septic tank effluent disposal systems.

Table 5:
Summary of Source Availability

Source	Licensed Extraction (ML/yr)	Cumulative System [licensed] (ML/yr)	Available Extraction [limited by infrastructure or yield] (ML/yr)	Cumulative System [available] (ML/yr)
McMinns and Howard East Borefields	8,420	8,420	6,000	6,000
Darwin River Dam	49,100	57,520	36,780	42,780
Manton Dam	7,300	**64,820**	0	**42,780**

3.2 Water treatment

Water supplied from Darwin River Dam and the McMinns and Howard East Borefields is essentially untreated other than the addition of fluoride at the Darwin River Dam Pumping Station.

Raw water is disinfected with chlorine gas at Darwin River Dam. Groundwater from the borefield is blended with the water supplied from Darwin River Dam, then disinfected with chlorine gas at the McMinns Storage and Transfer Station. There are a number of small sodium hypochlorite booster systems at various locations in the water supply network.

A bore in the McMinns Borefield was previously removed from service due to the repeated detection of pathogen indicators. However an ultraviolet disinfection system was installed at the borehead in 2009 to enable its return to service.

3.2.1 Water Quality

Power and Water is committed to providing safe drinking water by adopting and implementing the Framework for Management of Drinking Water Quality included as a key part of the Australian Drinking Water Guidelines.

Power and Water publishes an annual Drinking Water Quality Report detailing its drinking water quality and performance and how it applies the 12 elements of the Framework for Management of Drinking Water Quality to ensure the quality of water delivered to its customers.

Power and Water applies a multiple barrier approach to protect drinking water supplies. The multiple barrier approach is universally recognised as the foundation for ensuring safe drinking water. A 'barrier' such as disinfection is a measure used to reduce water quality risks. Significantly, the main source of supply (Darwin River Dam) has a closed catchment. The significance of the protection of water sources cannot be overstated.

Complaints about the Darwin region's water quality generally relate to the way it looks, an aesthetic issue largely governed by seasonal variation in reservoir water quality and water demand. Darwin River Dam is highly stratified, which limits the mixing of different layers of water. Stratification occurs when the sun heats the upper layers faster than the heat can disperse into the lower depths. The difference in density between the hotter surface and the cooler bottom limits mixing between these layers.

This can lead to layers with significantly different water qualities. Seasonal weather patterns can cause a mixing of these layers affecting aesthetic quality.

Also, with the first major rains of the wet season, or after heavy rainfall associated with cyclones, dissolved organic matter in the catchment may enter Darwin River Dam leading to an increase in dirty-looking water making it through to our taps.

Recent changes at Darwin River Dam have increased the area of the water body when full. It is anticipated that dirty water episodes will increase over the next few years while these new areas adjust to more frequent immersion.

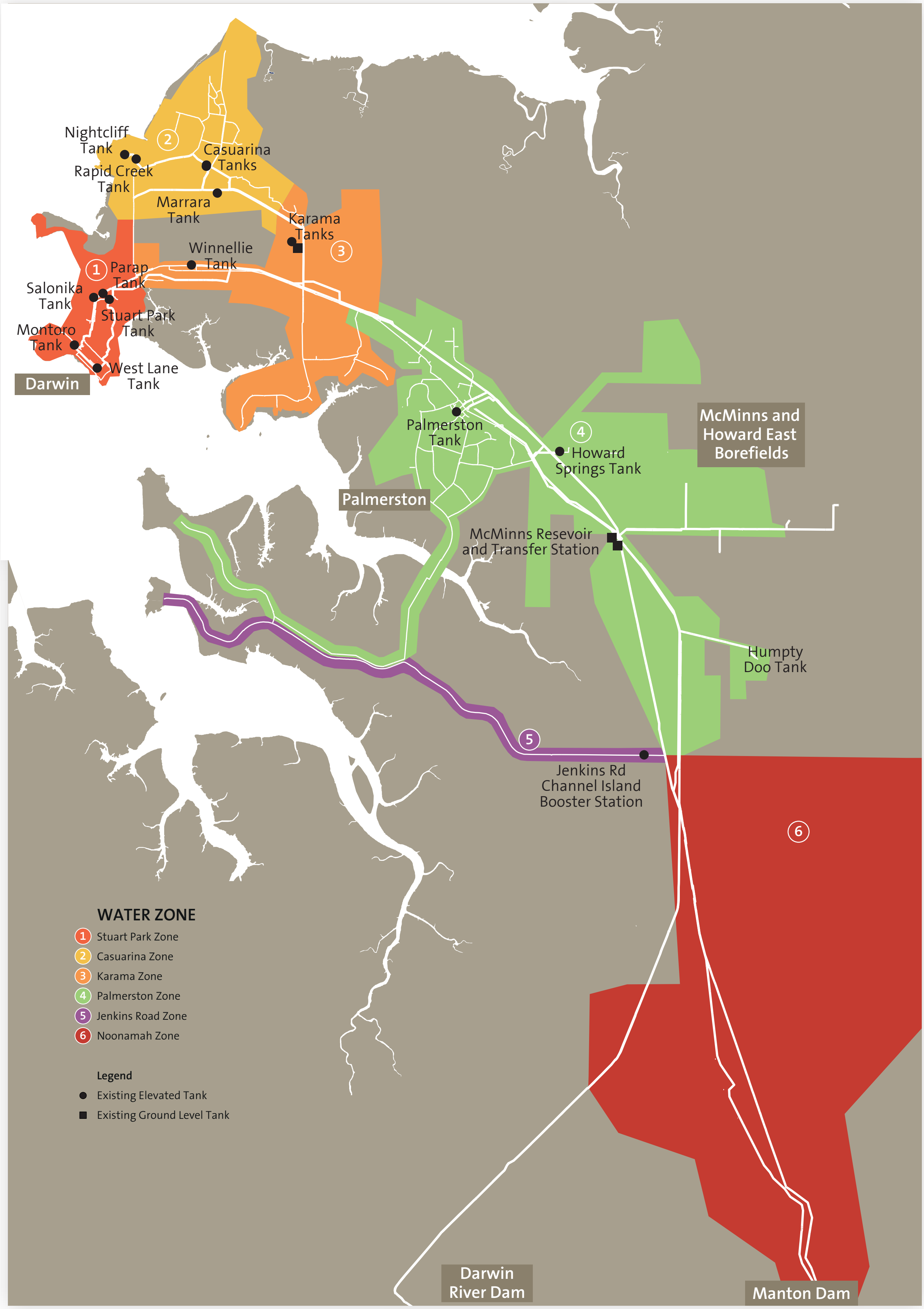
Consumer expectations are driving the need to improve aesthetic water quality and require Power and Water to consider options to improve the aesthetic quality of water delivered to the community, through planning for future water treatment capability.

3.3 Distribution Network

The Darwin Region water supply system provides potable water to customers in five water supply zones; Darwin Rural/Palmerston, Stuart Park, Casuarina, Karama and Channel Island.

The system provides potable water to approximately 50,000 properties (including commercial, industrial and Government) and serves a permanent population of approximately 118,500 people.

Figure 6:
Overview of the Darwin Region Water Supply Distribution System



3.4 Recent Water Supply Trends

3.4.1 Meteorological Influences – El Niño and La Niña

The term El Niño refers to the situation when sea surface temperatures in the central to eastern Pacific Ocean are significantly warmer than normal. This recurs every three to eight years and generally results in below average rainfall in the Darwin region. When the eastern Pacific Ocean is much cooler than normal, a La Niña event occurs, generally resulting in above average rainfall in the Darwin region.

The 2010/11 and 2011/12 La Niña events were two of the most significant in Australia's recorded meteorological history and resulted in above average rainfall in the Darwin region, including a record 2918.4mm of rain at the Darwin airport rain gauge in 2010/11.

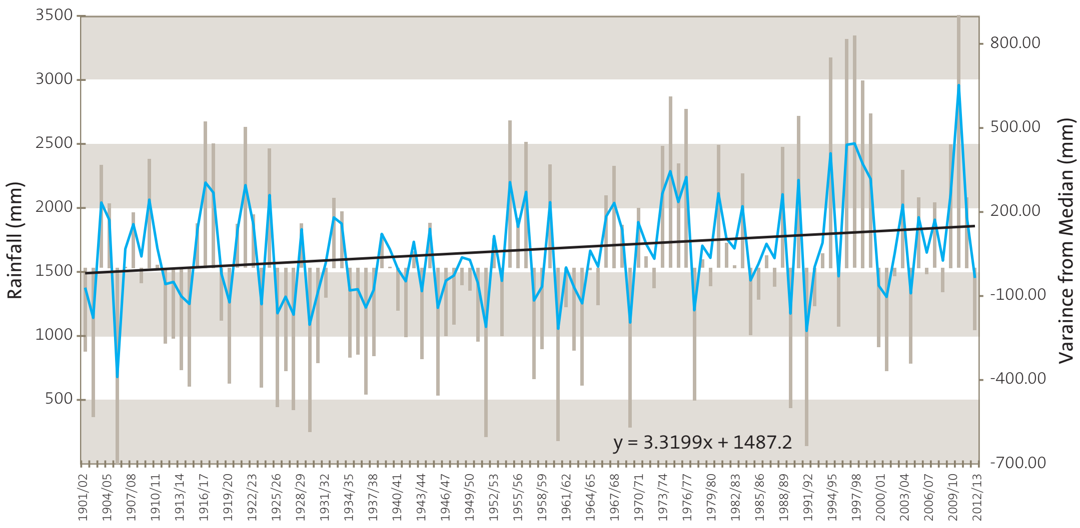
3.4.2 Rainfall

The Darwin region has been enjoying an increasingly wet period of weather, with increasing average rainfall. This is illustrated on the long term rainfall graph below. This is in stark contrast to Southern Australia where sustained drought conditions had (until recently) been indicative of a long term decrease in rainfall.

This does not mean that the Darwin region is immune from the effects of long term climate change and it is important to understand the combined effects of potential future rainfall, temperature and evaporation variations when assessing the Darwin region's future water supply and demand balance.

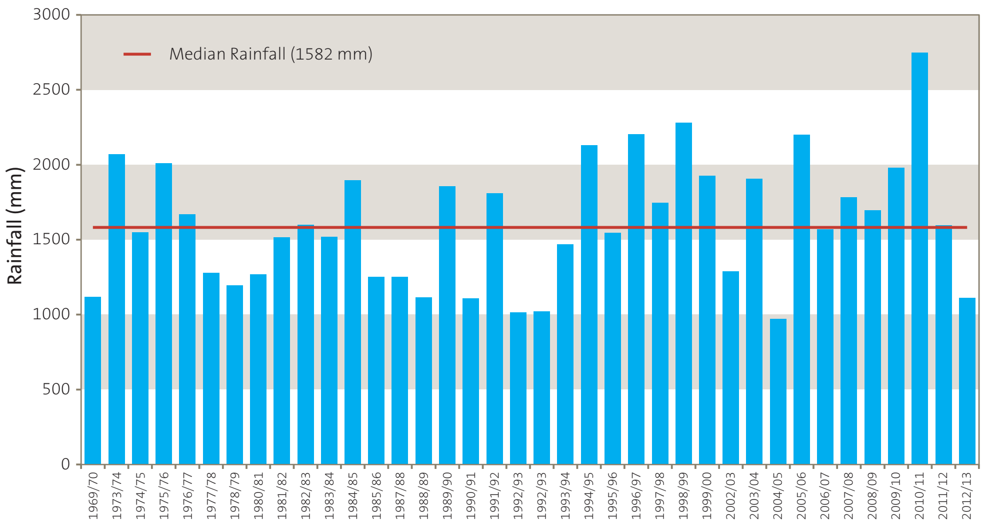
Annual rainfall in the Darwin River Dam catchment, like that of the Darwin region, is highly variable as illustrated in Figure 8: Darwin River Dam Catchment Rainfall (right). A sustained period of below-average annual rainfall, such as occurred between 1986 and 1993 can be considered as drought conditions for the wet/dry tropics, where even in the poorest of wet seasons annual rainfall reliably exceeds 1,000 mm.

Figure 7:
Darwin Region Long Term Rainfall Trend



Note: Seasons with missing data not shown

Figure 8:
Darwin River Dam Catchment Rainfall



3.4.3 Demand

Figure 9 (right) shows the significantly high level of residential water use in both Darwin and Alice Springs compared with the national median, which has decreased over the past several years. Of concern is the progressive increase in residential water demand reported for Northern Territory centres.

Annual water demand is highly weather dependant in the Darwin region. An extended wet season results in a lower annual water demand, but an extended dry season will lead to significantly increased annual water demand.

Growth in annual water demand has averaged approximately 2.3 per cent in the 30 years since 1980. Annual fluctuations in demand (principally due to the Darwin region's variable annual rainfall and wet season periods) are a regular occurrence and can exceed 10 per cent per annum. Demand growth figures for the past thirteen years are tabulated below.

Figure 9:
Residential Water Use

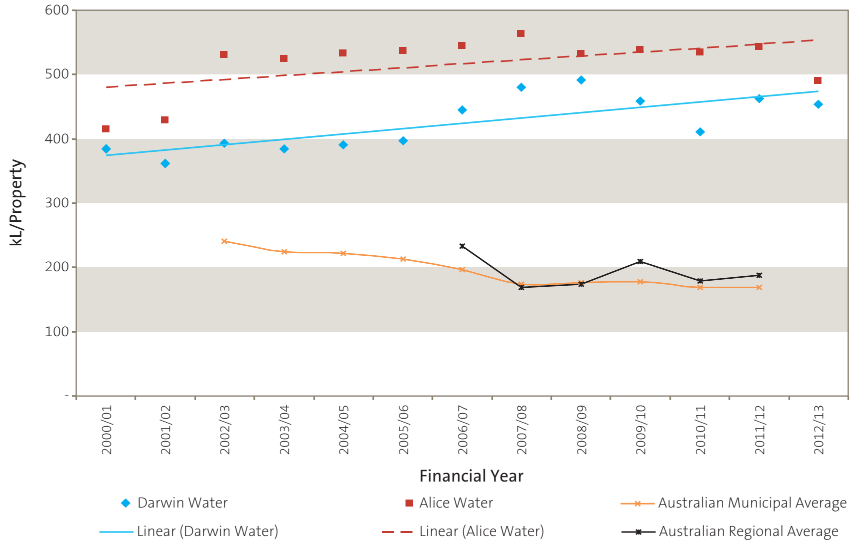


Table 6:
Annual Water Demand Variability

Year	Annual demand (ML)	Change from previous year (%)	Total rainfall (mm)	Correlation between demand change and rainfall*
2000/01	38,214	6	1,392	1
2001/02	36,872	-4	1,306	- 1
2002/03	39,467	7	1,645	1
2003/04	38,464	-3	2,026	1
2004/05	41,264	7	1,333	1
2005/06	38,276	-7	1,927	1
2006/07	40,531	6	1,652	1
2007/08	39,621	-2	1,908	1
2008/09	43,138	9	1,589	1
2009/10	41,367	-4	2,116	1
2010/11	38,760	-7	2,960	1
2011/12	41,856	8	1,927	- 1
2012/13	42,805	2	1453	1

* 1 = demand increase AND below median rain OR demand decrease AND above median rainfall. Long term median rainfall = 1,716 mm (1941-2012)

3.4.4 Water Storage

In the Darwin region, both surface water and groundwater resources experience significant fall in level owing to extraction and evapotranspiration during each year, but are usually significantly replenished by rainfall and runoff during each wet season.

Notably, the Darwin region experienced a significant series of poor wet seasons (equivalent to a drought) of 12 years, from 1984 to 1996, in which Darwin River Dam did not fill and spill. Conversely, with above average rainfall during the past fifteen years, Darwin River Dam has filled and spilt most years since 1997, with the exception of 2003, 2005 and 2013. As annual extraction increases, the end of dry season water level continues to drop each year. Should a period of poor wet seasons return, water levels in Darwin River Dam could fall to levels not previously experienced.

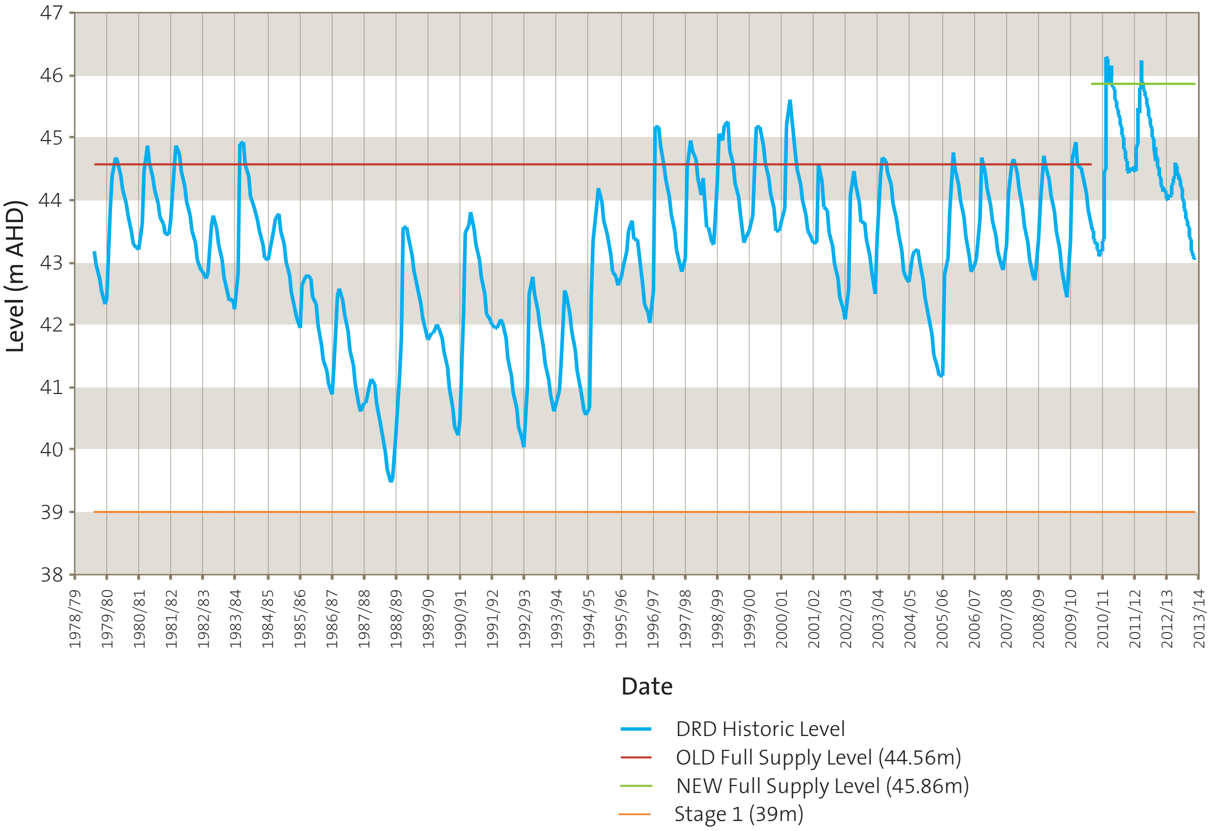
Figure 10 details varying water levels in Darwin River Dam over time. The chart identifies the original full supply level (FSL) and the new FSL associated with augmentation of the storage in 2010. The Stage 1 water restriction level trigger (further discussed in Section 3.6 Level of Service Objectives) is identified at 39m AHD.

3.4.5 Water Conservation

Whilst Power and Water has not previously imposed water restrictions on its customers, there is growing momentum to promote water conservation measures. It is recognised that these efforts need to be substantially ramped up to achieve the objectives of the Strategy.

Power and Water has developed a key initiative called 'Living Water Smart', which aims to reduce water demand by 10,000 ML/yr by 2018 through improved asset management (reducing water losses and managing system pressure) and a comprehensive water conservation programme. Living Water Smart's range of demand management initiatives are discussed further in Section 6 - Demand Reduction Strategies.

Figure 10:
Darwin River Dam Storage Levels - 1978 – 2013



3.5 Level of Service Objectives

The primary objective of a water utility is to ensure that the community has a safe and reliable water supply system and to communicate this to its consumers.[1] This does not mean there will never be restrictions, but it does mean that the community can expect to never run out of water.

This primary objective consists of three main components, namely:

1. The supply system has the capacity to maintain an adequate level of supply over most periods in the long-term.
2. When drought[2] periods occur, a drought response plan provides short-term protection against running out of water through the implementation of water restrictions.
3. In cases of extreme drought, a contingency or emergency plan exists that ensures that basic water needs for a community can be met for the duration of the emergency.

These high level objectives can be translated into specific objectives for a water supply system, known as 'level of service' objectives. The level of service objectives can relate to a number of specific measures including the desirable maximum frequency, duration and severity of water restrictions expected by the community.

In 2012, Power and Water undertook a review of levels of service across Australia and developed a set of level of service objectives for the Darwin Region water supply to be used for planning purposes. The target level of service objectives include:

- An unrestricted demand reliability of 95 per cent - water restrictions imposed not more than 1 in 20 years on average;
- A drought response plan that includes a four-stage water restrictions regime, delivering an incremental demand-dampening effect (to peak demand during the dry season) of 12.5, 25, 45 and 65 per cent (or 10, 20, 35 and 50 per cent when applied across a 12-month period);
- A reliability of avoiding stage 4 (extreme) water restrictions of 99 per cent - stage 4 water restrictions, contingency storage (and emergency supply options) triggered not more than 1 in 100 years;
- A contingency storage provision, sized to provide two years of highly restricted (stage 4) demand to allow time for emergency water supply sources to be connected to the water supply system; and
- A number of emergency water supply options sized to provide sufficient yield to deliver a highly restricted (stage 4) demand should extreme drought conditions persist.

The size of the contingency storage is based on maintaining supply under highly restricted (stage 4) demand conditions, where inflows to Darwin River Dam are equal to the lowest two consecutive years inflow in 100 years.

The emergency water supply source options are sized to maintain a highly restricted (stage 4) demand, during a period of sustained low inflows (the lowest two consecutive years inflow in 100 years, repeated in perpetuity) to Darwin River Dam. This provides assurance to the community that the system will never fail to meet (highly restricted) demand.

Emergency water supply source options may include (for example):

- additional groundwater supply, under an emergency supply licence issued by the regulatory authority;
- emergency extraction of river water piped to Darwin River Dam (or Manton Dam, once it's connected) through a temporary pipeline;
- an emergency desalination plant; or
- a combination of the above, or other options not yet identified.

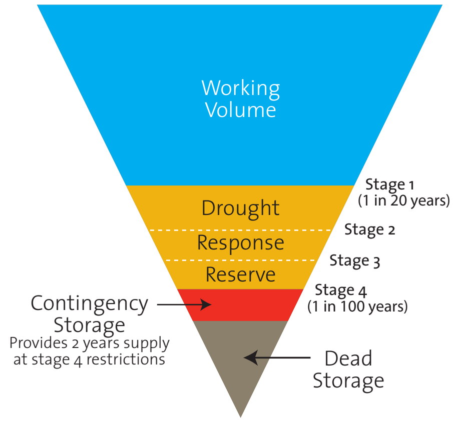
Power and Water is currently assessing a range of options for emergency supply and the recommended option or options will be progressed to design stage, to allow for connection within a two-year timeframe, should the contingency storage level be reached.

The following schematic and associated table illustrates the application of the targeted level of service objectives for the existing Darwin region water supply system. Figure 11 identifies the proportion of Darwin River Dam's storage to be used as 'working volume' and the proportion that falls within the drought response reserve and contingency storage triggers.

[1] Framework for Urban Water Resource Planning, WSAA, 2005

[2] A series of poor wet seasons is defined as a 'drought' for the Darwin region.

Figure 11:
Application of Level of Service Objectives to Darwin River Dam



Relative level (m AHD)	Volume (GL)	Volume (%)	Description	Demand (%)	Reliability (%)	Frequency of trigger (1 in X years)
45.86	320	100	FSL	100		
39	100	31	Stage 1	90	95	20
37	65	20	Stage 2	80	not defined	not defined
35.5	44.5	14	Stage 3	65	not defined	not defined
34	28	9	Stage 4	50	99	100
32	15	5	Dead Storage			
28	0	0	Empty			

FSL = Full Supply Level

3.6 System Yield

'System yield' is a term used to describe the volume of water that can be harvested in order to achieve the adopted standard of service. System yield is always associated with a standard of service and reduces as the standard of service increases. In practical terms, this means that a water supply system may be acceptable to one community, which is willing to accept more frequent restrictions, and unacceptable to another community less tolerant of restrictions.

Using the Darwin River Dam yield of 36,780 ML/yr, derived by taking into account the targeted level of service objectives for the Darwin region water supply, and the current limitation on borefield extraction of 6,000 ML/yr, the current system yield is 42,780 ML/yr (refer to Table 4). [3]

3.6.1 Headroom Requirement

Power and Water aims to maintain a 10 per cent buffer (headroom) between demand and supply capability to buffer the regular large annual fluctuations in demand (+/- 10%) driven by the Darwin region's variable annual rainfall and wet season periods, which strongly influences demand for water. This phenomenon distinguishes the Darwin region from others, and hence no industry standard exists for the provision of headroom. The headroom provision also caters for potential significant unplanned step increases in demand associated with rapid industrial development in the region.

3.6.2 Target System Yield

Due to the large annual fluctuations in demand, exponential regression of historical normalised demand is used to estimate system headroom requirements. Providing for 10% system headroom along with customer growth and demand management initiatives, the target system yield for the Darwin region water supply system is currently 47,864 ML/yr, indicating an immediate system yield shortfall of 5,084 ML/yr, providing the impetus for short-term source augmentation.

3.7 Emergency Supply

In the event that supply from Darwin River Dam becomes unavailable, due to a contamination event or infrastructure failure, Power and Water aims to provide an alternative supply, approximately equivalent to 25 per cent of wet season demand. The supply must be from a source independent of Darwin River Dam so as to maintain short-term emergency supply capability. Groundwater at the McMinns and Howard East Borefields would be required to meet this supply diversity objective. Furthermore, in the absence of an alternative supply independent from Darwin River Dam, the groundwater supply must also meet an 'n-2' reliability criterion. This criterion dictates that should the two highest-yielding bores fail, the groundwater supply would continue to meet the supply diversity objective.

The existing groundwater supply currently fails to meet the reliability criteria, and consequently fails to meet the supply diversity objective.

[3] Includes the increase in yield associated with the 2010 augmentation of Darwin River Dam.

Table 7:
Summary of Reliability of Supply and System Yield

Item	
Adopted standard of service	• 95% unrestricted demand reliability – water restrictions 1 in 20 years • 99% restricted demand reliability – severe (stage 4) water restrictions 1 in 100 years • 2 year contingency storage – sized to provide time to connect emergency supply sources in extreme drought • Emergency supply sources designed to provide continuity of supply in prolonged, extreme drought
Current serviced population	118,523
Current level of unrestricted demand	42,805 ML/yr
System yield target (includes 10% headroom)	47,864 ML/yr
Current system yield	42,780 ML/yr
Current augmentation required to meet adopted standard of service	5,084 ML/yr
Current emergency supply capability	7.2 ML/day (target for 2013 is 20.7 ML/yr)

3.8 Water Demand Trends

System demand in 2012/13 for the Darwin region was 42,805 ML.

Figure 12 (right) depicts the comparative usage of different consumer groups. Non-revenue refers to water taken or lost from the system that does not generate revenue, such as water lost through meter error, main breaks, leakage and theft, and water used for flushing of mains and fire fighting.

Community efforts towards water conservation are increasing, but sustained savings in water consumption are yet to be fully realised. Opportunities exist to achieve savings across all consumer groups. This issue is explored further in Section 6 - Demand Reduction Strategies.

Figure 13 (right) depicts the recent trends in water consumption for the Darwin region across customer types.

The Darwin region's residential per capita water consumption is one of the highest in Australia, with no downward trend at this time. Outdoor water use (irrigation) is a significant contributor to extremely high water demand in the dry season. System demand peaks during the dry season when demand exceeds 160 ML/day, reducing to approximately 80 ML/day during the wet season. The average residential demand of approximately 460 L/capita/day is up to three times the average per capita demand for most Australian utilities.

Figure 12:
Darwin Region Water Consumption by Customer Type

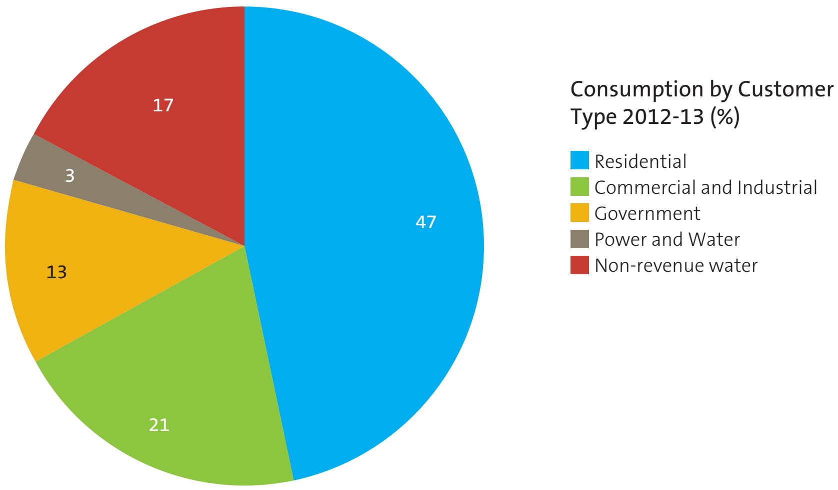


Figure 13:
Darwin Region Water Consumption Trend by Customer Type

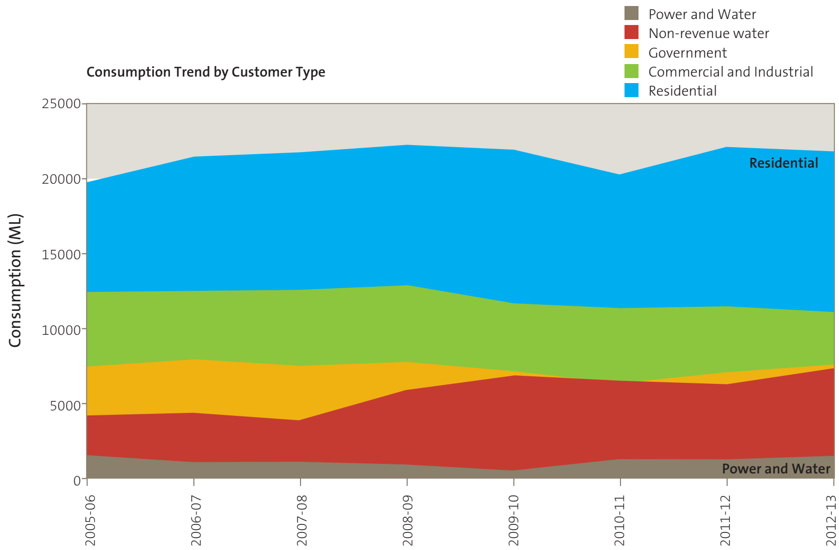
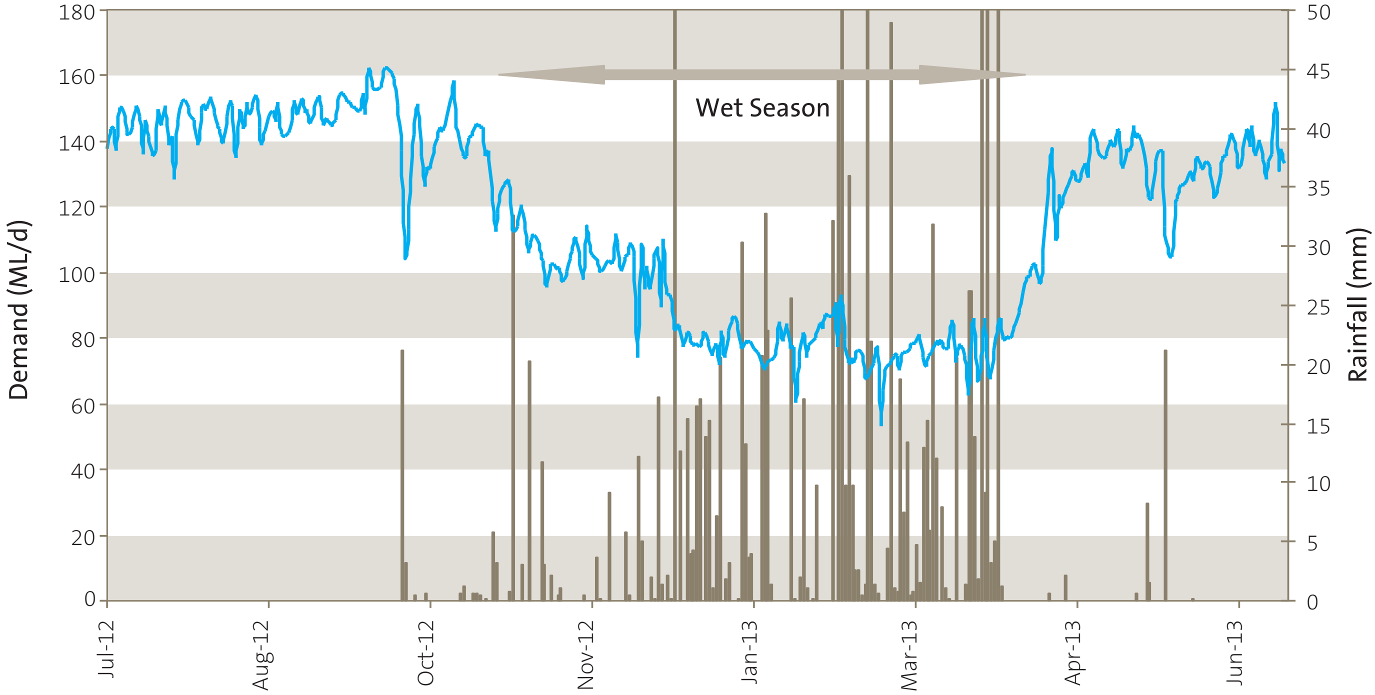


Figure 14 (below) demonstrates the seasonal impact of rainfall on water demand in the Darwin region.

Figure 14:
Darwin Region Water Demand – Seasonal Impacts



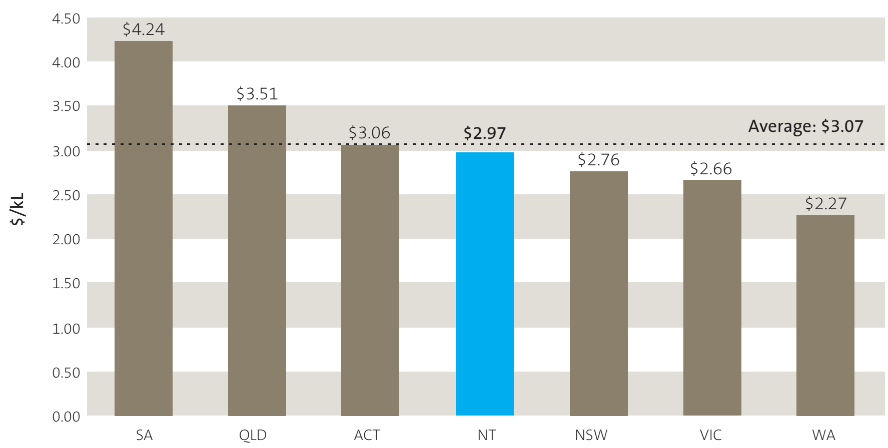
3.9 Water Supply Pricing

The Northern Territory Government sets water tariffs in consultation with Power and Water. The Government provides Power and Water with a Community Service Obligation payment to support a uniform Territory-wide tariff to compensate for the variability of cost in providing water supply services across its customer base.

Power and Water's pricing policy provides for a fixed daily charge dependent on meter size, and a volumetric charge based on usage.

Commencing in 2009-10, the water tariff was increased by 20 per cent per annum for three consecutive years to start to close the gap between operational costs and tariff-based revenue. In May 2013 (effective 1 January 2013), the water tariff increased by a further 30 per cent along with similar substantial increases in electricity and sewerage tariffs to improve Power and Water's financial sustainability. Incorporating the 2013 increase, the residential water tariff of $2.97 per kilolitre is slightly below the national average.

Figure 15:
Residential Water Tariff Comparison



Source: Retailers' published tariffs, as at 1 May 2013

Notes

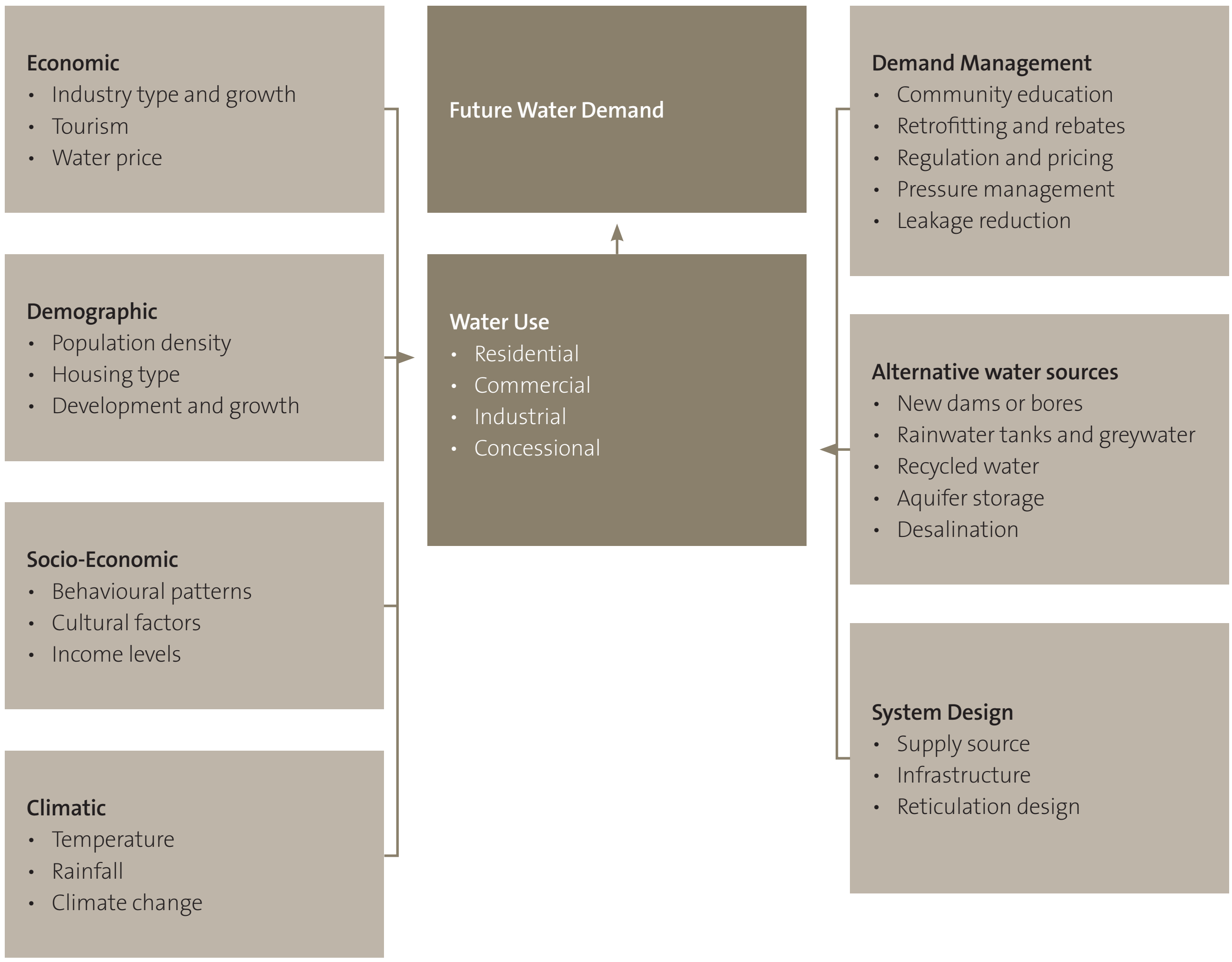
- The tariff comparisons in the chart are based on average annual consumption of 214kL (WSAA average). Consumption may vary in each jurisdiction from this derived average as a result of water restriction policies.
- Tariffs include a variable consumption charge and a fixed daily component.

4 Water demand forecasting

4.1 Introduction

Water demand forecasts are a key component of developing effective water supply-demand strategies. The forecasts help determine whether to implement measures that moderate demand or to investigate the provision of alternative and additional water supplies. Power and Water recognises the difficulty in establishing projections that are statistically accurate beyond a five-year period due to the wide range of factors influencing water demand, and has therefore used analysis of historical trends and developed forecasts using the most up-to-date local and regional information.

Figure 16:
Factors Influencing Water Demand



Source: Adapted from Guidelines for the Development of a Water Supply-Demand Strategy 2005

4.2 Methodology

Power and Water forecasts growth in water demand using a combination of population growth forecasts from the Australian Bureau of Statistics (ABS) and the Department of Treasury and Finance, as well as forecasts of industrial demand provided by the Department of Business and the Land Development Corporation.

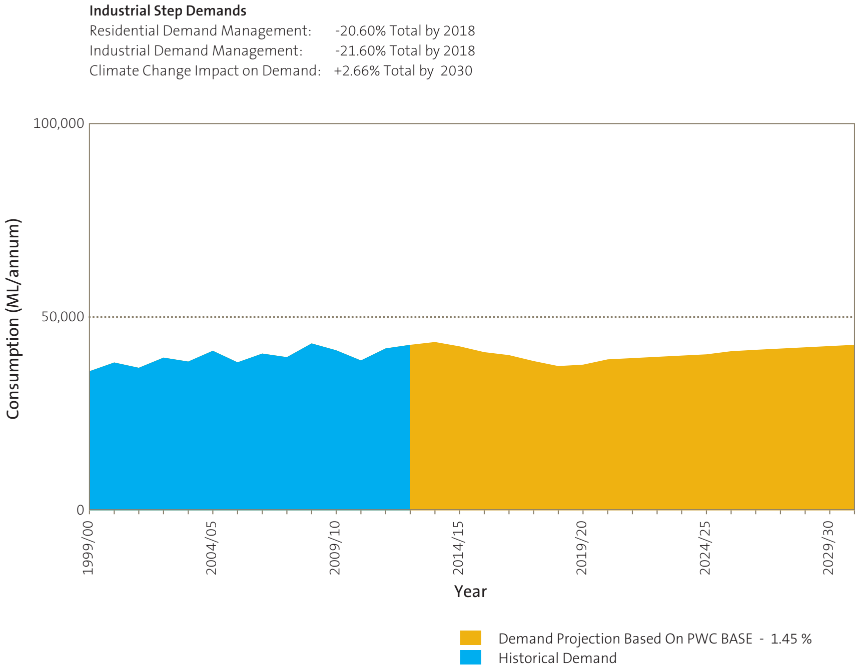
The Department of Treasury and Finance's population forecasts have been developed to meet the needs of Northern Territory Government agencies as well as the broader community. The assumptions and parameters on which they are based, are the result of extensive consultation within Northern Territory Government. The process has also involved Charles Darwin University (CDU) whose staff provided expert advice as well as the technical expertise to develop a projections model (NTPOP). Projection outputs for two scenarios are currently available – the NTG projections scenario and a high migration scenario.[4]

Power and Water uses the most up-to-date information for the development of water demand projections and plans to carefully review demand forecasts each year to help minimise the level of uncertainty inherently associated with long-term forecasts. Annual water demand in the Darwin region is strongly influenced by the type of wet season experienced. Annual fluctuations in demand of up to 10 per cent are not uncommon. To dampen the impact of annual fluctuations, demand forecasts use an exponential regression of historical normalised demand as a base.

4.3 Bulk Water Demand Projections

The base water demand projection shown in the graph (above) indicates the expected average annual demand in the Darwin region for periods without restrictions. The projections are based on average annual consumption and do not depict annual variations in water consumption that commonly occur due to climatic variation.

Figure 17:
Darwin Region – Projected Bulk Water Demand



4.4 Adopted Growth Rates

4.4.1 Base Case

Power and Water's base case for forecasting growth in demand utilises the Department of Treasury and Finance's NTG Projects scenario to 2025, and the ABS Series B projection thereafter. Forecast demands associated with major industrial development in the Darwin region have been included in the base demand projection as well as climate change impacts on demand, and demand management targets.

Table 8:
Base Case Population Growth to 2030

Financial Year Commencing	Population Growth (Base Case)
Average to 2030	1.54%
2012	1.70%
2013	1.70%
2014	1.70%
2015	1.70%
2016	1.60%
2017	1.60%
2018	1.60%
2019	1.60%
2020	1.60%
2021	1.40%
2022	1.40%
2023	1.40%
2024	1.40%
2025	1.40%
2026	1.52%
2027	1.50%
2028	1.47%
2029	1.45%
2030	1.43%

[4] http://www.nt.gov.au/ntt/economics/nt_population.shtml

Areas of significant demand growth forecast for the Darwin region include:

- New urban development in Palmerston East (Bellamack, Mitchell, Zucolli) and Lee Point (Muirhead);
- Infill development in Darwin CBD and surrounding suburbs;
- Potential development in the Berrimah farm area;
- Potential urban expansion in or around Noonamah to the South West of Palmerston;
- Industrial development in the East Arm and Middle Arm areas;
- A proposed abattoir in the outer Darwin area; and
- Major industry, such as the proposed Inpex development

The base case assumes achievement of Living Water Smart's targeted water demand savings (reduction in demand of 10,000 ML/yr by 2018).

4.4.2 Modelled Loads

The following forecast demands associated with major industrial development in the Darwin region have been included in demand modelling.

Table 9:
Major Industrial Development in the Darwin Region

Year	ML/yr	Activity
2014	500	Abattoir
2016	1000	East Arm Port Expansion
2018	1000	Conoco Phillips LNG - Stage 2
2025	500	Inpex - Stage 2

4.4.3 Alternative Demand Growth Scenarios

A number of other demand forecast scenarios are also routinely modelled to test the sensitivity of the model to variations in demand. The projection below uses the Northern Territory Treasury's forecast for 'high migration' scenario to 2021, and the ABS Series B projection thereafter, includes climate change impact on demand and assumes no demand management benefit. The 2030 demand is approximately 57,000 ML/yr, compared to the base case forecast of approximately 43,000 ML/yr showing how sensitive the model is to planning assumptions.

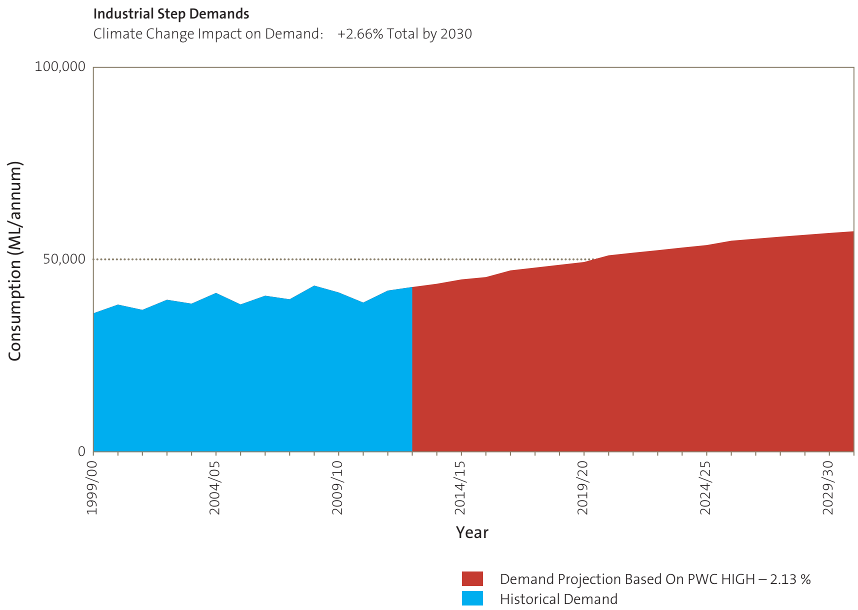
4.5 Future Improvements to Demand Modelling

The growing focus on water conservation and the emphasis on identifying new opportunities to generate water savings are fuelling the need to develop better tools for demand forecasting and analysis. Power and Water recognises the importance of understanding details and patterns of water use at the customer's tap.

Over the next five years, Power and Water will work towards improving its ability to model and forecast demand, so as to achieve the following objectives:

- Better understand the factors that influence water demand;
- Enhance the ability to map water consumption;
- Improve data collection on water use at the customer's tap;
- Better understand water use by the commercial and industry sectors;
- Improve ability to measure savings from water conservation projects; and
- Develop more accurate methods of quantifying water savings from restrictions.

Figure 18:
Demand Projection Based on 'High Growth' Scenario



5 Future water challenge

5.1 Climate Change

Perhaps the greatest uncertainty in assessing future water demand against system yield is the potential impact of climate change.

Climate change, and particularly global warming, has already been evident through recorded meteorological changes in the Northern Territory and elsewhere around the country and the world. For example, the Territory is already experiencing a rise in average temperatures[5].

In the Northern Territory, like elsewhere, climate change will affect meteorological elements including temperature, evapotranspiration, rainfall (and runoff, and recharge to groundwater), sea levels and storm surge and the occurrence and severity of cyclones.

Power and Water has undertaken assessments based on a range of different climate change scenarios, and a mid-range emissions scenario has been adopted for modelling to 2030.

A range of climate change outcomes for the Darwin region, obtained from the CSIRO's 2007 technical report – Climate Change in Australia, is tabulated below.

Table 10:
Climate Change Predictions for the Darwin Region

		CSIRO Climate Change Predictions								
Scenario	% Change	Low Emissions			Medium Emissions			High Emissions		
		2030	2050	2070	2030	2050	2070	2030	2050	2070
10th Percentile	Rainfall	- 3.5	- 7.5	- 7.5	- 7.5	- 7.5	- 15.0	- 7.5	- 15.0	- 15.0
	Max Temp	1.4	2.5	3.9	2.5	3.9	3.9	2.5	3.9	5.4
	Evaporation	-	-	-	-	-	-	-	3.0	3.0
50th Percentile	Rainfall	-	-	-	-	-	-	-	-	-
	Max Temp	2.5	3.9	5.4	2.5	5.4	7.0	2.5	5.4	8.6
	Evaporation	3.0	6.0	6.0	3.0	6.0	6.0	3.0	6.0	10.0
90th Percentile	Rainfall	7.5	7.5	15.0	7.5	15.0	15.0	7.5	15.0	30.0
	Max Temp	3.9	5.4	7.0	3.9	7.0	8.6	3.9	8.6	10.9
	Evaporation	6.0	6.0	10.0	6.0	10.0	14.0	6.0	14.0	18.0
Red cells	indicate the scenarios modelled in the most recent yield assessments									

Uncertainties in projected regional climate change in 2030 are mostly due to differences between the results of the various climate models employed rather than the different emission scenarios. Projections for 2030 are given for a mid-range emission scenario. Beyond 2030, the magnitude of projected climate changes are affected more by emissions[6] so a high emission outcome for 2070 has been used for assessment of yield impacts as a 'worst case' scenario.

The CSIRO report documents a range of impacts in terms of 50th, 90th and 10th percentiles. In line with the Intergovernmental Panel on Climate Change terminology on percentiles, the report indicates a change of less than the 50th percentile has a likelihood that is more likely than not, a change of less than the 90th percentile is extremely likely, and a change of less than the 10th percentile is extremely unlikely.

[5] Department of Climate Change, Australian Government (2008) – Fact Sheet – Climate Change – Potential Impacts and Costs – Northern Territory.
[6] CSIRO (2007) – Technical report – Climate Change in Australia

The impacts of climate change on yield are expected to be dramatic, with significant increases in evapotranspiration expected to significantly affect runoff to storages, and higher evaporation from storages, a particular problem for the Darwin region's relatively broad, shallow reservoirs.

Modelling of climate change impacts has identified significant potential impact on the yields available from Manton Dam and Darwin River Dam. While wet season rainfall is not expected to vary significantly, increased evapotranspiration in the catchment will lead to a reduction in inflows, and this, combined with increased evaporation from the dams themselves, will lead to a reduction in available yield.

The modelling identified the potential for a 13 per cent reduction in yield from Darwin River Dam and a three per cent reduction in yield from Manton Dam by 2030. The modelled impacts associated with climate change predictions for 2070 show even more impact, although greater uncertainty is associated with longer-term predictions.

The impacts of climate change on demand are more difficult to predict. Climate change impact assessments undertaken by other Australian utility organizations and Governments have assessed demand impact, including:

- CSIRO (2003) (for ACTEW) – Climate Change Projections and the Effects on Water Yield and Water Demand for the ACT – identified potential climate-related water demand increases of between one and five per cent by 2030 (three per cent for mid-range climate change scenarios), and between one and 16 per cent by 2070 (nine per cent for mid-range climate change scenarios). Importantly, the predicted demand increases doubled if climate change is expressed as an increase in the frequency of hot periods, as opposed to an increase in mean temperatures.
- CSIRO (2005) (for Melbourne Water) Melbourne Water Climate Change Study identified potential increases in average annual water demand due to climate change of between 0.5 and 2.3 per cent by 2020, and between 1.3 and 6.2 per cent by 2050.

In Power and Water's demand model, the effect of climate change on annual total rainfall, average maximum temperature and evaporation, is the percentage change relative to the base year realised in the end year. Estimated values for these parameters have been obtained from CSIRO reports. The effects of the changes on climate have then been estimated using linear equations calculated from a linear regression analysis of historical data.

5.2 Greenhouse Gas Emissions

Greenhouse gases are generated during the delivery of potable water supplies, with the primary source being the use of energy to transport and treat water.

Power and Water acknowledges that producing new water supplies will generate greenhouse gases, particularly for options where pumping water over long distances or elevations is required. Water sources that require water treatment will increase the level of greenhouse gas generation per unit of water supplied. Desalination for example is an extremely energy intensive water supply source option.

The potential generation of greenhouse gases will be one criterion used in the assessment of future water supply source options.

6 Demand reduction strategies

Power and Water is undertaking a number of initiatives to reduce the amount of water used by consumers (known as 'demand management') and water lost from the network system (known as 'supply management'). Collectively these initiatives are focussed on saving water or preserving existing supplies through a range of voluntary water efficiency measures and involuntary water conservation measures.

Demand management water efficiency measures include water-efficient fittings and appliances, technological improvements, behavioural change and pricing signals. Supply management initiatives include leak detection, pressure management, meter error and theft.

In times of need, mandatory water conservation measures such as water restrictions may also be imposed.

Darwin water consumption from residents and businesses is over twice as much as other comparable communities and continues to grow at a higher rate than the population.

Previous studies showing how water is used in homes (water end use studies) reveal outdoor water use is highest. Non-residential irrigation also continues to be high, with large seasonal variances in the Top End.

There are significant benefits in preserving the Darwin region's existing water supplies. Therefore Power and Water utilises these water end use consumption profiles to implement a range of water-efficiency demand-management strategies, as well as monitor the water network to determine appropriate supply-management initiatives.

6.1 Urban Water Use

Almost 60 per cent of the Darwin region's water is consumed by the residential sector, a level followed by the non-residential commercial and Government sectors. Therefore, the residential sector has the greatest effect on water consumption in Darwin – refer Figure 19 (right).

Further, on average, about three-quarters of the Darwin region's annual water consumption is for outdoor water use.

Water consumption also varies greatly with the wet/dry tropical seasons, with outdoor use in households increasing up to ten-fold in the dry season. Therefore, the Darwin region's water consumption and usage patterns are very highly correlated to Darwin's climate.

When compared to the rest of Australia, Darwin's residential water consumption is over twice as much as other comparable towns and cities. Additionally, outdoor use is still significantly higher when specifically compared to comparable regions such as Cairns, Townsville and Mackay.

Figure 19:
Darwin Region Water Supply Consumption Segmentation

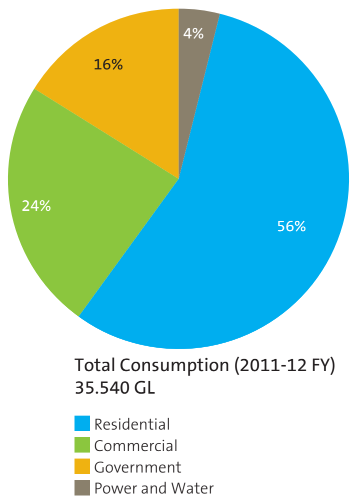
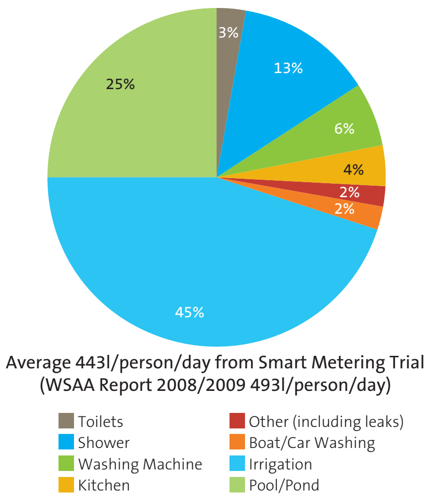


Figure 20:
Darwin Average Water End Use



6.1.1 Water End Use

Power and Water conducts water end use studies and audits from time to time in order to analyse how consumers use water in homes and businesses. Assessment of these studies determines how efficiently water is being consumed, and informs Power and Water programs that aim to promote water efficiency.

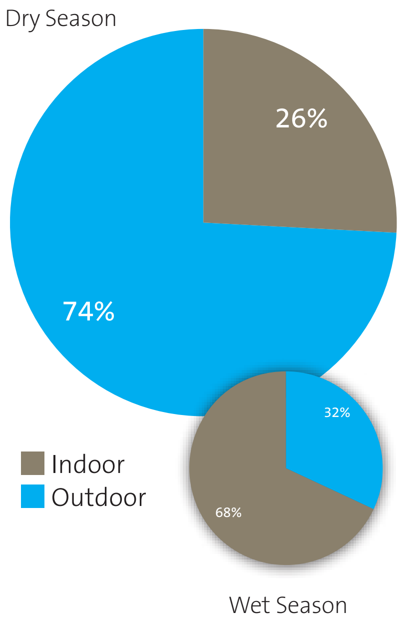
Figure 20 (left) shows how Darwin region households (that have gardens) typically use water. While the quantity of water consumed between wet and dry seasons varies greatly due to the change in outdoor use, the proportions between water uses in the dry do not change significantly from the annual averages shown. This shows that almost three-quarters of water used in Darwin region households with gardens is applied outdoors.

However, outdoor water use in houses with gardens increases markedly from wet to dry seasons as shown in Figure 21 (right), highlighting the very high influence of climate and garden watering and irrigation on the Darwin region's water consumption.

Water audits focus on how water is used in properties, and identify opportunities for consumers to become more water efficient and thereby reduce water use. Power and Water regularly undertakes water audits with businesses and promotes regular self-assessment of water use. Typically, the water audits reveal a financial benefit can be realised by reducing water use through irrigation scheduling and design, changing behaviours and upgrading appliances, without affecting lifestyles or core business.

There is capacity therefore, to reduce water consumption by encouraging water-efficient behaviours, fittings and appliances in Darwin's residential and non-residential sectors.

Figure 21:
Darwin Seasonal Water End Use



6.1.2 Benchmarking

Other Australian States and Territories categorise water users into groups. It is more convenient to benchmark water use for the purposes of comparison, by using residential and non-residential groups.

Residential water use is appraised using consumption per household. Non-residential water use is appraised using sector-specific benchmarks; for example, water consumption in hotels may be related to the number of beds or rooms used in a year.

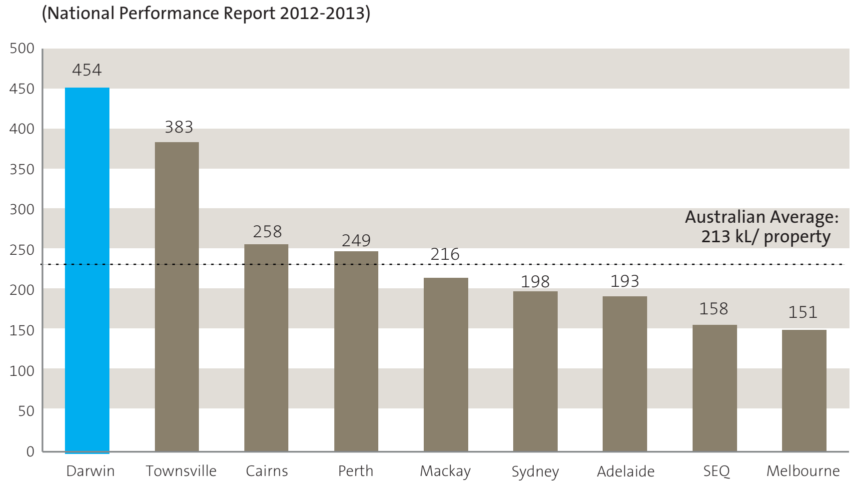
As residential water use is the largest consumer group, it is best to assess residential water consumption per household and/or per person, as this is the best indicator of the overall water use and efficiency of a particular community.

Figure 22 (right) compares Darwin's residential water use per household during the 2012-13 financial year, with other comparably-sized cities and other capital cities.

As for previous years, the Darwin region's residential water consumption remains more than twice the national average. Moreover, Darwin's residential consumption remains very high, even when compared with areas of similar climate, growth pressures and water supply network, such as Cairns, Townsville and Mackay.

During the past decade, such growth pressures have served to highlight how water efficiency measures can preserve existing water supplies. With community support, these same communities have successfully reduced their annual water consumption over the past five years.

Figure 22:
Average Annual Residential Water Supplied (kL/property)



6.2 Community Attitudes to Water Use

In 2005, Power and Water published a booklet called The Darwin Water Story and an accompanying survey was distributed to explore community attitudes around water use in the Darwin region.

A total of 610 surveys were completed by residents (602) and businesses (8) in the greater Darwin area.

Overall, most residents and businesses were open to water conservation, and in favour of measures to reform water use. While there was some division in the community about the need for permanent water restrictions, other measures such as water-efficient devices in new buildings, using recycled water and encouraging the use of rainwater tanks (for example through subsidising schemes) were supported by a majority of residents and businesses.

In 2012, Power and Water conducted focus-group surveys that generally confirmed the 2005 survey results. Darwin residents and businesses remain aware of water conservation behaviour and understand there is room to become more water efficient. It is important however, that all sections of the community are involved in water efficiency actions and that they are well informed.

6.2.1 Key findings

The key findings of the surveys included:

- More than half of all residents and businesses believed that water conservation in Darwin is critical.
- Residents and businesses agreed that it is socially responsible for them to monitor water use.
- Being well informed about the effect of water consumption on the water supply system and educated on water efficiency actions was a key driver to saving water.
- Residents and businesses agreed that mandatory installation of water-efficient devices in new buildings and residences was the preferred way to encourage water efficiency (out of five options).

- Suggestions for water management and social responsibility included 'organisations to lead by example' and 'educating the public on why water conservation is important for Darwin and the Top End whilst providing specific details about alternative options (e.g. cost, amount of water saved, details of proposed restrictions)'.
- Those who believed water conservation was critical were more supportive of recycling water and introducing an environmental levy to support water recycling, and were more likely to agree that higher water users should pay more.
- Among those who did not see water conservation as a critical issue, the majority believed that the rainfall in the Northern Territory guarantees our water supply.
- Although the respondents felt favourable towards water efficient devices there was no real support for introducing step water tariffs and permanent water-saving rules to encourage water efficiency.
- Encouraging the purchase of rainwater tanks was the first preference for most residents and businesses. However, when examining the top two priorities, encouraging greywater systems was the most popular overall initiative. Almost two in three people supported recycling water and agreed that a levy to support this would be a good initiative. Eighty per cent of households and businesses agreed they would use recycled greywater.
- The majority of residents and businesses stated they would use recycled greywater. Encouraging the purchase of rainwater tanks was the first preference for two in five respondents, followed by effluent reuse and greywater systems.

6.2.2 Power and Water's Response to the Survey

In response to the 2005 and 2012 survey findings Power and Water:

- Has put information about rainwater tanks and grey-water reuse systems on its internet site (www.powerwater.com.au) along with who to contact regarding the use of these measures in the Northern Territory.
- Encourages residents to review and benchmark their water end uses by undertaking an online interactive virtual water audit at www.powerwater.com.au.
- Has included additional information on water bills, which compares water use for the billing period with the same period in previous years.
- Understands the public is sensitive to new tariff reform and/or water restrictions.
- Has promoted National Water Week events and other initiatives such as 'Tapstar saves water' a school performance aiming to create awareness about water conservation.
- Has developed and promoted a suite of publications providing advice and guidance to householders including the Green Guide and Water Wise Gardening.
- Has added to customer bills graphs that compare the amount of water, power and greenhouse gas emissions used over the past 12 months, with the average residential consumption.
- Provides water audit services to help businesses analyse water consumption and develop water efficiency management plans.
- Continues to survey customers with a focus on water efficiency attitudes.

6.3 Drivers for Demand Management

Water efficiency continues to receive considerable support from the community and all other levels of Government. There is also a growing expectation that the conservation effort should be spread across all consumer groups.

Power and Water seeks to work with all sectors of the community to reduce water consumption, and in the area of unaccounted-for water to achieve the water savings goals. This approach better spreads water conservation efforts across the entire consumer base and prioritises efforts in areas with the greatest potential savings.

Power and Water regularly models the benefits of achieving demand management targets in terms of the deferral of capital expenditure on new water source development.

6.4 Demand and Supply Management Initiatives

In the short and medium term, significant water savings will need to be achieved to moderate the demands of a growing population, and to help prevent environmental stress during an era of greater climate variability and resultant impacts on water resources. Power and Water's customer engagement and other studies have shown there is capacity for consumers to become more water efficient and is investigating opportunities for further water demand savings in the future. The potential for significant reductions across all water consumption groups is achievable through the introduction of water efficient technologies, focussed incentives to preserve lifestyles, strong community support and a collective commitment towards water efficiency.

Power and Water has developed experience in demand and supply management over the past five years through various water conservation initiatives and industry support. In more recent times, the implementation of Alice Water Smart in 2011 has provided important contemporary experience in application of water conservation initiatives at a whole-of-community level, and within the Northern Territory. Some examples are outlined in Table 11 (on the following page).

Table 11:
Previous Water Efficiency Initiatives:

Initiative	Description
Leak Management Plan	A Leak Management Plan has been implemented in the Darwin region that will systematically monitor, identify and address leakage and pressure management zones in Power and Water's water supply network.
Public Education Campaign	Power and Water is implementing various public education campaigns, primarily aimed at improving water efficiency by promotion, publications, billing information, facilitating leadership with key non-residential organizations and schools to support reductions in commercial and residential water consumption.
Audits	Power and Water sponsors residential audits and undertakes water audits with businesses as part of ongoing consumer engagement to increase awareness and the benefits of water efficiency.
Alice Water Smart	Power and Water is leading Alice Water Smart, which is a whole of community water efficiency program. Launched in Alice Springs in 2011 and finishing in 2013, Alice Water Smart has been focussing and incentivising residents and businesses to become more water efficient through encouraging voluntary water saving rules, undertaking water audits, offering greater rebates and retrofits, automating irrigation systems in parks and gardens, providing more recycled water and establishing an intensive water loss management and smart metering programs. The consortium partners include the Department of Land Recourse Management, Alice Springs Town Council, Tourism NT and Arid Lands and Environment Centre.

6.4.1 Living Water Smart

Power and Water has developed a comprehensive multi-objective and multi-faceted water efficiency program called 'Living Water Smart'. Living Water Smart will be implemented over the next five years. The program aims to achieve water savings over the short and medium terms, and targets all water consumer groups and users in the Darwin region's urban areas.

Living Water Smart includes demand and supply management initiatives. The focus of supply management initiatives will be managing water loss through leakage reduction and better pressure management. Demand management initiatives will focus on working with residents and businesses to involve them in deciding the best ways to change their use of water.

By working with other Northern Territory Government agencies and Councils to implement water efficiency initiatives and provide leadership, the program aims to help Darwin's residents and businesses recognise the economic and social benefits of being more water efficient. This includes Power and Water, which aims to reduce water consumption in its own facilities.

Living Water Smart aims to reduce annual water consumption in the Darwin region by 10,000 ML/yr over five years.

Saving water under Living Water Smart will;

- Reduce the amount of water used by Darwin region households by an average of 25 per cent by 2018, compared with 2011-12 consumption levels.
- Improve competitiveness of Darwin's businesses and industry through efficient use of water.
- Foster water efficiency compliance in residential and commercial buildings, as measured under the standards of the Building Code of Australia.
- Embed water efficient infrastructure and practices in Northern Territory Government agencies and Darwin region Councils.

The initiatives of Living Water Smart are included in Table 12 (on the following page).

LIVING WATER SMART
Darwin Region

Table 12:
Living Water Smart Initiatives

Living Water Smart Initiatives	Activities
Homes & Businesses (Demand Management)	- Conduct 5000 residential water audits prioritising the highest water users. - Conduct 250 commercial water audits and produce water efficiency management plans prioritising the highest water users. - Develop water efficiency partnership program for all other businesses. - Develop residential and non-residential (by sector) water efficiency benchmark guidelines. - Offer incentives for taking up the recommendations from water audits through targeted rebates and smart metering. - Develop permanent voluntary water saving rules for Darwin.
Parks Ovals & Road reserves (Demand Management)	- Install smart water irrigation technology systems to road reserves and 200 parks and ovals. - Develop water efficiency management plans and irrigation scheduling tools for parks and ovals. - Encourage early leak detection and response to water leaks and wastage.
Accommodation (Demand Management)	- Conduct water audits and develop water efficiency plans for 30 key accommodation properties. - Develop guidelines for water efficiency benchmarks for the accommodation sector. - Offer incentives for taking up recommendations from water audits through targeted rebates and smart metering.
Schools (Demand Management)	- Conduct water audits and develop water efficiency plans for 40 schools. - Develop water efficiency benchmark guidelines. - Offer incentives for taking up recommendations from water audits through targeted rebates and smart metering. - Develop education resources and a delivery program for ongoing water efficiency education.
Hospitals and Defence (Demand Management)	- Conduct water audits and develop water efficiency plans for hospital and Defence facilities. - Develop guidelines for water efficiency benchmarks. - Offer incentives for taking up recommendations from water audits through targeted rebates and smart metering.
Reuse and Reticulation (Supply Management)	- Investigate and plan opportunities to recycle water. - Develop and implement leak detection program. - Develop and implement pressure management plan. - Provide industry training for leak detection in properties.
Smart Metering (Enabler)	- Install smart water meters to support the Homes and Businesses, Accommodation, Hospitals and Defence, and Schools projects. - Encourage savings by providing constant awareness of water use .
Rebates (Enabler)	- Rebate program customised to support Homes and Businesses, Accommodation, Hospitals and Defence, and Schools projects. - Encourage savings by providing rebates to general public (i.e. not participants in other projects).
Administration and Promotion (Enabler)	- Encourage savings by general public promotion (i.e. not from participants in other projects).
Tariff increase (30%+5%+5%)	- Promotion of water efficiency themes in response to recently introduced tariffs to fully realise price elasticity opportunity. - 0.1% price elasticity.

6.4.2 Non-revenue Water

Maintaining the efficiency of the water supply system can help to minimise the amount of water unaccounted for, otherwise called 'non-revenue water'.

Non-revenue water includes:

- water loss through mains breaks and leakage
- water meter and billing errors
- operational use (flushing etc)
- water theft; and
- unmetered fire fighting use.

Historically, non-revenue water for the Darwin region water supply system has been as high as 20 per cent of total system demand. Unaccounted for water represented 19 per cent of total system demand in 2012/13. Power and Water is implementing a Leak Management Plan to reduce unaccounted for water. This plan has informed development of Living Water Smart and will be greatly expanded under supply management initiatives.

6.4.3 Water Tariff Pricing Signals

The Northern Territory Government dictates water pricing policy in the Northern Territory using a flat rate tariff policy.

Power and Water regularly forecasts retail revenue associated with water consumption. In its modelling of the impact on demand of increased water pricing, Power and Water assumes a 0.1 per cent reduction in per capita demand for every one per cent increase in price. This assumption is based on interstate studies and is yet to be validated in the Northern Territory.

However, the increased focus on water efficiency provided by Living Water Smart is expected to realise this demand elasticity from the recent tariff increase of 30 per cent.

To influence consumer behaviour and promote water conservation, the Commonwealth Government's Productivity Commission has recommended reducing reliability on water restrictions, and emphasising the use of water tariff pricing signals that respond to the scarcity of supply. Also, the Commission suggests introducing a range of tariff structures matched to the customer's appetite for risk.

Power and Water has previously investigated the introduction of step tariffs, whereby a base level of supply is provided at a base cost, with an increased tariff tied to nominated steps in consumption. The introduction of step tariffs is not favoured by the Productivity Commission, but is standard practice for a number of Australian water agencies, where step tariffs support water efficiency by rewarding water efficient behaviour.

Power and Water will continue to liaise with the Department of Treasury and Finance and the Utilities Commission in order to agree a water pricing methodology that will provide for a return on Power and Water's investment in water supply infrastructure, and that uses pricing signals to support water efficiency targets.

6.4.4 Sustaining Water Demand Savings

Living Water Smart aims to encourage the community to save water by promoting water efficient practices and making available tools to help residents and businesses conserve water.

Managing water loss by making it part of every-day operations, will also help.

Promoting water conservation as a core business activity for Power and Water, will help to realise the full potential of Living Water Smart, and preserve water-efficient behaviour and infrastructure in the community.

Power and Water will keep abreast of appropriate technologies to save water, as they become available.

7 Future water source options

7.1 History

Power and Water's previous strategic plan for supplying water to the Darwin region provided for small incremental increases to supply, matched to relatively low forecasts of growth in demand. The plan covered the short to medium term (five to 10 years).

These small incremental increases to supply were to be provided by developing three additional stages of the Howard East Borefield over time. However, improved estimates of sustainable yield from the Koolpinyah aquifer in the Howard East area, have meant that developing the Howard East Borefield is no longer considered a sustainable way to supplement the Darwin region water supply system.

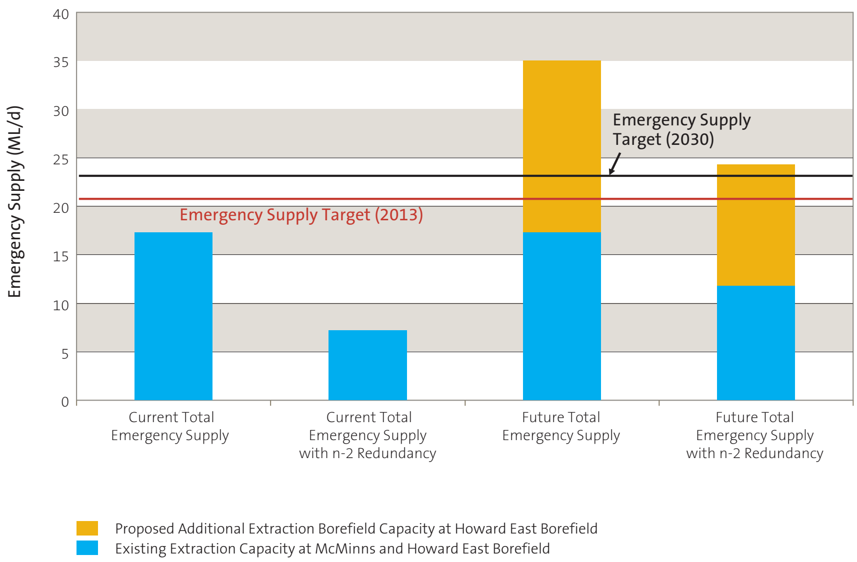
Moreover, because the region is growing more rapidly than first forecast – a combined effect of increased population-based growth and demand for water from major industrial and commercial developments – Power and Water must develop water sources on a greater scale than was previously planned for this period.

7.2 Immediate Action to Address Emergency Supply Shortfall

To address an immediate shortfall in emergency supply capacity, Power and Water is still planning to develop extra extraction capacity at the Howard East Borefield. Further development of the Howard East Borefield will provide additional emergency water supply capacity to a 2030 planning horizon. The connection of Manton Dam, planned for 2025 will further augment the emergency supply capability

Figure 23 (right) identifies the existing shortfall and the improvements to emergency supply capacity achieved by further developing the Howard East Borefield. The supply targets represent short-term emergency supply capability approximately equal to 25 per cent of wet season demand.

Figure 23:
Existing and Planned Emergency Supply Capacity



* 'n-2' refers to a policy requirement to ensure supply capability is maintained should the two highest yielding bores in the borefield fail

7.3 Source Augmentation in the Short Term

Limited options exist to significantly augment the Darwin region water supply in the short term (by 2020). Planned augmentation projects aim to maximise the benefit of existing assets and existing sources.

7.3.1 Further Development of the Howard East Borefield

As described above, Power and Water is planning to further develop the Howard East Borefield in 2014/15 to increase the emergency supply capacity for Darwin in the event of a short term supply constraint due to infrastructure failure or water quality issues at Darwin River Dam (i.e. not related to water resource reliability).

However, the additional redundancy in the Howard East Borefield will also allow Power and Water to reliably access its existing total licensed groundwater extraction, addressing the majority of the immediate supply shortfall (2,420 ML/yr of the current 5,084 ML/yr shortfall).

The further development of the Howard East Borefield may also allow Power and Water to partially shift regular groundwater extraction efforts away from the McMinns Borefield which is located closer to residential land, so as to reduce contamination risk and potential performance impacts on surrounding bores.

7.3.2 Manton Dam Return to Service

To provide additional water for the Darwin region water supply system in the short term, Power and Water is planning for the return to service of Manton Dam. Whilst the current water source development programme identifies Manton Dam's return to service in 2025, planning and design work continues to allow for earlier connection of Manton Dam should this be required.

Power and Water currently holds a licence to extract water from Manton Dam. Water is not presently extracted from Manton Dam however, owing to infrastructure constraints and unacceptable water quality.

The reconnection of Manton Dam is planned to provide an additional 7,400 ML/yr for the Darwin region water supply.

7.3.2.1 Infrastructure Requirements

Since the Darwin River Dam was commissioned in 1972, Manton Dam's two transmission mains (300mm and 375mm) have been used to pipe water from McMinns transfer station to the rural area (backfeed). However, the pipes are old, with reduced reliability, and can no longer be used as transmission mains. A new transmission main must therefore be constructed to return Manton Dam to service. The transmission main will deliver Manton Dam's water to the proposed Strauss Water Treatment and Storage Facility.

Transferring water from Manton Dam to Darwin River Dam for pumping into the water supply system was assessed as an option, but discounted on the basis of risk to water quality and supply security.

The intake tower and suction main pipework at Manton Dam have aged significantly and without significant augmentation, would represent an unacceptable operational risk were they incorporated into the supply system. Whilst the existing pumping station and pumping equipment have been maintained to provide for an emergency function, they require replacement to provide the security of operation required for an operational supply system. A new intake arrangement, new suction main pipework and a new pumping station will be required to support Manton Dam's return to service.

7.3.2.2 Recreation and Water Quality Issues

In 2008, Power and Water commenced a water quality study to determine the treatment required to improve Manton Dam's water quality to a level suitable for public consumption.

The water quality studies have identified that the reservoir at Manton Dam suffers seasonal thermal stratification (layering), has elevated levels of iron, manganese, colour and turbidity at times, and is susceptible to periodic high levels of cynobacteria (blue-green algae). Significant water treatment will be necessary to overcome these water quality challenges.

The Northern Territory Government opened up Manton Dam to recreation in the late 1980s after lobbying from the public and interest groups. Allowing recreation on a potable water supply source represents a significant risk to the public water supply and is inconsistent with Power and Water's adherence to the Framework for Management of Drinking Water Quality, which is a key component of the Australian Drinking Water Guidelines.

The future of recreational activities at the dam will be carefully reviewed as part of the strategy to return Manton Dam to service. Clearly defining management responsibilities and liabilities, additional operating controls and significant operational resources will be needed, as well as regular consultation with recreational user groups, if recreational use is to continue.

7.4 Strauss Water Storage and Treatment Facility

Increased regulation of drinking water quality, rising expectations of consumers and the need for improved risk management has driven the need to plan for the future treatment of water for the Darwin region.

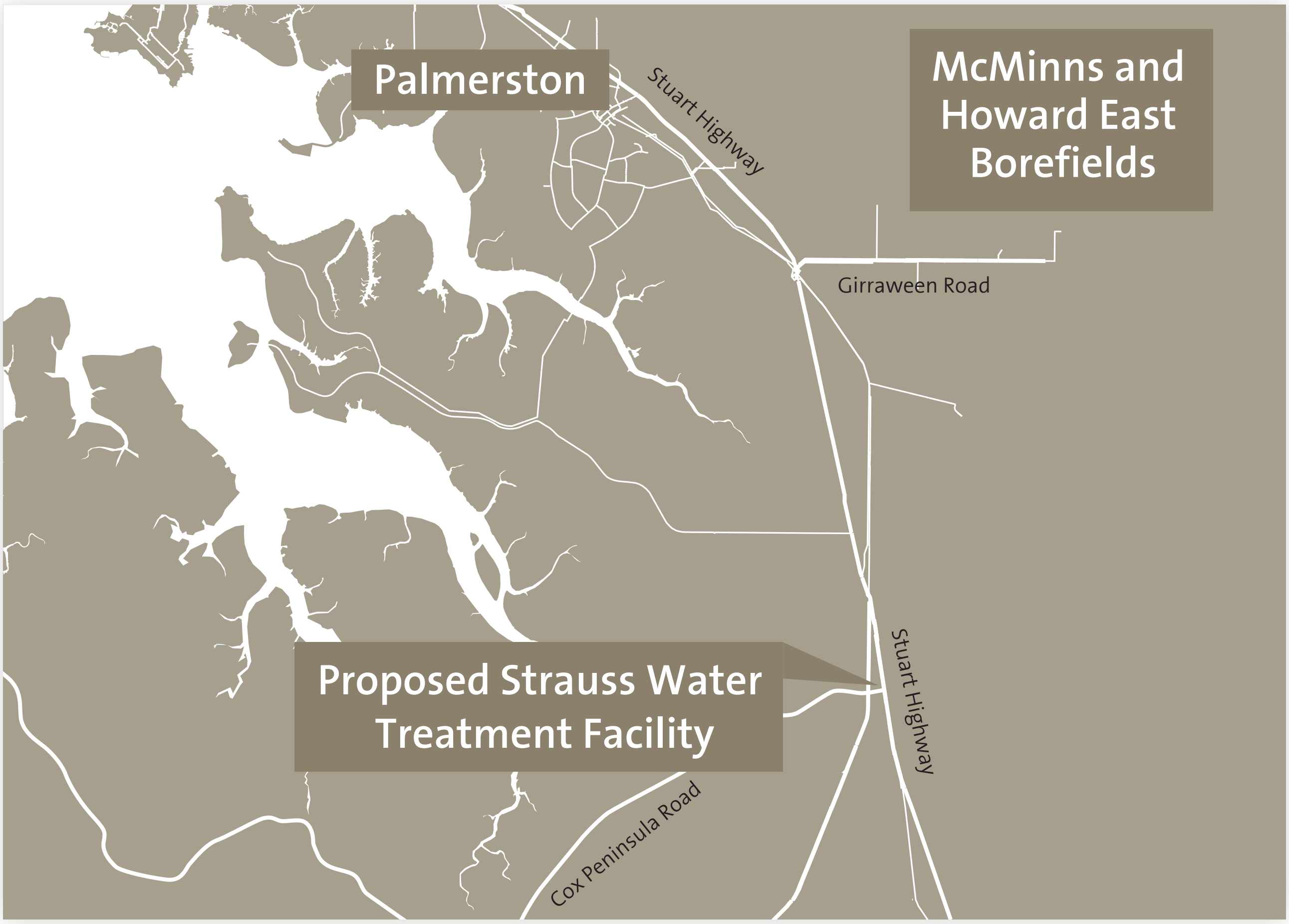
Moreover, recent water quality assessments at Manton Dam bring forward the need for a major water treatment facility for the Darwin region water supply system.

Power and Water plans to develop the Strauss Water Treatment and Storage Facility on approximately 42ha of land adjacent to the intersection of the Stuart Highway and Cox Peninsula Road. The site is strategically located at the intersection of the transmission mains from Darwin River Dam and the planned water transmission main from Manton Dam. It provides an ideal location for major water storage to service future residential development in the area, and will house new water storage and water treatment facilities to be developed in the short term.

Water treatment will at first be sized to cater for water from Manton Dam only. The planning and design of the treatment facility will however, allow for expansion so as to provide whole-of-system treatment for the Darwin region water supply in the future.

Preliminary design of the treatment process and planning of the site layout are complete and further planning and investigation is underway. Land acquisition has commenced, and Power and Water is working with Government to address the requirements of the *Native Title Act*.

Figure 24:
Site Map for Strauss Water Treatment Facility



7.5 Source Augmentation Options for the Medium Term

There are a number of potential sources which could augment the Darwin region's water supply in the medium term (beyond 2020). A preliminary assessment of options undertaken over the past five years has identified a shortlist of preferred options for detailed assessment and prioritising.

Detailed hydrological, geophysical, engineering and environmental studies will be undertaken over the next two years to determine the viability and priority of the shortlisted options.

Besides new sources of water supply, a range of decentralised integrated water management solutions have clear potential. These options aim to reduce reliance on the potable water system for non-potable uses, and help defer the development of major new sources of potable supply. These include rainwater tanks, greywater reuse and wastewater recycling to be implemented over time. Further discussion is provided in Section 7.6 Alternative Supply Options.

Technologies to reduce evaporation can help manage water supplies, providing the technologies can be proven at a commercial scale. Evaporation from Darwin River Dam has a major impact on yield. If evaporation from the reservoir could be reduced, then more water would be available for extraction. This issue is explored further in 7.7 Evaporation Reduction Technology.

7.5.1 Future Dam Sites

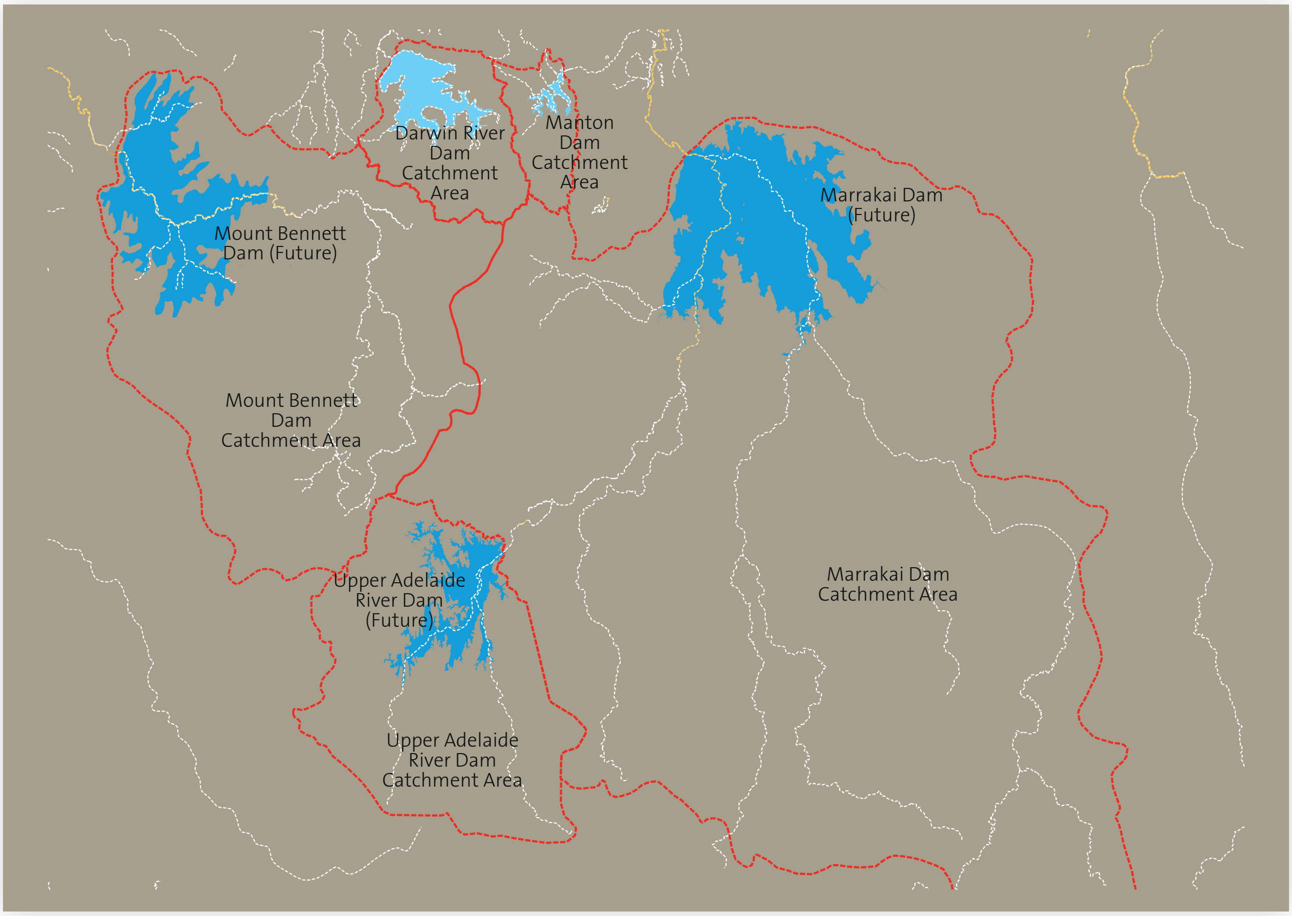
In 1988, the Northern Territory Government endorsed the Warrai, Marrakai and Mount Bennett Dams as its preferred options for major dams in the Darwin region. A plan of the three dam sites is shown in Figure 25.

A contemporary review of the three dam sites by Power and Water has selected Upper Adelaide River Dam as the preferred development priority of the three dam sites, based on a range of economic, social, environmental and water quality criteria.

Of the three dam sites, Upper Adelaide River Dam is the only site for which the catchment can be closed to the public, as for Darwin River Dam. Closing the catchment may reduce the level of treatment required to achieve a potable supply.

A plan of the future dam sites is provided (on the following page).

Figure 25:
Plan of Future Dam Site Options for the Darwin Region

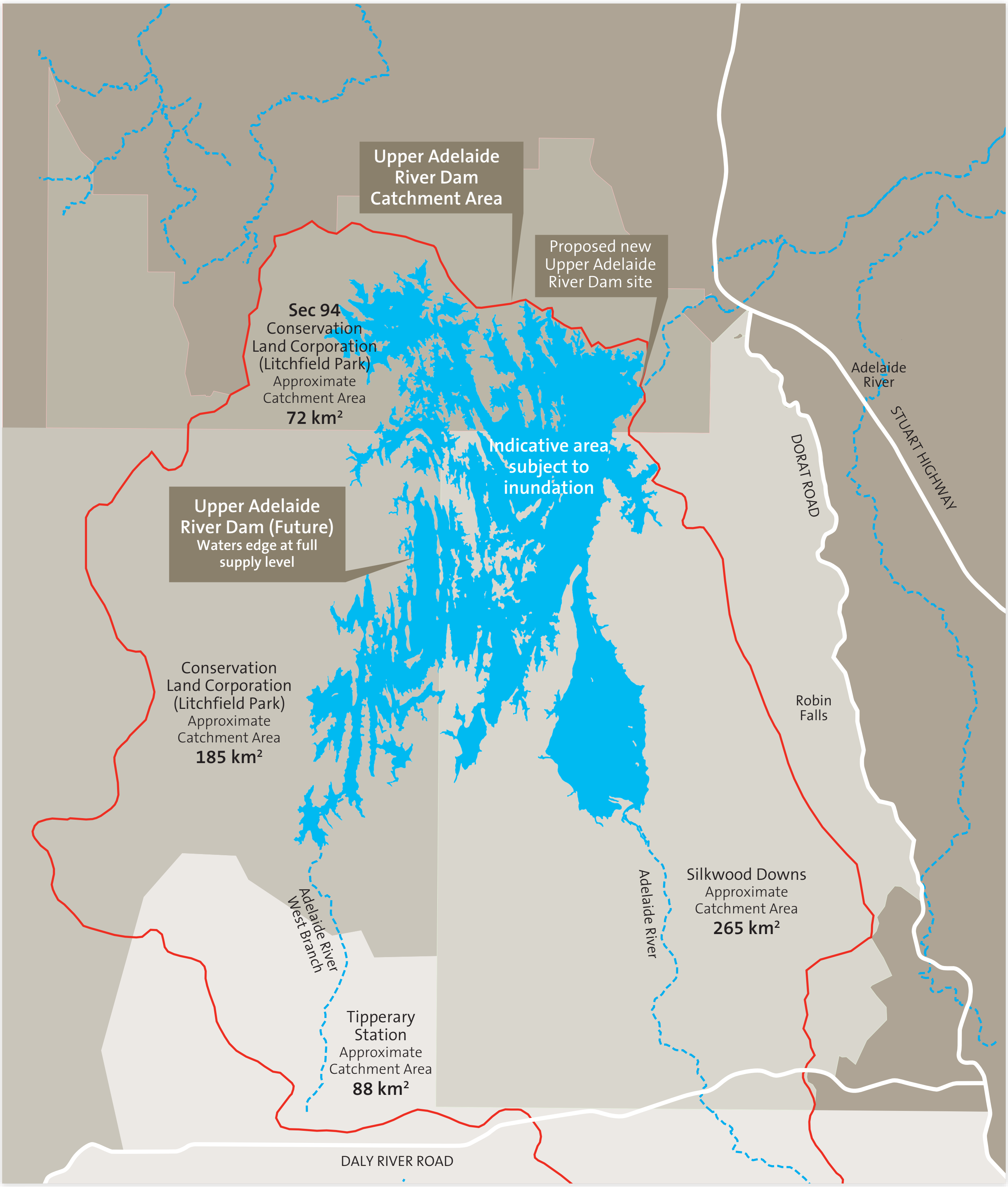


7.5.1.1 Upper Adelaide River Dam

The proposed Upper Adelaide River Dam is located on the Adelaide River, about five km upstream from the town of Adelaide River. The catchment area is approximately 610 square km. The catchment comprises segments from four parcels of land, indicated by the hatched areas on Figure 26.

Approximately half of the catchment comprises two land parcels that are part of Litchfield National Park. Two other properties make up the rest of the catchment — Silkwood Downs, a Crown Lease with very few existing improvements, and Tipperary Station, a pastoral lease with current stock operations.

Figure 26:
Proposed Upper Adelaide River Dam Site and Affected Land Parcels



Power and Water and the Northern Territory Government have been investigating potential future dam sites for many years and have undertaken various investigations for the Upper Adelaide River Dam site including:

- Streamflow monitoring to provide an indication of potential yield from Upper Adelaide River Dam catchment;
- Geophysical studies and geotechnical investigations to provide information about the structural suitability of the land for constructing a dam, and positioning of the dam wall;
- Land use and erosion studies of the catchment; and
- Flood studies.

These previous studies provide Power and Water with confidence that the Upper Adelaide River Dam site is technically suitable for the construction of a major dam. Further engineering investigations are required however, as well as an assessment of the environmental, social and cultural impacts of the dam. Additionally, a contemporary calculation of yield is required to be able to assess Upper Adelaide River Dam against other medium term water supply options for the Darwin region.

Currently, a catchment management plan is being developed for the Upper Adelaide River Dam option, as well as other environmental, hydrological and engineering studies.

The land on which it is proposed that Upper Adelaide River Dam be constructed is subject to the *Native Title Act* (i.e. Native Title may not be extinguished), and a number of registered and recorded Aboriginal sacred sites are known to exist in the catchment and/or the inundation area. Power and Water has been liaising with the Traditional Owners of the area through the Northern Land Council, and the Aboriginal Areas Protection Authority, as well as landowners in the area, to secure permission to access the catchment for the purpose of undertaking environmental studies.

7.5.1.2 Marrakai Dam

The Marrakai Dam proposal would create a very large, shallow reservoir on the Adelaide River in the Marrakai area. The catchment area is 4,325 square km and the reservoir would cover 211 square km with an average depth of only 3 m.

In 1990, Cabinet approved acquisition of properties affected by the inundation area of Marrakai Dam, which at the time, was considered to be the preferred water source development option. Land acquisition for the inundation area of Marrakai Dam has been completed, with the land re-leased for a range of low impact uses.

A significant number of existing and legacy mines exist within the Marrakai Dam catchment, resulting in potential water quality risks for any future water supply scheme. A dam at this location would impact on a large proportion of the Adelaide River catchment. Moreover, with evaporation rates forecast to increase significantly due to climate change, the viability of the Marrakai Dam will require reassessment should it be prioritised for development in the future.

As a result of a contemporary assessment of the three shortlisted dam options, Marrakai Dam is not a preferred option for the medium term, but will remain an option for further assessment in the longer term.

7.5.1.3 Mt Bennett Dam

Mt Bennett Dam is the third option for a dam site in the Darwin region that was shortlisted in 1988, and is downstream of Batchelor on the Finniss River.

A significant number of existing and legacy mines exist within the Mt Bennett Dam catchment, including the Rum Jungle Uranium Mine, resulting in potential water quality risks for any future water supply scheme.

Development of the Mt Bennett Dam would impact on a large proportion of the Finniss River catchment. Development of the Mt Bennett Dam would require successful negotiations with members of the Finniss River Aboriginal Land Trust, who are custodians of a significant proportion of the dam's inundation area.

As a result of a contemporary assessment of the three shortlisted dam options, Mt Bennett Dam is not a preferred option for the medium term, but will remain an option for further assessment in the longer term.

7.5.2 Augmentation of Manton Dam's Storage

Augmenting Manton Dam's storage provides an opportunity to increase the yield available from the reservoir.

A number of storage augmentation options have been identified and investigated for Manton Dam over the years. The two main approaches involve either:

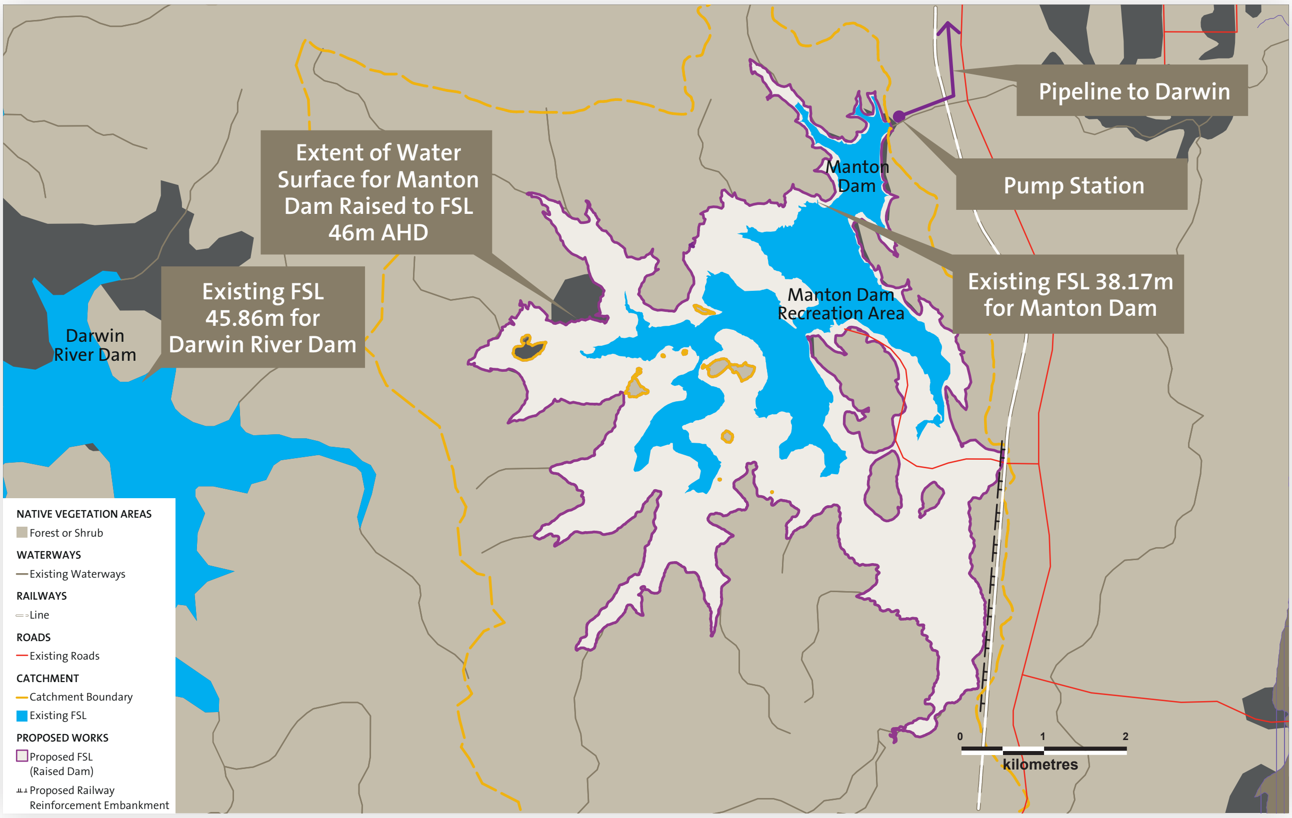
- Raising the full supply level for the existing storage by constructing a new, higher dam at the existing dam site; or
- Developing a new dam further upstream in the catchment, and maintaining the existing full supply level for the existing storage.

Cost estimates for the augmentation options range from $60 million to $220 million, which could increase yield by 5,000 to 15,000 ML/yr.

Raising the full supply level at the existing dam site will maximise the yield potential of the catchment, but will adversely impact the existing recreational use of the dam by flooding existing roads, the boat ramp and the car park. Constructing a dam further upstream reduces the impact on recreation, but is more expensive and results in a significantly lower yield improvement.

The augmentation of Manton Dam will be assessed against other short-listed medium term options to augment the Darwin region water supply. A number of hydrological and environmental studies will be undertaken over the next two years to support the assessment.

Figure 27:
Manton Dam – Potential Storage Augmentation



FSL = Full Supply Level

7.5.3 Adelaide River Off-stream Water Storage Scheme

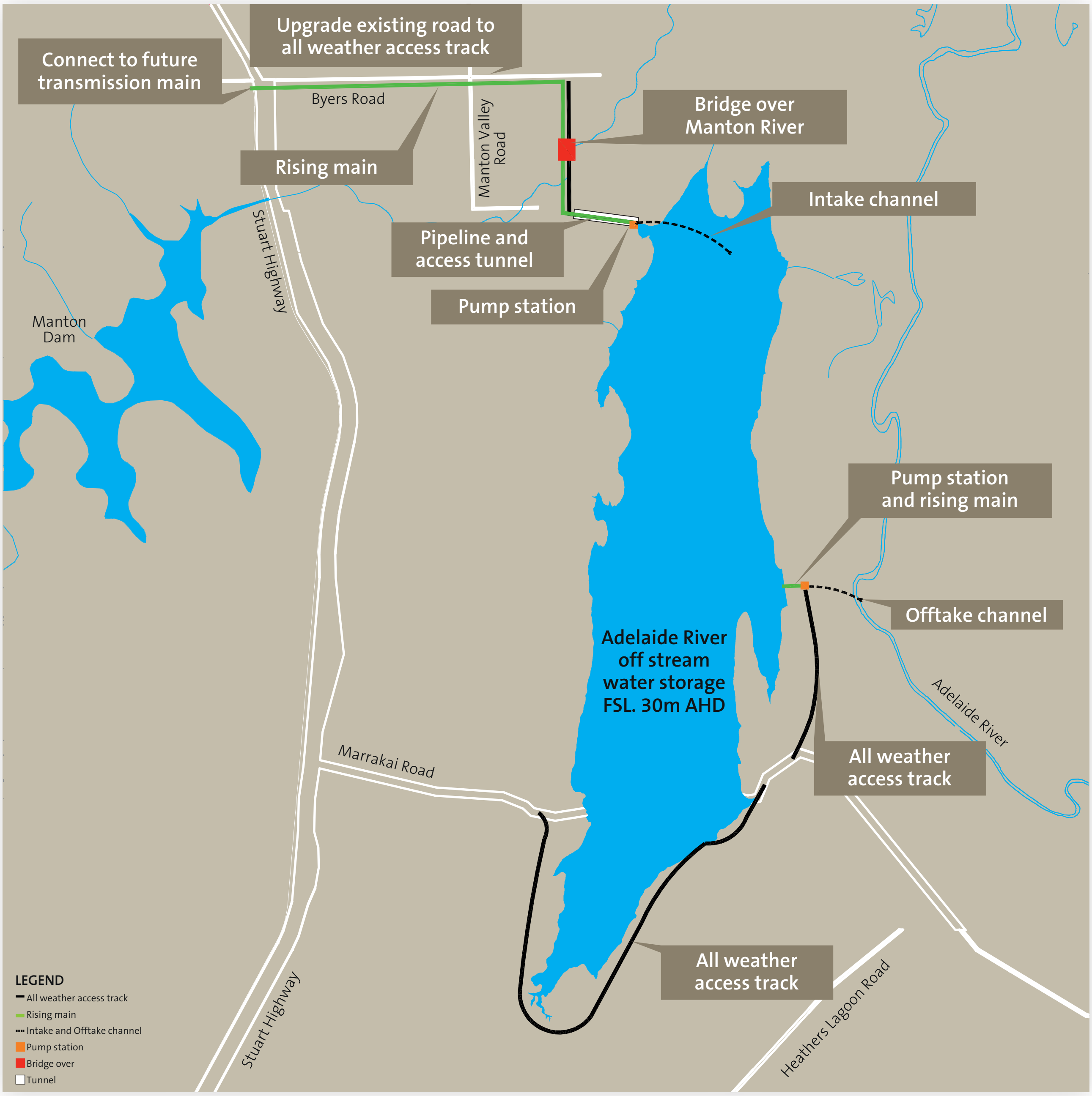
An area in the Marrakai region could provide off-stream storage adjacent to the Adelaide River of 300,000 ML, a volume roughly equivalent to that of Darwin River Dam. The area could store water harvested from the Adelaide River during flood flows in the wet season. The stored water could then be transferred to the Strauss Water Treatment and Storage Facility for treatment and distribution.

A feasibility study undertaken in 2011, suggested the Adelaide River water harvest and off-stream storage scheme could supply up to 50,000 ML/yr to the Darwin region water supply system. It is likely the scheme would be constructed in stages. The study also considered the scheme's potential role in harvesting water from a future Upper Adelaide River Dam, whereby water is released from the Upper Adelaide River Dam to the Adelaide River for transfer downstream. These channel flows would be in lieu of a pipeline connecting Upper Adelaide River Dam with the water supply system.

Power and Water has commenced sampling water quality in the Adelaide River to assess its variability and the sediment load it carries. This data will help in assessing the scheme's viability and frame any potential operating strategy.

The Adelaide River off-stream water storage scheme will be assessed against other short-listed medium term options to augment the Darwin region water supply. A number of hydrological, geophysical, engineering and environmental studies will be undertaken over the next two years to support the assessment.

Figure 28:
Adelaide River Off-stream Water Storage Scheme



FSL = Full Supply Level

7.5.4 Desalination

Desalination plants exist in most capital cities in Australia, or are planned for development. Whilst the Top End receives reliable rainfall and this is not expected to change over time, Power and Water recognises there are is significant risk in developing surface water supplies. Desalination needs to be part of the suite of water source development options being assessed for the medium term.

Furthermore, desalination technology and operation has improved significantly in recent times, providing increased efficiencies and reduced environmental impacts. A contemporary review of the potential for desalination is warranted, and should be included in Power and Water's water source development planning.

Power and Water is currently undertaking a feasibility study into the use of desalination as a water supply option for the Darwin region.

The study assesses:

- The suitability of Darwin harbour as source water for a desalination plant;
- Requirements for pre-treatment and appropriate desalination technologies;
- Infrastructure requirements for connecting to the public water supply system;
- The logistics of disposing of waste streams; and
- Energy use and greenhouse gas production.

7.6 Alternative Supply Options

In addition to the traditional options for augmenting the Darwin region water supply in the medium term, a range of decentralised integrated water management solutions also warrant consideration. Such options aim to reduce reliance on potable water for non-potable uses, and help to defer the development of major new water sources. The options include rainwater tanks, greywater reuse and wastewater recycling implemented over time.

7.6.1 Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) is a contemporary and holistic approach to urban development that aims to minimise impacts on the natural water cycle and protect the health of aquatic ecosystems.

The principles of WSUD are to:

- protect and enhance natural water systems (creeks and rivers etc.);
- treat urban stormwater to meet water quality objectives for reuse and/or discharge to receiving waters;
- match the natural water runoff regime as closely as possible (where appropriate);
- reduce potable water demand through water efficient fittings and appliances, rainwater harvesting and wastewater reuse;
- minimise wastewater generation, and treat wastewater to a standard suitable for effluent reuse, and;
- integrate stormwater management into the landscape, creating multiple-use corridors to maximise visual and recreational opportunities.

The recently developed suburb of Bellamack in Palmerston has been used by the Northern Territory Government to showcase WSUD principles. The following initiatives support WSUD objectives:

- Three constructed ephemeral wetlands which treat stormwater;
- A non-potable water supply reticulation network within the development will supply water for outdoor uses, including irrigation of public and private landscapes. Initially, groundwater will supply the non-potable reticulation network, but ultimately recycled wastewater from Palmerston Wastewater Treatment Plant will charge the non-potable water supply reticulation network; and
- Additional water conservation measures, which are promoted within all public buildings and public open space, as well as demand management within private dwellings and private open space.

7.6.2 Rainwater Tanks

The marked seasonality of rainfall in the wet/dry tropics is the major barrier to take-up of rainwater tanks in urban areas of the Darwin region. Rainwater tanks cannot substitute for potable water, as a potential source for irrigation water in Darwin. Irrigation demand is very high during the dry season, but little irrigation occurs during the wet season. Large rainwater tanks would be needed to capture and store enough water during the wet, for use during the dry. Such tank sizes are not feasible for typical urban lots, and are costly. In the wet/dry tropics, therefore, rainwater tanks are best suited to replacing indoor demands for water.

Despite the high degree of seasonality of rainfall in the Darwin region, significant volumes of rainwater can still be harvested during the wet season. Rainwater tanks can effectively service high-volume indoor uses, such as washing machines and hot water services. The large volumes and high reliability of rainfall during the wet season means rainwater tanks can meet almost all of the demand for internal water during the wet season. This high reliability for up to five months of the year, compensates for the lack of rainfall during the dry season.

7.6.3 Greywater Reuse

Greywater from residential and commercial areas (water from the laundry, bathroom taps and shower) along with industrial greywater (slightly polluted water reused in manufacturing or other industrial processes) is a potential water source requiring less treatment than blackwater (water from toilets and kitchen).

Greywater contaminants include; low levels of bacteria, faecal matter, organic matter, microorganisms, salts and detergents. All of these contaminants can contribute to colour and odour. Depending on how it is to be reused, greywater may require a high level of treatment, including screening, sedimentation, biological treatment and disinfection. However, where public access is limited, treatment requirements are lower. For example, it may be possible to divert greywater for subsurface irrigation with minimal treatment.

Reuse of greywater requires that the greywater is separated from blackwater at the source. This may be feasible in new high density developments or at individual industrial sites, but it is difficult to retrofit existing buildings or to apply the technique on a regional scale. Generally speaking, it falls to individual households to take up the initiative.

7.6.4 Stormwater Reuse

Stormwater flows in urban environments are higher, more frequent and of lower quality than in undeveloped catchments. This leads to adverse impacts on downstream waterways. Harvesting stormwater flows from a catchment can therefore benefit downstream waterways by removing excess pollutants along with the excess stormwater flows. This environmental benefit is the principal driver for stormwater reuse in the Darwin region.

Theoretically, stormwater harvesting could reduce potable water demand. As for rainwater tanks however, the slump in demand for irrigation water during the wet season means stormwater reuse is less viable than it might be. Moreover, the treatment required to allow non-potable reuse of stormwater in the household, means stormwater is unlikely to substitute for potable water under most circumstances.

Due to the seasonal nature of rainfall in the Darwin area, significant storage would be needed to make captured stormwater viable for irrigation. Storage in Darwin can be in storage ponds, storage tanks or via aquifer storage and recovery. Aquifer storage involves the pumping of water into a groundwater aquifer during the wet season, and recovering the water again for use during the dry season. Aquifer storage and recovery can be cost effective and eliminates the loss of water from storages to evaporation during the dry season. However, aquifer storage and recovery is highly dependent on the underlying geology and the nature of the aquifers, and there are no suitable aquifers in the Darwin region.

7.6.5 Recycled Wastewater

Power and Water aims to use recycled wastewater when justified on economic, social and environmental grounds. A target has been set for the long term: Power and Water aims to reuse 100 per cent of dry weather flows as treated wastewater in all wastewater systems. This remains an aspirational target at this time, owing to cost and logistical constraints.

The Darwin region has five wastewater treatment plants (WWTP), which service different areas of the collection network. The WWTPs are located at Ludmilla, Leanyer/Sanderson, Palmerston, Berrimah and Humpty Doo. Over 20,000 ML of treated wastewater is currently discharged each year to Darwin Harbour from these plants.

Power and Water operates one major treated wastewater recycling scheme in the Darwin region, with highly-treated wastewater from the Northlakes Recycled Water Treatment Plant (RWTP) supplied to the Darwin Golf Club and Marrara Sports Complex. Approximately 200 ML/yr is supplied by the Northlakes RWTP, which is operating at its maximum capacity.

Power and Water also uses treatment wastewater in its process train at the Ludmilla WWTP. Approximately 550 ML/yr is currently reused on-site at the plant.

A scheme to provide treated wastewater to a turf-growing business near the Palmerston WWTP has been partially developed. This scheme would supply less than 100 ML/year and is dependant on a commercial commitment from the turf farm operators.

A study into the viability of a treated wastewater recycling scheme to irrigate public open space in the northern suburbs of Darwin is being undertaken. The study investigates upgrading the Leanyer Sanderson WWTP to provide high-quality treated wastewater for recycling.

A third pipe system has been installed at the new suburb of Bellamack in Palmerston, and is charged with non-potable groundwater. In the long-term, the third pipe will be charged with treated wastewater from the Palmerston WWTP, once additional treatment is available.

The level of treatment required for a wastewater recycling scheme varies depending on the end-use of the recycled water. The general philosophy applied in treated wastewater recycling is that wastewater is treated to the minimum level required for it to be 'fit-for-purpose'. For example, some industrial processes, or irrigating open spaces where there are high levels of human contact, require a higher level of treatment than uses where public access and human contact is limited.

The cost of treating wastewater to higher levels is currently much higher than the cost of supplying potable water. However, there are a additional benefits from recycling of treated wastewater, including a reduction of environmental impacts and the deferral of capital expenditure on additional water sources.

7.7 Evaporation Reduction Technology

Evaporation from Darwin River Dam is responsible for between one half to two-thirds of the total water loss (water level drop) each year. This loss significantly affects the yield (sustainable annual extraction limit) from the reservoir. If evaporation from the reservoir could be reduced, then more water would be available for extraction.

There are three main types of evaporation reduction technologies available:

1. shading the water with shade cloth or plastic screens;
2. covering the water surface with floating plastic modular material; and
3. applying chemical products to the water surface to reduce its evaporation potential.

These technologies have been applied elsewhere on small water storages, such as farm dams. None of the available technologies have been tested on a large-scale potable water reservoir like Darwin River Dam.

The primary issues affecting the application and effectiveness of the available technologies are:

- the impact of seasonal wave and wind action, and extreme weather events;

- the logistics of securing shading or modular floating technologies in areas which are inaccessible by land, and the provision of safe access for maintenance; and
- the impact on drinking water quality resulting from changes in limnology due to shading, cooling, heating and chemical influence, including potential treatment requirements.

At full supply, Darwin River Dam's surface area is 52 square km and the water body is subject to significant wind and wave action at various times during both the wet and dry seasons.

Whilst some of the technologies could potentially be applied to only a proportion of the surface area and still achieve measurable evaporation savings, covering even a part of the water body offers up significant logistical challenges, at extremely high capital and maintenance costs. For example, the application of an existing floating plastic modular technology to a quarter of the water body of Darwin River Dam is estimated to cost hundreds of millions of dollars .

Water utilities, mining companies and researchers around the country are undertaking both small and larger scale trials, and manufacturers are responding with further product development. Power and Water is closely monitoring the continuing development and testing of the various evaporation reduction technologies. Whilst it is unlikely that an appropriate evaporation reduction technology will be available for application to Darwin River Dam within the next five years, this may represent a viable supply augmentation option in the medium term.

7.8 Excluded Options

Over the past two decades, numerous water source development options have been considered as part of a long term planning process. The following section briefly lists and describes the major options that have been excluded from the current strategy.

7.8.1 Darwin River Dam Storage Augmentation

In 2010, Power and Water completed the upgrade of embankments and spillway at Darwin River Dam to increase the full supply level by 1.3m. The works increased the capacity of Darwin River Dam by 20 per cent, which increased yield. Additional storage augmentation options are available through further works to the embankments, spillway and the construction of a series of saddle dams, however, though these were considered in the planning process, the optimal project was selected for construction. The further augmentation of Darwin River Dam's storage is now excluded as an option.

7.8.2 Darwin River Dam – Further Extraction Supported by Water Treatment

Historically, the minimum operating level adopted for Darwin River Dam was 40m AHD . This was to ensure the quality of water extracted from the reservoir met the standards for potable water.

It is likely that the quality of water available from Darwin River Dam will deteriorate as it becomes necessary to operate the dam at lower levels than have occurred in the past. The development of water treatment capabilities for the Darwin water supply system could allow Power and Water to safely draw water from below the previously set minimum operating level, providing opportunity to increase the previously assessed yield.

However, the recent adoption of the targeted level-of-service objectives for the Darwin region relies on the whole of the extractable volume of Darwin River Dam being available as working volume, drought response reserve, or contingency storage, to assure adequate water security for the Darwin region. As such, the option to increase yield, by more fully utilising Darwin River Dam's storage combined with the provision of water treatment has been nullified.

7.8.3 Lambell's Borefield

Lambell's Borefield, on the Koolpinyah Aquifer in the Humpty Doo area, was once suggested as a potential drinking water supply source. The water resource in this area is part of the Koolpinyah Aquifer which is likely to be already over extracted. As such, additional development of this resource (beyond the current Howard East Borefield project) is no longer considered to represent a sustainable option for additional water for the Darwin region water supply system.

7.8.4 Continued Development of the Howard East Borefield

The continued development of the Howard East Borefield was planned to deliver an additional 14,000 ML/yr supply to the Darwin region over time. However, with the improved understanding of sustainable yield from the Koolpinyah aquifer, ongoing significant development of the Howard East Borefield is no longer considered to represent a sustainable option for additional water for the Darwin region water supply system.

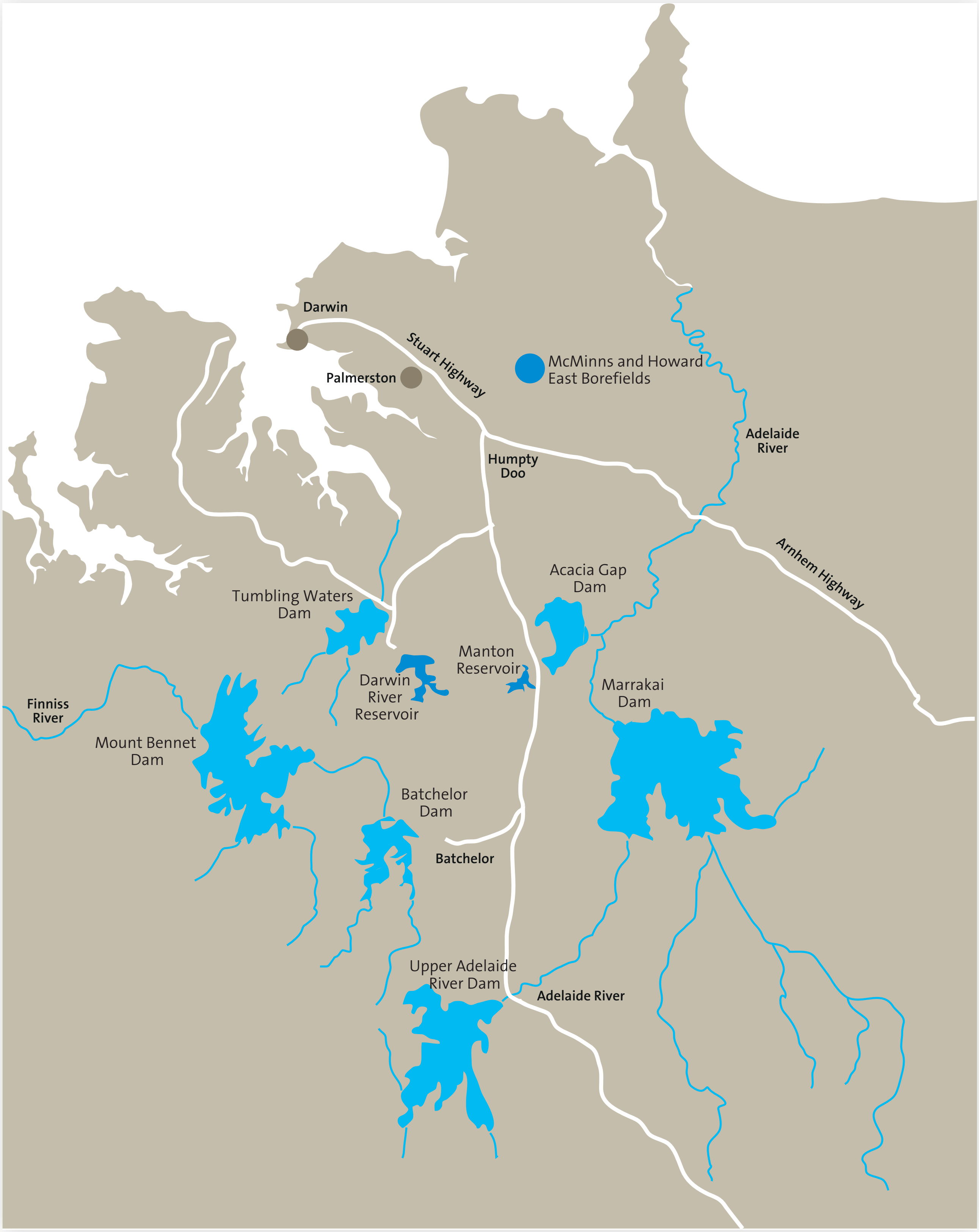
In the absence of a significant reduction in other consumptive uses (horticulture irrigation and private rural residential bores), the continued development of the Howard East Borefield, beyond the additional development identified for 2014/15 to increase emergency supply provisions and to improve the reliability of extracting Power and Water's current licensed groundwater allocation, is excluded as an option.

7.8.5 Alternative Dam Sites

In the 1980s at least three alternative dam sites (additional to the three that were eventually shortlisted) were considered.

Figure 29 (right) identifies the location of three previously-considered dam sites: Tumbling Waters, Acacia Gap and Batchelor. In 1990 the Northern Territory Government considered the relative risks and benefits associated with these sites and selected three dam sites (Upper Adelaide River, Marrakai and Mt Bennet) to be taken forward in Power and Water's water source planning. The other sites were discounted for a range of reasons including potential environmental, engineering, economic, social and water quality impacts.

Figure 29:
Previously Considered Dam Sites



7.8.6 Existing Dams and Lakes

A number of small dams and lakes exist in the Darwin region, such as Lake Bennett. Many of these storages are privately owned, have significant water quality challenges and are not large enough to provide an economically viable water source option for the Darwin region water supply system, given the significant connection costs associated with their remoteness from the water supply network.

7.8.7 Hanna's Pool on the Finniss River

An interbasin transfer scheme (Hanna's Pool) identified in the 1980s, whereby flood flows would be harvested from the Finniss River for transfer to the Darwin River Dam was the subject of a feasibility study in 2011.

Given the assumptions for environmental flows that were applied, the study found there was insufficient water available for the scheme to be an economically-viable source for the Darwin region water supply system.

8 Development of plans

8.1 Demand/Supply Model

Integral to the Strategy is the development and ongoing refinement and review of a long-term demand/supply model. The model relies on a range of key parameters including:

- source (surface water and groundwater) yields;
- base demand (total production);
- demand growth (organic and incremental);
- climate change impacts (on both demand and supply); and
- demand management outcomes.

The values attributed to each of these key parameters are subject to varying levels of confidence, with the greatest uncertainty surrounding the impacts of climate change and the outcomes of demand management.

Power and Water's demand/supply model has been developed and refined over the past three years and has the capability to test sensitivities for key parameters. It is intended that the key parameters in the model be reviewed regularly, so as to incorporate the latest and most accurate information available.

8.2 Demand Driven Water Source Development Programme

Power and Water aims for its capital works programme to deliver the base case – a demand-driven water source development programme.

Power and Water's base case demand/supply model scenario incorporates:

- system yield based on the targeted level-of-service objectives;
- forecast general demand growth (PWC base demand);
- forecast industrial demand growth;
- achievement of the Living Water Smart water demand savings targets;
- climate change-driven demand growth (based on temperature and evaporation increases);
- climate change-driven yield reductions from sources (largely due to increased evapotranspiration);
- a 10 per cent headroom requirement (buffer) between demand and supply; and
- programmed development of water source projects.

Figure 30 (on the following page) represents Power and Water's current water source development programme and indicates that the supply system will be subject to a reduced level of service (increased likelihood of water restrictions) at times, as demand encroaches on the 10 per cent headroom requirement ahead of programmed source augmentation.

The current programme identifies the further development of the Howard East Borefield in 2014/15, the return to service of Manton Dam in 2025 and the connection of the preferred (but yet to be selected) medium-term supply augmentation option beyond 2030. The programme is subject to key planning assumptions, including the realisation of the Living Water Smart water demand savings targets.

A new major water supply source such as Upper Adelaide River Dam could cost in excess of $500 million to develop and connect to the water supply system. Capital investment of that magnitude will have a significant impact on water pricing in the region, in order to recover the costs of the investment. Successful demand management will be essential to defer the need to develop new sources of water for as long as possible. Decentralised integrated water management solutions will likely be a key tool in reducing demand on the potable water supply system over time.

Power and Water recognises that the water demand savings targeted by Living Water Smart are ambitious and require sustained community and Government support. As a prudent way to manage risk, Power and Water is continuing the planning and design work required to return Manton Dam to service and to find additional future sources of water. This will allow the programme to be fast tracked should growth in water demand outpace demand management.

Illustrated in Figure 31 (on the following page), the alternative programme represents the earliest achievable timeline, considering the significant engineering and environmental studies and approvals that are required, and making allowance for construction. The alternative programme assumes 50 per cent of the Living Water Smart demand management targets are achieved.

Figure 30:
Current Water Source Development Programme

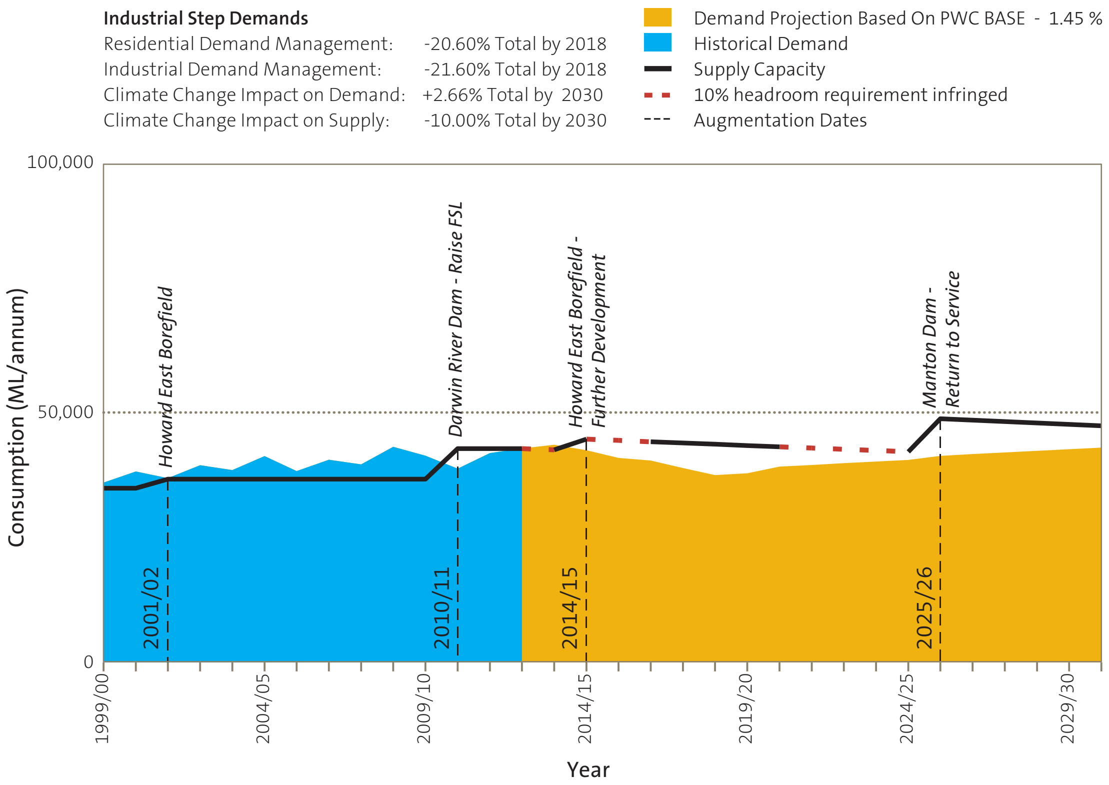
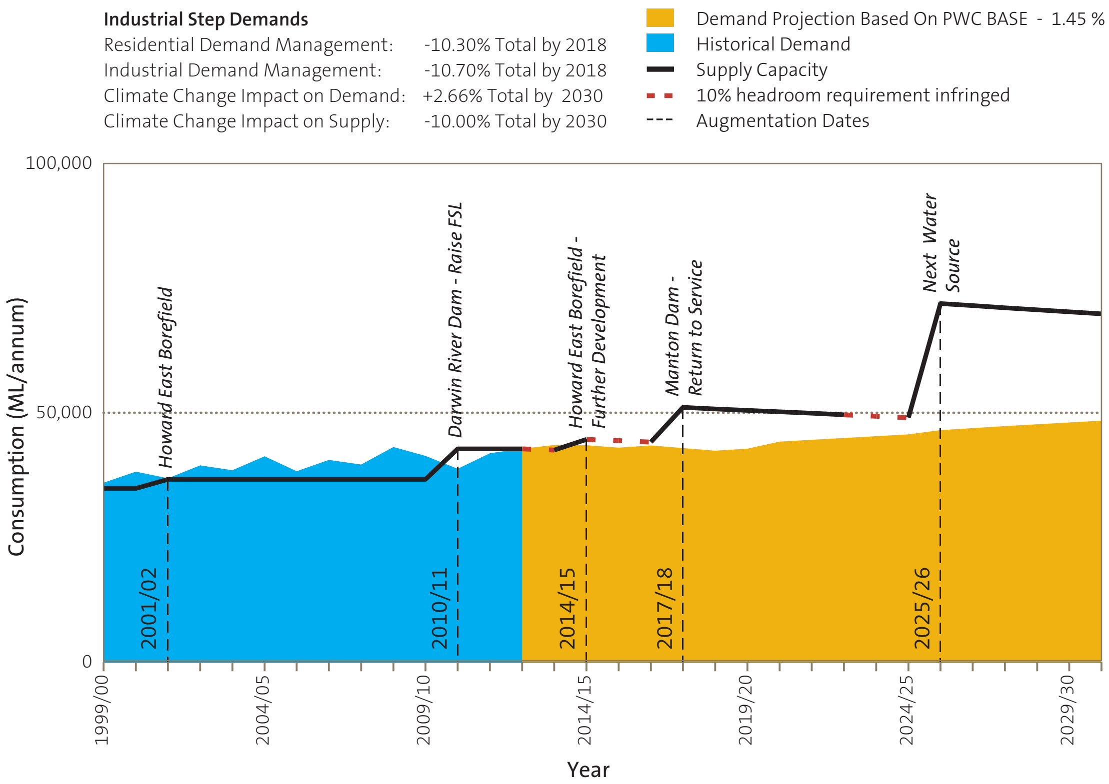


Figure 31:
Alternative Programme – For Planning and Design Purposes



8.3 Capital Expenditure Programme

Power and Water's short term capital expenditure programme is identified in its Statement of Corporate Intent, an annual publication identifying Power and Water's strategies, risks, investment plans and performance targets. Table 13 details Power and Water's capital investment programme for water source planning and development.

The programme identifies the further development of the Howard East Borefield and the return to service of Manton Dam as the significant water source development investments in the short term.

The cost of further developing the Howard East Borefield is $15.6 million, providing increased emergency supply capacity, and enhancing redundancy so as to reliably extract Power and Water's existing licensed groundwater allocation.

The major components of the Manton Dam return to service project total $161.5 million, including the Strauss Water Treatment Facility and storage.

During the next two years, there will be opportunity to review the assumptions influencing the timing of capital expenditure on Manton Dam's return to service, including growth in demand and the outcomes of demand management. The construction costs identified in the programme are order-of-cost estimates only. Project development and design over the next two years will firm up these estimates, allowing the programme to be updated accordingly.

Funding of $30 million has been allocated to construct additional water storage at the Strauss Water Treatment Facility. The staging of storage development depends on load growth in the area.

Also, $21.4 million has been allocated to construct a new pumping station at Darwin River Dam, to meet increasing peak-day demand pumping, and to manage risk over time.

Hydrological, engineering, geophysical and environmental studies are being undertaken for a range of medium-term water source development options, and are funded from a $4 million allocation to strategic planning.

Table 13:
Capital Investment Programme – Water Source Development Projects

Description of Works	Total
Howard East Borefield - Stage 2	**$15.6**
Strauss Water Treatment Facility	**$70.0**
Bulk Water Storage at Strauss	**$30.0**
Darwin River Dam - New Pump Station	**$21.4**
Manton Dam Transmission Main	**$51.0**
Manton Dam - Upgrade Pump Station / Intake	**$10.5**
Long Term Water Source Strategy Works	**$4.0**
TOTAL ($ Millions)	**$202.5**

Works Category
EMERGENCY SUPPLY
TREATMENT AND STORAGE
WATER SOURCE AUGMENTATION
STRATEGIC PLANNING

9 Management of risk and uncertainty

The inherent difficulty of planning for a 20-year period means plans and strategies need to be flexible to adapt to changing circumstances in the future. This section outlines some of the major uncertainties associated with long-term water resource planning, and the measures that have been implemented to manage these uncertainties.

9.1 Water Demand Growth

Power and Water recognises the difficulty of calculating statistically-accurate projections of growth beyond five years. This is due to the range of factors that influence water demand, prompting the analysis of historical trends, and the development of forecasts using up-to-date local and regional information.

The growing focus on water conservation and an emphasis on finding new ways to save water, are driving the need for better demand forecasting and analysis tools. Power and Water recognises the importance of understanding details and patterns of use at the customer's tap.

Over the next three years, Power and Water aims to improve its demand modelling and forecasting capabilities.

9.2 Impacts of Climate Change

An area of uncertainty within the planning horizon is climate change. Modelling climate change has identified significant impacts on yields that are likely to be available from surface water storages in the Darwin region by 2030.

The nature and severity of future climate change will clearly have implications for the Darwin region water supply system. Power and Water will continue to monitor the impacts of climate change, and plan for it using the best available scientific information.

Power and Water will model impacts on yields in line with new regional climate change information as it becomes available. Also, adaptation strategies will be pursued, with a view to recommending measures for water supply planning.

9.3 Impact of Government Policy

Water allocation planning in the Darwin region may impact on Power and Water's licensed extraction from water resources.

The water allocation planning process formally commenced in 2010 in the Koolpinyah (Howard East) Aquifer with the formation of the Howard East Water Advisory Committee. The groundwater resource is considered to be under stress, and current extraction may be exceeding sustainable levels. The water allocation planning process is expected to limit extraction to sustainable levels, and to achieve an equitable share of the resource for each stakeholder, whilst providing for environmental and cultural water requirements.

Power and Water is active in the water allocation planning process for the Darwin region and will continue to work closely with DLRM to ensure public water supply is at the forefront of water resource planning and allocation.

Environmental policy initiatives have the potential to impact on water source development planning and project development. Power and Water will liaise closely with DLRM and Government over existing and proposed initiatives to ensure the Darwin region water supply remains sustainable in the long term.

9.4 Catchment Risks

A number of significant catchment-related risks have the potential to impact on the Darwin region water supply's sources.

In the McMinns Borefield, land adjacent to Power and Water's water supply bores has been developed for rural residential and horticultural land uses. These land uses pose a risk of contamination to the public water supply. Power and Water has established management zones around these bores to help reduce risk of contamination.

Planned further development of the Howard East Borefield to provide redundancy in Power and Water's groundwater supply, may present an opportunity to partially shift Power and Water's regular extraction away from the McMinn's Borefield, further reducing contamination risks.

Surface water catchments present a number of significant risks with the potential to detrimentally affect the quality of water drawn from dams. These risks include illegal access to the catchment, erosion and flood damage, bush fires, feral animals and weeds.

The detection of the aquatic weed *Cabomba* downstream of Darwin River Dam in the Darwin River in 2004, triggered a significant weed eradication action plan by the Northern Territory Government. Whilst occurrences of *Cabomba* have since reduced significantly, an active monitoring and quarantine regime continues.

Power and Water regularly reviews its catchment management activities to protect source water quality. Some of the most important activities include river health works, biodiversity management, fire prevention and property management.

Power and Water has developed a Catchments and Water Source Protection Strategy to support the proactive management and protection of its water supply catchments.

10 Stakeholder consultation

Delivering the Strategy in the most effective way, will require consultation with stakeholders and managed communications.

The development of the Strategy has been informed in part by the results of Power and Water's 2005 survey of community attitudes to water use.

The Strategy is intended to provide a basis for community debate over the next few years around demand management and water source development.

The outcomes of community debate, measured changes to customer water-use, regulatory direction and updated climate change data as it comes to hand, will be used to inform the next issue of the strategy in approximately five years.

Detailed stakeholder engagement plans will be developed for individual water source development projects. The projects include the further development of the Howard East Borefield and the return to service of Manton Dam, once the timing of the project is resolved. The stakeholder engagement phase for these projects will directly influence their design and implementation.

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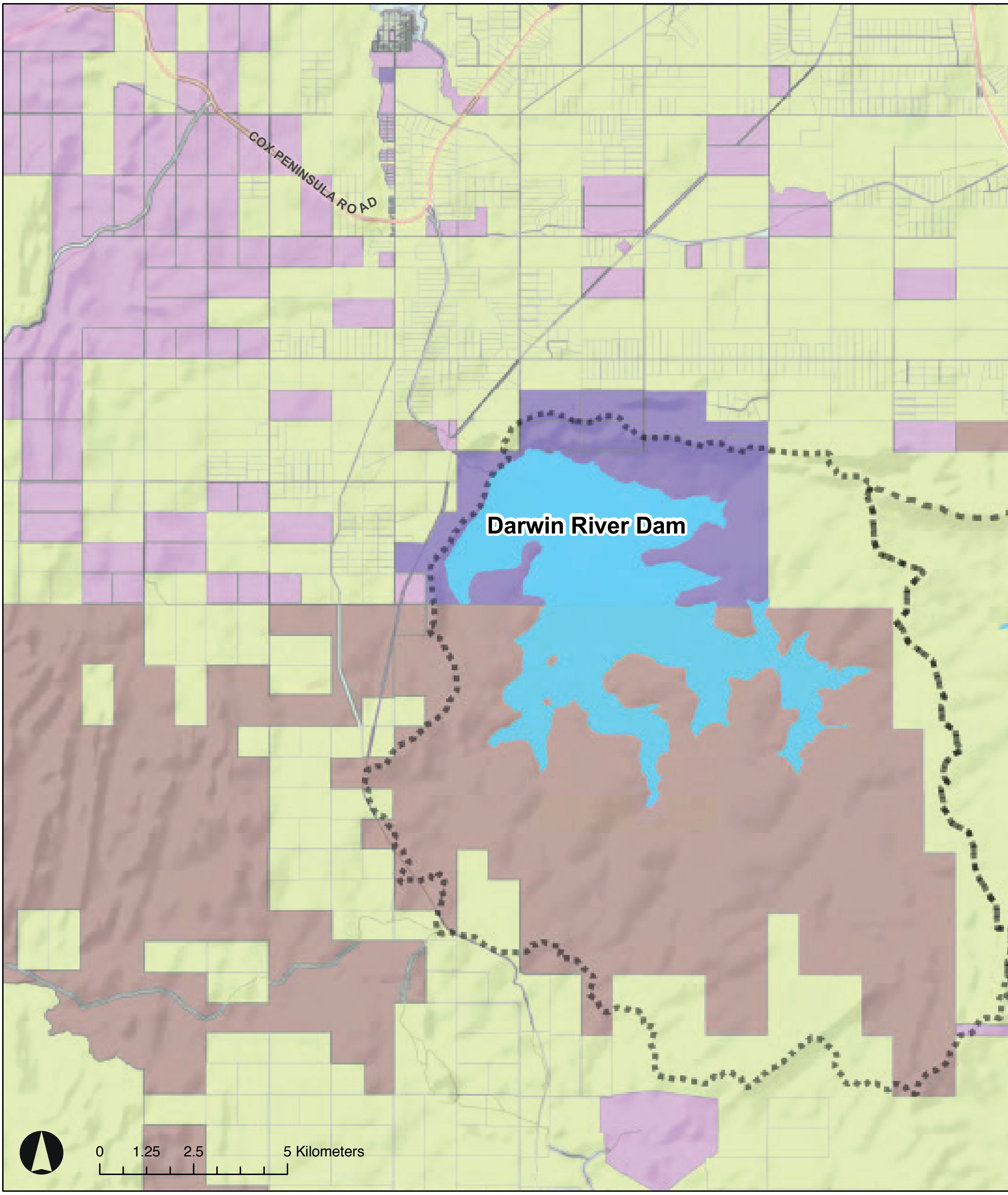
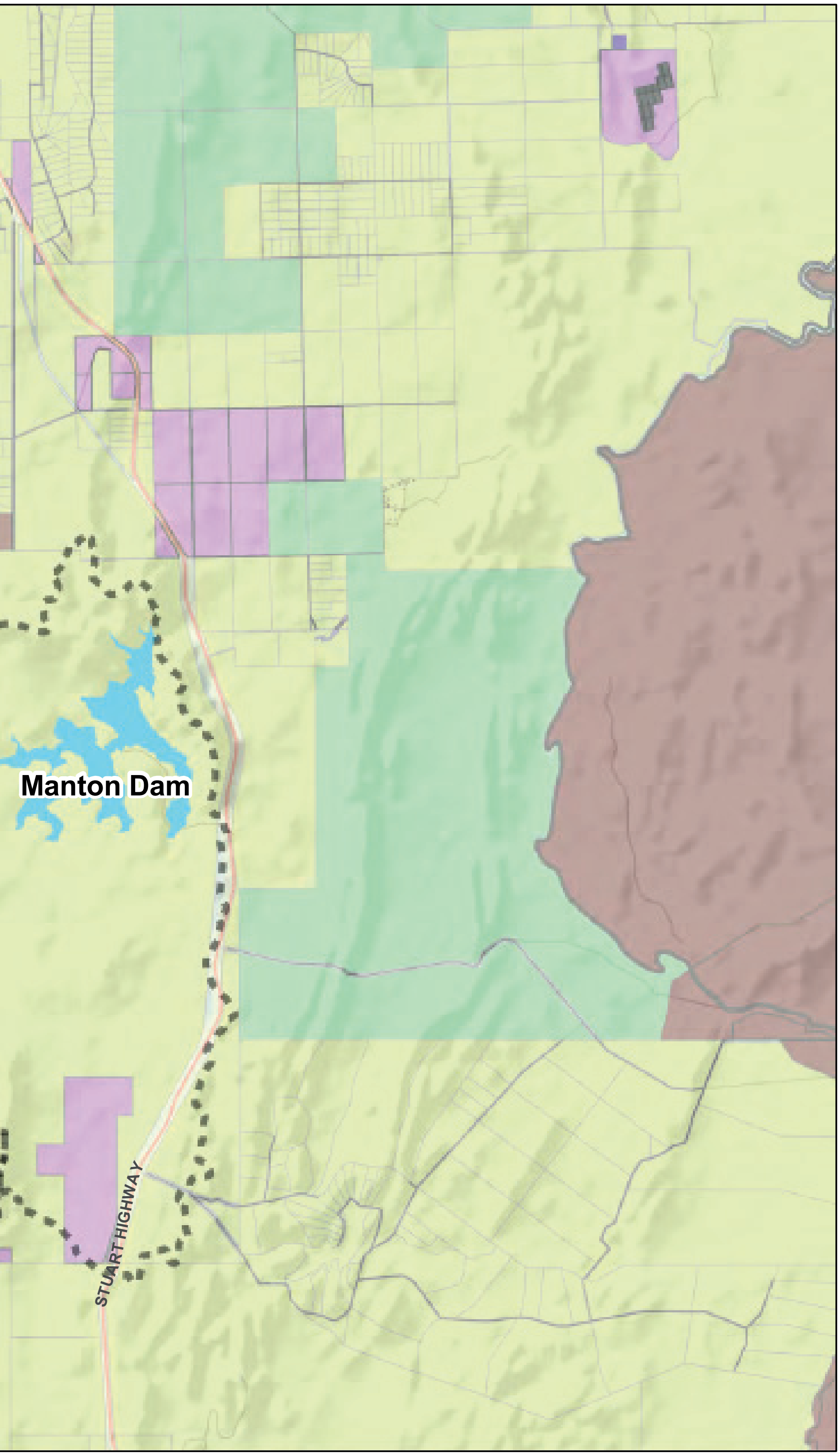
Appendix 1: Land tenure and land zoning maps for Darwin region water supply catchments

Darwin River Dam and Manton Dam Land Tenure





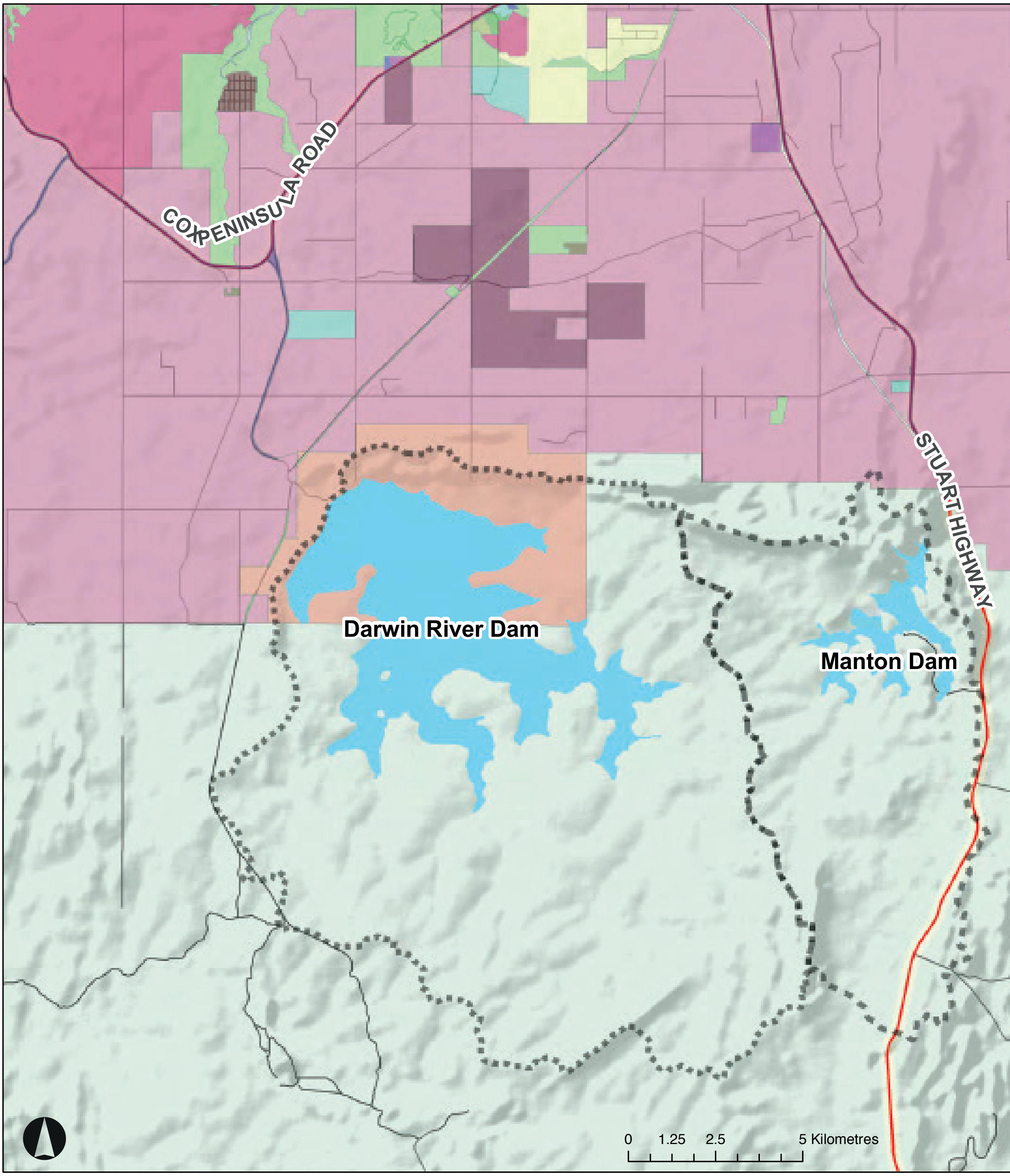
LEGEND

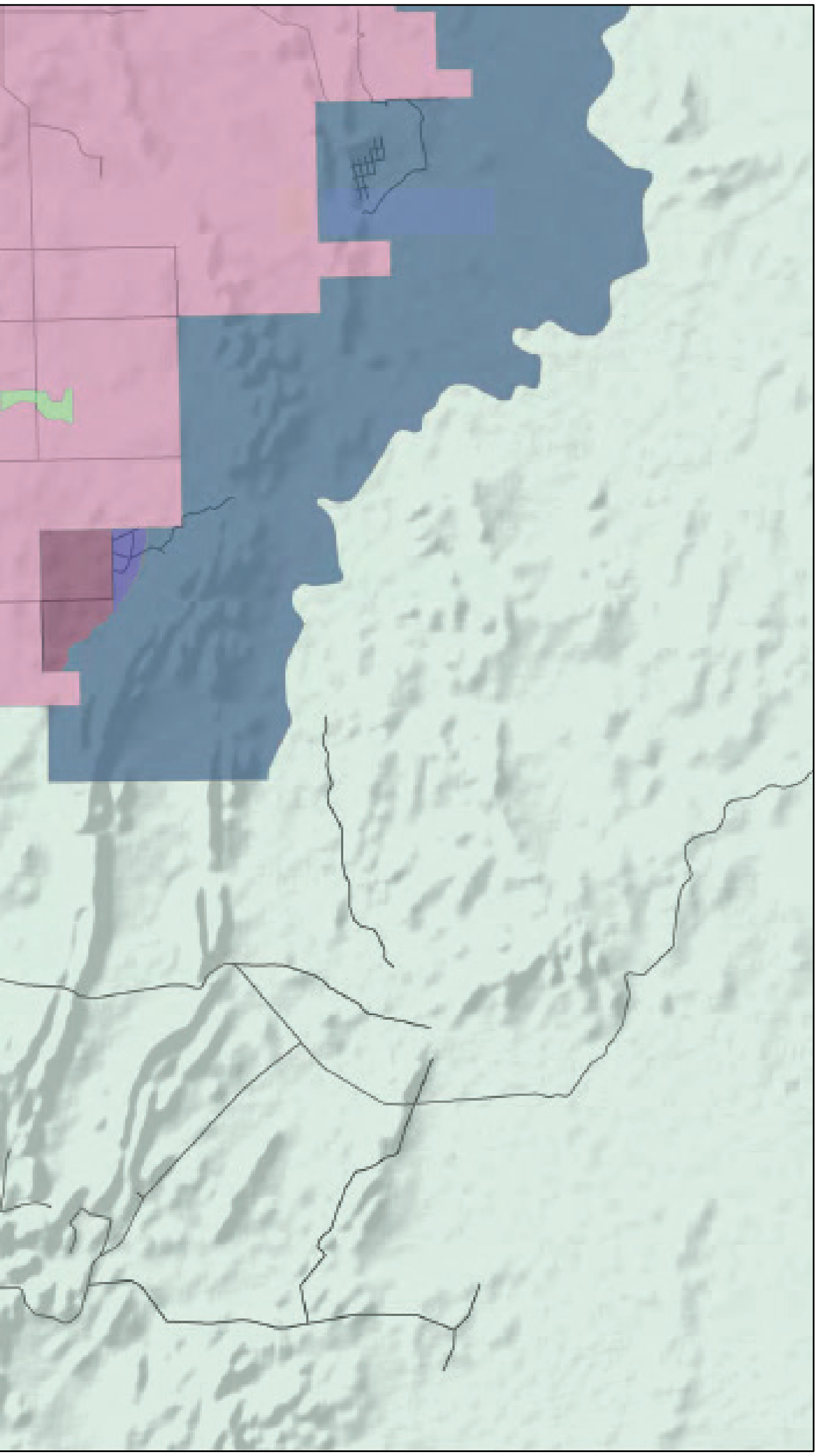
- Dams
- Dam Catchment
- Roads Major

TENURE REFERENCE TYPE

- Freehold
- Crown Lease Perpetual
- Vacant Crown Land
- Government
- Perpetual Pastoral Lease
- Reserve

Darwin River Dam and Manton Dam Land Zoning





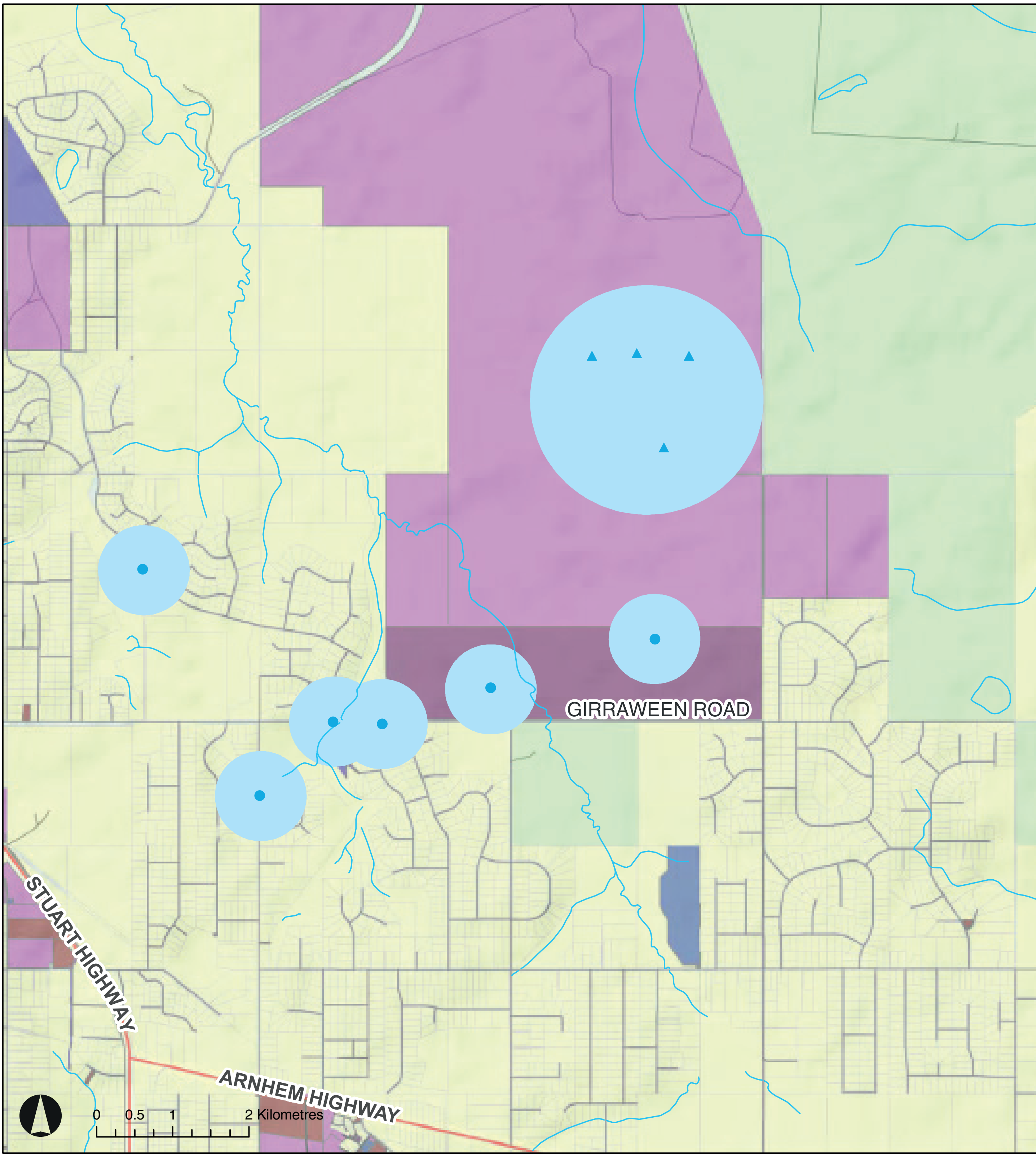
LEGEND

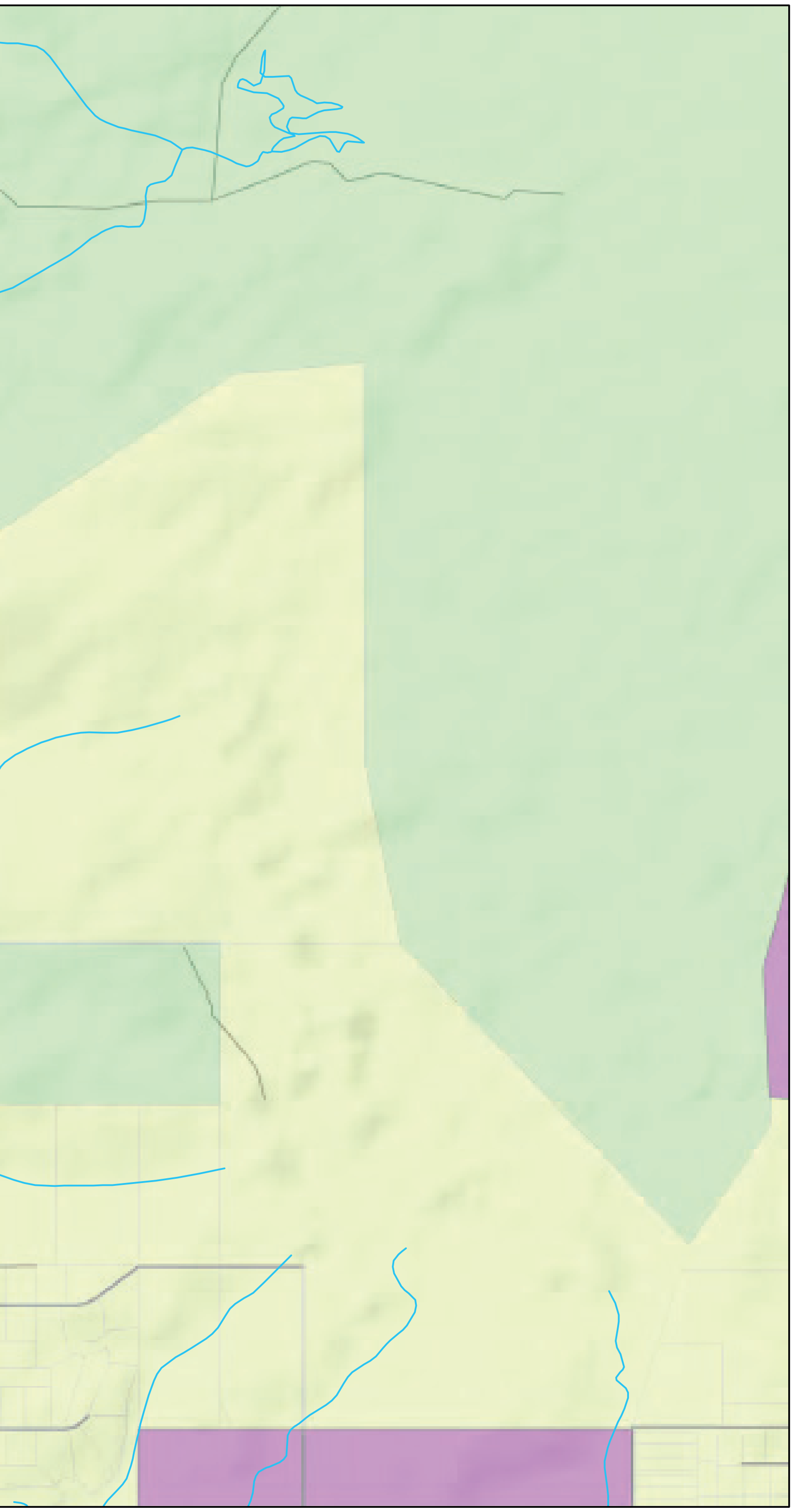
- Roads Major
- Dam Catchment
- Dams

Zone Description

- Agriculture
- Commercial
- Community Living
- Community Purpose
- Conservation
- Future Development
- Horticulture
- Light Industry
- Main Road
- Multiple Dwelling
- No Planning Scheme Controls
- Organised Recreation
- Proposed Main Raod
- Public Open Space
- Rural
- Rural Living
- Rural Residential
- Service Commercial
- Single Dwelling
- Specific Use
- Tourist Commercial
- Utilities
- Water Management

McMinns and Howard East Borefields Land Tenure





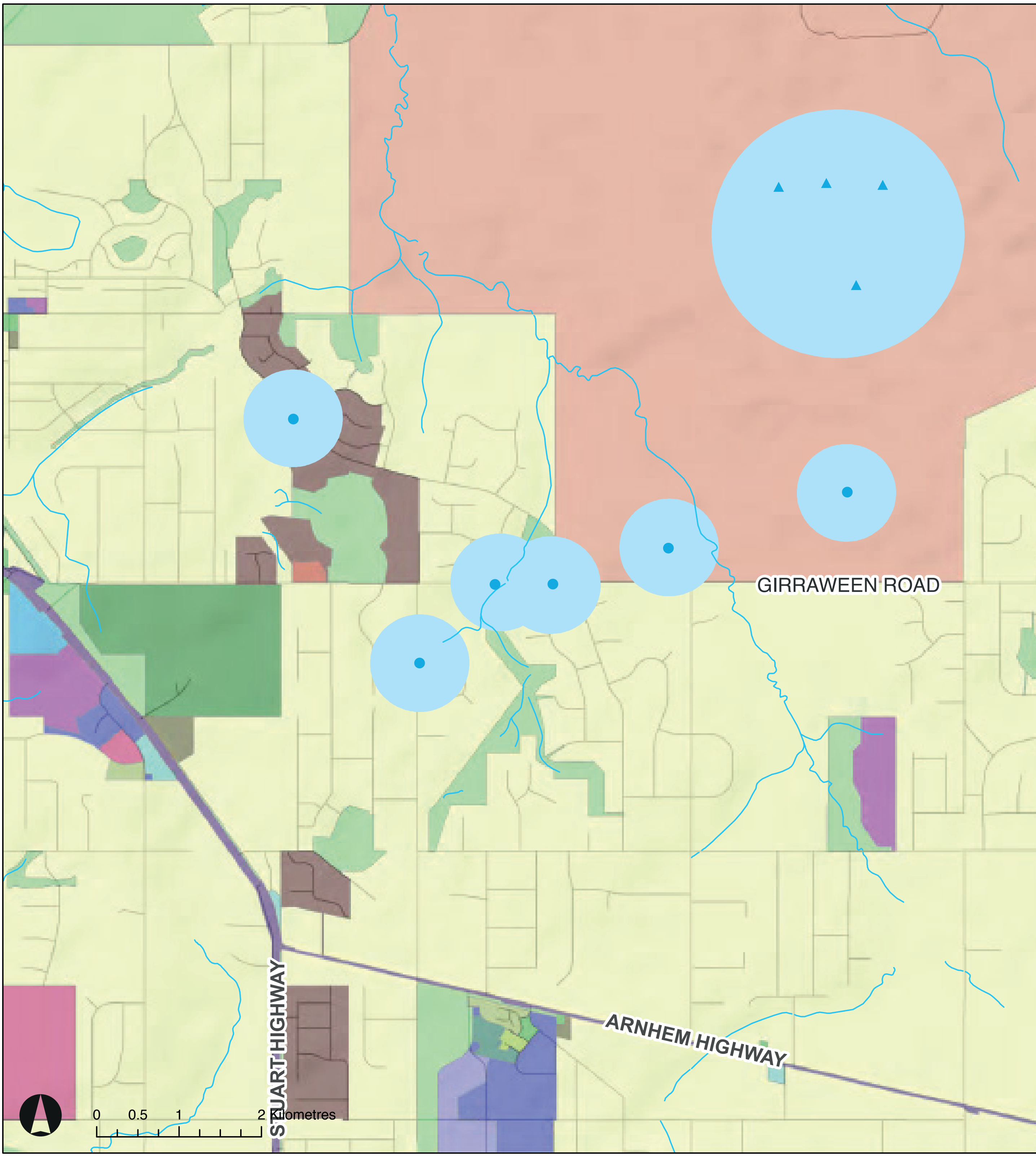
LEGEND

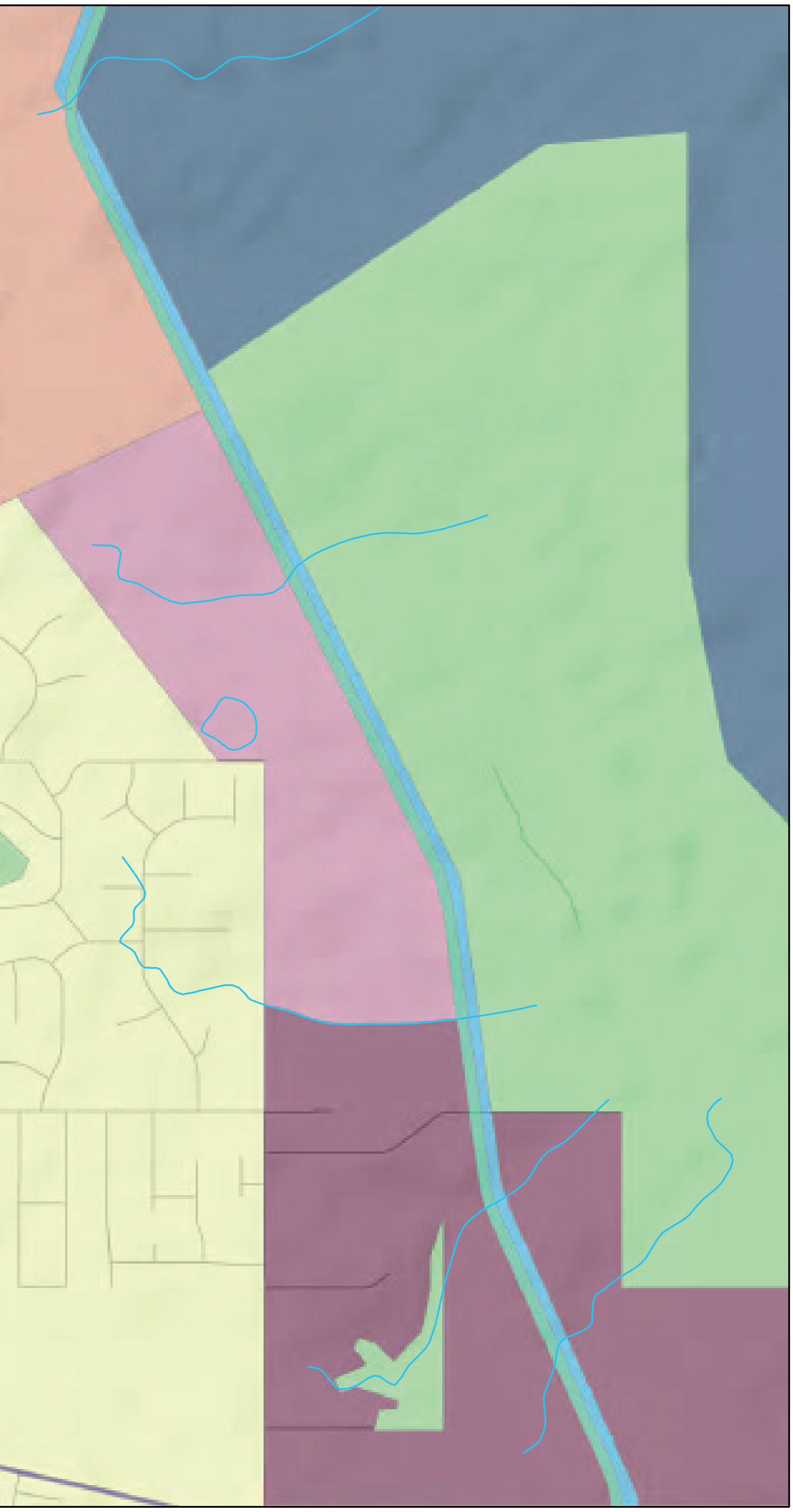
- Existing Power and Water Production Bores
- Proposed Power and Water Production Bores
- Wellhead Protection Zone
- Rivers Lakes
- Roads Major

TENURE REFERENCE TYPE

- Crown Lease Perpetual
- Crown Lease Term
- Freehold
- Government
- Perpetual Pastoral Lease
- Reserve
- Special Purposes Lease
- Vacant Crown Land

McMinns and Howard East Borefields Land Zoning





LEGEND

- Existing Power and Water Production Bores
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- Wellhead Protection Zone
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ZONE DESCRIPTION

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Contact us

Call 1800 245 092
Email customerservice@powerwater.com.au
Visit powerwater.com.au
Follow PowerWaterCorp on Twitter
ABN 15 947 352 360

Head office

Level 2, Mitchell Centre
55 Mitchell Street, Darwin
GPO Box 1921
Darwin NT 0801

Customer service centres

Shop 28, Ground Floor, Mitchell Centre
55 Mitchell Street, Darwin

Shop 21, Palmerston Shopping Centre
10 Temple Terrace, Palmerston

Ground Floor, Government Centre
5 First Street, Katherine

Shop 8, Alice Plaza
36 Todd Mall, Alice Springs

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