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Socio-economic assessments to inform water resource planning in the Darwin region: Berry Springs Water Allocation Planning Area (BSWAPA)

Report prepared for the Northern Territory Department of Natural Resources, Environment, the Arts and Sport

MARSDEN JACOB ASSOCIATES

Marsden Jacob Associates
Financial & Economic Consultants

ABN 66 663 324 657
ACN 072 233 204

Internet: http://www.marsdenjacob.com.au
E-mail: economists@marsdenjacob.com.au

Melbourne office:
Postal address: Level 3, 683 Burke Road, Camberwell
Victoria 3124 AUSTRALIA
Telephone: +61 3 9882 1600
Facsimile: +61 3 9882 1300

Brisbane office:
Level 14, 127 Creek Street, Brisbane
Queensland, 4000 AUSTRALIA
Telephone: +61 7 3229 7701
Facsimile: +61 7 3229 7944

Canberra office:
Unit 10, 11 Mackay Gardens, Turner
ACT 2612, AUSTRALIA
Telephone: +61 2 6247 6549

Perth office:
Level 1, 220 St Georges Terrace, Perth
Western Australia, 6000 AUSTRALIA
Telephone: +61 8 9324 1785
Facsimile: +61 8 9322 7936

Sydney office:
119 Willoughby Road, Crows Nest
New South Wales, 2065 AUSTRALIA
Telephone: +61 418 765 393

Authors: Jim Binney, Siobhan Davies

Contact: economists@marsdenjacob.com.au

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Acronyms

Acronym	In full
ABS	Australian Bureau of Statistics
BSWAP	Berry Springs Water Allocation Plan
BSWAPA	Berry Springs Water Allocation Planning Area
EPBC	Commonwealth *Environmental Protection and Biodiversity Act*
FTE	Full time equivalent
GIS	Geographic Information System
GL	Gigalitre (1,000 megalitres or 1,000,000,000 litres)
INRM	Integrated Natural Resource Management
LGA	Local Government Area
ML	Megalitre (1,000,000 litres)
NT	Northern Territory
NTG	Northern Territory Government
NWC	National Water Commission
NWI	National Water Initiative
PWC	Power and Water Corporation
TAAU	Tropical Australia Algae Utilize
TEV	Total Economic Value
TWP	Territory Wildlife Part
WAC	Water Advisory Committee
WAP	Water Allocation Plan

Executive summary

Marsden Jacob Associates (MJA) has been engaged to provide independent guidance to water planners and water advisory committees in the Berry Springs Water Allocation Planning Area (BSWAPA) on the use of baseline information on current social and economic condition of the area, from which to evaluate social and economic impacts of future water extraction scenarios; and how this information can be used in the development of an economically and socially acceptable water resources plan for the Berry Springs region.

The BSWAPA has mix of land uses with many of the principal land uses (horticulture, rural residential, pastoral and nature conservation) being highly reliant on the condition and performance of the aquifer.

Demographics in the BSWAPA

The population of the BSWAPA (i.e. people actually residing in the area) based on census information is approximately 640 persons. Over the life of the water allocation plan (WAP), the population could increase to around 900 without and major change in government policy or major land developments. It should be noted that there are no official Northern Territory Government (NTG) population estimates or forecasts for the actual Berry Springs area and that population growth would be significantly affected by government policy and decision-making or changes in land market conditions.

An analysis of key demographic data and other information for the BSWAPA revealed that:

- The Indigenous population is relatively smaller than the rest of the Top End but that many Indigenous Territorians with an interest in the outcomes of the water allocation plan live outside the region.
- Educational attainment is skewed towards trades (as opposed to tertiary education) and census data indicates that proficiency in English is relatively lower than the Top End in general.
- Income distribution in Berry Springs is generally in line with the Top End, but incomes are generally higher in BSWAPA than in the Northern Territory (NT).

The analysis of key demographic information indicates that population growth in the BSWAPA creates a significant potential risk to the condition of the aquifer. In addition, education attainment and English proficiency in the BSWAPA indicate that care will be needed during consultation for the development and implementation of the water allocation plan.

The BSWAPA economy

Data on economic activity in the BSWAPA is extremely limited and economic activity that occurs within the BSWAPA will have impacts across Litchfield and potentially the Top End.

Analysis of the local economy indicates that the structure of the economy in the BSWAPA differs significantly from the Top End, with a higher reliance on agriculture, a lower reliance on white-collar economic activity, and a large proportion of small businesses.

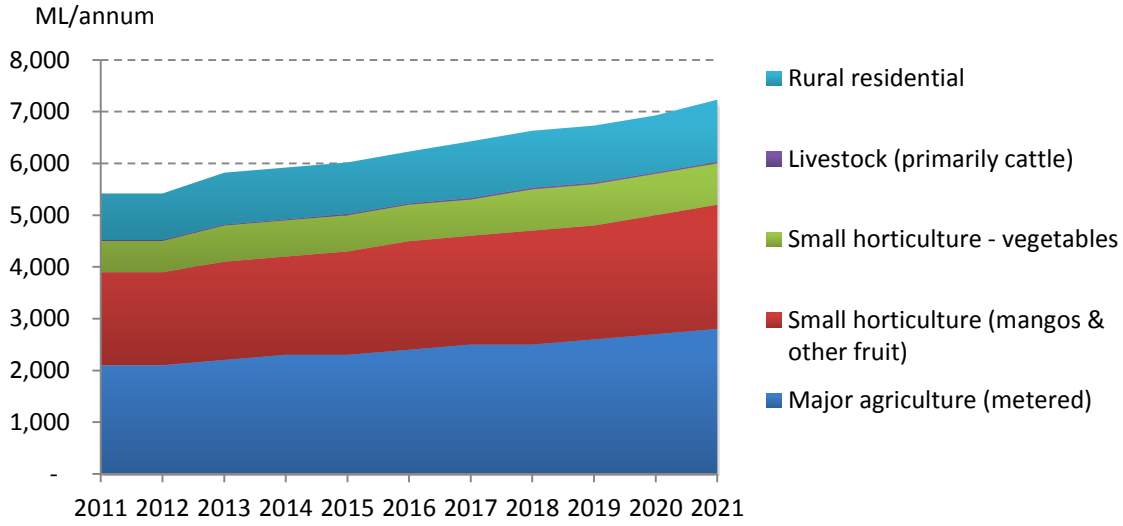
MJA estimate that the value of irrigated agriculture in the BSWAPA is approximately $20 million per annum ($14 million fruit production and $7 million vegetables). Growth prospects for irrigated agriculture are relatively good.

The structure and prospects for the economy in the BSWAPA also has significant implications for the water allocation planning process as the region's reliance on irrigated agriculture exacerbates the downside economic risk of any decline in aquifer performance and increases the need to manage future growth in groundwater use carefully. In addition, the prevalence of rural residential land use and likelihood of future growth in the areas also creates significant risks to aquifer performance.

Groundwater use

MJA has assessed available data and information and developed estimates of current groundwater use and scenarios of future use. The figure below illustrates the bottom range scenario of groundwater use – increasing from around 5,300 ML per annum currently, up to around 7,000 ML over the next 10 years.

Figure ES1: Bottom range scenario of groundwater use (Berry Springs aquifer) (ML)



Source: MJA estimates.

Even under a low growth scenario that builds upon the lower end of the estimates of current usage, business as usual growth is relatively significant, and if unmanaged, may create risks to the performance of the aquifer with economic and social consequences.

It is important to note that around 60% of the potential growth is in areas that are currently not regulated (i.e. small scale irrigation, pastoral and rural residential irrigation uses). In effect, much of the risk to aquifer condition and performance will come from largely unregulated growth under current policies.

Under a high growth scenario, the *increase* in groundwater use could be as high as 6,000 ML, resulting in a total use of around 14,000 ML. Of the 6,000 ML in growth, around 4,800 ML would be from largely unregulated uses. Under current policy and regulatory arrangements, this growth has the potential to create significant risks to aquifer health and function with few options in terms of management.

Economic and social implications

There are economic and social benefits and costs of further expansion in groundwater use in the BSWAPA. While there is generally very limited data available on many of the values, MJA has assessed some of the potential economic and social implications related to the water allocation plan. While the economic benefits are relatively easy to develop using indicative economic and social values, these benefits need to be weighed against the potential risks associated with further groundwater extraction.

The economic and social benefits of groundwater development

MJA has developed an economic impact assessment model for the irrigation sector in the BSWAPA to assess possible economic impacts (change in gross value of production and employment) associated with changes in groundwater use. The table below summarises key outputs from the economic impact modelling for 2021.

Table ES1: Potential economic impacts of primary industries growth (2021)

Economic indicator	Low growth	High growth
Additional economic activity ($ million p.a.)		
Direct economic activity	7	13
Indirect economic activity	4	7
Total economic activity	11	20
Additional employment (FTEs)		
Direct employment	27	41
Indirect employment	12	20
Total employment	39	61

Source: MJA estimates.

By 2021, total economic activity attributable to the higher levels of horticulture production could be $11-20 million per annum higher than current levels, of which $7-13 million would be focussed in the Litchfield Municipality. MJA estimate that growth in the BSWAPA would account for between 2% and 4% of growth in the Territory's primary industries over the next 10 years.

Growth in irrigated agriculture will also create additional jobs. Our modelling indicates that under a low growth scenario, up to 39 additional full time equivalent (FTE) positions may be created (up to 27 direct and 12 indirect). Under a high growth scenario, up to 61 jobs could be created. Putting the employment growth into perspective, MJA estimate the additional direct jobs created are likely to account for less than 0.5% of total employment in the Litchfield Municipality in 2021.

In summary, while there is likely to be additional economic activity and employment from further development of the groundwater resource in the BSWAPA, this growth is negligible in terms of regional economic activity and employment.

Groundwater development also provides direct personal benefits to rural residential homeowners in the form of the amenity value derived from the ability to create and enjoy a watered garden year-round. This amenity value will be reflected in the values of properties. Discussions with local real estate agents indicate that established gardens often increase

property values by in excess of 10% (typically $50-70,000 based in current market values). This capital value could not be realised without access to reliable water.

The economic and social risks of groundwater development

These benefits of groundwater development need to be weighed up against the risks of potential over-extraction to other sectors and values. While a formal physical risk assessment of alternative scenarios of groundwater extraction is yet to be completed, an indication of potential risks is outlined below.

Primary production

Where the performance of the aquifer declines due to over-allocation, this will have negative impacts on all irrigators utilising that aquifer in the form of lower yields and revenue and higher production costs. MJA conducted a basic threshold analysis of risks to irrigated agriculture and found that declines in horticulture yields attributable to poor aquifer performance of only 5% would more than offset any gains from further horticultural development over the longer term (based on an assessment of revenue to farmers). Commercial viability for irrigators would be impacted at much lower levels of aquifer decline as both revenues would decline and costs would increase (e.g. deepening bores).

Rural residential sector

Declines in the performance of the aquifer will have economic and social impacts on the rural residential sector both for current dwellings and future dwellings. Amenity values will be lost and even temporary disruptions to groundwater availability will trigger rehabilitation costs to landholders and potentially trigger costly investment in water infrastructure to offset declines in groundwater reliability or quality.

Risks to non-consumptive and social values

Section 5.3 of this report outlines a suite of non-consumptive values associated with the maintenance of the Berry Springs aquifer. Over-extraction of groundwater may trigger a number of risks to those values.

While there is insufficient information to quantify many of the other risks to non-consumptive and social values, they are briefly described in the table below.

Table ES2: Potential risks to social values from declining aquifer condition

Social value	Risk to value	Comments
Tourism & recreation	Loss of tourism activity	Major values largely already lost due to decline in water quality Berry Springs. Potentially in the range of $1.2-$4.2 million if the springs are closed to swimming.
Commercial fishing	Loss of breeding habitat condition	Potentially a major issue for an important sector, but relationships between groundwater extraction and fish breeding habitat not well understood.
Aquaculture	Loss of production & market share	Current aquaculture production and market demand is highly reliant on the fact that the production environment is very pristine.
Recreational fishing	Loss of breeding habitat condition	Potentially a significant issue for a major recreational pastime in the Top End, but relationships between

		groundwater extraction and fish breeding habitat not well understood.
Hunting	Loss of habitat	Some habitat may be groundwater dependent ecosystems. Loss of habitat will diminish bag rates and subsequent recreational values.
Nature study, birdwatching & education	Loss of habitat	Some habitat may be groundwater dependent ecosystems. Associated social values will also diminish.
Environmental values	Loss of habitat & ecosystem function	Some ecosystems may be groundwater dependent. Any decline in the extent and condition of these ecosystems will also diminish associated social values.
Indigenous values	Loss of traditional rights, environmental custodianship and cultural connections	Relationships between aquifer condition and these Indigenous values is complex and poorly understood. Any losses in these Indigenous values would be extremely difficult to quantify.

Source: MJA.

While many of risks to non-consumptive uses and broader social values are difficult to measure, they are likely to be significant.

1. Introduction and background

MJA has been engaged to provide independent guidance to water planners and water advisory committees in the BSWAPA on the evaluation of social and economic impacts of future water extraction scenarios. This guidance will be built upon baseline information on current social and economic conditions in the area, and will show how this information can be used in the development of an economically and socially acceptable water resources plan for Berry Springs.

The report is intended to assist in the understanding of trade-offs between competing water planning objectives in the BSWAPA for the development of robust and balanced WAPs consistent with the *NT Water Act 1992* and national commitments such as those under the National Water Initiative (NWI).

1.1 Water planning in the Top End

In the Northern Territory, the context for water planning differs significantly to other jurisdictions. Rainfall, river flows and groundwater recharge in the Top End are highly seasonal. In the Top End, storage yields are poor, as high temperatures and regional geology result in significant losses through evaporation and seepage.

The nature of consumptive water use in the Northern Territory is also very different to water use in southern jurisdictions. Proportionally speaking, very little water is stored in large dams,[1] and groundwater is a much more significant source of water in the north than in southern Australia, accounting for over 90% of freshwater use. Less than 1% of the total water resource in the Territory is used for economic purposes.[2] Indigenous cultural use of water is far more significant than in other jurisdictions. There is enormous potential for future economic growth in the Territory, and associated growth in consumptive water use. Some pressures are beginning to emerge in the BSWAPA. The challenge will be to balance the needs of growth, while maintaining ecological integrity of the ecosystems dependent on the groundwater in the BSWAPA.

Because of the, as yet relatively undeveloped nature of water resources in the Territory, many Northern Territory water plans aim to ensure that systems will be protected from future increases in consumptive use. Recognising that further scientific research is required to develop a full understanding of environmental water requirements in many systems, a precautionary approach to sustainable yield is used in the Territory.

The Northern Territory is developing its water allocation and planning framework in this context. Water allocation plans are being developed under the *Water Act* and include:

- water allocations for towns, agriculture and industry;
- water allocations for the environment, which are designed to protect river and groundwater ecology;
- strategies to achieve water use efficiency, including arrangements for water trading;

[1] For example, the National Water Commission's (2007) *Australian Water Resources 2005* report found that of the Northern Territory's total 2004-05 water resource of 55,784 GL, only 251 GL (less than half a percent of the total) was stored in large dams. By way of comparison, the equivalent figures in south-eastern states were 30% (ACT), 18% (NSW), 20% (Victoria) and 30% (Tasmania).

[2] As reported in ibid.

- information about the reliability of water allocations; and
- monitoring and reporting programs, to report on plan outcomes.

Thus far, three water allocation plans have been declared - the Tindall Limestone Aquifer (Katherine) Water Allocation Plan, the Alice Springs Water Resource Strategy, and the Ti Tree Water Allocation Plan. Seven water allocation plans are under preparation: the Berry Springs Water Allocation Plan, the Howard East Water Allocation Plan, Tindall Limestone Aquifer (Mataranka) Water Allocation Plan, Oolloo Aquifer Water Allocation Plan, Western Davenport Water Allocation Plan, Tiwi Water Resource Strategy, and Great Artesian Basin Water Control District.

An overview of the national policy and planning requirements under the NWI and the regulatory basis for water planning in the Northern Territory is outlined in more detail in Appendix A.

1.2 Purpose of report

The Northern Territory's declared water allocation plans use socio-economic information to:

- construct a baseline 'profile' of communities covered by the plan;
- estimate future consumptive water demand; and
- comment on the economic implications of the estimated future patterns of water use.

In contrast to water plans in other parts of Australia (for example, plans that may be made in the Murray-Darling Basin), Northern Territory water plans anticipate future expansion of consumptive use, relative to the current very low levels of development. Thus, water plans do not consider the socio-economic implications of future cuts to water availability, but focus instead on the impacts of constraints to future growth in water extractions.

For example, the Tindall Limestone Aquifer (Katherine) Water Allocation Plan allocates a percentage of water resources to public benefit outcomes (including Indigenous cultural outcomes), this percentage being 87%, 80% or 70% depending on how wet or dry the conditions are. Chapter 6 of the Tindall (Katherine) Plan considers water demand for current and future consumptive uses. It estimates future urban water demand, drawing on population projections from the Australian Bureau of Statistics (ABS). It allows for future increases in agricultural water use, drawing on consultations with industry and the Katherine Water Advisory Committee. It also estimates future rural stock and domestic use on the basis of population and housing projections, and estimated consumptive demand per household per day.

The Alice Springs water plan draws on socio-economic information and population growth projections when forecasting future consumptive demand. It also estimates future industrial and agricultural use of water, based on land use assessments.

The water plan being developed for the BSWAPA will need to consider similar issues. Berry Springs is a priority area for the development of a WAP because of high levels of water use and expected growth in the region over the next 10 years. Water use is already reaching the limits of sustainable extraction.[3] The Berry Springs WAP will need to:

- Include basic community profiles and other relevant data to describe a 'baseline' for the water plan.

[3] Department of Natural Resources, Environment, the Arts and Sport (NRETAS) (2011), *Berry Springs Aquifer Situation Analysis Report*, 2011.

- Identify and describe drivers of future consumptive demand. These will include projected population change.
- Consider the economic implications of the likely future patterns of water use. This will include assessment of factors such as:
  - Data on consumptive water users, and how much water they use;
  - How water resources are used, and the marginal contribution of those water resources to economic output and employment; and
  - Future economic trends and market outlook of key industries.

Water plans should, among other things, define and describe outcomes (environmental, public benefit, and consumptive) which are to be achieved from the use of water resources, and allocate water between uses so that trade-offs between those outcomes take into account the best available science, social and economic analysis and community input.

In allocating water between uses, water plans need to: (1) identify the different uses to which water will be put, including the water requirements of both consumptive users and non-consumptive uses (i.e. environmental and other public benefit outcomes); (2) place a value on these different uses, so that informed trade-offs between different allocations of water can be made; and (3) define the water requirements (quantities and/or timing) of these uses.

While social and economic data are a key input into this process, it is important to recognise that biophysical data are also important. Water planners need to use both socio-economic and biophysical data to: (1) identify water requirements; and (2) place a value on different uses (human and environmental). They then need to integrate their understanding of water requirements, and the value of different water uses, with a biophysical understanding of environmental watering requirements. Therefore, in establishing the water plan for the BSWAPA, it will be important to also consider the biophysical analysis being prepared by SKM for the BSWAPA.

1.3 Approach to this assessment

Under the NWI the economic and social assessments are intended to assist in the development of water plans by:[4]

- Advising on economic and social impacts of water allocation options as an input to the settling of tradeoffs.
- Identifying ways of mitigating negative impacts including structural adjustment options.
- Providing information to stakeholders.
- Providing an understanding of the cultural context within which planning is taking place in order to identify public benefit outcomes, take relevant values (including Indigenous, social and spiritual) into account, and to minimise conflict.

The water plan being developed for Berry Springs will need to include:

- Profiles – to provide context (cultural, social, economic) as input to understanding potential conflicts and impacts.

[4] Hamstead et al (2008), *Water allocation planning in Australia – Current practices and lessons learned*, Waterlines Occasional Paper No. 6, National Water Commission, April 2008.

- Baselines – to provide baseline of water use (consumptive and non-consumptive) against which changes can be compared as input to settling trade-offs.
- Identify and describe drivers of future consumptive demand. These will include projected population change.
- Consider the economic implications of the likely future patterns of water use. This will include assessment of factors such as:
  - Data on consumptive water users, and how much water they use.
  - How water resources are used, and the contribution of those water resources to economic output and employment.
  - Future economic trends and market outlook of key industries.
  - Impact assessment as a means of understanding trade-offs and options for mitigating impacts. Identifying impacts also allows the identification of users of water and hence enables future pressures to be anticipated. This is important for understanding who has an interest in water planning and hence who should be a party to WAP process (eg fishers, tourism operators), and whose values should be considered to avoid or minimise conflict.

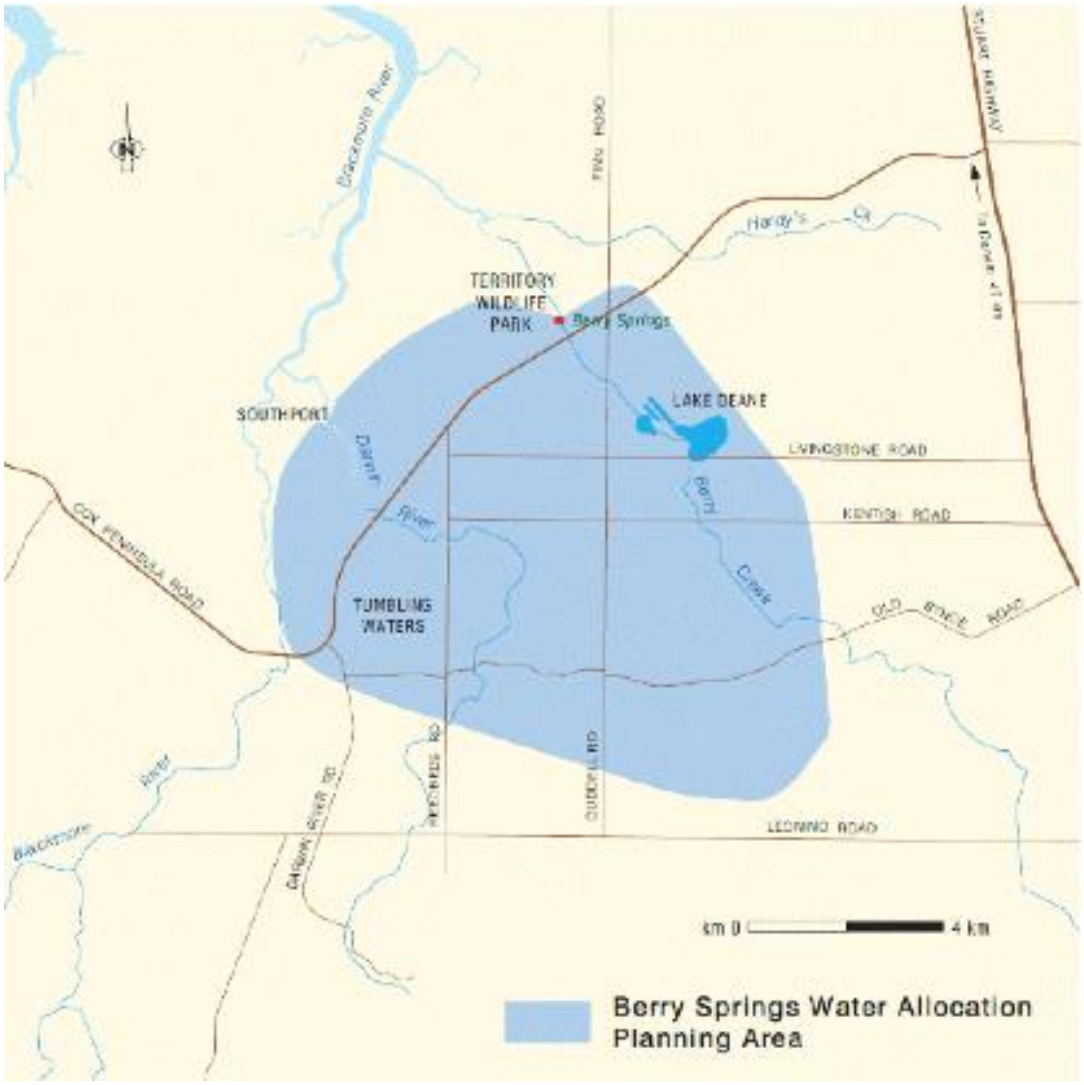
The remainder of this report summarises the findings and recommendations from an application of this approach to the BSWAPA.

2. Overview of the region

The Berry Springs aquifer covers 90km^2 of the Darwin hinterland, lying within the Litchfield Municipality.

The Berry Springs aquifer is an important source of water for irrigated horticulture (e.g. mangoes and Asian vegetables) and rural domestic water supply, as well as a number of important ecosystems.[5] Water thus underpins a variety of economic and environmental values in the BSWAPA (shown in Figure 1).

Figure 1: Berry Springs Water Allocation Plan area



Source: Department of Natural Resources, Environment, the Arts and Sport (NRETAS), Northern Territory Government.[6]

[5] Ref 3.

[6] Ref 3.

2.1 Climate and rainfall

The average annual rainfall in the Berry Springs area is 1,600 mm (measured at Darwin River Dam nearby). 80% of this rainfall occurs between December and March, with little or no rainfall during the dry season from May to October. Temperatures range from 22.8°C to 31°C during the day depending on the season.

2.2 Land use

Conservation and natural areas dominate current land use, accounting for approximately two-thirds of the 8,500 ha in the BSWAPA. Dryland agriculture accounts for a further 11.5% (approximately 975 ha), while irrigated agriculture accounts for approximately 10% of the total area (around 865 ha).[7]

The region has long been recognised for its prospects as a major horticulture production hub in the Territory due to agronomic, market and logistical opportunities to exploit growing tropical fruit and Asian vegetable markets.

Other uses include customary and Indigenous uses, tourism (the Territory Wildlife Park) and recreation (particularly around the actual Berry Springs site). There are also significant areas of environmental importance including Berry Springs, Woodfords Lagoon, and Lake Deans.

[7] Ref 3.

3. Demographic overview

Social and/or economic impact assessment is a process for evaluating and managing the intended and unintended social consequences of changes in water allocations through the prediction of the social and economic impacts that are likely to follow from the introduction of a WAP. These impacts include economic impacts such as on employment, income, or production; and non-economic impacts such as on a way of life, culture, environment, and health and well-being for either individuals or communities.[8]

When developing economic and social assessments, it is vital to develop a base case against which alternative water allocation planning scenarios can be assessed.

This section provides an overview of the population of Berry Springs region in terms of language; employment; income; and education characteristics. These numbers are all based on the ABS 2006 Census of Population and Housing. Estimates for the BSWAPA have been established through a process of concording (matching) data from ABS collection districts (the smallest geographical scale of data availability) with the boundaries of the BSWAPA.

Section 3 of this report concludes with an outline of the demographic implications for water allocation planning. This information will assist with the development of the Plan and ultimately approaches to ensure compliance with the Plan during implementation.

3.1 Population

The current population of the BSWAPA is small, estimated at around 640 persons based on Census data. This represents approximately 3% of the Litchfield Municipality population, and around 0.5% of the Top End population. ABS data indicates that the population of Litchfield Municipality is growing at one of the fastest rates of any area in the Territory.[9] Key population estimates are shown in the table below.

Based on official 2006 Census data, the population is somewhat skewed towards males. This is generally consistent with data across the Territory, although in Berry Springs it is more pronounced.

Table 1: Population – key statistics

Population	BSWAPA	Litchfield	Top End	NT
Estimated residential population – number (end 2011)	640	19-20,000	128,000	225,000
Gender split - percentage (2006 Census data)				
% Male	56.0	54.9	52.0	51.5
% Female	44.0	45.1	48.0	48.5

Source: MJA based on ABS 2006 Census.

Population by age indicates:

- Berry Springs has a much smaller cohort of 20-29 year olds (6.56%) than the Top End (15.6%) and the Northern Territory (16.0%).

8 Larson, Silvia and Kostas Alexandridis (2009), *Socio-economic profiling of tropical rivers*, Tropical Rivers and Coastal Knowledge (TRACK) Report, April 2009.

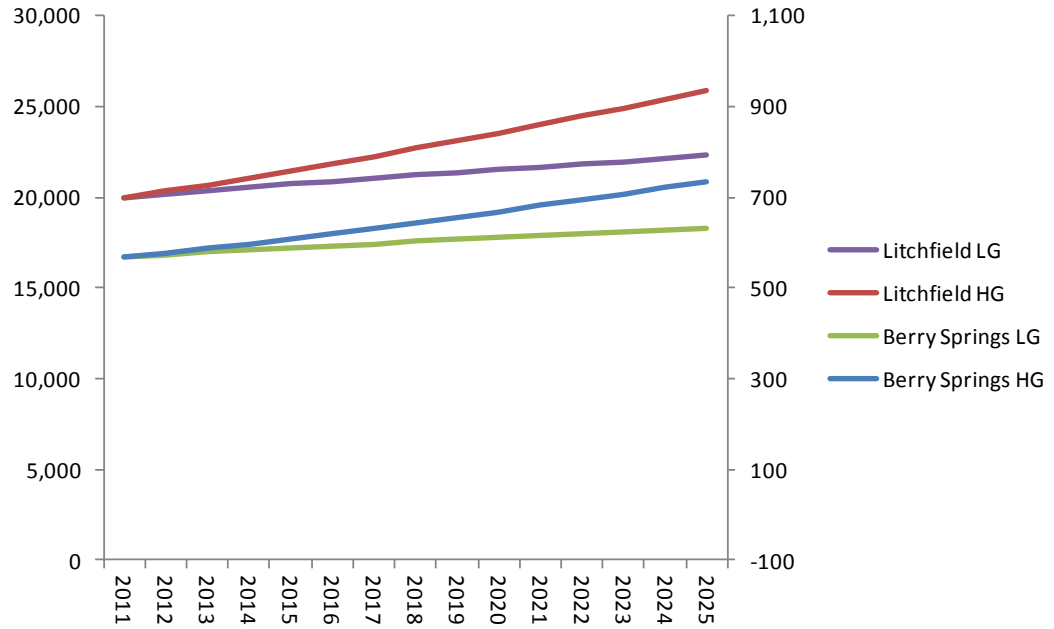
9 ABS (2011), *Category 1362.7 - Regional Statistics, Northern Territory*, Mar 2011.

- The largest age cohort in Berry Springs and Litchfield Shire is 40-49 year olds (20.9%), whereas the largest age cohort in the Top End and Northern Territory as a whole is 30-39 year olds (17.2% and 16.9% respectively).

3.1.1 Population forecasts

Figure 2 below gives population projects for Berry Springs and Litchfield. The 2011 estimates are those provided in Section Table 1. The growth rates have been based on figures in the Northern Territory Population Projections released by NT Treasury. Under the high growth scenario (HG), Berry Springs's population is expected to reach 828 by 2025, while under the low growth scenario (LG) it is only expected to reach 713. Litchfield is estimated to have a population of around 26,000 by 2025 under the high growth scenario, while it is only estimated to have a population of around 22,000 under the low growth scenario.

Figure 2: Population projections for Berry Springs and Litchfield (Litchfield on the left axis and Berry Springs on the right axis)



Source: MJA based on ABS 2006 Census, (growth rates based on Northern Territory Treasury, Northern Territory Population Projections, 2011: Darwin).
Note: Litchfield Low Growth and High Growth scenarios accord to the left axis, Berry Springs Low Growth and High Growth scenarios accord to the right axis.

It should be noted that there are no official Territory Government population estimates or forecasts for the actual Berry Springs area and that population growth would be significantly affected by government policy and decision-making or changes in land market conditions. For example:

- any decision to establish a rural village near the a actual springs during the planning period;
- there are already in excess of 100 blocks in Southport (many "dead mans blocks") that are actively being marketed; and
- a large proportion of the existing rural blocks could be further subdivided within existing planning and land use arrangements.

3.1.2 Indigenous population

There is a high proportion of Indigenous Territorians in the Top End, and Indigenous people have a particular affiliation with waterways and the environment that relies on the condition of groundwater. The table below summarises key Census data relating to the Indigenous population.

Key points to note are:

- The proportion of Aboriginal persons in Berry Springs (4. 7%) is lower than for the Northern Territory as a whole (26.8%).
- A higher percentage of people in Berry Springs reported being Non-Indigenous (71.6%) than in the Northern Territory (63.6%).

Table 2: Population by Indigenous Status (2006)

Indigenous Status	BSWAPA		Litchfield		Top End		Northern Territory	
	No.	%	No.	%	No.	%	No.	%
Non-Indigenous	406	71.6	12,813	82.4	85,246	80.4	122,733	63.6
Aboriginal	27	4.7	815	5.2	8,946	8.4	51,703	26.8
Torres Strait Islander	5	0.8	62	0.4	440	0.4	615	0.3
Both Aboriginal and Torres Strait Islander	0	0.0	64	0.4	875	0.8	1,347	0.7
Not stated	130	23.0	1,800	11.6	10,485	9.9	16,501	8.6
Total	568	100.0	15,554	100.0	105,992	100.0	192,899	100.0

Source: ABS 2006 Census.

3.2 Education and language

Education levels and language skills are also important to water allocation planning. Generally, education levels are an indicator of human capital and the ability to adapt to changing economic and social circumstances (e.g. through retraining and switching between sectors). Similarly, limited English language skills can also constrain an individual's ability to adapt to changing economic conditions.

In addition, lower levels of education attainment or English speaking skills can inhibit an individual's ability to engage in the water allocation planning process. They may also create a risk to long-term compliance with requirements under water allocation plans where individuals are unable to understand their rights and responsibilities under the Plan.

3.2.1 Education

Table 3 below outlines data on the highest level of schooling attained. Key points to note from the data are:

- Generally, the populations of both BSWAPA and Litchfield have attained a lower level of schooling than the overall population of the Top End.
- A smaller proportion of Berry Springs' residents completed Year 12 (17.7%) than in either the Top End (31.2%) or the Northern Territory as a whole (25.2%).

- A higher proportion of Berry Springs' residents completed Year 10 (18.3%), than for the Top End (16.0%) and the Northern Territory as a whole (14.9%).

Table 3: Highest Level of Schooling

Highest Level of Schooling	BSWAPA		Litchfield		Top End		Northern Territory	
	No.	%	No.	%	No.	%	No.	%
Year 12 or equivalent	93	17.7	3,809	24.5	33,040	31.2	48,601	25.2
Year 11 or equivalent	51	9.6	1,884	12.1	11,729	11.1	18,355	9.5
Year 10 or equivalent	96	18.3	3,127	20.1	16,983	16.0	28,653	14.9
Year 9 or equivalent	36	6.8	832	5.4	4,516	4.3	10,041	5.2
Year 8 or below	29	5.4	582	3.7	3,744	3.5	15,267	7.9
Did not go to school	4	0.7	52	0.3	662	0.6	3,161	1.6
Not stated	92	17.4	1,728	11.1	11,401	10.8	21,217	11.0
Not applicable	127	24.2	3,540	22.8	23,917	22.6	47,604	24.7
Total	527	100.0	15,554	100.0	105,992	100.0	192,899	100.0

Source: ABS 2006 Census.

Table 4 outlines data for non-school education qualifications. Key points to note include:

- The BSWAPA has lower levels of education qualifications than the Top End in both trade qualifications and formal university educations.
- 4.6% of residents from Berry Springs reported having a Bachelor Degree, compared to 8.3% in the Top End and 6.7% in the Northern Territory as a whole.
- In Berry Springs 13.5% of residents reported having a Certificate level non-school qualification, compared to 13.0% in the Northern Territory as a whole.

Table 4: Non-school Qualification

Non-school Qualification

	BSWAPA		Litchfield		Top End		Northern Territory	
	No.	%	No.	%	No.	%	No.	%
Level of education not stated	97	18.3	1,910	12.3	12,425	11.7	23,162	12.0
Level of education inadequately described	4	0.8	177	1.1	1,110	1.1	1,739	0.9
Postgraduate Degree Level	6	1.1	139	0.9	2,021	1.9	2,872	1.5
Graduate Diploma and Graduate Certificate Level	4	0.7	148	1.0	1,451	1.4	2,195	1.1
Bachelor Degree Level	24	4.6	822	5.3	8,745	8.3	12,907	6.7
Advanced Diploma and Diploma Level	18	3.4	752	4.8	5,669	5.4	8,476	4.4
Certificate Level	71	13.5	2,770	17.8	15,909	15.0	25,022	13.0
Not applicable	303	57.6	8,836	56.8	58,662	55.4	116,526	60.4
Total	526	100.0	15,554	100.0	105,992	100.0	192,899	100.0

Source: ABS 2006 Census.

3.2.2 Language

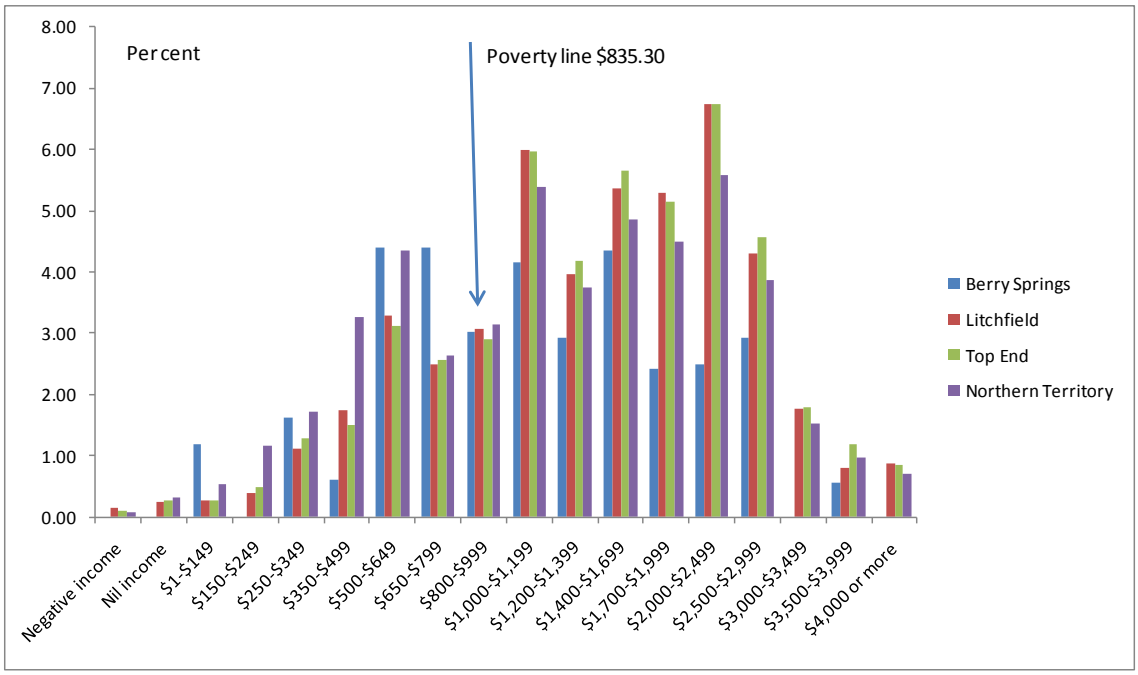
Analysis of Census data also indicates that the population of BSWAPA has a different English language capacity than the Territory as a whole. Specifically:

- A lower proportion of people in Berry Springs reported that they speak English "very well" (3.2%) than in either the Top End (7.2%) or in the Northern Territory as a whole (10.4%).
- However a large percentage of people in Berry Springs (21.6%) did not state their proficiency in spoken English (10.1% not stated in Northern Territory as a whole).
- A larger proportion of people in Berry Springs (71.9%) reported speaking Northern European Languages at home than for the Northern Territory as a whole (66.6%).
- A larger proportion of people in Berry Springs (4.0%) speak Southeast Asian Languages than in Litchfield (2.2%) the Top End (3.3%) and the Northern Territory (2.1%).

3.3 Incomes

Incomes are also an indicator of the resilience of individuals and communities to cope with policy shocks, particularly when the policy may impact directly on incomes received. The figure below outlines key incomes data for the BSWAPA and other relevant regions for comparative purposes.

Figure 3: Family Income Profiles (weekly income)



Source: MJA based on ABS 2006 Census, Poverty Line from the Melbourne Institute Poverty Lines: March Quarter 2011 edition (poverty line of $835.30 weekly income for a couple with two children).

Key points to note are that:

- Income distribution in Berry Springs is generally lower than for the Top End and the NT as a whole.
- The Melbourne Institute estimated the weekly poverty line for a family (a couple with two children) to be $835.30 (including housing). The proportion of households in the BSWAPA

area at or below the poverty line (around 15%) is greater than in the Top End (12-13%), but lower than the Territory as a whole (around 17%).

- While it is impossible to determine economic vulnerability of those impacted by water planning from the data, anecdotal information from the consultation phase of this project has indicated that many of the horticulturalists may be at the lower end of the income spectrum. This is consistent with studies conducted elsewhere in Australia.

3.4 Demographic implications for water allocation planning

Analysis of the demographic data indicates a number of potential implications for the development of the BSWAPA, specifically:

- **Risks from rural residential population and population growth.** Expected population growth will largely be in rural residential areas. Based on the current understanding of water use by the rural residential sector, and the likely location of future development, population growth and associated groundwater use creates a material risk to aquifer health if this increase in demand is not properly managed.
- **Indigenous population may require broad consultation.** While the Indigenous population living in the BSWAPA is relatively small, many Traditional Owners will live outside the Plan area. Efforts may be required to ensure relevant Indigenous stakeholders have an appropriate opportunity to participate in the planning process.
- **Education and language differences create difficulties for planning and compliance.** Education and English language capacities in the BSWAPA have implications for water allocation planning. Targeted and carefully crafted consultation will be required during the development of the HEWAP, particularly for horticulturalists where there is significant anecdotal evidence to suggest that English is a second language for many of them. Furthermore, the implementation stage of the Plan will require targeted and 'language specific' communications to underpin any compliance regime. There will be a need to ensure consultation and compliance approaches are not overly bureaucratic (including language used).

4. Economic overview

This Section provides an economic overview of the BSWAPA and the Litchfield areas. Information in the Section is drawn from a number of official ABS, NT Government, and industry sources. That data has been augmented by qualitative information gathered during the consultation phase of the project.

A note on small economies

Economic analysis of small economies such as the BSWAPA is complicated by a number of factors that limit the extent to which quantitative economic analysis is possible; including:

- Very rarely is economic data actually available at the small scale required.
- What data does exist tends to be gross values of production, or turnover. While this is an indicator of economic activity, it is not a measure of net economic benefits from economic activity.
- Areas such as the BSWAPA tend to be very import and export orientated. Most of what is consumed is imported, while much of what is produced is exported, limiting the degree of economic value adding in the actual region.
- Often only a small proportion of economic activity and economic values are directly relevant to water allocation planning, particularly as much of the economic values associated with waterway health have no direct economic value (i.e. their value is not reflected in the prices of goods and services traded).

4.1 Structure - businesses

Data specific to the BSWAPA is not available from any source and the smallest scale of economic data availability is the Local Government Area (LGA) – i.e. the Litchfield Municipality. MJA has analysed available business registration data that provides insight into the structure of the local economy. Table 5 indicates the percentage of total business registrations by industry. The key points to note are that the structure of the Litchfield economy is significantly different to the Top End economy in a number of ways, specifically:

- **The importance of agriculture.** In Litchfield 20% of registered businesses are in agriculture - three times the level of the Top End as a whole. In addition, the makeup of the wholesale and retail trade sector (e.g. around Coolalinga) is also heavily skewed towards servicing the agriculture sector, indicating the flow-on impacts of changes in agricultural activity attributable to the water allocation plan could be significant at the local level.
- **Construction.** There is also a relatively high proportion of businesses in the construction industry reflecting the geographical and land use availability advantages of the region and the broader demographic makeup of the region (high proportion of tradespeople).
- **Fewer business services.** Business services (finance, insurance, property, other business services) account for 16% of businesses in Litchfield, compared to 30% in the Top End. This is largely due to the close proximity of Litchfield to Darwin. Essentially, many of the business services required in Litchfield can be provided out of Darwin.

In summary, the local economy in Litchfield is heavily skewed to agriculture and the availability of water (quantity, reliability, quality) and maintaining the condition of the Berry Springs aquifer is vital to the future of the most significant industry in the region.

Table 5: Business registrations by industry

Industry	Litchfield %	Top End %
Agriculture, forestry and fishing	20	7
Mining	1	1
Manufacturing	6	5
Electricity, gas and water supply	0	0
Construction	29	23
Wholesale trade	3	3
Retail trade	10	11
Accommodation, cafes and restaurants	2	3
Transport and storage	6	6
Communication services	1	1
Finance and insurance	2	5
Property and business services	14	25
Education	1	1
Health and community services	2	4
Cultural and recreational services	1	2
Personal and other services	4	3
Total businesses	100	100

Source: MJA based on online ABS National Regional Profile data (2007 data (latest available)).

Table 6 shows the count of businesses by size categories for Litchfield and the Top End. Key points to note are that:

- There are approximately 1,600 registered businesses in Litchfield, or approximately 18% of the total number of registered business in the Top End.
- Litchfield has a significantly higher percentage of businesses that do not directly employ individuals, or have less than five staff (89%) when compared to the Top End (84%). This is typical of areas dominated by regional and rural activities.

Table 6: Business structures by size

	Litchfield		Top End	
	Number	%	Number	%
Non-employing businesses	1,119	70	5,472	62
Employing businesses (1 to 4 employees)	300	19	1,905	22
Employing businesses (5 or more employees)	177	11	1,443	16
Total businesses	1,596	100	8,820	100

Source: MJA based on online ABS National Regional Profile data (2007 data (latest available)).

4.2 Structure - employment

An analysis of Census employment data in the region provides further insight into the structure of the economy. **The key point to note from the employment data is that employment in primary industries in the BSWAPA is almost seven and a half times more important than in the Top End (5.1% compared to 0.7%). Furthermore, there will be a significant number of people from Litchfield who are employed directly and indirectly in primary industries that do not actually reside within the BSWAPA.**

Table 7: Employment by Industry to the 1st Digit

Employment by industry (1st digit)	Berry Springs		Litchfield		Top End		Northern Territory	
	No.	%	No.	%	No.	%	No.	%
Not stated	2	0.3	99	0.6	651	0.6	1,725	0.9
Not applicable	350	61.7	7,576	48.7	51,752	48.8	105,719	54.8
Agriculture, Forestry and Fishing	29	5.1	395	2.5	722	0.7	2,093	1.1
Mining	9	1.5	220	1.4	846	0.8	1,710	0.9
Manufacturing	14	2.5	459	3.0	2,597	2.5	3,918	2.0
Electricity, Gas, Water and Waste Services	5	0.9	80	0.5	357	0.3	518	0.3
Construction	27	4.8	932	6.0	4,237	4.0	6,097	3.2
Wholesale Trade	6	1.1	270	1.7	1,678	1.6	2,143	1.1
Retail Trade	15	2.6	697	4.5	5,243	5.0	7,898	4.1
Accommodation and Food Services	10	1.8	278	1.8	3,237	3.1	5,643	2.9
Transport, Postal and Warehousing	18	3.1	458	2.9	2,861	2.7	3,987	2.1
Information Media and Telecommunications	2	0.3	99	0.6	909	0.9	1,221	0.6
Financial and Insurance Services	2	0.4	98	0.6	1,061	1.0	1,367	0.7
Rental, Hiring and Real Estate Services	4	0.6	106	0.7	983	0.9	1,289	0.7
Professional, Scientific and Technical Services	8	1.4	357	2.3	2,871	2.7	3,981	2.1
Administrative and Support Services	6	1.1	218	1.4	1,653	1.6	2,629	1.4
Public Administration and Safety	18	3.1	1,590	10.2	11,474	10.8	18,835	9.8
Education and Training	19	3.3	591	3.8	4,581	4.3	7,537	3.9
Health Care and Social Assistance	9	1.5	435	2.8	4,451	4.2	8,583	4.5
Arts and Recreation Services	3	0.6	121	0.8	1,171	1.1	1,779	0.9
Other Services	12	2.1	349	2.2	2,049	1.9	3,135	1.6
Inadequately described	2	0.4	126	0.8	608	0.6	1,092	0.6
Total	567	100.0	15,554	100.0	105,992	100.0	192,899	100.0

Source: ABS 2006 Census.

The prominence of agricultural employment is consistent with business registration data, which also indicates the regional importance of agriculture to the local economy.

Table 8: Detailed agricultural employment

Agricultural employment to the 4th digit	Berry Springs		Litchfield		Top End		NT	
	No.	%	No.	%	No.	%	No.	%
Agriculture, nfd	0	0.0	24	6.1	40	5.5	92	4.4
Nursery Production (Outdoors)	0	0.0	13	3.3	21	2.9	28	1.3
Floriculture Production (Under Cover)	1	2.8	4	1.0	3	0.4	5	0.2
Floriculture Production (Outdoors)	1	2.8	21	5.3	25	3.5	26	1.2
Vegetable Growing (Outdoors)	8	27.6	59	14.9	66	9.1	97	4.6
Fruit and Tree Nut Growing, nfd	1	2.8	18	4.6	19	2.6	30	1.4
Other Fruit and Tree Nut Growing	10	35.7	111	28.1	135	18.7	176	8.4
Beef Cattle Farming (Specialised)	4	12.4	22	5.6	36	5.0	1,060	50.7
Other Livestock Farming, nec	2	5.3	23	5.8	38	5.3	38	1.8
Aquaculture, nfd	0	0.0	10	2.5	15	2.1	14	0.7
Onshore Aquaculture	2	5.3	6	1.5	23	3.2	24	1.2
Fishing, Hunting and Trapping, nfd	0	0.0	12	3.0	42	5.8	52	2.5
Other Fishing	0	0.0	18	4.6	105	14.5	129	6.2
Other Agriculture and Fishing Support Services	2	5.3	18	4.6	26	3.6	77	3.7
Agriculture, Forestry and Fishing, nfd	0	0.0	4	1.0	11	1.5	14	0.7
Other	0	0.0	32	8.1	113	15.7	210	10.0
Total	28	100.0	395	100.0	722	100.0	2,093	100.0

Source: ABS 2006 Census.

4.2.1 Employment in primary industries

Given the relative importance of primary industries to the region, further analysis of the employment in the sector is warranted to determine the linkages between employment and agricultural water use. Table 8 shows agricultural employment data by sub-sector.

The key point to note from the data is that approximately 20 full time jobs are in sectors reliant on irrigation (shaded in the table). This is approximately two-thirds of all employment in primary industries. Furthermore, these estimates of employment are likely to be underestimates as many people who work in irrigated agriculture do not actually reside in the BSWAPA.

4.3 Irrigated agriculture

Official statistics for agricultural production are not available for the BSWAPA region. Industry consultation indicated that reliable industry statistics are needed to underpin investment, and the lack of such data is a major impediment to sound policy and planning.

Consultation with industry indicated that the proportion of Litchfield's horticulture production within the BSWAPA is probably about 50%. Furthermore, ABS historical data from 2006-07 indicates the Litchfield LGA accounts for approximately 55% of the Territory's fruit crops and 95% of vegetable crops.[10] Overall, the BSWAPA may account for up to 7% of the Territory's relevant fruit crops and around 13% of vegetable crops.

Using the above calculation to allocate production, it is possible to develop high-level estimates of the value of production in the BSWAPA and make comparisons with other relevant regions based in Territory-wide figures.[11] Table 9 shows MJA's estimates of the value of irrigated agriculture in the BSWAPA.

Table 9: Estimated value of irrigated agriculture 2011 ($ millions)

Industry	BSWAPA	Litchfield (balance)	Top End (excluding Litchfield)	NT
Fruit	14	42	37	103
Vegetables	7	19	1	26
Irrigated agriculture	20	62	38	129

Source: MJA based on ABS and NT Department of Resources data.

The data shows that the value of irrigated agriculture in the BSWAPA is regionally significant and is a major contributor to the horticulture sector in the Territory.

There have been some significant changes in the structure of the horticulture industry over the last decade however, both in terms of the varieties grown and in terms of the nature of the industry organisation.

[10] Ref 9.

[11] Territory-wide figures were sourced from: Department of Resources (2011), *Northern Territory Primary Industry and Fisheries Overview and Outlook 2010*, Northern Territory Government.

4.3.1 Key crops

Mangoes

Mangoes are the dominant irrigated crop in the region. The traditional variety of mango grown in the Berry Springs region is the Kensington Pride. These are low productivity crops averaging 10 tonnes per hectare (ha). They are typically grown by growers on small blocks and sold to independent wholesalers.

In contrast, new varieties of mango – especially Calypso, but also other varieties such as Honey Gold and Mambula – are being produced through vertically integrated operations. For example, One Harvest manages the production of mangoes from the growing through the packaging and distribution to southern markets. Productivity is three times that of Kensington Pride at 35 tonnes per ha, and the time between planting and first harvest is three years compared to seven years. The single marketing desk arrangement also allows growers more control over price and quality. Calypso now supplies 15% of the mango market.

Industry sources indicated during consultation that mango production has increased significantly over the last 10 years and is expected to grow gradually in the short to medium term as key markets grow and new mango varieties impact on the composition of fruit consumption.

However, it should also be noted that there are currently a significant number of established mango trees in the region that are currently not being irrigated and are not being utilised for commercial production due to a number of reasons (including inferior quality product). Where market demand increases for these mangos, commercial production from the BSWAPA could increase rapidly.

Asian vegetables

Asian vegetables are also a regionally significant crop. They are mostly grown on small blocks of 20 ha or less, and often grown by first generation Asian immigrants. They are the fastest growing horticultural sector in the Territory. Many growers bypass traditional marketing channels and sell direct to wholesale markets. There are also a number of larger designated horticulture blocks in the BSWAPA which would allow for greater commercial scale production in the future as market demand expands.

4.4 The pastoral industry

There is a currently on a relatively modest pastoral industry in the BSWAPA. Stocking rates vary with climatic and market conditions, such that pastoralists water entitlements under water allocation plans need to be flexible. However, large cattle (i.e. >350 kg) can have a daily watering requirement of around 40 litres.[12] Total annual watering requirements for cattle are relatively low compared to other uses and most producers use surface water sources. However, cattle producers do have a right to access water from the aquifer under current arrangements.

[12] NTG (2006) *Feeding Livestock in Temporary Holding Facilities in the Northern Territory Part 1: Cattle.*

4.5 Aquaculture

There is also one of the Territory's largest aquaculture ventures that is reliant on water from the BSWAPA – Tropical Australia Algae Utilize (TAAU). TAAU own and operate a $7 million operation that grows an algae product (spirulina) that is harvested, dried, packaged and sold as a dietary supplement. The award winning TAAU operations require ideal and pristine growing conditions and any decline in the quality of water from ideal conditions would both risk market access and production.[13]

4.6 Local growth prospects – water dependent sectors

There are two key sectors that have a major implication on water use in the BSWAPA that also have significant growth prospects in the medium to linger term – horticulture and residential development.

4.6.1 Horticulture

Horticulture in the BSWAPA is a significant regional industry and employer within the broader Litchfield Municipality. While the emphasis of the horticulture industry is on the fresh market and growth in that market constrains feasible development on the BSWAPA, the area has distinct locational, logistical and counter-seasonal advantages over many other areas with horticultural prospects. In addition, larger blocks in the area are more suitable to commercial-scale developments in the future.

In short the prospects for further horticultural development are relatively positive and this will have a significant impact on groundwater use.

4.6.2 Residential development

ABS data indicates that residential building approvals for new properties in Litchfield Municipality, typically exceed 120 new dwellings per year[14] and there is no evidence to suggest this trend will slow unless significant constraints on land availability are imposed. Many of these new dwellings will be rural living and rural residential. For example, the mooted rural village close to the actual Berry Springs site. Under the Land Use Plan for rural villages, a major component of new dwellings will be rural living and rural residential lots that currently have no material restrictions on groundwater use.[15] However, ultimately, the rural residential lots proposed (all under 1 ha) will be connected to Power and Water Corporation (PWC) reticulated services. In addition, further development of blocks in Southport and from building on undeveloped rural living and rural blocks is also likely to drive growth in groundwater use.

Given the emphasis of rural residential allotments within the growth strategy and the locational advantages Berry Springs has over other proposed rural residential villages (i.e. relatively close to Darwin), market demand is likely to drive rapid uptake of land available in the area and hence rapid growth in groundwater use.

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13 See www.taau.com.au/index.html

14 ABS (several years), *Category 1362.7 - Regional Statistics, Northern Territory.*

15 NTG (2011), *Greater Darwin Region Land Use Plan - Towards 2030.*

Unless carefully managed, water use from growth of rural residential development has the potential to place significant additional pressures on groundwater resources in development hotspots.

4.7 Economic structure implications for water allocation planning

The economic structure and growth prospects for the BSWAPA present a number of implications for water allocation planning, specifically:

- **Structure of economy increases relative economic risks of aquifer deterioration or failure.** The structure of the local economy is significantly skewed towards a reliance on agriculture, particularly irrigated agriculture. Therefore, even marginal declines in the performance of the aquifer (water quantity and quality) could have significant impacts on regional productivity and the commercial viability of existing irrigators.
- **Growth of irrigated agriculture needs to be managed.** There is evidence to suggest the performance of the aquifer in some areas is already declining. This risk will only be further exacerbated by further growth in the irrigated agriculture sector unless growth in use is carefully monitored and managed.
- **Risks from rural residential growth.** Current groundwater use by rural residential lots is effectively unmanaged. Significant growth in demand from rural residential developments in the medium-term should be expected and this growth will have to be taken into account in the development of the BSWAP.

5. Economic and social values

This section outlines some of the key economic and social values that may be impacted by the water allocation planning process.

5.1 Framework for considering economic and social values

Resource economists often use the concept of total economic value (TEV) as a means of categorising and (sometimes) aggregating values attributable to natural resources (e.g., water).[16]

Figure 4: Total economic values of Berry Springs aquifer

		Total economic value framework									
		Consumptive use values	Indirect use values	Option Value	Non-consumptive use values				Non-use values		
					Recreational	Aesthetic	Educational	Distant use	Existence	Bequest	Philanthropic
Primary industries	Irrigation	✓		✓							
	Farm use	✓		✓							
	Stock water	✓		✓							
Recreation	Primary recreation			✓	✓						
	Secondary recreation	✓		✓	✓						
	Visual appreciation		✓	✓		✓		✓			
Human consumption		✓		✓							
Industrial and mining use		✓		✓							
Cultural and spiritual use		✓	✓			✓	✓	✓	✓	✓	✓
Aquatic ecosystems		✓	✓	✓			✓	✓	✓	✓	✓

Source: MJA based on Greiner, R & Hall, N (2006) Social, Economic, Cultural and Environmental Values of Streams and Wetlands in the Burdekin Dry Tropics Region.

There are a number of different types of values that comprise TEV. These include:

- Direct consumptive use values. These values relate to the use of natural resources as a factor of production or direct consumption. This includes values attributable to irrigation and human consumption.
- Indirect use values. These values relate to uses that are indirect in nature, such as visual appreciation of waters for recreation or to underpin tourism.

[16] Freeman, A. M. (1993), *The Measurement of Environmental and Resource Values: Theory and Methods.*

- Option values. These values relate to the preservation of options to either use or preserve a natural resource in the future, such as not allocating water for consumptive use to maintain the option to ensure more water for environmental flows in future.
- Non-consumptive use values. These values relate to the use of a natural resource where the quantity or quality of the resource does not decline with use, such as swimming or kayaking in waters.
- Non-use values. These values represent preservation of natural resources for their own sake, even if the resource will never be consumed. Typically, these values relate to values such as the protection of ecosystem functions or cultural values.

Figure 4 above outlines the relationship between different types of use and the TEV framework. The figure indicates that many of the uses relate to multiple types of economic values.

There is a distinct lack of data and information to enable estimation of most of these values for the BSWAPA. For example, there are no estimates available for cultural and spiritual values attributable to maintaining aquifer condition and function.

5.1.1 Estimating values under a TEV framework

While some economic and social values are revealed through market prices (e.g., the margin from the use of an extra ML of irrigation water), not all are revealed through market transactions (for example, the value of maintaining the extent and condition of groundwater dependent ecosystems). There are a number of valuation approaches that can be used as part of a TEV framework (outlined in Table 10 below). Which approach is finally adopted will be dependent on the priority natural assets and ecosystem services to be valued, and the risks to those assets.

Table 10: Approaches to estimating socio-economic values

Method	Relevant values	Useful for…
Market techniques		
Market values	Based on market transactions	Situations where there are established markets such as irrigated agriculture
Productivity - based	Based on production of commercially marketed goods	Estimating changes in natural asset condition to key sectors such as nature-based tourism and recreation
Replacement / avoided cost	Based on costs of replacing, or value of avoiding costs	Value of water quality attributable to catchment management
Non-market techniques		
Travel cost	Based on cost to visit a site	Valuing reserves and visits to Berry Springs Reserve
Hedonic pricing	Values attributes	Value of a view, local green space
Choice modelling	Community willingness to pay to protect asset or avoid loss	Value of biodiversity and ecosystem function

Source: MJA.

Previously MJA has tended towards using multiple approaches within the same study (depending on the asset/ecosystem service, data constraints, time and financial resource constraints), for example:

- Productivity based approaches (often impacts on headline indicators of economic activity) for impacts on sectors such as tourism.

- Averted cost approaches for relationships between catchment condition, pollutant loads and water treatment or risk to human health from exposure to lower water quality.
- Choice modelling to value ecosystem functions and to obtain global estimates of changes to the extent of ecosystem assets/functions (e.g. native vegetation).

The remainder of this section outlines key economic and social values relevant to the BSWAPA. Consistent with the TEV framework, this has been structured based on consumptive and non-consumptive values. Quantitative data is used wherever possible, although it should be noted that this is limited for the BSWAPA.

5.2 Consumptive values

The greatest consumptive demand for water from the Berry Springs aquifer is for irrigated horticulture and public water supply. A variety of crops are irrigated including mangoes, bananas, and annual vegetables. Water from the Berry Springs aquifer is also used for stock and domestic purposes.

5.2.1 Irrigated horticulture

A large share of the NT's horticulture and Asian vegetables industry is based in the BSWAPA.

The economic value of horticultural production in the BSWAPA (at around $20 million) is clearly outlined in Section 4.3. This production, which is entirely dependent on the availability of reliable and good quality groundwater, generates approximately 100 FTE jobs (based on Census data). **In effect, one job is created for every $400,000 increase in horticulture production.**

There are a number of crops grown in Berry Springs, and the water demand and pattern of usage for each crop varies.

- Mangoes are the most significant crop grown in the BSWAPA. With new plantings, trees must be irrigated throughout the year for the first two years. After the second wet season trees are generally only irrigated during the flowering and fruit development period; the five month period between July and November in the dry season. The main variety grown is Kensington Pride, which tend to have a lower yield per tree compared to newer varieties. Calypso's require more water, at between 5 and 8 ML/ha, but are more densely planted, yielding 35-40 tonnes/ha compared with 10 tonnes/ha for Kensington Prides.[17]
- Other fruits than can be grown in the region include melons, bananas, paw, paw, grapefruit, jackfruit and rambutan.
- Asian vegetable production has also been increasing sharply in recent years. For example, cucumbers are a major vegetable crop of the Top End, because of greater water availability than in the southern states. Asian vegetables generally use between 5 and 8 ML/ha – but only 1-2 ML is used in the growing of the crop. The rest is used in the packing sheds to wash the vegetables before shipment to market.
- Cut flowers are currently a minor industry but require approximately 10 ML/ha.

[17] Diczbalis, Y., Wicks, C. and Owens, G. (2006), *Mango Irrigation Management Guidelines.* http://www.nt.gov.au/d/Content/File/p/Fruit/587.pdfnb

Annual vegetable and melon crops are particularly high users of water. Perennial tree crops tend to require less water and management than annual crops. However, perennial crops require high reliability in water supply to avoid large economic losses attributable to tree losses. Some tree crops (mango and cashew) require little or no water during non-flowering and non-fruiting growth periods; whereas, fruit trees (e.g. carambola, mangosteen, jackfruit and banana) require continuous irrigation throughout the year.

5.2.2 Rural residential uses

There is a public right to take water for domestic and stock purposes. In the Darwin rural area this is groundwater extracted from private bores for personal use and the irrigation of approximately 0.5 ha of garden and the watering of stock.[18]

Significant development in the area – both rural subdivision and urban growth in Darwin and Palmerston - has also led to substantial increase in the number of domestic water supply bores.[19]

Subdivision of rural blocks and new land releases as a result of the population growth in Darwin and Palmerston, have contributed to significant growth in the sinking of new bores in the rural area for stock and domestic purposes.

An estimate of the rural domestic rate of use is approximately 7 ML annually for each bore. This estimate is based on a 'return to sewer' of 380 litres/day/person for a family of four and the irrigation of 0.5 ha of garden at a rate of 50 mm per week for six months out of 12.[20] However, this rate is significantly higher than the results of bore monitoring undertaken by NRETAS, which indicates usage of less than 3 ML per bore. The NRETAS estimates are likely to be more reliable.

The combination of initial connection costs to reticulated water systems, and the ongoing cost of water, creates little incentive for rural residents to convert to town water supply and relinquish their bore. The Litchfield Planning Concepts and Land Use Objectives state that to minimise impacts on both the amenity of existing rural living areas and the environment, rural lots less than 2 ha should be connected with both reticulated water and sewerage as well as other waste disposal.[21] Currently, the cost of connection to sewerage is prohibitive and Alternative Septic Systems (individual tertiary treated systems) are the preferred option (PWC). The new rural residential developments are to be connected to Darwin's reticulated water supply system and are charged for the use of water.

Economic value to households

While rural residential residents do not pay for the actual groundwater resources used, they do pay for the cost of extraction, with capital costs of between $12,000 and $20,000 in addition to the operating costs of bores.[22] The use of the groundwater provides significant direct personal benefits to homeowners in the form of the amenity value derived from the ability to create and enjoy a watered garden year-round, with options for extensive use of lawns and exotic plant

18 *Water Act 1992* (NT).

19 Woodward, E, S. Jackson and A Straton (2008), *Water Resources of the Howard River region, Northern Territory: A report on the social and cultural values and a stakeholder assessment of water use scenarios, CSIRO Sustainable Ecosystems.*

20 Ibid.

21 NTG (2002), *Litchfield Planning Concepts and Land Use Objectives.*

22 Nolan, S (2010), *Collaborative Water Planning: Howard East Water Planning Project.*

species. The value to the landholder from this is must be at least equal to the cost of groundwater extraction or they would not incur the capital and operating costs associated with bores.

This amenity value will also be reflected in the values of properties. Discussions with local real estate agents indicate that established gardens often increase property values by in excess of 10% (typically $50-70,000 based in current market values). This capital value could not be realised without access to reliable water, and easily outweighs the costs of sinking a bore.

Using an avoided cost methodology it is possible to infer an approximate value of water for rural residential uses. If you assume that a loss of groundwater would be permanent and the value of impacted rural residential properties would decline by $50-70,000, then the value of *permanent* access to each ML of water is approximately $7,100-10,000 (based on average usage of 7ML per property). An equivalent annual economic margin per ML is between $350 and $500 (assuming a 5% discount rate).

The key point to note is that consumptive groundwater use by the rural residential sector has a significant amenity value to households and that value is reflected in house prices.

5.3 Non-consumptive values

As discussed above under Section 5.1.1, there are a number of methodologies for assessing the values placed on non-consumptive water uses by the community. These values include economic values such as those of the fishing and tourism industries and recreational users, as well as non-economic values such as ecological values, ecosystem services, biodiversity, and cultural and Indigenous values. Below is a description of the key non-consumptive values associated with the Berry Springs aquifer.

5.3.1 Tourism and recreation at Berry Springs Nature Reserve

The Territory Wildlife Park (TWP) owned and operated by the Territory Government is one of the Top End's major tourism drawcards, attracting approximately 70,000 visitors a year and has an annual revenue of $5.2 million per annum (including a community service obligation payment from NT Treasury).[23] The TWP is partially reliant on the performance of the aquifer to maintain the natural assets that underpin much of the TWP experience.[24]

In addition to the TWP, the Berry Springs Nature Park provides possibly the most significant recreation spot for freshwater swimming in the greater Darwin region. Current annual visitation exceeds 140,000 persons.[25] Studies undertaken elsewhere, although for other sites and undertaken several years ago, using the travel cost method indicate significant economic values from visits (often ranging from $10-30 per person per visit).[26] If similar values were derived from visitors to Berry Springs Nature Park, the economic value of the recreational activities

[23] NRETAS (2011), *Annual Report 2010–11.*

[24] Personal communication with Wedd, D. (2011).

[25] NRETAS estimates.

[26] Gillespie, R. (1997), *Economic Value and Regional Economic Impact of Minnamurra Rainforest Centre, Budderoo National Park*, NSW National Parks and Wildlife Service. James, D. et al (1993), *Environmental Economics: Gerringong Gerroa Case Study*. Report prepared for the Water Board as part of the Clean Waterways Programme.

would be in the range of $1.4 to $4.2 million per annum. Anecdotal evidence suggests that much of this visitation is by locals and is not associated with tourist visits to TWP.[27]

The key point is that the any over-allocation of the aquifer, particularly around the springs, could result in a permanent closure of the springs for swimming (as occurred in Howard Springs). This has significant economic ramifications for the community.

Another regionally important tourism venture is the Lakes Resort Caravan Park. This facility is popular for water sports including water-skiing, kayaking and swimming and well as opportunities for camping and cabin-based overnight accommodation. The facility is used by residents of the Top End and interstate/international tourists.

5.3.2 Other recreation

There are a number of other recreation values potentially at risk from any over-allocation of the groundwater resource, particularly where it impacts on groundwater dependent environmental assets that underpin recreation. These are briefly outlined below.

- **Recreational fishing.** The performance of the Berry Springs aquifer can impact on surface water flow regimes that can be important to fish breeding habitat in the broader region. Therefore, the water allocation planning process can have an indirect impact on the economic and social benefits derived from recreational fishing. Approximately 75% of the annual recreational fishing effort and 75% of the annual recreational fishing spend occurs in the Darwin region.[28] Due to its proximity to Darwin, and reliable barramundi and mud crab fishing, many sites within the Berry Springs region are popular with recreational fishers, including at permanent coastal and rivers as well as seasonally flooded inland sites.
- **Nature appreciation.** A number of groups, including the Top End Native Plant Society and NT Field Naturalist's Club (Darwin) have specific interests in the observation and sighting of birds, butterflies, unusual or rare plant species, as well as group guided walks to learn more about the natural environment.
- **Bird watching.** The Berry Springs region has a diversity of habitat that in turn supports a diversity of bird species – both local birds as well as migratory species at specific times of the years. The wetlands and springs around Darwin are particularly good for bird watching from about June to December. Small reserves provide good areas of spring-fed monsoon forest, where Rainbow Pitta, Rose-crowned Fruit-Dove and other monsoon forest birds can be seen.[29]

5.3.3 Educational value

The lagoons and other surface water features of the Berry Springs region are used by community groups, school groups, non-government organisations and government agencies, amongst others, to provide and facilitate educational and learning opportunities for school children and the broader public.

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27 Ref 24.0

28 Handley, A. J., Editor (2010). *Fishery Status Reports 2009.* Northern Territory Government, Department of Resources. Fishery Report No. 104.

29 Ref 19.

5.3.4 Commercial fishing and aquaculture

While the commercial fishing industry is not a 'user' of water, it is dependent upon the flow and quality of water from rivers for estuarine health. The performance of the Berry Springs aquifer can impact on surface water flow regimes that cab be important to fish breeding habitat in the broader region. Therefore, the water allocation planning process can have an indirect impact on the economic and social benefits derived from commercial fishing.

One of the Territory's largest aquaculture ventures is also reliant on water from the BSWAPA – TAAU. The TAAU operations require ideal and pristine growing conditions and any decline in the quality of water from ideal conditions would both risk market access and production.[30]

5.3.5 Environmental values

Given the time and budget constraints of this project, we have not been able to undertake any non-market valuations in the BSWAPA. However, a study undertaken in the Howard River catchment in 2011 by Straton et al found that there were strong community preferences for the water planning process to give high priority rankings to the condition of aquatic and terrestrial habitat, to minimising the risks to water quality, to encouraging development of new industry, to the accessibility of sites for hunting and fishing, and to increasing the availability of rural residential and rural living blocks.[31] Water availability for horticulture and residential use were ranked as less important.

5.3.6 Indigenous values

Access to water thus has a number of elements for Aboriginal people in the Berry Springs region, involving economic development, employment and participation in the mainstream economy but within the context of 'traditional rights, environmental custodianship and the maintenance of cultural connections.'[32] The separation of land and water rights raises particular issues of equity and the ability to maintain cultural values within a water planning framework.

There are two Traditional Owner groups that have strong cultural connection to the BSWAPA, the Kungarakan and the Larrakai. Water and water-dependent ecosystems contribute to the cultural and economic values of both groups:

- Kungarakan are the recognised custodians of the region within which the BSWAPA lies. There are nine Recorded and one Registered Sacred sites within the BSWAPA, all with linkages to groundwater-dependent ecosystsms, providing further evidence of the importance of the region to the Kungarakan people. The Kungarakan people are represented by the Kungarakan Culture and Education Association and specific representation on the Water Advisory Committee for the Plan development.
- The Larrakia people are the Traditional Owners of all land and waters of the greater Darwin area. The Larrikia speak for the Larrikia country, whilst the Kungarakan speak for the

30 Ref 13.

31 Straton, Anna, Sue Jackson, Oswald Marinoni, Wendy Proctor and Emma Woodward (2011), *Exploring and Evaluating Scenarios for a River Catchment in Northern Australia Using Scenario Development, Multi-criteria Analysis and a Deliberative Process as a Tool for Water Planning*, Water Resources Management, V 25, pp 141-164.

32 Collings, Neva (2011), *Indigenous Water Planning and Management Issues*, First Peoples Water Engagement Council, report prepared for the National Water Commission (NWC) 2011 Biennial Assessment of progress in implementing the NWI.

traditional land covered by the BSWAPA. The Larrakia Nation Aboriginal Corporation is the peak representative body for the Larrakia people. As a key frontline service provider of housing and community services to Indigenous people, the Larrakia Nation's priorities include core issues of employment and jobs, protection of cultural sites, access to bush tucker and being able to stay on-country. Interest in water focuses on the maintenance of ecosystem services and non-consumptive values for the maintenance of traditional cultural activities.

In addition to the two Tradition Owner groups above, the Darrandarra Aboriginal Corporation have a relatively large holding of land in the region (Southport Road) with a large cleared area, a number of dwellings and wetland habitats. This group also has an interest in the outcomes of the planning process.

6. Estimated groundwater consumptive use

This section outlines MJA's estimates of current and potential consumptive use of groundwater uses in the BSWAPA. This section outlines the approach taken to estimating usage, the assumptions underpinning estimates and estimates of current and future use in the BSWAPA.

It should be noted that there is significantly less hard data to underpin the estimates of current use than would typically be available for a water allocation planning exercise. There are major deficiencies in data availability.

However, it is possible to establish indicative estimates of groundwater extraction to inform the water allocation planning process based on available information and by making a number of assumptions.

6.1 Approach to developing estimates of current use

In developing these estimates, MJA has used a variety of information sources to establish estimates. The basic process of estimating usage was to:

- For unmetered irrigated agriculture we estimated the area of irrigated agriculture and applied a range of irrigation application rates based on available information (e.g. estimated use = ha x ML/ha).
- For rural residential, we estimated the number of bores and applied a range of use rates (based on available information).
- For livestock cattle, we estimated the number of cattle and applied a watering requirement (based on available information).
- We then summed all uses from all sources to estimate total water use.

Key assumptions used to estimate existing demand are shown in the table below.

Table 11: Key assumptions underpinning estimates of existing use

Data item	Estimates	Notes
Land use – total irrigated area (ha)	860ha	Based on NRETAS estimates. 45% of this area has been allocated to large (metered) irrigation, while the remainder has been allocated across small (unmetered) irrigators.
Irrigation use (large irrigators)	2,000 ML	Based on NRETAS data.
Irrigation use (small fruit irrigators)	5-8 ML / ha	Based on industry guidance, previous research reports and stakeholder consultation.
Irrigation use (small vegetable irrigators)	5-8 ML / ha	Based on industry guidance, previous research reports and stakeholder consultation. Note: this includes water use in packing sheds.

Number of rural residential bores	320	Based on NRETAS estimates of bores (i.e. 3,300 – 600 irrigators).
Annual usage for rural residential blocks in the proposed urban village	0.7 ML	Based on PWC analysis of metered use in greater Darwin.[33]
Annual usage per rural residential bores (larger blocks)	2.75-4.0 ML	Based on NRETAS bore monitoring program. Note. NRETAS data indicates no real relationship between usage and block size.
Cattle number	<1,000	Based on ABS Agricultural Census data for Darwin Statistical division.[34]
Cattle daily usage (litres)	40 L	Based on recommended watering rates outlined in NT Department of Resources guidelines.

Source: MJA estimates.

6.2 Estimates of current use

Based on the approach and assumptions outlined in Section 6.1, MJA has established a range of estimates of water use in the BSWAPA (low and high estimates). The bottom of the range of water use is based on low estimates of irrigation application rates per area (or by bore for rural residential lots), while the top of the range is based on the high estimates of usage per area.

The range of estimates for current use is shown in the table below. Key points to note are:

- Total use is estimated in the range of 5,300-8,200 ML.
- The major driver of the variation in spread in the range is the uncertainty regarding irrigation application rates for unmetered groundwater users.
- The accuracy of these estimates could be further enhanced at little cost through developing more accurate estimates of land use (by land use type) using Geographic Information Survey (GIS) and analysis of the proportion of current horticultural area with planted tree crops that are actually being irrigated.

Table 12: Estimated current annual groundwater use in the BSWAPA (ML)

	Bottom range estimates		Top range estimates	
Use	**ML**	**%**	**ML**	**%**
Major agriculture (metered)	2,100	40	2,100	26
Small horticulture (mangos & other fruit)	1,800	34	3,700	45
Small horticulture - vegetables	600	11	1,300	16
Cattle	20	0	20	0
Rural residential	900	17	1,300	16
Totals	5,300	100	8,200	100

Source: MJA estimates.

[33] Wiltshire, M (2011), *Rethink: water use and misuse in Northern Australia.* Presentation to the living with climate change at home, at work, at play, 13 October 2011.

[34] ABS (2006-07), *Agricultural Commodities: Small Area Data, Australia.*

6.3 Estimated future use scenarios

Scenarios of potential future water use have been built upon estimates of current water use. Key growth assumptions underpinning future water use are outlined below.

Table 13: Key assumptions underpinning growth estimates (Berry Springs aquifer)

Water use	Low growth %	High Growth %	Notes
Major agriculture (metered)	3.0	5.0	Low growth scenario based on Dept of Resources forecasts (extrapolated out to 10 years). High growth slightly higher reflecting greater market share captured as water availability on southern competing regions is further constrained.
Small horticulture (mangoes & other fruit)	3.0	5.0	As per major agriculture.
Small horticulture - vegetables	3.0	5.0	As per major agriculture.
Cattle	6.5	10.0	Low growth scenario based on Dept of Resources forecasts (extrapolated out to 10 years). High growth reflects continued growth in live cattle exports and rapid expansion from a low regional base.
Rural residential	2.5	5.0 (+ 400 rural residential blocks established from 2018)	Low growth rate based on NT Government population growth forecasts. High growth rate reflects the fact that there are a large number of blocks that could be developed without major planning approval hurdles. It also includes additional demand for a further 400 rural residential homes in the proposed rural village.

Source: MJA estimates.

Other key points underpinning growth assumptions include:

- **Irrigated horticulture.** While irrigated horticulture production and water use will fluctuate in the short-term, conditions will continue to underpin future growth. Further expansion of irrigated horticulture will be driven by growth in local and interstate demand for product and the ability of producers in the BSWAPA to exploit any competitive advantages into those markets. While producers in the region are disadvantaged by distance to markets, they are able to exploit counter-seasonal marketing opportunities into domestic markets in southern states. Given the resources boom in Australia, the level of the Australian dollar is likely to remain relatively high in the foreseeable future. This will constrain opportunities for major expansion into overseas export markets.
- **Cattle.** Production in the BSWAPA is currently relatively limited as the region has a competitive disadvantage when compared to many areas in the Australian rangelands. However, the region is likely to have the potential to grow at least as fast as the industry as a whole and may be able to exploit some locational opportunities in the future due to the region's proximity to Darwin as an export base for live cattle and the establishment of feedlots in the Litchfield Municipality.
- **Rural residential.** Growth in groundwater demand will generally be in line with population growth expectations and the availability of land releases. Given the proximity of

the region to Darwin and the popularity of the area as one of Darwin's nearer affordable rural residential areas, where land is available within the more accessible areas of the BSWAPA, growth rates may exceed those for Litchfield as a whole. In addition, specific land use planning underway by the Territory Government is could trigger relatively faster growth.

The low growth and high growth assumptions have then been applied to the bottom end and top end estimates of current water use to establish estimates of future water use over the next 10 years. These estimates are presented in the following sections.

6.3.1 Bottom range groundwater use scenario

Current bottom of the range estimates of groundwater use in the BSWAPA are approximately 5,300 ML. The table below shows the bottom range growth in groundwater use for the period to 2021. Key points to note include:

- Overall use is expected to grow approximately 33% to around 7,000 ML per annum over the 10 years.
- In absolute terms, irrigated horticulture will be the biggest contributor to growth.
- Rural residential development is also likely to be a major contributor to growth, potentially increasing around 1,200 ML.

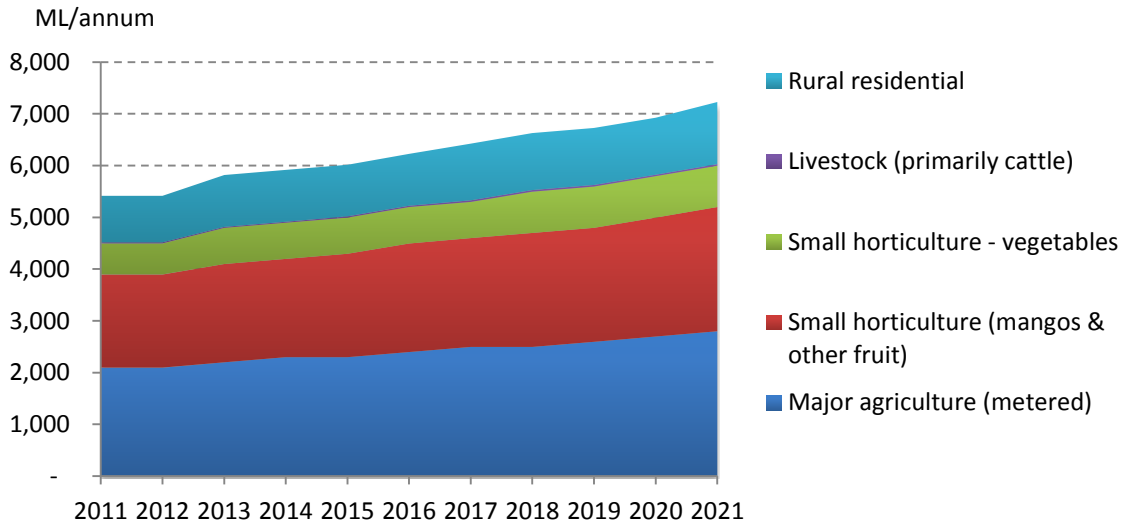
Table 14: Bottom range scenario of groundwater use (Berry Springs aquifer) (ML)

Use	2011 ML	2016 ML	2021 ML	Growth 2011-2021 %
Major agriculture (metered)	2,100	2,400	2,800	34
Small horticulture (mangos & other fruit)	1,800	2,100	2,400	34
Small horticulture - vegetables	600	700	800	34
Cattle	20	30	30	88
Rural residential	900	1,000	1,200	28
Totals	5,300	6,100	7,000	33

Source: MJA estimates.

The figure below shows existing use and growth for each major class of water use.

Figure 5: Bottom range scenario of groundwater use (Berry Springs aquifer) (ML)



Source: MJA estimates.

Even under a low growth scenario that builds upon the lower end of the estimates of current usage, business as usual growth is relatively significant, and if unmanaged, may create risk to the performance of the aquifer with economic and social consequences.

It is important to note that around 60% of the potential growth is in areas that are currently not regulated (i.e. small scale irrigation, pastoral and rural residential irrigation uses). In effect, much of the risk to aquifer condition and performance will come from largely unregulated growth under current policies.

6.3.2 Top range groundwater use scenario

Current top of the range estimates of groundwater use in the BSWAPA are approximately 8,200 ML. The table below shows the top range growth in groundwater use for the period to 2021. Overall use is expected to grow approximately 73% to around 14,200 ML per annum over the 10 years. In absolute terms, irrigated horticulture will be the biggest contributor to growth, while in relative terms, rural residential has the potential to grow the fastest.

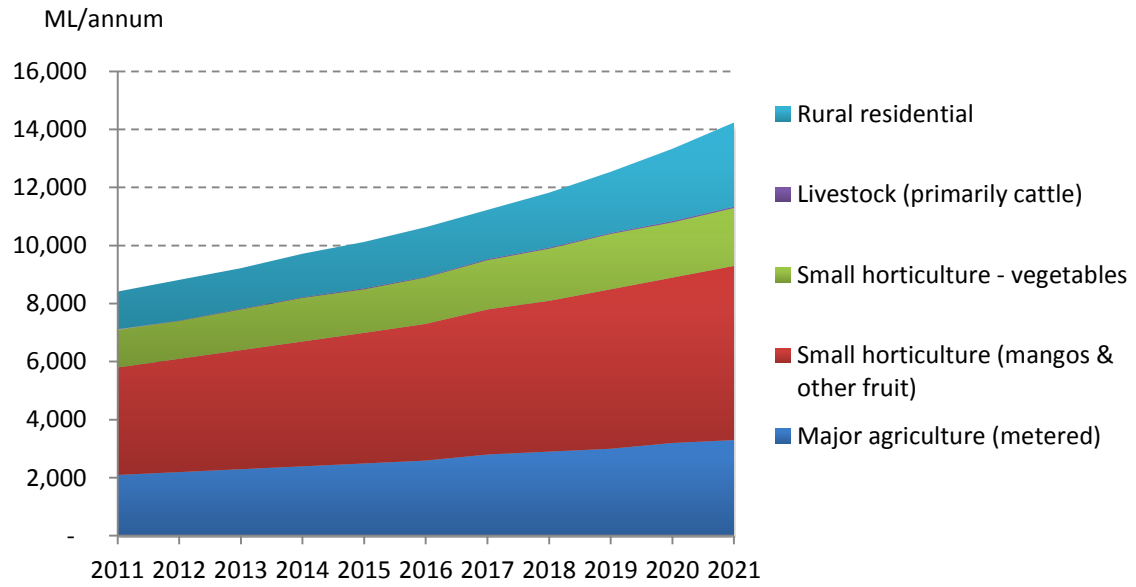
Table 15: Top range scenario of groundwater use (Berry Springs aquifer) (ML)

Use	2011 ML	2016 ML	2021 ML	Growth 2011-2021 %
Major agriculture (metered)	2,100	2,600	3,300	57
Small horticulture (mangos & other fruit)	3,700	4,700	6,000	62
Small horticulture - vegetables	1,300	1,600	2,000	54
Cattle	20	30	40	100
Rural residential	1,300	1,700	2,900	123
Totals	8,200	10,500	14,200	73

Source: MJA estimates.

The figure below shows existing use and growth for each major class of water use. It indicates that the *proportion* of total water use actually declines marginally (despite use growing in absolute terms).

Figure 6: Top range of scenario of groundwater use (Berry Springs aquifer) (ML)



Source: MJA estimates.

Under a high growth scenario, the increase in groundwater use could be as high as 6,000 ML, of which around 4,800 ML would be from largely unregulated uses. Under current policy and regulatory arrangements, this growth has the potential to create significant risk to aquifer health and function with few options in terms of management.

6.4 Implications for water allocation planning

The estimates of current and potential consumptive use of the groundwater resource in the BSWAPA over the next 10 years have a number of implications for water allocation planning in the BSWAPA, specifically:

- **Policy and planning uncertainties.** Because only a proportion of groundwater use is actually measured, this uncertainty will undermine the effectiveness of water allocation and planning (e.g. the accuracy of groundwater modelling to inform management decisions). As the water allocation plan is progressed, additional effort should be made to enhance estimates through more accurate land use mapping and additional analysis of data available from existing meters to establish groundwater usage patterns for different land uses.
- **Metering and risk.** While a lack of metering creates uncertainties for policy, it also reduces the potential effectiveness of any future management regime as compliance and enforcement would be compromised.
- **Perverse outcomes from land use planning.** Proactive planning is underway to expand urban development in the region that, under existing policy and planning arrangements, will result in major growth in unregulated groundwater use. The potential unintended consequences of this for the condition and function of the aquifer need to be more formally recognised in land use planning.
- **Growth exacerbates risk to aquifer and groundwater-dependent sectors.** Both scenarios of growth in groundwater use would see major increases in groundwater extraction. While it is beyond the scope of this report, it should be recognised that increased

extraction will increase the risk to aquifer condition, groundwater dependent ecosystems and sectors highly reliant on groundwater (particularly horticulture).

7. Possible economic and social implications

This section outlines some of the possible economic and social implications from water allocation planning in the BSWAPA. This section provides an indication of the trade-offs between possible outcomes. However these should be treated as indicative only, as it is too early in the planning process to formally establish planning scenarios and undertake in-depth assessments of trade-offs between outcomes.

7.1 Potential economic benefits associated with primary industries growth

MJA has developed a relatively simple economic impact model to assess the economic impacts of changes in horticulture and cattle production in the BSWAPA. The model uses relevant data from the ABS, NRETAS and broad employment multipliers. Key assumptions in the model include:

- The gross value of production per ML remains constant at current estimated levels for the BSWAPA (i.e. fruit at $3,600, vegetables at $11,800, cattle $8,600). It is assumed that these values remain constant.
- Growth occurs at the rate outlined in Table 13.
- Output multipliers are 0.51 for both horticulture and beef cattle, while employment multipliers are 0.51 for horticulture and 0.36 for beef cattle.[35]

Using the model it is possible to assess the economic impacts (change in gross value of production and employment) associated with growth in groundwater use outlined in Section 6 of this report. It should be noted, that these economic impacts require two key conditions to be met before they would be realised. Firstly, market demand is sufficient to drive the investment in expanded production. Secondly, the performance of the aquifer does not deteriorate (water availability or quality) and productivity and yields are maintained. The table below summarises key outputs from the economic impact modelling.

Table 16: Potential additional economic activity (2021)

Economic indicator	Low growth	High growth
Additional economic activity ($ million p.a.)		
Direct economic activity	7	13
Indirect economic activity	4	7
Total economic activity	11	20
Additional employment (FTEs)		
Direct employment	27	41
Indirect employment	12	20
Total employment	39	61

Source: MJA estimates.

[35] Ref 11.

The key points to note are that by 2021:

- The increase in direct economic activity would be in the range of $7-13 million per annum.
- Increases in total economic activity including direct and flow-on impacts attributable to the higher levels of horticulture production would be in the range of $11-20 million per annum.
- Putting this growth in additional economic activity into perspective, assuming the NRETAS forecast growth rates continue beyond 2012 until 2021, the growth in the BSWAPA would only constitute between 2% and 4% of the total growth of primary industries in the Territory.
- Under a low growth scenario, up to around 39 additional FTE positions may be created (up to 27 direct and 12 indirect). While a number of these jobs will be fulfilled by people living in the BSWAPA, it is more likely that many of the direct jobs would be fulfilled by residents from across the Litchfield Municipality.
- Under a high growth scenario, up to 61 jobs could be created.
- The additional direct jobs created are likely to account for around 0.5% of total employment in the Litchfield Municipality.

In summary, while there is likely to be additional economic activity and employment from further development of the groundwater resource in the BSWAPA, this growth is negligible in terms of regional economic activity and employment. These benefits need to be weighed up against the risks of potential over-extraction to other sectors and values.

7.2 Economic and social risks from declines in aquifer condition

At the time of writing this report, a formal risk assessment of alternative scenarios of groundwater extraction had not been completed. However, the potential growth in groundwater use will place significant additional pressure on the aquifer that could adversely impact on its performance (yields and water quality). Therefore, it is instructive to consider the economic and social consequences of this decline. It should be noted that for most of these risk there is virtually no quantitative data to underpin a formal assessment.

7.2.1 Primary production

Where the performance of the aquifer declines, this will have negative impacts on all irrigators utilising that aquifer in the form of lower yields and revenue and higher production costs. Often relatively small marginal changes in either yields or input costs can have significant impacts on the commercial viability of farms and subsequent employment.

Previous economic modelling assessments undertaken in other groundwater irrigation districts have found that declines in aquifer condition (yield and water quality) can occur very quickly and take decades to recover.[36] In effect, the risks of over-extraction can be virtually permanent

[36] MJA (2008a), *Social and economic assessment of the amendment of the Pioneer WRP to incorporate groundwater*, for the Queensland Department of Natural Resources and Water.

in an investment timeframe and offset any gains from further expansion of groundwater extraction.[37]

While there is no quantitative relationship between extraction volumes and bore yields to underpin any sophisticated economic analysis of the risks to irrigators, it is possible to do some relatively basic threshold analysis to determine the reduction in effective bore yields that would be sufficient to completely offset the potential gains from future horticultural development.

A simple threshold analysis based on the data and model used for Section 6.1 found that declines in horticulture yields attributable to poor aquifer performance of only 5% would more than offset any gains from further horticultural development over the longer term (based on an assessment of revenue to farmers). Commercial viability for irrigators would be impacted at much lower levels of aquifer decline as both revenues would decline and costs would increase (e.g. deepening bores). **In summary, extreme care should be taken in the water allocation planning process to ensure over-extraction does not occur, as the economic consequences can be considerable.**

7.2.2 Rural residential sector

The rural residential sector is a major beneficiary of relatively unregulated access to groundwater in the BSWAPA. The ability to access groundwater and establish and maintain gardens year-round adds significantly to the amenity of households and the value of houses.

Declines in the performance of the aquifer will have economic and social impacts on the rural residential sector both for current dwellings and future dwellings. However, this impact cannot be quantitatively determined without detailed groundwater modelling including estimation of the potential for material changes in reliability and/or permanent changes to yields or quality.

7.2.3 Risks to non-consumptive and social values

Section 5.3 outlined suite of non-consumptive values associated with the maintenance of the Berry Springs aquifer. Over-extraction of groundwater may trigger a number of risks to social values. While there is insufficient information to quantify these risks, they are briefly described in the table below.

Table 17: Potential risks to social values from declining aquifer condition

Social value	Risk to value	Comments
Tourism & recreation	Loss of tourism activity	Major values largely already lost due to decline in water quality Berry Springs. Potentially in the range of $1.2-$4.2 million if the springs are closed to swimming.
Commercial fishing	Loss of breeding habitat condition	Potentially a major issue for an important sector, but relationships between groundwater extraction and fish breeding habitat not well understood.
Aquaculture	Loss of production & market share	Current aquaculture production and market demand is highly reliant on the fact that the production environment is pristine.
Recreational fishing	Loss of breeding habitat condition	Potentially a significant issue for a major recreational pastime in the Top End, but relationships between

[37] MJA (2008b), *North Queensland regional water supply strategy: rural demand*, for the Queensland Department of Natural Resources and Water.

		groundwater extraction and fish breeding habitat not well understood.
Hunting	Loss of habitat	Some habitat may be groundwater dependent ecosystems. Loss of habitat will diminish bag rates and subsequent recreational values.
Nature study, birdwatching & education	Loss of habitat	Some habitat may be groundwater dependent ecosystems. Associated social values will also diminish.
Environmental values	Loss of habitat & ecosystem function	Some ecosystems may be groundwater dependent. Any decline in the extent and condition of these ecosystems will also diminish associated social values.
Indigenous values	Loss of traditional rights, environmental custodianship and cultural connections	Relationships between aquifer condition and these Indigenous values is complex and poorly understood. Any losses in these Indigenous values would be extremely difficult to quantify.

Source: MJA.

While many of risks to non-consumptive uses and broader social values are difficult to measure, they are likely to be significant.

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Appendix A – policy context (National Water Initiative and NT arrangements)

Water planning at its simplest is the formalised regulatory planning process for allocation of water between consumptive and non-consumptive uses. The objective is to ensure that water is used and managed in a way to underpin economic, social development, while simultaneously ensuring ecosystem functions reliant on water are maintained.

Water planning arrangements vary across jurisdictions. Water planning instruments have different names, and adopt differing approaches to how they allocate water to consumptive users and the environment.[38]

National requirements

The NWI 2004 is an agreement between jurisdictions to undertake transparent, statutory based water planning (clause 23ii), using best available information (clause 36) to: define and describe environmental and other public benefit outcomes and put management arrangements in place to achieve those outcomes (clause 37); adequately define resource security outcomes and water allocation and trading rules and adjust over-allocated and/or overused systems (clauses 37, 43); and put in place mechanisms to manage risk and adapt to improved information and knowledge, including monitoring and reporting (clause 40).

Under the NWI, water plans need to: (1) identify productive, environmental and other public benefit uses of water (clause 25iii); (2) identify surface and groundwater systems of high conservation value (clause 25x); (3) describe (geographically and physically) the water resource to be covered by the water plan (schedule E1i); (4) describe the health and condition of the system (schedule E1ii); (5) describe the risks to the system that can affect the availability of water or the allocation of water resources to different uses (schedule E1iii); (6) describe uses and users of water including indigenous use (schedule E1vi); and (7) assess the connectivity between groundwater and surface water (schedule E5ii).[39]

The objectives of the NWI are to:[40]

- Achieve transparent statutory based water planning.
- Provide investment certainty through improved water security.
- Provide for environmental flows and other public benefit outcomes.
- Meet the water needs of indigenous people.
- Enable water trading for more profitable (efficient) use of water.
- Enhance water use efficiency in urban and rural areas.
- Enhance water planning and management through improved metering.

[38] Hamstead (2009). *Improving environmental sustainability in water planning*. Waterlines report series no. 20, September 2009. National Water Commission.

[39] Ref 8.

[40] Ref 3.

- Recognise the connectivity between groundwater and surface water.

Through the NWI, jurisdictions have also committed to water planning processes which: (1) consult and involve the community, including Indigenous communities (clauses 52, 95); (2) actively consider and settle the trade-offs between competing outcomes for water systems, using best available science, social and economic analysis and community input; and (3) address impacts on affected entitlement holders and communities (clauses 36, 97).

Effective water planning is thus fundamental to the NWI. When fully implemented, water planning under the NWI will provide a clear and secure basis for water access entitlements and allocations, providing certainty to both consumptive water users and non-consumptive water use (the environment and other public benefits), and 'appropriately' balance economic, social and environmental considerations.[41] Through providing a basis for the allocation of water between uses, water planning is integral to efforts to deal with the challenges of stressed water systems, or – in the case of the Territory – efforts to avoid stressed water systems in the future, ensuring environmental and resource sustainability, and a secure basis for continued economic growth and development.

Water Planning in the NT

The Northern Territory *Water Act 1992* (amended 2004) provides for the allocation, use, control, protection and management of water resources. Water in the Territory (both surface and groundwater) are owned by the Crown and managed through a regulatory framework.

Under the *Water Act*, statutory water allocation plans are to be developed in all declared water control districts to provide for the allocation of water to beneficial uses in accordance with the principle of sustainable yield. Beneficial uses include environmental uses.[42] To date only three water allocation plans have been developed, but a number of others are underway. WAP developed under the Act will be in accordance with the Territory's obligations under the NWI.

Water allocation plans must (1) be in Water Control District; (2) be reviewed every five years, with a maximum life of 10 years; (3) allocate water within sustainable yields to beneficial uses; (4) allocate water to the environment; (5) allow for trade of licenses.[43] The *Water Act* also allows for the creation of Water Advisory Committees (WACs) for each Water Control District for which a management plan is being developed, but the interests represented by the WAC are at the discretion of the Minister.[44]

In areas covered by a water allocation plan, water is allocated to consumptive uses which are licensed (such as agriculture or public water supplies) and non-consumptive uses (such as environmental or other public benefit uses) which are not licensed. Water licenses allow the holder to take surface or groundwater subject to conditions. The issue and transfer of water licences must be in accordance with that plan. Water plans determine the allocation of the water pool between consumptive and non-consumptive uses.

41 NWC (2009), *Australian water reform 2009: second biennial assessment of progress in implementation of the National Water Initiative.* (Chapter 1 Water Planning).

42 Ref 3.

43 Tan, Poh-Ling (2009), *National Indigenous Water Planning Forum: a review of the legal basis for Indigenous access to water*, report prepared for the National Water Commission, February 2009.

44 Ibid.

The *Water Act* does not provide explicit guidance on the development of water allocation plans however – and hence sustainability of water use under water allocation plans is provided for by the concept of beneficial use.

Under the *Water Act*, water control districts can be declared to ensure that water systems do not become stressed or over-allocated. They are declared for areas with relatively high water demands to enable better water management through control of water extraction.

Water allocation plans in the Territory must also be consistent with the *Integrated Natural Resource Management Plan for the Northern Territory: Sustaining our Resources – People, Country and Enterprises (INRM Plan).* The INRM Plan embodies the principles of ecologically sustainable development, the precautionary principle, and adaptive management. It incorporates specific actions and targets in relation to water allocation.[45]

A WAP must allocate water to beneficial uses. There are two categories of beneficial use:

1. Consumptive use:
    a. Public water supply
    b. Rural stock and domestic
    c. Agriculture
    d. Industry (commercial use other than primary)
    e. Aquaculture
2. Non-consumptive:
    a. Environmental values
    b. Public benefit outcomes (such as public health, indigenous and cultural values, recreational uses, fisheries, tourism, navigation and amenity values)[46]

Beneficial uses thus include economic uses, social and cultural uses (including Indigenous), and environmental and public benefit uses. Some of these uses are – or can be – met through in-stream flows rather than water abstraction. Some also require physical access to a river or waterway.

[45] Ref 8 (pages 477-478).

[46] Ref 19.