

Background

Water Allocation Plan

Tindall Limestone Aquifer, Katherine

1. Introduction

Water is the life blood of the Territory and with the marked fluctuation between wet and dry seasons in the Top End, water allocation planning is of critical importance to ensure the sustainability of water resources to meet the needs of all water users, including the environment.

Water Allocation Plans are being progressively developed for water resources in the Territory, where there is significant competition for water from growing communities, agricultural enterprises and industry as well as a need to maintain the ecological and cultural values that require ongoing access to good quality water. Water planning is currently underway in the Alice Springs, Mataranka, Katherine, Douglas Daly and Darwin regions.

The Tindall Limestone Aquifer in the Katherine Region represents one of the Territory's highest yielding, good quality groundwater resources. The geological make up of the Tindall formation is a karstic limestone aquifer system featuring spring discharge, sinkholes, limestone outcrops and intricate cave systems.

Every person living, working or visiting the town of Katherine uses water from this aquifer, in one way or another. The Tindall Aquifer supplies the Katherine Township and Tindal RAAF base with drinking water, and many rural properties have bores drilled directly into this source for use at home and around the garden. Water from the Tindall Aquifer is also used to irrigate the many open spaces around the town including municipal gardens, sporting ovals, main street lawns and school grounds. Agriculture and industry enterprises are the largest users of water from the Tindall Aquifer in the Katherine region and this provides significant economic return to the township.

Another significant function of the Tindall Aquifer is that it discharges flow into the Katherine River through upwelling directly into the river and through springs. This includes the Katherine Hot Springs that provide base flow to the Katherine River allowing it to continue to flow throughout the dry season.

The values associated with this system are immensely important to local community, including the Jawoyn, Wardaman and Dagoman people, who hold a deep seated spiritual connection to the features of the aquifer, billabongs, swamps, rock holes, sinkholes, springs and river. The Tindall Aquifer is a highly valued and sought after water resource, valued by consumptive industries and non-consumptive users alike.

The Water Allocation Plan (the Plan) has provisions to manage discharge from the Tindall Aquifer via springs to the Katherine River ensuring its perennial nature, and provides for adaptation to annual climatic variability. An annual allocation to each licence will be made based on the predicted late-dry season flow in the Katherine River, protecting aquifer discharge that maintains these flows.

This background document outlines:

- The rationale behind water allocation planning
- The water allocation planning process
- A description of the Plan area and its dependent ecosystems
- Modelling of the Tindall Limestone Aquifer
- Water management strategies in the Plan
- Water for environmental, Indigenous cultural and other public benefit outcomes
- Water for current and future consumptive uses
- The use of adaptive management

This document forms part of a range of material, and **should be read in conjunction** with the following documents:

- The Water Allocation Plan for the Tindall Limestone Aquifer, Katherine 2009 - 2019.
- Guide to the Water Allocation Plan for the Tindall Limestone Aquifer, Katherine.

1.1 Why we need water allocation planning

1.1.1 To provide certainty for water users and the environment

The continued expansion of water use from the Tindall Limestone Aquifer in the Katherine region is pushing the system towards the limits of historically available water under contingent water allocation arrangements. There is increasing competition for water for agriculture, industry and public water supply, to the point where there is the potential for future water use to adversely affect the environmental values of the Katherine River.

Water Allocation Plans provide certainty for water users and the environment by defining rules for the distribution of water resources within sustainable limits.

Under the *NT Water Act* (the *Water Act*), a Water Allocation Plan can be declared to allocate water to beneficial uses within the estimated sustainable yield. Sustainable yield refers to the amount of water that can be reliably supplied from a water source to the consumptive beneficial uses of public water supply, agriculture, aquaculture, industry and rural stock and domestic, without causing unacceptable degradation to the non-consumptive environmental and cultural beneficial uses.

The Plan refers to the estimated sustainable yield for consumptive purposes as the extraction limit. Further information about the extraction limit is provided in section 5.2.5 of this document and in Part 7 of the Plan.

1.1.2 To enable water trading

In the Northern Territory, water trading can only occur after the declaration of a Water Allocation Plan. The Water Allocation Plan sets the rules and limits within which water licences can be traded.

In the Plan, water trading refers to the transfer of water under a valid licence from one person to another, where the water is used in a new location. The new location must be within the Plan area and is subject to some limitations. Temporary trading will be available to all licensees for a maximum of one year at a time up to the volume of water that has been made available for extraction under their licence for that year. Permanent trading may be permitted if the seller can demonstrate that they have achieved full development of their property and may encourage improvements in water use efficiency.

Water trading is explained further in section 5.2.8 of this document and under Part 7, Clause 34 of the Plan.

2. Water Allocation Planning Process

2.1 General

Water Allocation Plans provide a blueprint for future sustainability by establishing a framework to share water between human and environmental needs. They are developed through detailed technical and scientific assessment as well as extensive community consultation to determine the right balance between competing requirements for water. They can be declared for one or multiple water sources including surface and/or groundwater.

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

A Water Allocation Plan can only be prepared for an area that lies within a declared water control district. A water control district is an administrative boundary that allows the regulation of groundwater and surface water use through water extraction licences and bore construction permits.

Water Allocation Plans are declared under section 22B of the *Water Act*. The *Water Act* requires that a Water Allocation Plan will:

- allocate water within the estimated sustainable yield to beneficial uses; and
- ensure that total water use for all beneficial uses is less than the sum of the allocations to each beneficial use; and
- enable the right to take or use water under a licence granted under section 45 or 60 of the *Water Act* to be traded (in part or in full); and
- specify an allocation to the environment.

Water Allocation Plans may also include the following information and provisions:

- a description of the area and water source to which the Plan applies
- a description of the water source and public benefits associated with the water source;
- defined outcomes and objectives and strategies to meet them;
- defined limits to the availability of water for consumptive purposes;
- defined reliability of licences to extract water, based on historic climate information;
- rules to announce the volume of water that may be used under water licences in accordance with annual climate variability;
- rules for water trading;
- a monitoring program to evaluate whether the strategies in the Plan are meeting the stated outcomes and objectives;
- a specified process for mandatory reviews of the Plan.

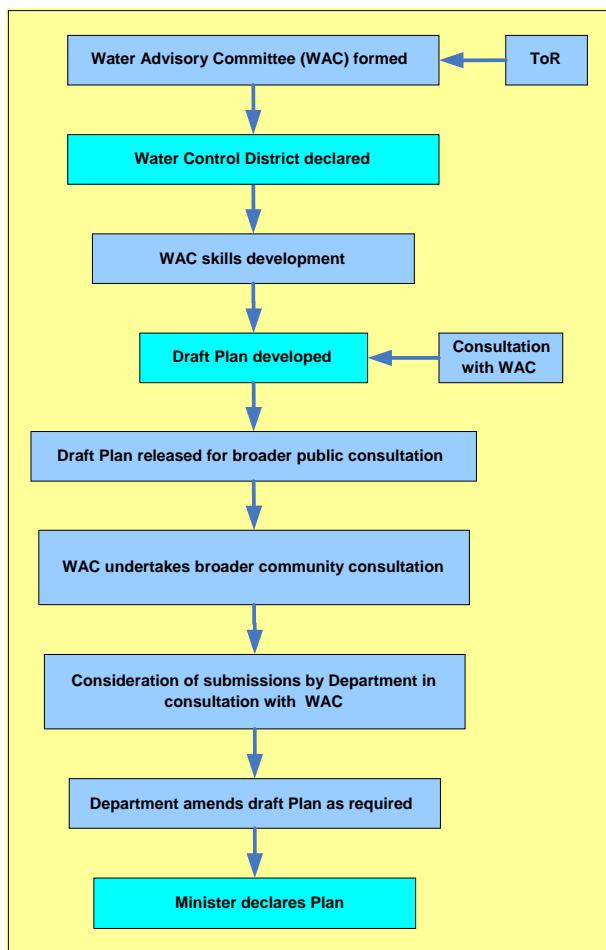
When declared, a Water Allocation Plan has a maximum life of ten years and a maximum review period of five years. The review allows the Plan to adapt to the needs of the future in a timely manner, based on the outcomes of the monitoring program and new research.

Water Allocation Plans are developed in close consultation with the community to ensure the requirements of various user groups are considered. In most cases, a water advisory committee is established to ensure that all interest groups contribute to the development of a Water Allocation Plan.

Before a Water Allocation Plan is formally declared, a draft is released to allow members of the public an opportunity to make submissions on the proposed content of the plan. All issues raised in submissions are considered in developing the final version of the plan.

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

The diagram below describes the process for development of a Water Allocation Plan.



2.2 Tindall Limestone Aquifer (Katherine) Water Allocation Plan

The Water Allocation Plan for the Tindall Limestone Aquifer (Katherine) has been prepared to initiate strategies for sustainably allocating and managing water within the Katherine region. Its vision is to ensure that a balance is created between the needs of the environment and all other uses.

2.2.1 Outcomes of the Plan

Outcomes are the overall goals that the Plan is striving to achieve. Many of these are long-term goals and may be partly reliant on factors beyond the scope of the Plan. The Plan's provisions have been developed with respect to these overall outcomes:

- Ecosystems dependant on the Tindall Aquifer, which are important for biodiversity, tourism, aesthetics, recreation and Indigenous cultural values are maintained in good condition;
- Communities, including Katherine, the Tindal RAAF base and rural properties, have access to water sufficient in quantity and quality for essential needs and commercial development;
- Indigenous people have access to water from the Tindall Aquifer for economic development purposes;
- Economic benefits from agricultural and other uses of water from the Tindall Aquifer are maximised;

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

- Water dependant sites with identified Indigenous cultural importance, including the Katherine Hot Springs, are preserved.

These outcomes and a summary of objectives and strategies that have been developed specifically to meet them are provided in Part 3 of the Plan.

2.2.2 Benefits for consumptive uses

The Plan has been developed with the intention of providing the following benefits to users of water from the Tindall Limestone Aquifer:

- Greater protection for water users by ensuring that extractive use can be sustained over the long term;
- Water for public water supply and other drinking water sourced outside the reticulated supply services is provided with the highest level of security;
- Better definition of the reliability of licences under different security categories;
- Establishment of provisions for water trading.

2.2.3 Benefits for non consumptive uses

In order to provide adequate protection of environmental and cultural values associated with the Tindall Limestone Aquifer, the Plan includes strategies to:

- Protect low flows in the Katherine River, in order maintain stream connectivity and contribute to the provision of minimum environmental flows in the Daly River;
- Maintain spring discharge to the Katherine River from the Tindall Aquifer, including to the Katherine Hot Springs which have Indigenous cultural significance;
- Improve understanding of Indigenous cultural water needs to ensure sufficient water is provided for this purpose;
- Adjust the extraction limit on an annual basis, based on rainfall and recharge, to ensure that environmental flows continue to be protected in drier years.

2.3 Consultation

Extensive consultation has occurred throughout the development of the Plan. Whilst this occurred primarily through the advisory committees described in the following sections, individual industry groups, water users and other affected parties were also actively involved in the development of the Plan. Posters and brochures about the planning process were made available in several public locations around Katherine, including a static display at the Katherine show.

The initial draft of the Plan was released on 26 June 2008 for a public submission period and a public information session was held on 16 July 2008 at the Katherine Town Hall. 11 submissions were received from a range of stakeholders and individuals. The draft Plan was revised based on these submissions and released for a second public comment period on 18 December 2008. A further 8 submissions were received resulting in some additional changes prior to the finalisation of the Plan.

It is acknowledged that meaningful engagement with Indigenous communities was limited during the development of the Plan. Despite this, the North Australian Indigenous Land and

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

Sea Management Alliance (NAILSMA) commissioned a case study on Indigenous water values in the Katherine region of the NT. This case study identified major themes and considerations for Indigenous groups within the Plan area, relevant to the Water Allocation Plan.

2.3.1 Daly River Management Advisory Committee

The Daly Catchment includes all the land, creeks and rivers that flow into the Daly River, including the Katherine River. The Daly Catchment is located south of Darwin and stretches from the edges of Arnhem Land to the east and the Victoria River District to the southwest. It includes the major townships of Katherine, Daly River, Pine Creek and many smaller Aboriginal communities.

The Daly River Management Advisory Committee (DRMAC) has been created to work with relevant Government agencies to develop options for the sustainable use and conservation of natural resources within the Daly River Catchment. The fundamental goal of the DRMAC is to promote the highest standards of management of land, water and other resources in the region so that important values identified by residents and the wider community are protected.

The Plan applies to the part of Tindall Limestone Aquifer that is bounded by the Katherine River catchment. Discharge from the Tindall Aquifer in this region, provides base flows to the Katherine River, which eventually flows into the Daly River. As such, DRMAC assisted the Katherine Water Advisory Committee in the development of the Plan.

2.3.2 Katherine Water Advisory Committee

The water resources within the Daly catchment are vast and consist of several surface water catchments and connected groundwater aquifer systems. Because of this, DRMAC recommended that where possible, separate water advisory committees should be formed to make recommendations on the management of each resource. As such, the Katherine Water Advisory Committee (KWAC) was announced by the Minister for Natural Resources, Environment and Heritage on the 21 February 2007 as sub-committee of DRMAC.

The role of the KWAC is to advise government, directly and through DRMAC, on the formulation of the Water Allocation Plan for the Tindall Limestone Aquifer (Katherine). The KWAC met on 18 occasions during the development of the Plan.

The KWAC includes representatives from various stakeholder groups, including agriculture, horticulture, pastoral, industry, conservation, public water supply, Indigenous, local government, tourism, recreation and community so that the complete range of values associated with water from the Tindall Aquifer in the Katherine region were incorporated into the Plan.

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

The KWAC consists of twelve voting members, an independent chairperson and is supported by three NT Government officers. The KWAC members and the constituency they represent are listed in the following table:

Committee Member	Representing	Organisation
Ms Anne Shepherd	Chairperson	Katherine Town Council
Ms Jodie Locke	Local Government	Alderman, Katherine Town Council
Mr Rohan Sullivan	Pastoral	Chairman, NTCA
Mr John Etty	Conservation	Organic horticultural producer in the Katherine Region
Mr Preston Lee	Indigenous - Jawoyn	Trainee manager, Jawoyn Association Aboriginal Corporation
Mr Bill Harney	Indigenous - Wardaman	Traditional Owner, Katherine Region
Mr Gary Want	Department of Defence	Manager Base services, Tindal
Mr Warren De With	Recreation	President, Amateur Fisherman's Association NT
Mr David Higgins	Horticulture / Agriculture	Horticulturalist, Katherine Region
Mr David George	Power and Water Corporation	Natural Systems Engineer, PWC
Mr Mick Peirce	Community	Irrigator, Katherine
Mr Mick Jerram	Tourism	Owner, Gecko Tours, Katherine
Mr Peter Sinnott	Industry / Commerce	Farm Manager, Manbulloo Mangoes, Katherine

The Northern Territory Government advisors, whom have provided continual direction and information to the KWAC, are listed in the table below:

Water Resource Planner	Department of Natural Resources, Environment, The Arts and Sport
Hydrogeologist	Department of Natural Resources, Environment, The Arts and Sport
District Agronomist	Department of Regional Development, Primary Industry, Fisheries and Resources

2.4 Technical Expert Group

A Technical Expert Group was formed specifically to provide input and guidance to the Water Allocation Plan for the Tindal Limestone Aquifer (Katherine). The Technical Expert Group included staff from many areas within the Department of Natural Resources, Environment, the Arts and Sport with specialist knowledge in hydrology, hydrogeology, aquatic ecology, limnology, planning and management.

Additionally, the Northern Territory Government has provided support to the KWAC through ongoing access to relevant experts outside the Technical Expert Group. These experts covered a range of interests and perspectives including agriculture, climate change,

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

community development, cultural water use, Indigenous water use requirements, public water use and environmental flow requirements. These experts all presented information and material at KWAC meetings and represented a wide range of institutions including CSIRO and Charles Darwin University.

3. Description of this Water Source and its Dependent Ecosystems

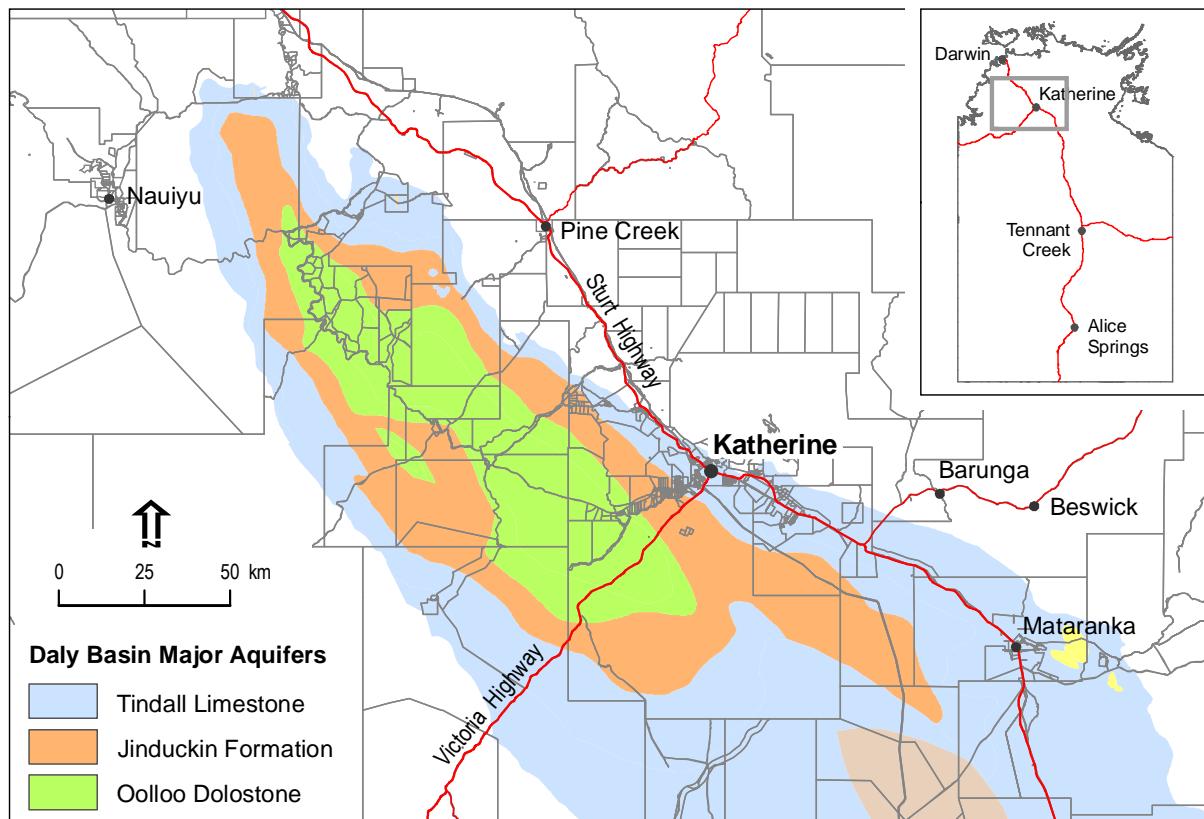
3.1 General

The Tindall Limestone Aquifer is the oldest of three geological formations that comprise the Daly Sedimentary Basin and spans beneath the catchments of the Daly and Roper Rivers as shown in Map 1. Water from the Tindall Aquifer discharges into many of the river systems within these catchments, including the Katherine, Flora, Douglas and Roper Rivers.



Map 1: Tindall Limestone Aquifer with respect to the Daly and Roper River catchments

The Tindall Limestone Aquifer is a cavernous aquifer system that is largely overlain by the younger Ooloo Dolostone and Jinduckin geological formations. The three geological formations that comprise the Daly Basin aquifers are shown in Map 2. **Map 2: Geological**



aquifer formations comprising the Daly Basin

The Tindall Aquifer is confined by the Jinduckin and Ooloo Dolostone formations, as water does not infiltrate through them to the Tindall Aquifer. Recharge to the Tindall Aquifer only occurs in areas where it is in direct contact with the ground surface as occurs around Katherine. These areas are described as unconfined.

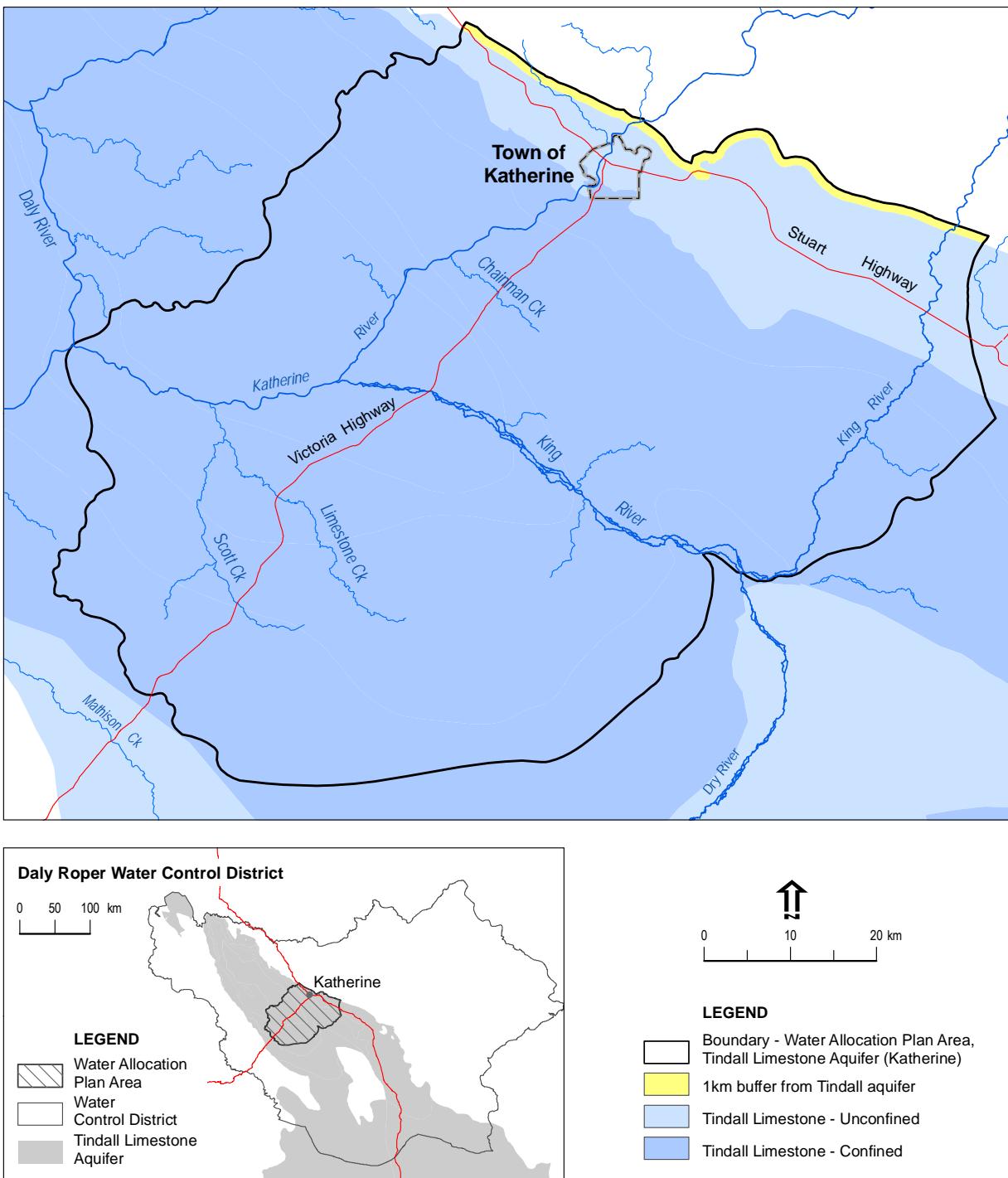
3.2 Plan area

The Plan applies to water within the section of the Tindall Limestone Aquifer that is bounded by the Katherine River catchment. This is referred to as the Plan area and covers 5,860 km². The Plan area is shown in Map 3 of this document and in Schedule 3 of the Plan.

Within the Plan area, water in the Tindall Aquifer flows naturally towards the Katherine River, where it discharges and contributes to its base flow. Subsequently flow in the Katherine River makes its way into the Daly River such that discharge from the Tindall Aquifer is important to maintaining flows in both of these river systems.

The Plan area falls wholly within the Daly Roper Water Control District (WCD). The Daly Roper WCD is an administrative boundary declared under section 22 of the *Water Act* that allows regulation of water extraction through water licences and bore construction permits. A Water Allocation Plan can only be made for an area that lies within a declared WCD.

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine



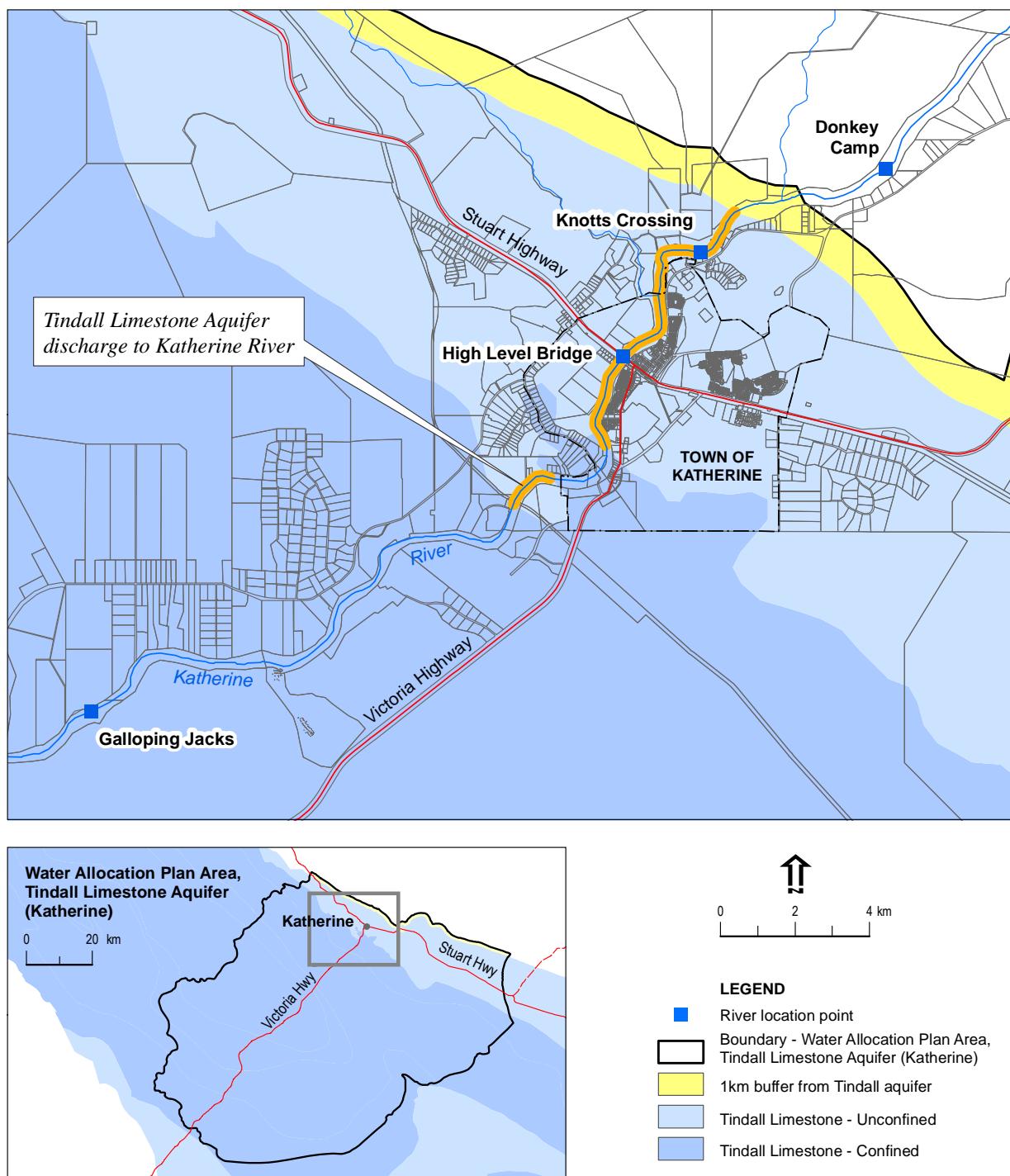
Map 3: Plan area showing the extent of confined and unconfined Tindall Limestone Aquifer within Katherine River Catchment.

3.3 Hydrogeology

The Tindall Limestone Aquifer is one of the two major fractured and cavernous aquifers occurring in the Daly Basin. The other is the Oolloo Dolostone aquifer, which is a younger formation overlaying the Tindall and Jinduckin formations as shown in Map 2. Large volumes of water can be stored within the fractures of these types of geologic formations and water flows relatively easy through them resulting in potential to extract water from these aquifers at high rates of 50L/s or more. The groundwater flow paths within the Tindall Aquifer are described as occurring parallel to the Daly groundwater basin edge and towards

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

the streams that cut across the basin. In the central part of the Daly groundwater basin where the Tindall Aquifer is at considerable depth, only minor flow is considered to occur. The aquifer is unconfined in places around the basin margin, where it outcrops close to the surface. As described in section 3.1, the Tindall Aquifer is largely confined by younger geologic formations. Recharge is highest in the unconfined areas and negligible where it is confined by the Jinduckin Formation. Recharge can be reduced in the unconfined area where overlying cretaceous rocks are present. Discharge zones are mainly located along the major rivers and comprise both karstic springs and more diffuse streambed discharge. The sections along the Katherine River where discharge from the Tindall Aquifer is known to occur are shown in Map 4.



Map 4: Discharge Zones into the Katherine River within the Plan Area

3.4 Climate

The extent of the Tindall Aquifer falls within the wet-dry tropics, having two distinct seasons. The wet season is from December to April and the dry season spans the remainder of the year. During the wet season, the area comes under the sporadic influence of the monsoon as well as intense rain depressions, resulting from decaying tropical cyclones. This results in rainfall that is highly variable. Annual rainfall (from October to the following September) totals at Katherine vary from a low of 364mm to a high of 1990mm. Over 90% of Katherine's mean annual rainfall of 970mm occurs between the months of November and March.

Annual pan evaporation is high at around 3000mm. Evaporation rates are highest around October and lowest around March. Temperatures range from a mean annual maximum of 34°C to a minimum of 20°C. Temperatures are highest in October and November when daily maximum approaches 38°C.

Figure 1 depicts river flow at the end of the dry season between 1961 and 2007 at three gauging stations on the Katherine and Daly Rivers. The lowest recorded river flow occurs each year just before the first substantial rains of the wet season, typically in October or November. During the period of lowest river discharge each year all of the water is sourced from groundwater, via springs and seepage into the riverbed.

Figure 1 shows how end of dry season flows progressively increase from the Katherine River downstream to the Daly River. This is a result of cumulative groundwater contributions to base flows which is related to rainfall and aquifer recharge. Flows over the past 30 years are higher than the long term average.

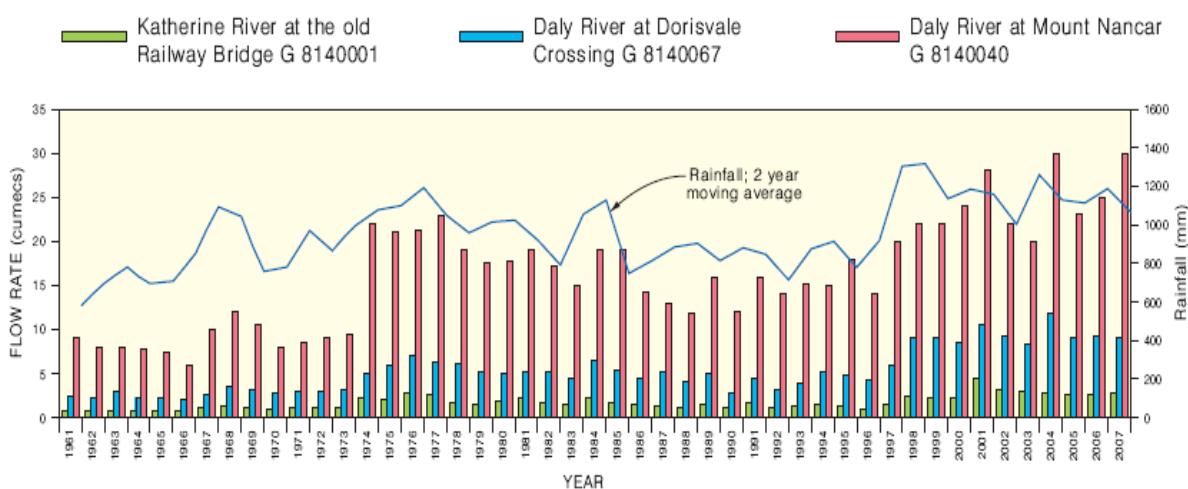


Figure 1: Katherine rainfall and end of dry season flows in the Katherine and Daly Rivers. Note: G814001 is upstream of G8140067 and G8140040, respectively

3.5 Land use

Land use within the Plan area is dominated by pastoral leases. However, many of these leases are located where the Tindall Aquifer is overlain by other geological formations (refer to section 3.1). In these areas, the depth to the Tindall Aquifer is greater than 150m below the ground surface. The cost of drilling to depths beyond 150m for stock water has rendered water from the Tindall Aquifer relatively unused for pastoral purposes in areas where it is confined.

Within the unconfined section of the Tindall Limestone Aquifer there are four main land uses including; national parks, pastoral leases, freehold land and the Tindal Royal Australian Air

Force (RAAF) base. Freehold land comprises a variety of specific land uses including dryland agriculture, irrigated agriculture, horticulture and stock grazing. By far the greatest demand for water within the Plan area comes from irrigation on freehold land. The expansion of irrigation industries in this area is constrained by the volume of water available from the Tindall Aquifer.

3.6 Ecological condition

The ecological condition of the Tindall Aquifer is largely unknown, due to a lack of general and resource specific understanding in groundwater ecology. In the Plan, ecological condition refers generally to the Katherine and Daly Rivers, which are considered to be the most significant groundwater dependent ecosystems that depend on water discharged from the Tindall Aquifer within the Plan area.

The ecological condition of the Katherine and Daly Rivers is sparsely documented in literature; Faulks first conducted an assessment of the physical and ecological condition of the Daly River and its major tributaries in 1998, including:

- reach environs and site features
- channel habitat types, diversity and dimensions
- bank condition and stability
- bed and bank condition and stability
- bed and bank sediments
- riparian vegetation
- aquatic vegetation
- instream and bank habitats

The study concluded that the overall condition of the majority of rivers and creeks studied throughout the Daly catchment was high.

A subsequent study undertaken by Norris et al. in 2001, to audit the ecological condition of Australian rivers concluded that the Daly River Catchment is in largely unmodified condition with respect to the environment and aquatic biota, when compared to other river systems across Australia.

The audit specifies that rivers that are in largely unmodified condition are categorised as having some or all of the following attributes:

- catchment land uses that minimally disturb the river such as conservation, some types of forestry, low levels of grazing or cropping;
- limited changes to the hydrological regime;
- limited changes to the habitat (e.g. riparian vegetation reasonably intact, no dams or levees and very little sediment deposition);
- loads of suspended sediment, total nitrogen and total phosphorous close to that which would occur naturally.

As supported by this research, the Daly River catchment, which includes the Daly and Katherine Rivers, has high ecological value. Despite limited knowledge about the specific environmental water requirements of the Katherine and Daly Rivers, the Plan includes provisions to ensure the majority of discharge from the Tindall Aquifer to the Katherine River is protected for environmental purposes. This is described in section 5.2.1 of this document and in Part 4 of the Plan.

Studies on the environmental water requirements of the Katherine and Daly Rivers are continuing under the auspices of the Tropical Rivers and Coastal Knowledge program (TRaCK). This research is designed to enhance understanding of the ecological processes of tropical river systems in Northern Australia. It is intended that the outcomes of this research, together with the results of the monitoring program initiated under Plan, will be used to inform the 5 year review of the Plan.

3.7 Water quality

3.7.1 Regional aquifer

Groundwater in the Tindall Limestone Aquifer is slightly alkaline on average, but pH can range from 6.4 to 8. Calcium, magnesium and bicarbonate ions do not show much geographic variation.

Most groundwater sourced from the Tindall Aquifer falls within acceptable limits for human consumption as described in the Australian Drinking Water Guidelines, 2004. The concentration of fluoride generally does not exceed these guidelines. Hardness is normally high and will cause scale build up in plumbing. Total dissolved solids, sodium and chloride in the southern parts of the basin can be high enough to adversely affect the taste.

3.7.2 Plan area

The description of water quality in the previous in section 3.7.1 is generally relevant to the Plan area. However, in the Plan area sodium and chloride levels are not usually high enough to adversely affect taste.

Whilst water quality usually falls within the acceptable limits for human consumption in the Plan area, several samples tested from water bores in the Plan area do not comply with the guidelines for drinking water, as described in the Australian Drinking Water Guidelines, 2004. As such, it is recommended that raw water sourced from the Tindall Aquifer be tested prior to being used for drinking purposes.

4. Modelling of the Tindall Aquifer

Fundamental to the development of the Plan for the Tindall Limestone Aquifer (Katherine) is the use of a computerised model that represents the aquifer system. The model is a complex water balance tool used to assess what happens to groundwater levels and river flows based on inputs such as rainfall and outputs such as groundwater extraction. A simple conceptualisation of inputs and outputs that are factored into the model is shown in Figure 2.

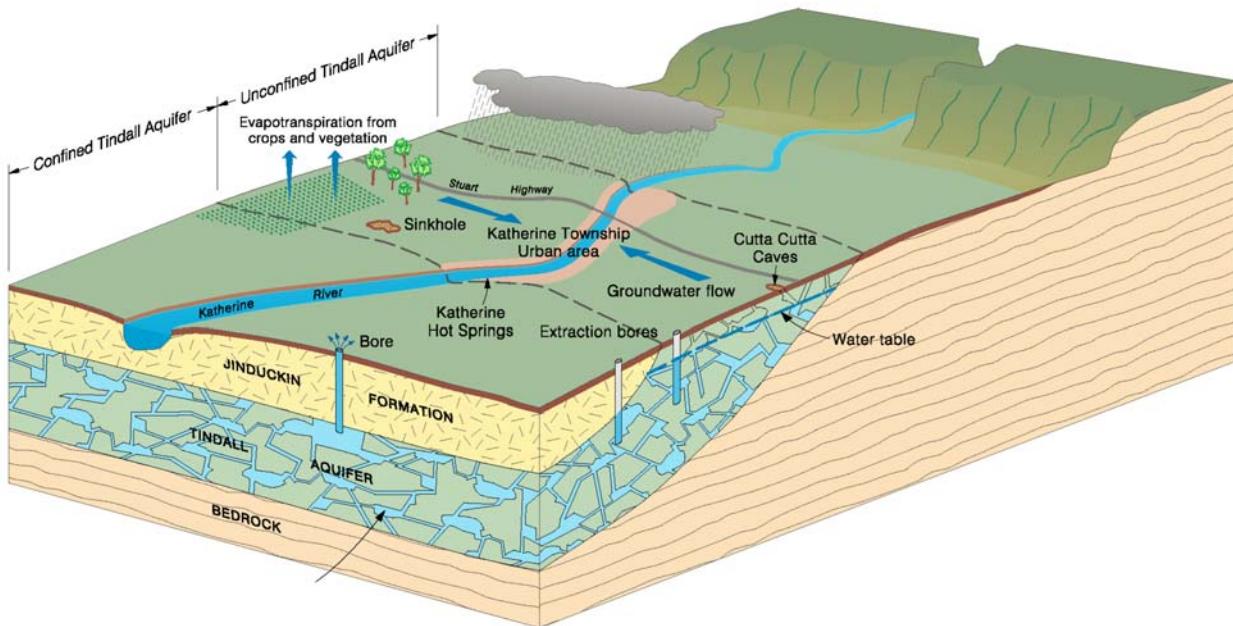


Figure 2: Conceptual groundwater model for the Katherine region

A holistic catchment approach has been adopted in developing the integrated water resource model for the Daly basin. The model accounts for 'basin wide' water usages in terms of impact on river flows, spring discharges and water availability to groundwater dependent ecosystems. The dynamic interaction of the groundwater and surface water systems is also represented as accurately as possible. When connected surface water and groundwater systems are modelled separately, there is potential for the water that moves between these systems to be accounted for in both models. Using an integrated surface and groundwater model more accurately estimates the available water by eliminating double accounting.

The model encompasses the Daly surface water system comprising the Daly River and its tributaries (including the Katherine River) and the two significant groundwater systems of the Daly basin, the Tindall Limestone and Oolloo Dolostone aquifers. Recharge to the groundwater systems and runoff across surface catchments into rivers are derived by inputting historically recorded rainfall data into the model. Water discharging from the model is represented either as flows from the Daly River at the model's extremity (the river model terminates in the vicinity of Mount Nancar) or by pumping (either from groundwater or rivers). All natural groundwater discharges manifest as springflow to rivers or streams in the model.

Modelling of the interaction between the surface water and groundwater systems occurs in those reaches of the river or stream where connection with the relevant underlying groundwater system has been identified. Within the Plan area, such interaction occurs between the groundwater resources of the Tindall Limestone Aquifer and the Katherine River in the reach from just upstream of Knots Crossing to Galloping Jacks (see Map 4). The water resource behaviour within this area is captured as a sub-area of the larger integrated model.

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

The model is calibrated against actual recorded flow data and is tested several times during its development. The model is run to predict flows in the Katherine and Daly Rivers and then compared to actual gauged flow recordings. If there is significant discrepancy between the two, the model is refined until it predicts flows that are similar to those actually recorded in these Rivers.

Recharge to the groundwater system within the Plan area occurs mainly over the unconfined portion of the Tindall Limestone Aquifer. The rates at which recharge occurs is variable and is spatially defined by the character of ground coverage. The estimated recharge rates using the integrated model described in this section are provided in Figure 3.

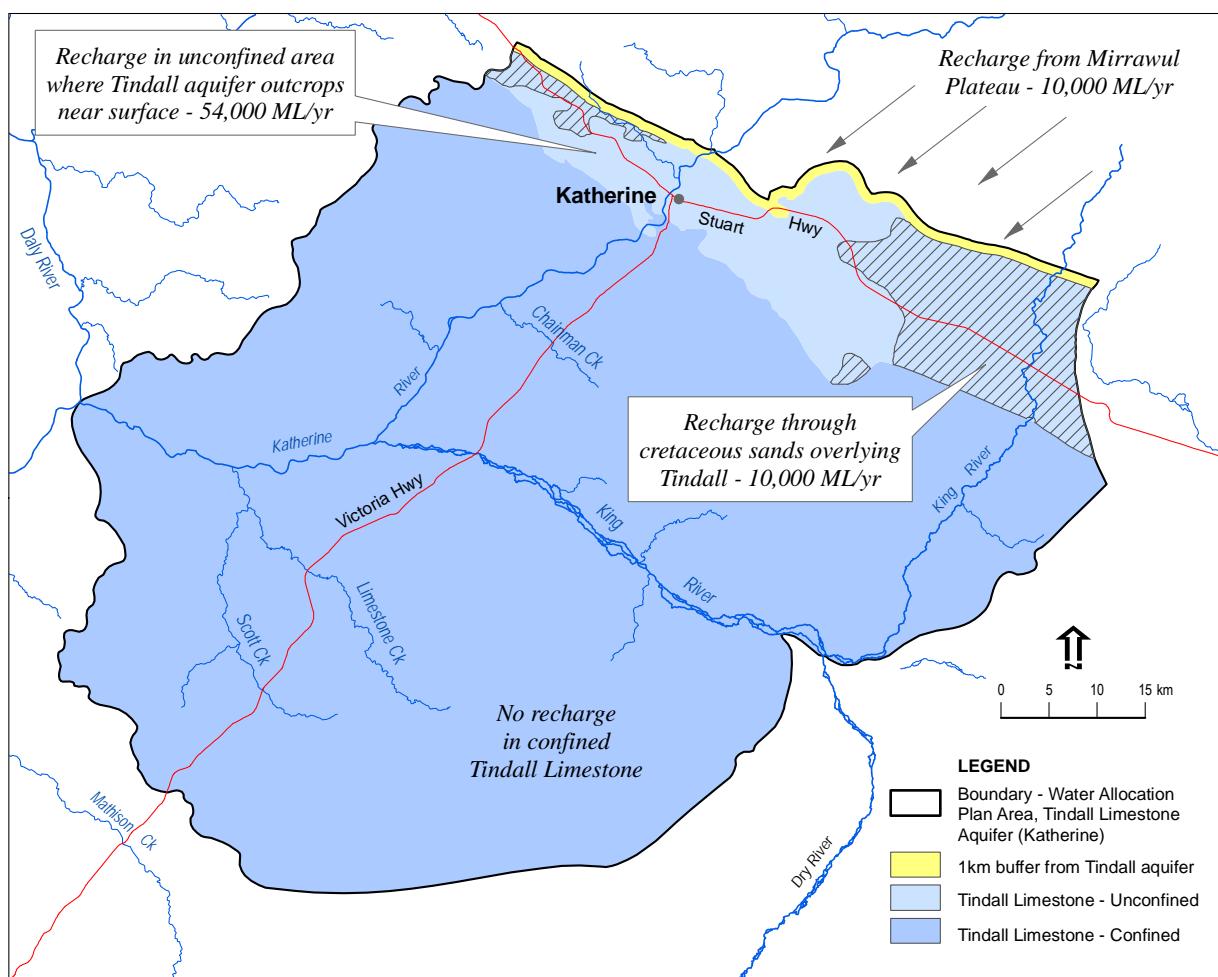


Figure 3: Spatial representation of average recharge within the Plan area based on period of record from 1961-2004

5. Water management in the Northern Territory

5.1 Water allocation guideline used outside water allocation plan areas

For water resources in the Top End of the Territory, where there has not been a detailed assessment of water availability carried out as part of preparing a Water Allocation Plan, a contingent water allocation guideline applies. The guideline requires that at least 80 per cent of annual recharge to a groundwater system be allocated for environmental and other public benefit outcomes. Consequently, groundwater is not allocated in a manner that will allow extraction for consumptive uses to exceed 20 per cent of annual recharge.

5.2 Water management strategies in the Plan

The purpose of developing a Water Allocation Plan is to undertake a detailed assessment of water use requirements, including environmental and cultural needs, for a specific water resource. Water allocation policies can then be developed that are tailored to achieving the desired long-term management outcomes for that resource.

Based on extensive consideration of water use requirements and environmental and cultural values associated with the Tindall Limestone Aquifer in the Katherine region, the guideline described in section 5.1 does not apply in the Plan area. This section describes the more rigorous water management strategies adopted in the Plan.

5.2.1 Water for Environmental, Indigenous Cultural and other Instream Public Benefit Outcomes

At present, there are no recommendations regarding environmental water requirements pertaining to the Katherine River. In the absence of these studies, the Plan includes provisions to protect very low flows (as defined by the lowest 10% of years on record) and provide water to meet the minimum environmental water requirements of the Daly River to which the Katherine River is a major tributary.

Erskine *et al* (2003) developed environmental flow recommendations for the Daly River. These recommendations were revised in May 2004 and subsequently endorsed by the Northern Territory Government. Erskine *et al* (2004) proposes environmental water requirements for the Daly River between Dorisvale and Mt Nancar.

Erskine *et al.* (2004) defines minimum dry season stream flows that should be maintained to protect the aquatic macrophytes *Vallisneria nana* and *Spirogyra*, the pig-nosed turtle and other aquatic flora and fauna. Recommendations are also made to ensure that the water requirements of riparian vegetation can be supplied at times of extreme water stress.

At the Dorisvale gauging station, Erskine *et al* recommend for discharges greater than 6.2 cumecs, at least 80% of the stream flow should be protected for the maintenance of water quality, flow hydraulics, aquatic habitats, flora and fauna. For discharges less than 6.2 cumecs, at least 92% of the stream flow should be protected for the maintenance of critical habitats and their associated flora and fauna.

The provisions in the Plan to achieve environmental and other instream public benefit outcomes have been made recognising the recommendations by Erskine et al. (2004), the demand for water from the Tindall Aquifer within the Plan area and acceptable reliability for

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

licences based on recommendations made by the Katherine Water Advisory Committee (KWAC).

Essentially, these provisions represent a trade-off between the demand for water for consumptive purposes and the protection of flows in the Katherine River. They also ensure that flows are not reduced in a manner that would compromise the environmental water requirements recommended for the Daly River.

It is considered that the correlation between the environmental and cultural requirements is high. However, it is recognised that environmental water requirements may not always align with Indigenous cultural, aesthetic and social requirements. Unfortunately, the requirements of these specific uses are at present not well understood. As such, the Plan assumes the majority of cultural requirements will be maintained by providing adequate flows to the environment. Research is currently underway as part of the Tropical Rivers and Coastal Knowledge program that will assist in quantifying water requirements to meet relevant Indigenous cultural and other social outcomes. This will allow for more specific provisions for cultural requirements to be incorporated in the review of the Plan.

The provisions in Part 4 of the Plan describe environmental and other instream public benefit outcomes in terms of protection of discharge to surface waters during very dry years, protection of discharge to surface waters during dry years and protection of discharge to surface waters during normal and wet years. Each year, the model (as described in section 4) will be used to predict the late dry season flow in the Katherine River, based on the previous wet season rainfall. The volume of water that may be extracted will be based on ensuring a sufficient proportion of this flow is maintained for environmental purposes.

5.2.1.1 Protection of discharge to surface waters during very dry years

The minimum yearly flow is the lowest recorded flow during each dry season. Late dry season flows in the Katherine River are sourced almost entirely from discharge from the Tindall Aquifer as there are no rainfall inputs. The 90th percentile minimum yearly flow in the Katherine River at the Katherine Railway Bridge is 0.6 cumecs. That is, in 90% of years on record, the minimum dry season flow in the Katherine River has been recorded as more than 0.6 cumecs. Figure 4 shows the duration curve for minimum yearly flows recorded from 1961 to 2007 at the Katherine Railway Bridge.

When flows in the Katherine River late in the dry season are predicted to be 0.6 cumecs or less, 87% of annual discharge from the Tindall Aquifer is maintained for environmental flows. Up to 13% of annual discharge may be extracted and this figure corresponds to the volume of water required to provide for essential water demands, including public water supply, rural stock and domestic and other small volume groundwater uses (see section 5.2.3). Extraction under licences for agriculture, aquaculture and industry would be reduced to zero at this threshold.

5.2.1.2 Protection of discharge to surface waters during dry years

When flows in the Katherine River late in the dry season are predicted to be between 0.6 cumecs and 1.0 cumec, 80% of annual discharge from the Tindall Aquifer is maintained for environmental flows. Up to 20% of annual discharge may be extracted in this case and this figure is in accordance with the recommendations made by Erskine *et al* (2004) for high base flows.

1.0 cumec represents the 85th percentile flow and appears to be the point below which recorded dry season flows begin to rapidly decline. Based on recorded minimum yearly flows, 1.0 cumecs is exceeded in 85% of the years on record as shown in Figure 4.

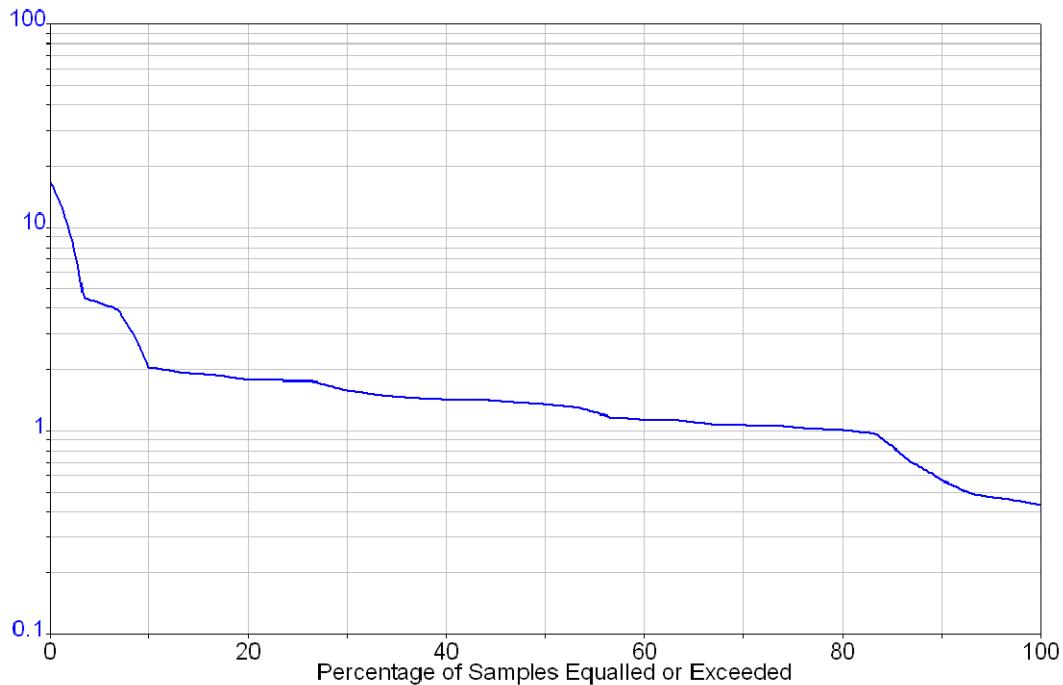


Figure 4: Katherine River minimum yearly flow duration curve. Note: logarithmic scale.

5.2.1.3 Protection of discharge to surface waters during normal and wet years

When flows in the Katherine River late in the dry season are predicted to be above 1.0 cumec, 70% of annual discharge from the Tindall Aquifer is maintained for environmental flows. Up to 30% of annual discharge may be extracted at this threshold. This represents a trade off whereby a larger proportion of dry season flows are protected during dry and very dry years whilst more extraction can occur during normal and wet years.

5.2.1.4 Environmental water requirements for the Daly River at Dorisvale

Erskine *et al* (2004) recommended that 80% of the flows at Dorisvale on the Daly River above 6.2 cumecs should be maintained. In field investigations have been conducted to assess the contribution of flows from the Katherine and Flora Rivers to the Daly River at Dorisvale. Table 1 describes the contribution of discharge from the Tindall Aquifer to flows in the Daly River at Dorisvale, including the potential impact of extraction.

Table 1: Contribution of Tindall Aquifer discharge to stream flows in Katherine and Daly Rivers

Survey year	Katherine River @ Blue Metal Crossing (cumecs)	Katherine River @ Galloping Jacks (cumecs)	Tindall Aquifer discharge to Katherine River (cumecs)	Daly River @ Dorisvale (cumecs)	Tindall Aquifer discharge contribution to flow @ Dorisvale	Reduction in flow at Dorisvale with 30% extraction of Tindall discharge	Percentage reduction
2002	1.3	4.0	2.48*	9.8	25.31%	0.74	7.5%
2008	0.684	3.28	2.39*	9.79	24.41%	0.72	7.4%

* Tindall Aquifer discharge represents approximately 92% of flow gained between Blue Metal Crossing and Galloping Jacks.

Based on Erskine's recommendations, a flow of 9.8 cumecs at Dorisvale under natural conditions should not be reduced by more than 20%, or below approximately 8 cumecs. Based on the 2002 and 2008 stream flow surveys, the Tindall Aquifer contributes about 25% of the flow recorded at Dorisvale. Under the provisions of the Plan, Tindall Aquifer discharge could be reduced by up to 30% via extraction. This would reduce flows by up to 0.75 cumecs, resulting in a total flow at Dorisvale 9.05 cumecs. This would maintain more than 80% of the natural flows at this location.

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

Additional monitoring will be undertaken as part of the implementation of the Plan to assess whether the minimum environmental water requirements as specified in Erskine *et al* (2004) are being adequately maintained.

5.2.2 Protection of groundwater dependent ecosystems, culturally significant sites and other groundwater users

Management strategies have been included in the Plan to protect groundwater dependent ecosystems, culturally significant sites and other groundwater uses.

Spring flows, such as the Katherine Hot Springs, are important for maintaining river flows and have significant cultural value, particularly to Indigenous people. Due to the karstic (fractured and cavernous) nature of the Tindall Limestone Aquifer, there is potential for extraction near the Katherine River to affect the discharge from a single spring to the Katherine River. This is because a karstic conduit, or fracture within the aquifer, may be coincident with the source of the spring. It has been demonstrated that in karstic aquifers, such conduits may exist for considerable distances and represent the sole or predominant avenue for flow of groundwater to its discharge point on the river. Figure 5 shows how groundwater can move through a single fracture and discharge directly to the river through a spring.

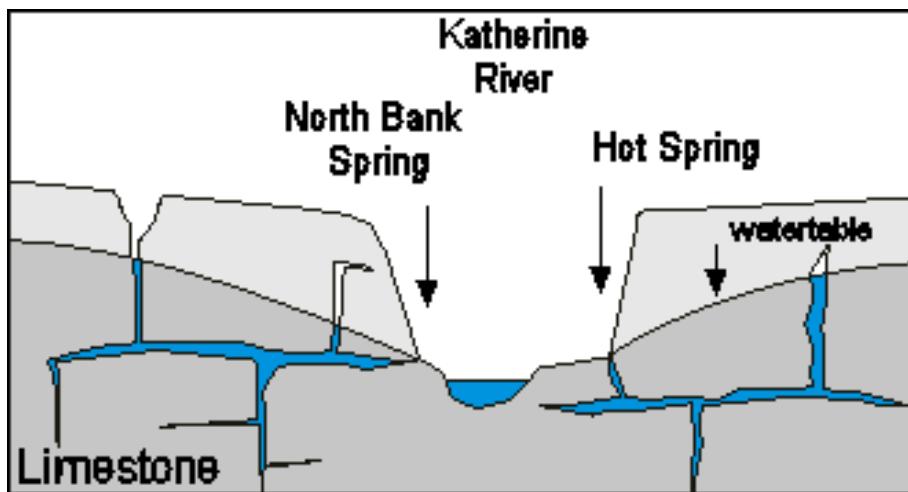


Figure 5: Groundwater flow to spring discharge in the river

If a bore extracts water from a karstic conduit at an excessive rate, spring flow at the river may be severely reduced. As a result, the Plan does not allow new licences, including traded licences, resulting in extraction exceeding 20L/s within 1km of the Katherine River to be issued.

Similarly, the karstic nature of the Tindall Aquifer may result in the use of one bore influencing the availability of water from another. If extraction occurs at a high rate, localised draw down within the aquifer may drop water levels below the depth of a bore located nearby. To protect existing groundwater users, the Plan does not allow new licences to be granted for a bore equipped to extract more than 20L/s if the bore is constructed within 100m of an existing operational bore.

These provisions are under Part 6, Clause 25 of the Plan.

5.2.3 Exempt small volume groundwater users from licensing

There is an exemption to the *Water Act*, which allows the use of groundwater for any purpose not exceeding 5ML/yr to occur without a licence within the Daly Roper Water Control District. This exemption was pursued on advice from the Katherine and Mataranka Water

Advisory Committees and the Daly River Management Advisory Committee, to reduce regulatory encumbrances for users requiring equal to or less than the volume of water nominally assigned to bores for rural stock and domestic use. The exemption is referred to in Part 5 of the Plan.

Use of groundwater for rural stock and domestic purposes does not require a licence pursuant to section 14 of the *Water Act*. An average rural property is estimated to use 4.5ML/yr, based on domestic requirements for 4 people (380L/person/day) and watering of 0.5 hectares of garden. During the development of the Plan, some instances of groundwater use of less than 5ML/yr for purposes other than stock and domestic were identified. These included truck wash down facilities, small businesses such as auto dealers and small nurseries and watering of green spaces such as sporting fields.

The risk of substantial increases in groundwater extraction within the Daly Roper Water Control District, and consequently within the Plan area, as a result of the exemption is considered to be low. This is because there are limited water uses requiring less than 5ML/yr for purposes other than stock and domestic. Most increases in small volume groundwater use will be a result of new stock and domestic requirements, already authorised without a licence under the *Water Act*. Small volume groundwater uses will still require a bore construction permit which will protect groundwater resources from contamination through minimum construction standards.

5.2.4 Restricted access to groundwater in the Katherine Urban Water Reticulation Area

Section 14 of the *Water Act* defines the rights of owners overlying land to take groundwater. This includes the provision of access to groundwater for rural stock and domestic purposes without a water extraction licence. Despite this, the Plan proposes to prohibit the issuance of bore construction permits in areas that are currently serviced by the Katherine Urban Water Reticulation Area.

The intent of section 14 of the *Water Act* is to ensure access to water for rural stock and domestic purposes. As potable water is made available from the Katherine Urban Water Reticulation Area, the restriction of access to groundwater in this area will not compromise access to water for domestic purposes. The Plan makes provision for estimated stock and domestic use totalling 1,128ML/yr. The potential increase in demand from additional bores that may be drilled to augment domestic water supply within the reticulation area poses some risk to the ongoing availability of water to existing users and the environment. Additionally, the cost associated with the construction, maintenance and operation of a private bore for a small volume use, is likely to outweigh the cost of using the reticulated supply. This policy is also designed to encourage water use efficiency through urban water pricing.

The Katherine Urban Water Reticulation Area is illustrated in Schedule 4 of the Plan and bore construction permit conditions are given in Part 10.

5.2.5 Annual extraction limit

In recognition of the intimate connection of groundwater from the Tindall Aquifer with surface water in the Katherine River, this Plan will provide a target base flow to the Katherine River as described in section 5.2.1. Due to annual climatic variability, an extraction limit is calculated each year. The extraction limit is the total volume of water that may be extracted under licences for the water accounting year.

The extraction limit is calculated annually prior to the commencement of the water accounting year on 1 May. The model (see section 4) is used to predict recharge based on the previous wet season rainfall and subsequently the river flow that will occur in the

Katherine River late in the dry season. In years when recharge is poor and discharge to the river is consequently low, the extraction limit may need to be reduced to ensure discharge from the aquifer is sufficient to maintain river flows throughout the dry season.

The extraction limit under the Plan allows for a flexible water extraction regime based on actual availability of water from year to year. The extraction limit ranges from 4,340ML/yr during very dry years, gradually increasing through to 35,631 ML/yr in very wet years. The minimum extraction limit is sufficient to provide for essential public water supply and rural stock and domestic requirements, whilst the maximum extraction limit is equivalent to the total volume of water allocated under licences and for rural stock and domestic and other small volume groundwater uses. The extraction limit is based on protecting adequate flows for environmental, Indigenous cultural and other public benefit outcomes described in Part 4 of the Plan.

5.2.6 Licence volumes, security categories and defined reliability

5.2.6.1 Determining licence volumes and security categories

A key outcome of the water allocation planning process was to determine the volume of water to be issued under licences for the 10 year life of the Plan. The Katherine Water Advisory Committee (KWAC) developed a framework designed to achieve the equitable distribution of available water for consumptive purposes from the Tindall Aquifer (Katherine) between all competing users extracting water for various purposes.

This framework was applied by an independent consultant, who assessed the water requirements of the 19 valid licensees and 54 pending applicants based on land capability, sustainable consumption and protection of water quality and quantity. This framework was used in conjunction with an approved standardised crop water use model to determine the amount of water that could be issued to each licensee, as a share of the actual volume of water available from the Tindall Aquifer for consumptive purposes within the Plan area.

For existing valid licences where full development had not been realised, licensees were required to demonstrate their capacity use the water issued under their current licence against the following criteria:

1. Soils suitability for the irrigation method
2. Climate suitability for crop type
3. Suitability of the topography for the proposed production system
4. Availability of sufficient land area for the proposed production on the nominated portions
5. Crop water requirements, as calculated using the Department of Regional Development, Primary Industries, Fisheries and Resources Crop Water Use Model for Katherine, calculated using the D1 rainfall series (this is the annual rainfall exceeded 90% of the time – 655mm for Katherine)
6. Compliance with meter installation and backflow prevention for chemical fertiliser injection systems achieved or proposed as part of the development proposal.

Those landowners with development in place but without an existing valid licence were, as a minimum, to be issued a licence of sufficient quantity to maintain that level of development into the future. Any further development proposed by these landowners was assessed against the criteria above.

Following these assessments, licences were categorised into three security categories. To ensure a reliable supply would be maintained for existing irrigators, KWAC recommended that high security licences be issued for all existing developments. The volume issued under

these high security licences is based on water required for any existing crops to reach full maturity.

Medium security licences were issued where additional development was proposed on an NT Portion as part of property development plan that was partially complete. This recognises that the initial investment in capital is largely based on the full development proposal and provides additional security for those that will be completing a property development plan that has already commenced.

Low security licences were issued in accordance with proposed property development plans on NT Portions where no development had commenced. This allows new development to occur in the region, whilst protecting ongoing access to water by existing users. The reliability of supply in this category is low, however as no development has commenced in accordance with these licences, it is expected that the level and type development that occurs will reflect the risk associated with potentially inconsistent water supply.

Licence security categories are managed differently at times when the total extraction limit cannot be supplied for the upcoming water accounting year. When there is not enough water available to meet the total demand under licences, reductions are first applied to low security licences and subsequently to medium security licences. High security licences are only reduced if the allocation to medium security licences has been reduced to zero, thus providing the most reliable water supply to existing developments where investments have already been made and businesses are well established.

Essential public water supply licences are categorised as total security. Based on the historic rainfall record, the volume of water required for this purpose is completely secure. If there is severe water scarcity in the future, it may be necessary for total security licences and rural stock and domestic and other small volume groundwater users to conserve water through efficient practices.

5.2.6.2 Reliability of supply for licence security categories

The four licence security categories each represent a different level of reliability. Reliability is defined as the percentage of years that a licence holder is expected to be able to access their maximum licence volume, based on historic flow data in the Katherine River from 1961-2007. The reliability is specified to give licence holders an understanding about how often they are likely to access their maximum licence volume if past climatic conditions are similar in the future.

Using the yearly minimum recorded dry season flow in the Katherine River at the Katherine Railway Bridge from 1961-2007, an equivalent extraction limit was calculated for each year in the historic period of record. As such, the volume of water that could have been issued to each security category in each year during the historic period of record was determined. The reliability for each security category is the percentage of years that the full demand of that licence category would have been available based on historically observed dry season flows in the Katherine River.

The reliability for each security category, based on the full development of all licences is as follows:

1. Total security – licence holders can expect access to their maximum annual licence volume in all but extreme circumstances.
2. High security – licence holders can expect access to their maximum annual licence volume in about 70% of years.
3. Medium security – licence holders can expect access to their maximum annual licence volume in about 30% of years.
4. Low security – licence holders can expect to access to their maximum annual licence volume in about 15% of years.

The above figures are based on a full development scenario for the past 49 years of climatic data that represents periods of above and below average rainfall. The reliability of licences in each security category is higher when based on recent rainfall data from 1996-2007. High security licence holders would have received their maximum annual licence volume in 9 out of the last 10 years because rainfall has been consistently above average during this time. Conversely, for the period 1961-1975 when rainfall patterns were below average, high security licences holders would have been received their full licence volume in 5 out of 15 years.

At present, it is estimated that approximately 16,000ML is used annually within the Plan area, whilst full development will require up to 34,503ML. The reliability figures in the Plan are based on the full demand scenario and are actually higher whilst full development of the system is not realised. Comparisons of reliability based on various levels of demand are provided in Table 1 of Part 6 in the Plan. This provides licence holders with more information about how regularly they may receive up to 60 or 80% of their total licence volume.

5.2.7 Rules for announcing annual allocations to licences

This Plan includes rules to announce allocations to licences on an annual basis, ensuring that the sum of water allocated to consumptive uses remains within the annual extraction limit. An announced allocation will be made each year for each security category and refers to the percentage of the annual licence volume that may be extracted in that water accounting year.

Each licence has a specified maximum annual licence volume for each year from 2009 – 2019. This is because over the life of the Plan, each licensee will be at a different stage of development each year, ranging from no development through to full development. Annual licence volumes were determined based on crop water use requirements for the stage of development proposed each year by the licensee. To ensure available water is distributed against the actual demand for that year, announced allocations will be based on the total annual licence volumes, as shown in Table 2.

Determining announced allocations based on the annual licence volumes will ensure the resource is managed as a community commodity, whereby unnecessary reductions to licences do not occur as a result of basing the announced allocation on the full development scenario and not the actual staged development scenario. This means water will only be allocated where it can be used for a development that will be in place for that water accounting year.

Each year the announced allocation will be determined prior to the commencement of the water accounting year on May 1 as described in Figure 6.

Table 2: Annual licence limits

Year	Total Security Demand (ML)*	High Security(ML)		Medium Security (ML)	Low Security (ML)		Total (ML)
		Public Water Supply	All others		Public Water Supply	All others	
2009	3004	483	14662	4788	1717	1981	26634
2010	3004	483	14662	5715	1717	2492	28072
2011	3004	483	14662	6659	1717	2743	29268
2012	3004	483	14662	7147	1717	2743	29756
2013	3004	483	14662	7351	1717	2743	29961
2014	3004	483	14662	7775	1717	3991	31632
2015	3004	483	14662	8012	1717	3991	31869
2016	3004	483	14662	7623	1717	3991	31480
2017	3004	483	14662	7347	1717	3991	31204

Background: Water Allocation Plan - Tindall Limestone Aquifer, Katherine

* Total security demand refers to total security licences (1,876ML) and water allocated for stock and domestic and other small volume groundwater uses not requiring a licence (1,128ML).

**The annual licence limit varies from year to year based on individual property developments and annual crop rotations. The extraction limit specified in the Plan (35,631ML) is not achieved until full development is achieved, which occurs after the life of this Plan. The maximum extraction limit based at full development has been used for planning processes.

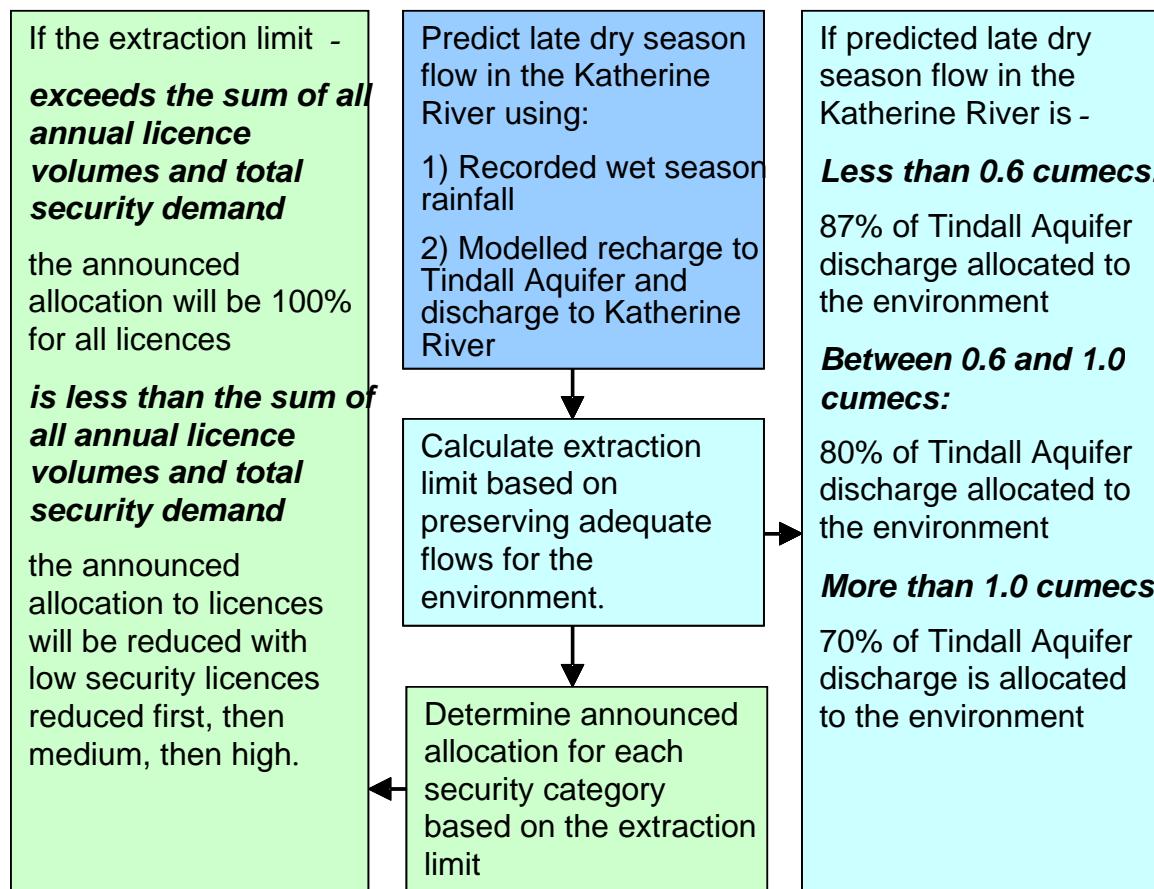


Figure 6: Process for determining annual announced allocations to licences.

The extraction limit is determined by predicting the late dry season flow in the Katherine River at the Katherine Railway Bridge on 1 November. At this time, almost all flow in the Katherine River is sourced from Tindall Aquifer discharge. The prediction is made by inputting the previous wet season rainfall into the Daly Basin model, and using it to calculate recharge into the aquifer and subsequently discharge to the Katherine River. Based on the predicted flow level, a certain proportion of the Tindall Aquifer discharge to the Katherine River must be protected for environmental purposes, with the remainder available to be shared between licence holders.

If the extraction limit is calculated to be greater than the total annual licence limit and total security demand, then the announced allocation will be 100% of the maximum annual licence volume for all licences for that year.

If the extraction limit is calculated to be less than the total annual licence limit and total security demand, allocations to licences shall be reduced according to the below criteria:

- Full access to total security licences will be maintained as a priority;
- Reductions will be placed on low security licences first;
- Once low security licences have been reduced to zero, medium security licences will then be reduced.
- Once medium security licences have been reduced to zero, high security licences will then be reduced.

The full announced allocation process is provided in Part 7, Clause 30 of the Plan.

Examples of announced allocations based on possible extraction limit scenarios are presented in Table 3.

Table 3: Example announced allocations based on possible extraction limits for the full development scenario.

Predicted Katherine River flow at 1 Nov	Environmental Allocation (ML)	Extraction limit (ML)	Total Security AA	High Security AA*	High Security Public Water Supply	Medium Security AA	Low Security AA*	Low Security Public Water Supply
0.6	29,044	4,340	100%	9%	0%	0%	0%	0%
1.0	44,511	11,128	100%	56%	0%	0%	0%	0%
1.3	50,632	21,699	100%	100%	100%	32%	0%	0%
1.6	62,316	26,707	100%	100%	100%	73%	0%	0%
1.9	74,000	31,714	100%	100%	100%	100%	31%	0%
2.2	85,684	36,631	1005	100%	100%	100%	100%	100%

5.2.8 Rules for water trading

The *Water Act* specifies that a Water Allocation Plan shall allow the rights to take or use water under licence to be traded in part or in full.

Water trading in the Plan refers to the temporary and permanent trading of water under a valid licence from one person to another. The traded water can be used in a different location, subject to some limitations specified in the Plan. For temporary trades, licensees will only be able to trade water in accordance with their current level of development and their announced allocation for that year. For example, if an efficiency gain is made, the licensee may wish to trade the volume of water saved to another user. It will not be acceptable for a licensee to trade water that is not being used because their proposed development is not being progressed.

Permanent water trading is only permitted under the Plan when the property development plan for which their water was allocated has been completed. If a licensee has invested fully in the development for which water was granted, it is reasonable to allow that licensee to trade water as a result of improved efficiency or decisions to reduce or change production.

Permanent trading is not permitted whilst a property development plan is still progressing as licences are subject to review and amendment in response to development progress. This is to ensure that water allocated is used for the indicated purpose and not simply traded for profit in the first instance. As detailed in section 5.2.9 of this document, the ability to review licences is an interim measure employed under the Plan to achieve the equitable distribution of water. It is intended that licences will be separated from land to facilitate permanent water trading when the Plan is renewed after 10 years.

The rules for water trading in the Plan have been devised to allow flexibility for the movement of rights without compromising environmental or cultural values. To manage local impacts due to temporary movement of extraction rights, two water management zones have been declared. Only 15% of the total extraction limit is permitted from Zone 1 in order to protect flows in the Katherine River. A trade into Zone 1 will only be permitted if the resultant extraction from this zone will not exceed 15% of the total extraction limit for that year. The extent of Zone 1 is based on the area where the impact of extraction on flows in the Katherine River would be noticed within 1 year. Management zones are shown in Schedule 5 of the Plan.

5.2.9 Reviewing and amending licenses

The licence limit specified in this Plan is 34,503ML/yr and the average extraction limit is 22,200ML/yr based on the period of record from 1961-2004. This means that if full development of licences is reached, the announced allocation process would reduce licences by approximately 12,000ML/yr under average recharge conditions. The reliability of licences (as explained in section 5.2.6) is compromised by the current licence limit because the demand exceeds the average availability of water. However, as the current level development of licences and issued under the Plan is low, reliability of these licences is at present much higher.

Licences under the Plan have been issued in good faith for a specified development at no cost. All landowners with proposed future developments have been given the opportunity to commence water dependent development. At this stage, it is not known which of these developments will progress as proposed.

The Plan encourages the sustainable development of licences but requires that water be recovered from licensees that do not meet their development targets. During the 5 year review, all licences volumes will be reassessed against their level of development. At the time of the review, if the progress of on-ground development is not in accordance with what was proposed by the licensee, the licence volume may be reduced. Extenuating circumstances that have affected the progress of the proposed development may be considered as part of the review.

The licence review process is specified in Part 8, Clause 37 of the Plan. Inefficient water use is discouraged because the review will not take into account water use, but rather the level and type of development that has been achieved. Those licensees that are developing as they proposed will not have their licence limit reduced unless all licences are required to be reduced to provide for any required changes to environmental and cultural flow provisions.

Any water recovered at the time of the licence review will be reallocated for the following purposes in order of priority:

5.2.9.1 Changes required to meet identified environmental and cultural flow requirements

In accordance with the *Water Act*, a Water Allocation Plan must be reviewed at intervals not longer than five years. During the review, the amount of water provided for environmental, Indigenous cultural and other river-based public benefit outcomes, may be modified if the results of the monitoring program, or new research findings demonstrate that it is necessary to do so. If more water is required to achieve specific environmental or cultural outcomes, any water recovered through the licence review process will first be reallocated for this purpose.

5.2.9.2 Accounting for an increase in demand from rural stock and domestic and other small volume groundwater users

The Plan estimates demand from rural stock and domestic and other small volume groundwater users as 1,128ML. A voluntary bore metering project is currently being implemented in the Darwin and Daly regions to provide a more accurate understanding of stock and domestic water use. The outcomes of this project will improve the estimation of stock and domestic water use requirements during the review of the Plan.

The estimated stock and domestic demand is based on 4 people per household (at 380 litres per person/per day), watering of 0.5 ha of lawn and 50 litres per day per head of cattle. This is considered a generous estimate and is likely to accommodate any additional stock and

domestic requirements for the life of the Plan. However, water recovered from licences may be used to account for any increase in demand by rural stock and domestic and other small volume groundwater users above what has been estimated in the Plan.

5.2.9.3 Providing water for future Indigenous economic development

At present, Indigenous owned or managed land overlying the Tindall Aquifer comprises less than 1% of the Plan area. Under the Plan, water is provided for existing Indigenous developments through five separate licences, including one used for agriculture and four used for industry at a total of 411ML/yr. Water for future Indigenous economic development has not currently been set aside in the Plan because there are no other Indigenous land holdings in the Plan area. In other water allocation planning areas, where Indigenous land holdings are present, processes are under development to ensure Indigenous people have access to water for economic development purposes on their land.

It is recognised that the provision of water for future Indigenous economic development is significant to Indigenous people to secure future opportunities for their livelihood. Consequently, if sufficient water is recovered as part of the licence review an allocation will be reserved for the purpose of future Indigenous economic development.

The Plan states that up 680ML of water recovered from licensees may be reserved for future Indigenous economic development. This is based on a pending Native Title application (NTD6002/99), which may result in the acquisition of additional land by Indigenous people within the Plan area. Should this application be successful, Indigenous owned land directly overlying the Tindall Aquifer within the Plan area will increase by approximately 2%. In relative terms, 2% of the licence limit represents 680ML/yr. This figure does not include land that may be acquired in areas unsuitable for development, such as Katherine Township.

Should Native Title be recognised as a result of application NTD6002/99 prior to the 5 year review process, 680ML will be made available for Indigenous economic development purposes on this land immediately through amendments to the Plan as provided for in Clause 35(vi). It is anticipated that this additional allocation would later be offset through the review process.

5.2.9.4 Improving reliability of licence security categories

As development and subsequently the demand for water increases, the reliability of supply to individual licences declines. For the first five years of this Plan licences are expected to be much more reliable than indicated under the Plan, because the current demand (estimated to be approximately 16,000ML) can be achieved under average recharge conditions. Reliability figures stated in the Plan are based on the full development scenario of 34,503ML.

Water recovered from licensees through the review process will be absorbed to reduce the overall demand and improve the reliability of all licence security categories. The licence reliability targets are 50% for medium security and 30% for low security. Once these thresholds are reached, water recovered may then be made available for other purposes.

5.2.9.5 Issuing new licences

The last priority for use of any water made available through the review process will be to issue new licences. Whilst it is not anticipated that sufficient water will be recovered to allow new licences to be granted, water can be accessed for new development in the Plan area through the provisions for water trading.

6. Water for Current and Future Consumptive Uses

Public Water Supply

Water from the Tindall Aquifer in addition to that sourced from the Katherine River at Donkey Camp Weir, allows a dual supply for public water to supply the township of Katherine and the Tindal RAAF Base. The ability to meet this demand (both current and future) is based on the combined reliability of these two sources. These two independent sources are necessary to maintain water quality, meet peak water demands and perhaps most importantly allow a diversity of supply enabling the full reliance on either one, in the event of infrastructure failure.

Historically, water use for public water supply from the Tindall Aquifer has ranged between 737ML/yr and 921ML/yr.

Future demand on the Tindall Limestone Aquifer through to 2018 has been established through a combination of operational water quality requirements affecting the blending ratio between the two sources and population projections according to the 2007 Australian Bureau of Statistics. Three scenarios have been developed to account for possible risks to the water supply.

The first scenario reflects a normal situation in which the expected operational requirements to meet the projected demand holds true. This requirement corresponds to the total security licence volume of 1,876ML as specified in Part 6, Clause 24 of the Plan.

The second scenario reflects a situation where supply from the Donkey Camp Weir in the Katherine River is unavailable for a short period (three months or less) and the water from the Tindall Aquifer is required to supply the total water requirements for this period. This additional requirement has been allocated as a high security licence in the Plan.

The third scenario reflects the worst case situation where supply from Donkey Camp Weir in the Katherine River is unavailable for a longer period (up to 12 months) and the Tindall Aquifer is required to supply the total water requirements for this period. This additional requirement has been issued as a low security licence under the Plan. In normal circumstances the low security licence will not be used for public water supply.

Agriculture

Prior to the commencement of the Plan, licences for agriculture had been issued with a combined total volume of 18,750ML/yr. A desktop mapping assessment utilising GIS and 2006 imagery, was undertaken to determine the current level of agricultural development within the Plan area. The assessment assumed the full development of all tree crops and represents the maximum water use requirements of all irrigated crops planted in 2006. The assessed maximum requirement at 2006 development was 12,456ML/yr.

The Plan allows for new and expanding agriculture over the next 10 years in the Katherine region. Future water requirements for agriculture were assessed via a framework developed in consultation with industry and the Katherine Water Advisory Committee, as described under section 5.2.6 of this document. Future water requirements for agriculture and industry were assessed at 30,427ML/yr in 2018. In the Plan, water is assigned for future agriculture and industry development according to three different licence security levels as follows: 14,869 ML/yr in high security, 12,064 ML/yr in medium security and 5,694 ML/yr in low security.

Aquaculture

Prior to the commencement of the Plan, licences were in existence for aquaculture totalling 108ML/yr. Extraction returns for 2006-2007 indicated that no water was actually used for this purpose. During the development of the Plan it was confirmed the licensed volume for aquaculture was no longer required. As such, the Plan does not allocate any water for aquaculture. However, water may be traded and used for this purpose if required.

Industry

Prior to the commencement of the Plan, licences for industrial purposes totalled 96ML/yr, whilst the estimated use for this purpose was actually 1,200ML/yr. The estimated use for industry purposes exceeded the valid licence volume because groundwater extraction not exceeding 15L/s was not required to be licensed prior to the declaration of the Katherine Water Control District in 2007. (NB: The Katherine Water Control District has since been replaced by the Daly Roper Water Control District). In the Plan water is assigned for industry development according to two different licence security levels, 114 ML/yr in high security and 1383 ML/yr in medium security.

Rural Stock and Domestic

Current and future water demands for rural stock and domestic users is difficult to accurately quantify as these users are not required to be licensed under the *Water Act* and are therefore not metered.

Current water requirements for rural stock and domestic use has been estimated using spatial records of bores extracting water from the Tindall Aquifer within the Plan area. An estimated volume (4.5ML/yr) based on a 4 person house (380 litres per person per day) and the watering of 0.5 hectares of lawn was applied to each of the bores being used for rural domestic purposes. 50 litres per head of cattle per day was used for stock purposes. These are likely to be generous estimates and the voluntary bore metering project currently being implemented in the Darwin and Daly regions will improve the accuracy of estimated stock and domestic water use. The current estimated requirement for rural stock and domestic and other small volume groundwater uses is 1,128 ML. Whilst this volume is not issued under licences is accounted for in the Plan as specified in Part 5, Clause 22.

Future water requirements for rural stock and domestic use have not been factored into the Plan, as current estimates are considered to already exceed the current requirement. If at the 5 year review it is determined that stock and domestic use exceeds the current estimate, there is provision for water recovered through the licence review process to offset this additional demand.

7. Adaptive Management

Adaptive management is a major feature of the Plan in that annual announced allocations are based on an extraction limit that varies with annual climatic conditions. Additionally, the Plan stipulates a monitoring program that seeks to assess the adequacy of the Plan's strategies in achieving its objectives.

Monitoring

Monitoring under the Plan is directed by its performance indicators. These are given in Part 3 of the Plan. The monitoring program provided in Appendix 2 of the Plan identifies how each of the objectives will be measured and respective reporting frequencies.

Extraction licences issued under the Plan will carry conditions including appropriate metering and reporting of usage. Most licences are required to report usage on a monthly basis. These reported usages are checked against licensed volumes and any major variations are investigated.

The Northern Territory Government maintains a network of monitoring bores and surface water gauging stations and is also responsible for resource investigation studies and water resource modelling. The Aquatic Health and Biodiversity Conservation Unit conduct ecological health monitoring and assessment including physical, biological and chemical monitoring to detect changes in ecosystem function.

The monitoring program will be further developed as part of an implementation strategy specifically for the Plan. The implementation strategy will tailor the monitoring program to ensure it adequately assesses the performance of the Plan as well as identifying where further research is required to better inform the five year review of the Plan.

Implementation

As specified in part 7 of the Plan, an implementation strategy will be developed to ensure the provisions made in the Plan are being achieved. The implementation strategy will provide a program for water resource and ecological health monitoring and reporting mechanisms as well as methods to improve community awareness about the Plan and compliance with licence conditions. It is intended that the implementation strategy be prepared within the 2009 water accounting year.

Review

All Water Allocation Plans have a maximum life of ten years and a maximum review period of five years. The review will draw on new research and developments in our conceptual understanding of the Tindall Aquifer, coupled with the outcomes of the monitoring program, to establish how the Plan may change and evolve to meet the needs of the future. This process will include an assessment of environmental and cultural water requirements and a review of the extraction limits and licence volumes currently provided under the Plan.

Compliance with the National Water Initiative

The Plan has been made in accordance with the NT Government's obligation to implementing the National Water Initiative (NWI). The National Water Initiative requires that Water Allocation Plans are developed to ensure the equitable distribution of water resources between competing uses, including environmental and cultural water requirements. The NWI includes a series of water management objectives that all states and territories in Australia have agreed to implement.

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Under the NWI, it is desirable that licences are issued in perpetuity and permanently tradable. Fixed term or other types of entitlements such as annual licences are to be issued only in cases where there is ongoing assessment of the risk of expected development and demand on resources is not well understood. This is deemed to be the case in the Katherine region, and as such licences issued for the 10 year life of the Plan, will remain tied to land tenure and are subject to review.

The level of licence development within the Plan area is varied, but is generally limited. Some licensees are fully developed, whilst others will not achieve full development for 10 years. It is estimated that in 2006, approximately 16,000ML was extracted from this resource for consumptive purposes, which is approximately 45% of the licence limit in the Plan. Issuing permanently tradable water licences at this point in time would most certainly result in some individuals unduly benefiting from the sale of water issued in good faith for a proposed development. As such, licences will only be tradable on an annual basis and the volume of water that may be traded under a licence will be in accordance with the level of on-ground development that has been achieved. When full development has been reached in accordance with the licensee's property development plan, permanent trading will be permitted.

Clause 33 of the NWI allows interim measures to be used with regards to issuing licences to achieve the equitable distribution of water among water users, and to allow the required time to gain knowledge and provide greater certainty for all water uses, including the environment.

8. References

General

Numerous references and other external sources of information have been used in the collation of the Plan and this Background document.

The following section outlines these specific sources, however should clarification be required for any aspect of this background document or the Plan enquiries should be directed to the Water Resources Branch, Katherine, in the first instance.

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Cadastre, Road centrelines, Town locations:
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Catchment Boundaries:
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