



Background Brief – Tindall Limestone Aquifer, Katherine February 2017

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1 Introduction

The Tindall Limestone Aquifer, Katherine is a high yielding source of good quality groundwater utilised for agricultural and industry enterprises, public water supply, domestic use and the maintenance of green spaces in the Katherine town area. The aquifer also sustains the dry season flows of the Katherine River and the Katherine Hot Springs, providing important cultural, recreational and environmental benefits.

1.1 Purpose of this report

The purpose of this report is to provide the Katherine Water Advisory Committee with an overview of the Water Allocation Plan for the Tindall Limestone Aquifer. The report may also be of interest to the Community more broadly.

This report includes the following:

- Context about water allocation planning in Australia and the Northern Territory (Section 2);
- A brief history of water planning for the Tindall Limestone Aquifer, Katherine (Section 2);
- The role of the Katherine Water Advisory Committee (Section 3);
- Details about water in the Katherine region, current allocations and usage (Sections 4 and 5);
- An overview of water resource monitoring undertaken for the Tindall Limestone Aquifer, Katherine (Section 5).

2 Context

2.1 Water Allocation Planning in Australia

Water Allocation planning is well established in many jurisdictions throughout Australia and internationally. The National Water Initiative (NWI) was established by the Council of Australian Governments in 2004 to create a national approach to water resource management. All States and Territories are signatories to the NWI which seeks to achieve the following:

- Transparent, statutory based water planning;
- More confidence for investment through defined water licence security and risks that may arise from future changes to water availability;
- Provision of water for environmental flows and other public benefit outcomes;
- Provision of water to meet the needs of Indigenous people;
- Water trading for more profitable use of water;
- Enhanced water use efficiency in urban and rural areas;
- Water use metering to provide accurate information for planning and management;
- Recognition of the connectivity between surface and groundwater.

2.2 Water Allocation Planning in the Northern Territory

The Northern Territory is a signatory to the National Water Initiative and is committed to developing water allocation plans for water resources where current or potential water use could pose a possible risk to the ongoing availability and/or health of the resource.

The NT Water Act 1992 (the Act) is the legislation which provides for the investigation, allocation, use, control, protection, management and administration of water resources by the NT Government. This includes the protection of water supply to environmental, recreational, social and cultural uses. Water Allocation Plans are declared under Section 22 B of the Act. The Act also allows the creation of Water Advisory Committees, to ensure stakeholder input into the development of water allocation plans.

Table 1 gives an overview of the Water Allocation Planning Process.

Table 1 DENR Water Allocation Planning Process

Phase	Objective	DENR Planning activities	Consultation
Problem definition	Define purpose and objectives for water management within the Water Allocation Plan Area	Articulate purpose & objectives consistent with the Water Act, the NT water policy framework and NWI Confirm beneficial uses for water in the WCD	Identify stakeholders Establish WAC Stakeholders consulted (e.g. on beneficial uses)
Information	Obtain research / evidence based understanding of water availability (supply), water use (demand) and water dependent assets (environmental & cultural)	Assessment / modelling of water resource characteristics Assessment of current and forecast demand Identification of water dependant environmental and cultural assets	Information sought from stakeholders regarding forecast demand Consult with Indigenous people and other relevant stakeholders to identify cultural assets
Alternatives	Generate one or more plan alternatives (e.g. sustainable yield or water allocation scenarios)	Preparation of one or more planning scenarios	Stakeholders input into formulating planning scenarios
Assessment	Assess plans against key criteria (including policy purpose & objectives)	Model scenarios (e.g. varying levels of water extraction) to evaluate possible impact on water sources and water dependent assets Objectively assess options against key policy criteria	Stakeholders invited to provide feedback on options
Decision	Final water allocation plan, including sustainable yield and water allocations decided	DENR team consider assessment of options and provide preferred plan to the Controller of Water Controller of Water may accept the proposed plan or request changes (return to assessment stage) The Minister may approve the plan (after the Controller of Water has	Stakeholders informed

		approved) or may request changes	
Review	Manage risk and uncertainty in planning; noting the inherent limitations of water supply / demand modelling to accurately predict future consequences	Monitor plan implementation and impacts / response of water extraction Undertake review, within 5 years, using the above process (commencing at information phase). Review will account for new knowledge or improved understanding of water resources including their response to extraction	Stakeholders engaged as per above steps

2.3 Water Allocation Planning for the Tindall Limestone Aquifer, Katherine

The Tindall Limestone Aquifer is a geological formation that directly underlies Katherine. It is a source of good quality water utilised for agricultural and industry enterprises, public water supply, domestic use and the maintenance of green spaces in the Katherine town area. The aquifer also sustains the dry season flows of the Katherine River, providing important cultural, recreational and environmental benefits.

The aquifer extends well beyond the town of Katherine and is the lower-most unit of the Daly Geological Basin. The aquifer is recharged where it outcrops at the margins of the Daly Basin. In the area around Katherine, the aquifer is managed under the Water Allocation Plan for the Tindall Limestone Aquifer, Katherine. The Plan recognises the connection between the aquifer and the Katherine River and sets out management strategies to ensure that groundwater is available to sustain the existence and growth of the community whilst protecting environmental and cultural values.

The Plan was originally declared in 2009. A mid-term review occurred in 2015 and resulted in a new Plan that was declared in April 2016. The review was undertaken in consultation with the Katherine Water Advisory Committee whose members were appointed for the review. The Plan expires in August 2019.

3 Katherine Water Advisory Committee

3.1 Role of the Committee

The Katherine Water Advisory Committee was formed by the Minister for Environment and Natural Resources to improve the effective implementation of the plan over its remaining lifetime. The Committee will discuss matters such as new research, water resource investigations, monitoring programs, water trading and 'use it or lose it' policies as well as general licence holder compliance issues. In addition, the Committee will provide a point of contact and exchange for stakeholder concerns and interests in the sustainable use and conservation of the Tindall Limestone Aquifer, Katherine. The Committee will also provide advice and recommendations on the development of a new Plan for this water source, in preparation for its expiry in 2019.

3.2 Committee Members

Nominations for the Katherine Water Advisory Committee were sought in October 2016. Thirteen members have been appointed by the Minister for Environment and Natural Resources and they provide a broad representation of stakeholder and community interests. The members of the Committee are listed in Table 2 (over page).

Table 2 Members of the Katherine Water Advisory Committee

Name	Representation
Marie Piccone	Chair and Horticulturalist
Warren De With	AFANT Representative
Allister Andrews	Jawoyn Association Representative
Alison King	Aquatic Ecologist
Michael Jerram	Tourism Representative
Rick Fletcher	Regional Development, Northern Land Council
Marie Allen	Wardaman IPA Representative
Peter Rix	TFS Corporation Representative
Peter Marks	Horticulturalist and Community Member
Shane Papworth	Public Water Supply
Neal Adamson	Department of Defence Representative
Steven Rose	Katherine Town Council Representative
Charmaine Roth	Community Member

4 Water in the Katherine Region

There are three main aquifers in the Katherine region. These aquifers are all formed in geological units of the Daly Basin. The lower most aquifer is the Tindall Limestone Aquifer. This aquifer outcrops at the edges of the Daly Basin and is confined towards the centre of the basin. The Tindall Limestone Aquifer is overlain by the Jinduckin Formation which provides a confining layer over much of its extent. Aquifers in the Jinduckin Formation are generally lower yielding and of poorer quality than the Tindall Limestone Aquifer. The Ooloo Dolostone Aquifer overlies the Jinduckin Formation. The Ooloo Dolostone Aquifer is confined in some areas by the Florina Formation.

Where the aquifers outcrop, they receive recharge from rainfall. The aquifers can also discharge to rivers when they are outcropping. The Tindall Limestone Aquifer, Katherine provides important baseflows to the Katherine River via springs and seepage. The Ooloo Dolostone Aquifer also provides flows to the Katherine Rivers and very significant flows to the Daly River. In the Dry Season, groundwater discharge from the aquifers is critical for maintaining river flows and the ecosystems and cultural values that make our region such a special place to live and visit.

Figure 1 is a map of the aquifers underlying the Daly River catchment. The Tindall Limestone Aquifer, Katherine is the part of the Tindall Limestone Aquifer that is bounded by the Katherine River catchment.

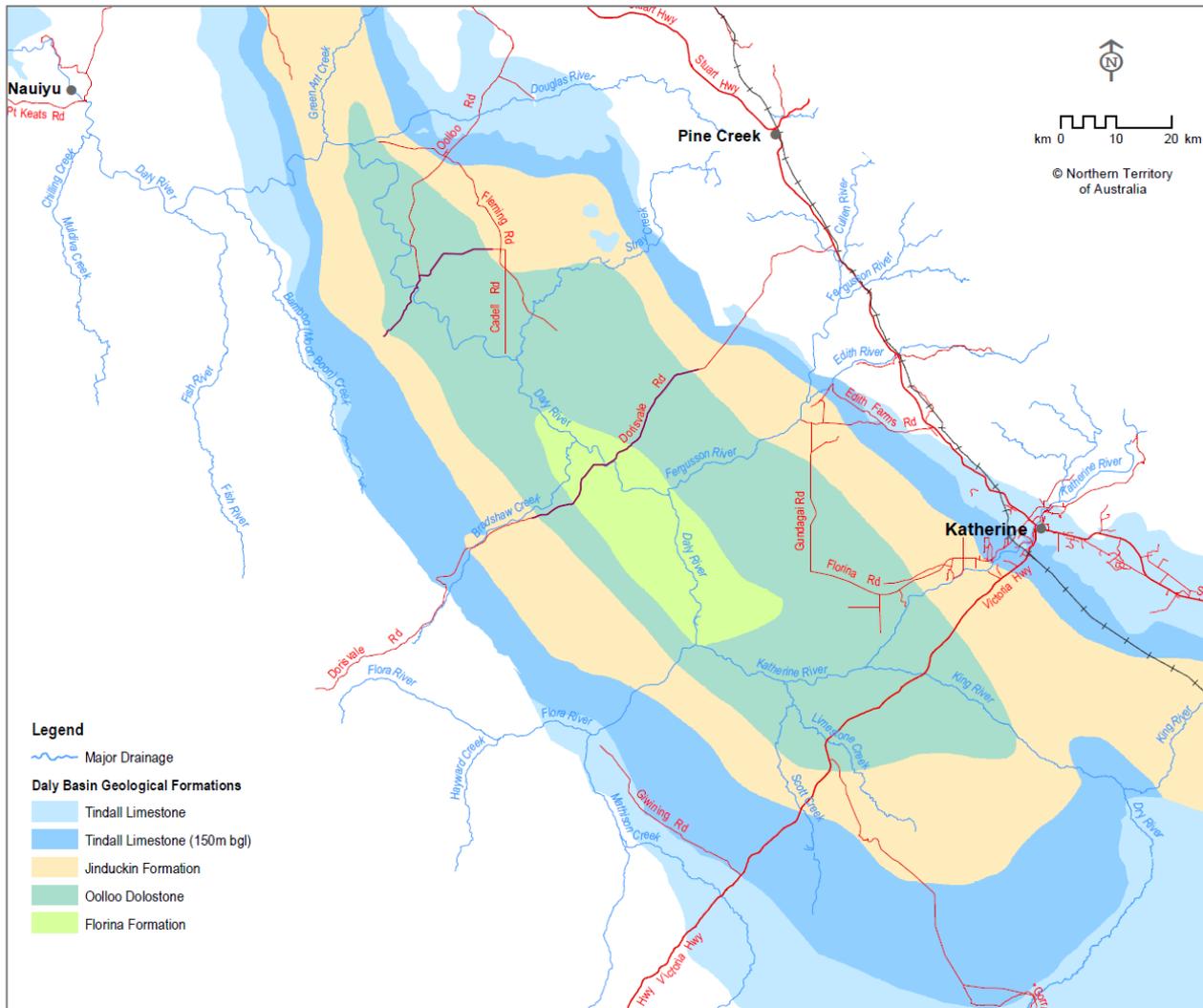


Figure 1 Map of the aquifers underlying the Daly River catchment

5 Tindall Limestone Aquifer, Katherine

5.1 Planning Area

The Water Allocation Plan for the Tindall Limestone Aquifer, Katherine covers the groundwater within the Tindall Limestone Aquifer Katherine underlying the Katherine River Catchment. The aquifer lies wholly in the Daly-Roper Water Control District which was declared in 2008. The Daly Roper WCD is an administrative boundary declared under section 22 of the Water Act. A water allocation plan can only be made for an area that lies within a declared WCD. Water allocation in the aquifer is intrinsically related to water allocation decisions throughout the Katherine River region groundwater and surface water systems. These relationships are taken into account by the Plan however the management instruments of the Plan are defined for the groundwater only.

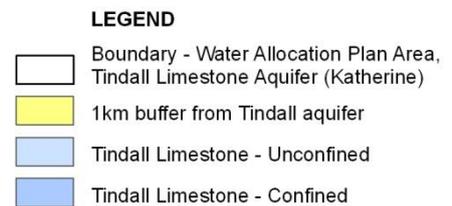
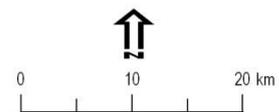
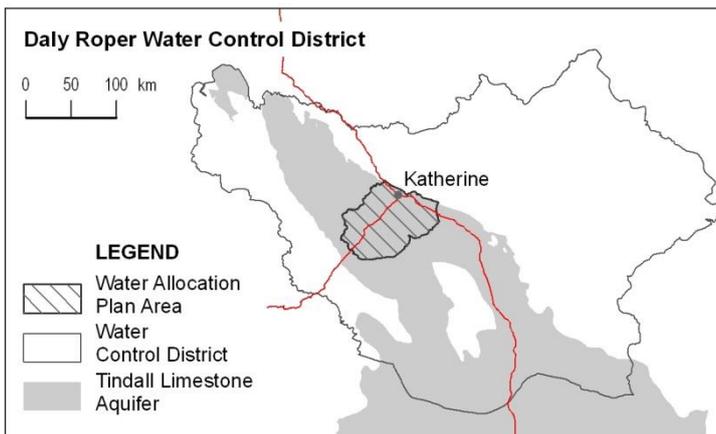
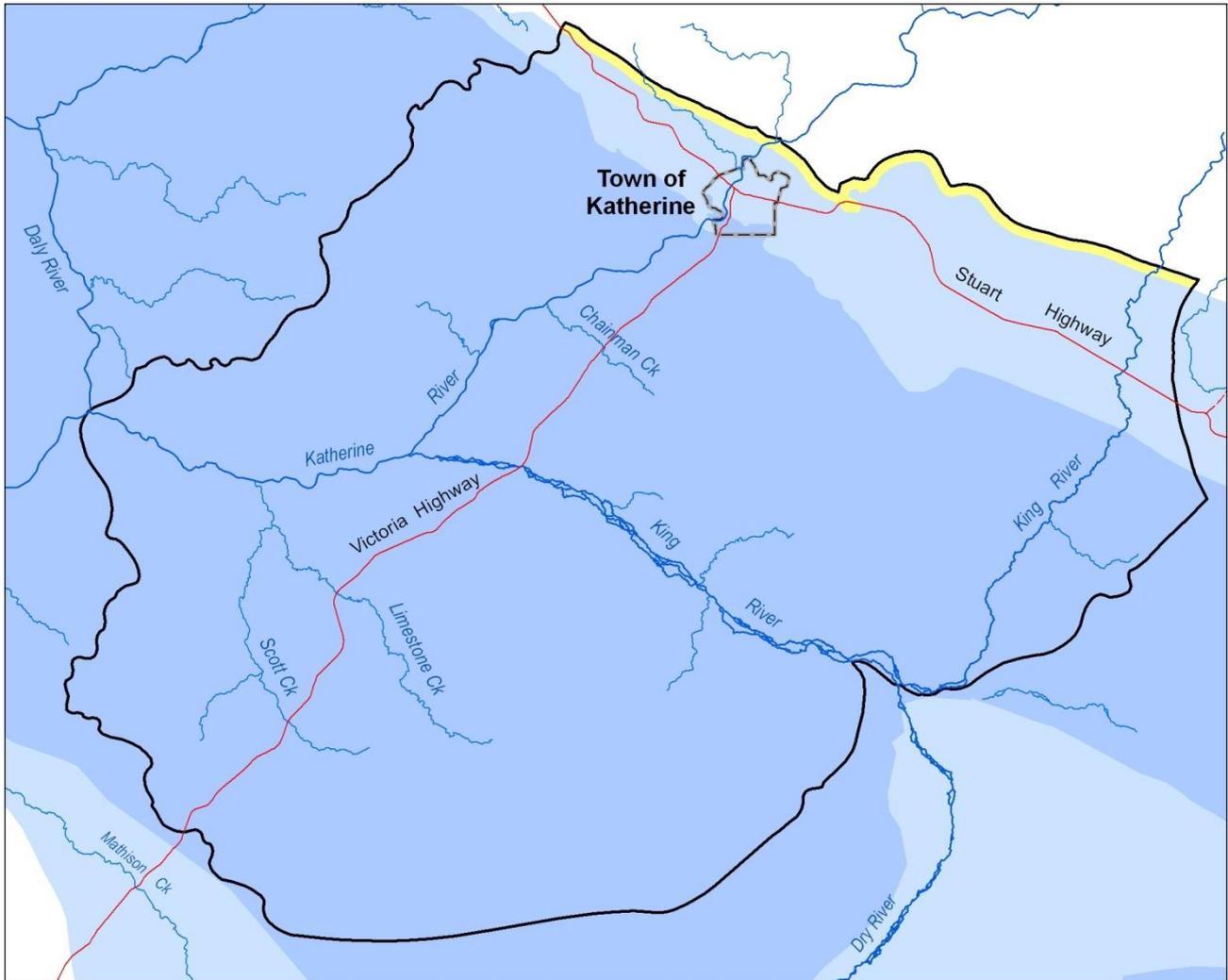


Figure 2 Plan area showing the extent of the confined and unconfined Tindall Limestone Aquifer within the Katherine River Catchment

5.2 Groundwater of the Tindall Limestone Aquifer, Katherine

When rain falls on land, some water evaporates, some flows to streams and rivers, and some seeps into the soil and is absorbed by plant roots. Excess water in the soil may percolate further down until it reaches a level known as the water table where all the pores or fractures in the sediment or rock are

saturated with water. Water in the saturated zone below the water table is called groundwater. Where the sediment or rock type show similar characteristics within the saturated zone, this is called an aquifer. Figure 2 shows a conceptual groundwater diagram.

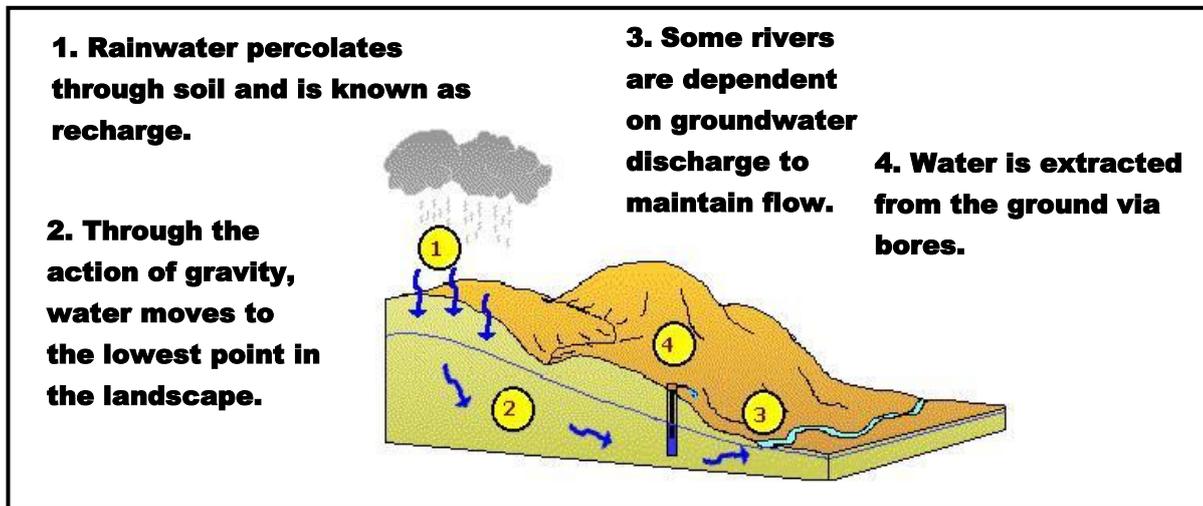


Figure 3 Conceptual Groundwater Diagram

Water is stored and transmitted within the fractures and cavities of the Tindall Limestone Aquifer, which range in size from submillimetre-scale up to the size of caves and caverns. Water can flow relatively easily through these features and bores can extract water at rates of 50 L/s or more.

As described in Section 4, the Tindall aquifer is largely confined by younger geological formations. Recharge is highest in the unconfined areas and negligible where it is confined by the Jinduckin Formation. Even in the unconfined areas, recharge can be reduced where overlying cretaceous rocks are present.

The groundwater flow paths within the Tindall aquifer occur parallel to the edge of the Daly Basin and towards the streams that cut across the basin. In the central part of the Daly basin, where the Tindall aquifer is at considerable depth, only minor flow occurs.

Discharge zones are mainly located along the major rivers where the aquifer is unconfined, and comprise both karstic springs and more diffuse streambed discharge.

A conceptual model of groundwater flow in the Tindall Limestone Aquifer, Katherine is shown in Figure 4 Conceptual Model of the Tindall Limestone Aquifer, Katherine Figure 4.

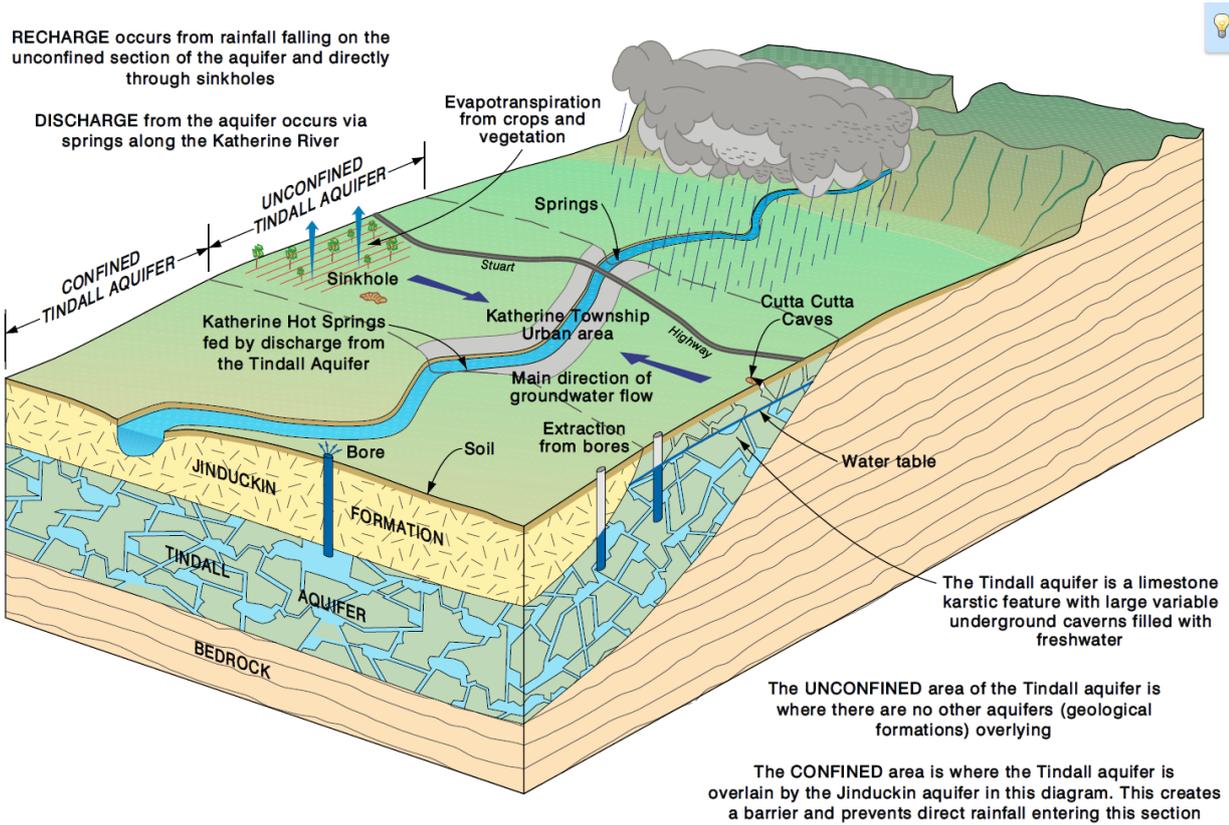


Figure 4 Conceptual Model of the Tindall Limestone Aquifer, Katherine

5.3 Beneficial Uses

The Act requires that Water Allocation Plans allocate water to beneficial uses. Beneficial uses summarise the different purposes for which water is used and valued. They are separated into two categories; non-consumptive uses and consumptive. Non-consumptive use is the water necessary for maintaining environmental and cultural values. Consumptive use is the water that is extracted for consumptive purposes and will only be allocated after the non-consumptive uses have been met.

The Beneficial Uses of the Tindall Limestone Aquifer, Katherine are shown in Table 3.

Table 3 Tindall Limestone Aquifer, Katherine Beneficial Uses

Non-Consumptive Beneficial Uses	Consumptive Beneficial Uses
Environmental	Public Water Supply
Cultural	Rural Stock and Domestic
	Agricultural
	Industry

5.4 Environmental Water Requirements

River flows are critical for the survival and function of ecosystems as well as the maintenance of social and cultural values. The Katherine and Daly Rivers rely on groundwater discharge from the Tindall

Aquifer to maintain flow all year round. To ensure this continues, the Plan protects a significant percentage of discharge from the Tindall Aquifer every year for this purpose. Rainfall and groundwater recharge and discharge varies from year to year. The proportion of water preserved for the environment varies from year to year, depending on whether the year is very dry, dry or normal to wet:

- During very dry years, 87% of the groundwater discharging into the Katherine River is reserved for environmental and other river-based public benefit outcomes whilst 13% is available for extraction. Very dry years are years for which modelling predicts that the flow in the Katherine River at Katherine Railway Bridge on November 1 will be less than or equal to 0.6 m³/sec.
- During dry years, 80% of the groundwater discharging into the Katherine River is reserved for environmental and other river-based public benefit outcomes, whilst 20% is available for extraction. Dry years are years for which modelling predicts that the flow in the Katherine River at Katherine Railway Bridge on November 1 will be less than or equal to 1 m³/sec.
- During normal to wet years, 70% of the groundwater discharging into the Katherine River is reserved for environmental and other river-based public benefit outcomes whilst 30% is available for extraction. Normal to wet years are years for which modelling predicts that the flow in the Katherine River at Katherine Railway Bridge on November 1 will be greater than 1 m³/sec.

5.5 Extraction Limits

The Water Allocation Plan for the Tindall Limestone Aquifer, Katherine specifies a maximum extraction limit of 38,391 ML/year.

Annual Extraction Limits are also specified in the Plan in order to maintain the environmental flows of the Katherine River as described in Section 5.4 above.

5.6 Current Water Entitlements

5.6.1 Stock and Domestic Entitlements

The Water Allocation Plan for the Tindall Limestone Aquifer, Katherine allocates a maximum volume of 1,300 ML/year to stock and domestic and other small volume (<5ML/yr) groundwater uses. Whilst these entitlements do not require licencing, 84 ML/year of stock and domestic entitlements have been licenced. Stock and Domestic entitlements have been licenced in cases where licence holders were extracting groundwater for both stock and domestic use as well as another consumptive beneficial use such as agriculture and that extraction was recorded by the same meter.

Current use of the aquifer by rural stock and domestic and other small volume groundwater users is estimated to be 1,243 ML/yr.

Under the Plan, Bore Construction Permits for new stock and domestic water supplies will only be granted up until the estimated use is 1,300 ML/year.

5.6.2 Licence Security Levels

There are six Licence Security Levels in the Tindall Limestone Aquifer, Katherine:

- Public Water Supply Total Security
- Public Water Supply High Security
- Public Water Supply Low Security

- High Security
- Medium Security
- Low Security

Licence Security Levels were specified according to seniority:

- High Security Licences were issued for all existing developments at the commencement of the Planning process in 2009. The volume issued under these high security licences was based on water required for any existing crops at 2007 to reach full maturity;
- Medium Security Licences were issued where additional development was proposed on an NT Portion as part of a property development plan that was partially complete at 2007.
- Low Security Licences were issued in accordance with a property development plan on an NT Portion where no development had commenced.

5.6.3 Licence Entitlements and Reliabilities

There are 72 licences that authorise a maximum annual extraction volume of 35,377 ML/ year including 84 ML/yr of licenced Stock and Domestic Entitlement. Figure 5 provides an overview of licenced entitlements in the Tindall Limestone Aquifer, Katherine.

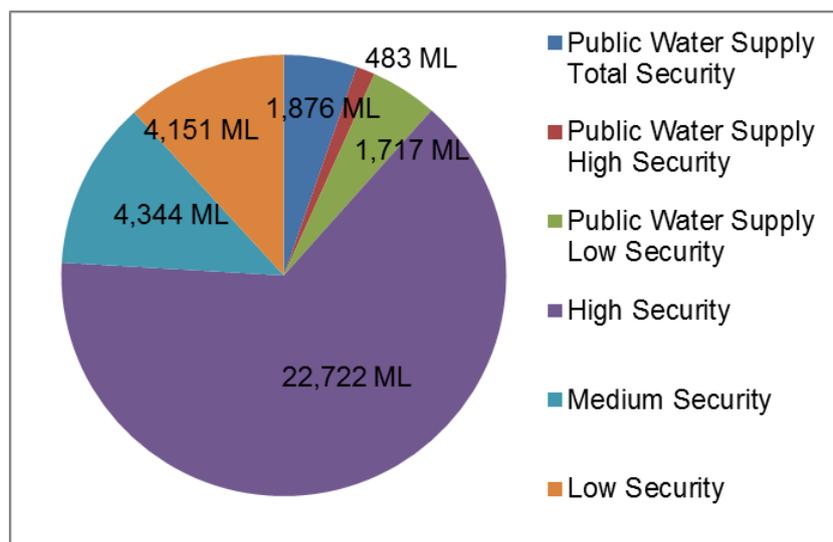


Figure 5 Licenced entitlements in the Tindall Limestone Aquifer, Katherine by Security Category

Licence Reliability is a percentage number representing how many years the maximum volume of licence entitlements would have been available in full under the same aquifer recharge and river flow conditions for a specified period. The Plan sets out the following objectives for long-term licence reliabilities based on the assessment period 1960-2007:

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

Licence Reliabilities have been estimated for the current levels of allocation for the specified period of 1986-2015 (the most recent 30 year period). Table 4 provides the reliability estimates for each licence security level.

Table 4 Licence Reliabilities

Security Level	Reliability
Public Water Supply Total Security	100%
Public Water Supply High Security	87%
Public Water Supply Low Security	50%
High Security	87%
Medium Security	70%
Low Security	60%

5.7 Annual Announced Allocations

The amount of groundwater that flows into the Katherine River is determined by the balance between seasonal recharge and the water extracted from bores for consumptive beneficial uses. The Department uses an integrated groundwater and surface water model of the Katherine - Daly River Region to predict the late dry season flow each year, using the amount of rainfall received over the previous wet season.

The Plan specifies the volume of water that can be extracted by licences each year, according to the late dry season November 1 flows predicted for the Katherine River. The volume of water that can be taken is announced each year on May 1st.

Table 5 summarises the Annual Announced Allocations for all years since 2011.

Table 5 Annual Announced Allocations 2011-2017 by Security Level

Licence Security	2011/2012	2012/13	2013/14	2014/15	2015/16	2016/17
Public Water Supply - Total	100%	100%	100%	100%	100%	100%
Public Water Supply - High	100%	100%	100%	100%	100%	100%
Public Water Supply - Low	100%	100%	100%	26%	0%	0%
High	100%	100%	100%	100%	100%	100%
Medium	100%	100%	100%	100%	100%	100%
Low Security	100%	100%	100%	100%	69%	64%

5.8 Estimated Water Use

5.8.1 Stock and Domestic

Current use of the aquifer by rural stock and domestic and other small volume groundwater users is estimated to be 1,243 ML/yr.

5.8.2 Licences

Licence holders are required to report their 'pumpage' (water use) on a monthly basis. Table 6 shows the total reported use for the 2015/16 Water Accounting Year. The table also shows the volume of estimated use. It is evident that there is a significant volume of unused water entitlement in the Tindall Limestone Aquifer, Katherine. Encouraging best use of unused water will be a theme of discussion with the Katherine Water Advisory Committee.

Table 6 Reported and Estimated Use 2015/16

2015/16 Extraction Limit: 32,325 ML	Volume of water used ML/ Year	Volume of water used as a percentage of the 2016/17 Extraction Limit
Total Reported	6,508	20%
Total Unreported (Estimated) ¹	3,430	11%
Total Reported and Estimated	9,938	31%

5.9 Water Trading

The Water Allocation Plan for the Tindall Limestone Aquifer, Katherine specifies rules for trading groundwater entitlements within the aquifer. There has been one application for trade of groundwater entitlement.

Enhancing groundwater trading in the Northern Territory is a key priority for the Department. There is opportunity for trading of water entitlements in the Katherine Region given the low level of water usage relative to licenced entitlements.

5.10 Compliance Monitoring

Licence holders are required to comply with the Terms and Conditions listed on their licence. Among other things, these conditions specify that a licence holder must not exceed their annual extraction limit, that all extractions must be metered and that extractions must be reported to the Controller of Water

¹ Water use was estimated for licences which had not reported pumpage and where it is reasonable to assume that the licence holder is extracting water e.g. where no pumpage is reported but the NT Portion has crop coverage such as mango trees. In these cases, pumpage was estimated by finding the area of the crop from the most recent available aerial photography and multiplying this area by the Department of Primary Industry and Resources crop water use estimate for the crop. In a few cases where licence holders had begun reporting pumpage in the 2016/17 water accounting year, the estimate was based on this reported pumpage.

Resources on a monthly basis. The metering and reporting of groundwater extractions is key to having the information required to sustainably manage this important community asset.

Table 7 provides an overview of the level of compliance with metering and reporting terms and conditions for the 72 licences in the Tindall Limestone Aquifer, Katherine.

Table 7 Overview of compliance with metering and reporting terms and conditions

Metering	
Fully Compliant	53
Partially Compliant	10
Non-Compliant	9
Pumpage Reporting	
Compliant	53

In 2015/16, Water Regulatory Officers inspected 55 of the 72 licences in the Tindall Limestone Aquifer, Katherine. Inspection of Water Extraction Licences aims to gather information to verify compliance with licence terms and conditions of licences as well as to provide a point of contact for licence holders to receive information about water resource management and their obligations and responsibilities as licence holders. Compliance strategies are broadly represented by the Compliance and Enforcement Pyramid defined in the National Framework for Compliance and Enforcement Systems for Water Resource management (Figure 6). Water Regulatory Officers place greatest effort in investigation and education to encourage and assist compliance.

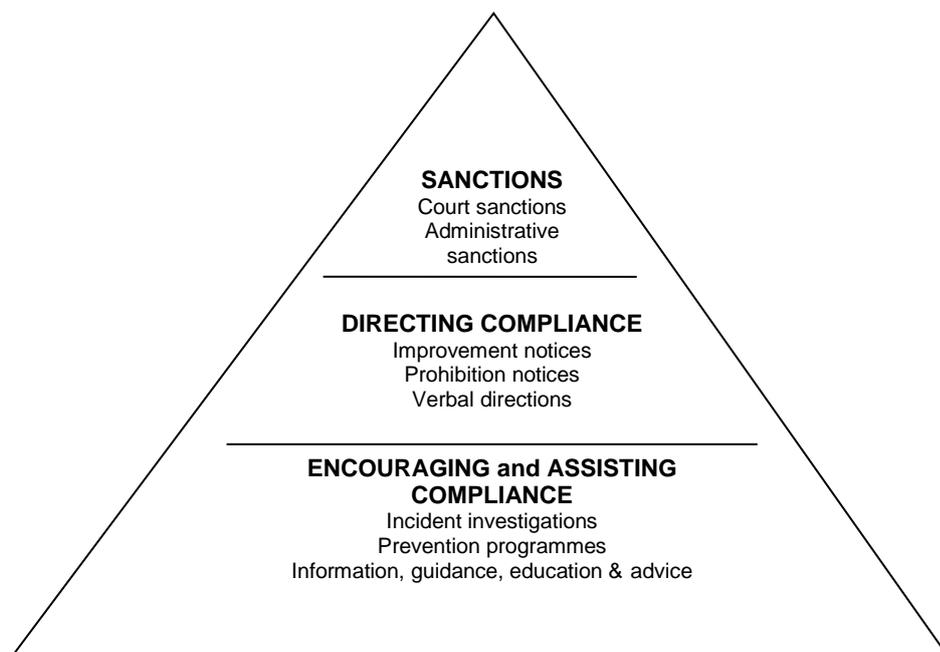
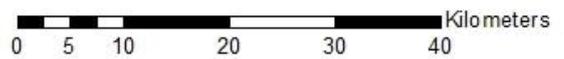
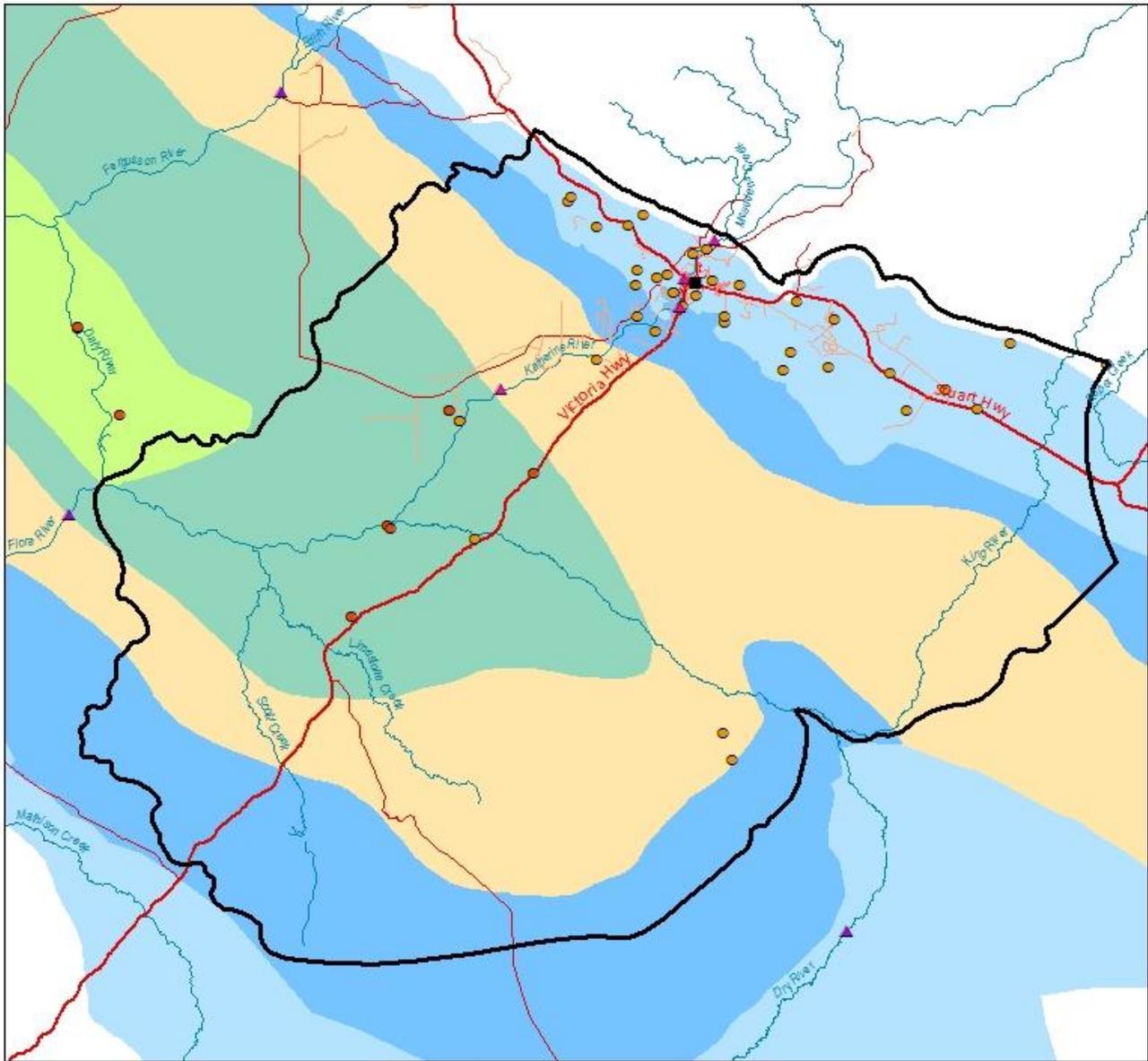


Figure 6 Compliance and Enforcement Pyramid – National Framework for Compliance and Enforcement Systems for Water Resource Management

5.11 Water Resource Condition Monitoring

The Department of Environment and Natural Resources undertakes dedicated monitoring of the groundwater and the surface water system throughout the Daly Basin including the Katherine River and the Tindall Limestone Aquifer, Katherine. This includes general water quality parameters as well as groundwater levels and stream flows. These datasets are a long-term investment that is essential for monitoring the condition of our water resources and for ongoing water resource assessment work. The data is made publically available through the NT Water Data Portal (<https://nt.gov.au/environment/water/water-data-portal>).

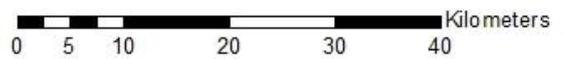
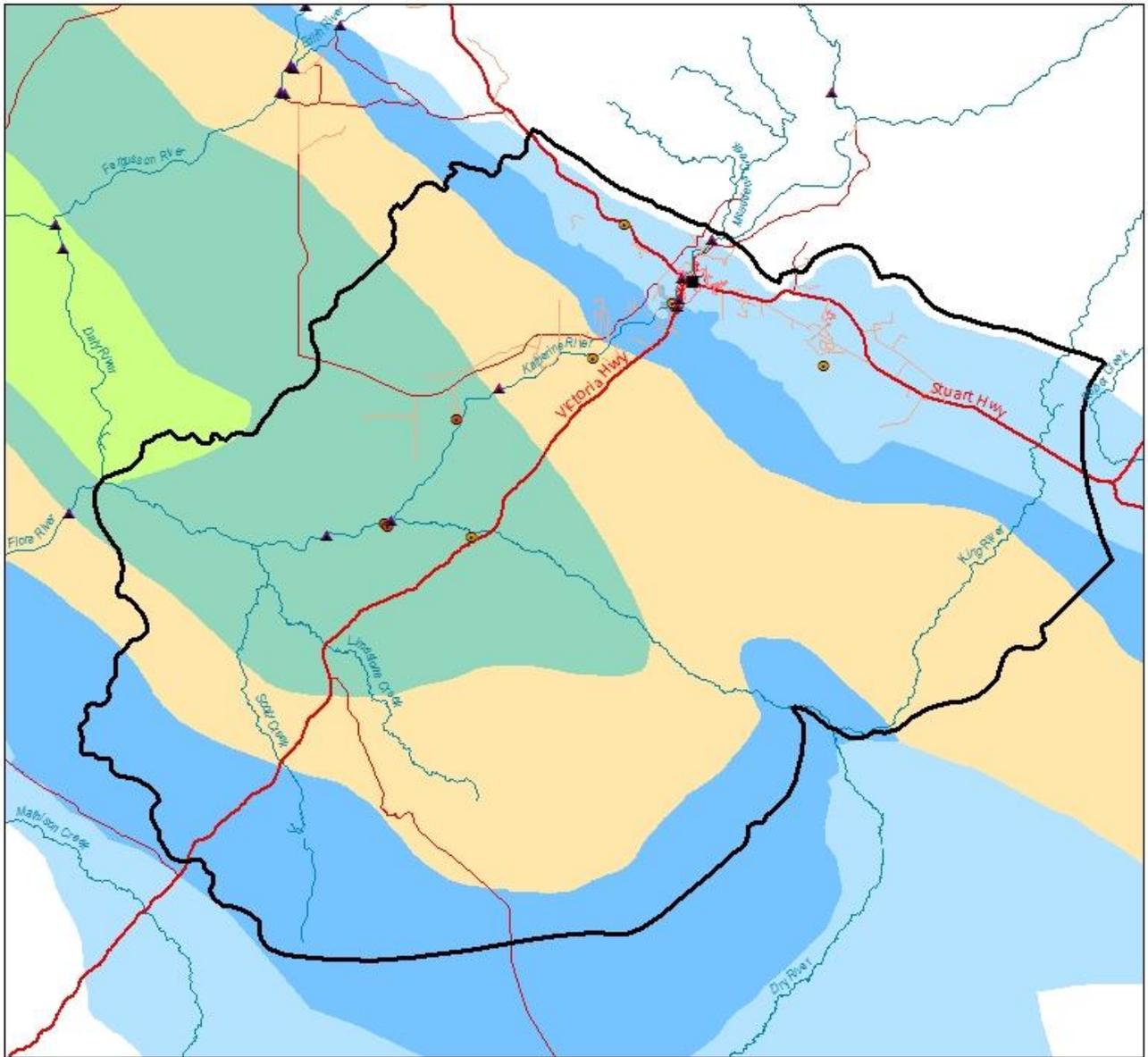
Figure 7 and Figure 7 are maps of the surface water and groundwater monitoring sites for the Water Allocation Plan for the Tindall Limestone Aquifer, Katherine.



Legend

- | | | |
|---|------------------------------|---|
| Tindall Limestone Aquifer, Katherine WAPA | Tindall Limestone | <i>Fractured and cavernous aquifer largely unconfined</i> |
| River Flow Monitoring | Tindall Limestone (150m bgl) | <i>Confined by Jinduckin Formation</i> |
| Katherine Tindall Water Allocation Plan | Jinduckin Formation | <i>Minor interbedded limestone, fractured and cavernous</i> |
| Ooloo Water Allocation Plan | Ooloo Dolostone | <i>Major widespread cavernous aquifer</i> |
| River Level Monitoring | Florina Formation | <i>Limestone locally cavernous</i> |
| Katherine Tindall Water Allocation Plan | | |
| Ooloo Water Allocation Plan | | |
| Groundwater Level Monitoring | | |
| Katherine Tindall Water Allocation Plan | | |
| Ooloo Water Allocation Plan | | |

Figure 7 Groundwater and River Monitoring Program – Flows and Levels



Legend

- | | | |
|---|------------------------------|---|
| Tindall Limestone Aquifer, Katherine WAPA | Tindall Limestone | <i>Fractured and cavernous aquifer largely unconfined</i> |
| River Quality Monitoring | Tindall Limestone (150m bgl) | <i>Confined by Jinduckin Formation</i> |
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| ▲ Ooloo Water Allocation Plan | Ooloo Dolostone | <i>Major widespread cavernous aquifer</i> |
| Groundwater Quality Monitoring | Florina Formation | <i>Limestone locally cavernous</i> |
| ● Katherine Tindall Water Allocation Plan | | |
| ● Ooloo Water Allocation Plan | | |

Figure 8 Groundwater and River Monitoring Program – Water Quality

5.12 River Flow and Groundwater Levels

Figure 9 shows the river flows measured at Katherine Railway Bridge, Low Level and Wilden. Gaugings are collected at Low Level at least twice a year. Continuous monitoring occurs at Katherine Railway Bridge so there is a continuous record of streamflow at this monitoring site. A river monitoring site was established at Wilden in 2008 and so there is now continuous stream flow data available at Wilden since 2008. All the groundwater discharge from the Tindall Limestone Aquifer to the Katherine River is captured by these stream gauges. Figure 9 shows that the river flows continuously throughout the dry season. The minimum flows in the river can be visualised by drawing a line between the lowest points of all the measurements for each gauge.

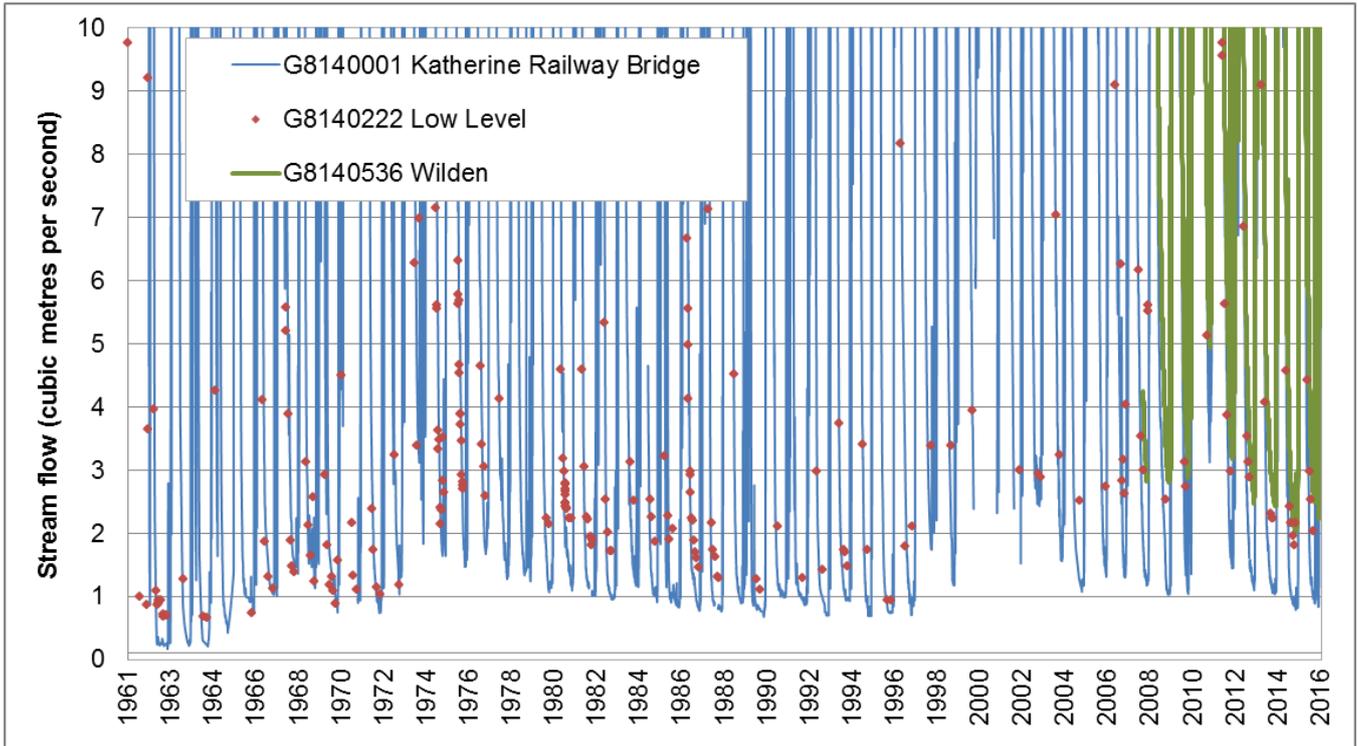


Figure 9 Measured stream flow of the Katherine River at Katherine Railway Bridge, Low Level and Wilden.

Figure 10 shows measured groundwater levels at two locations in the Tindall Limestone Aquifer Katherine.

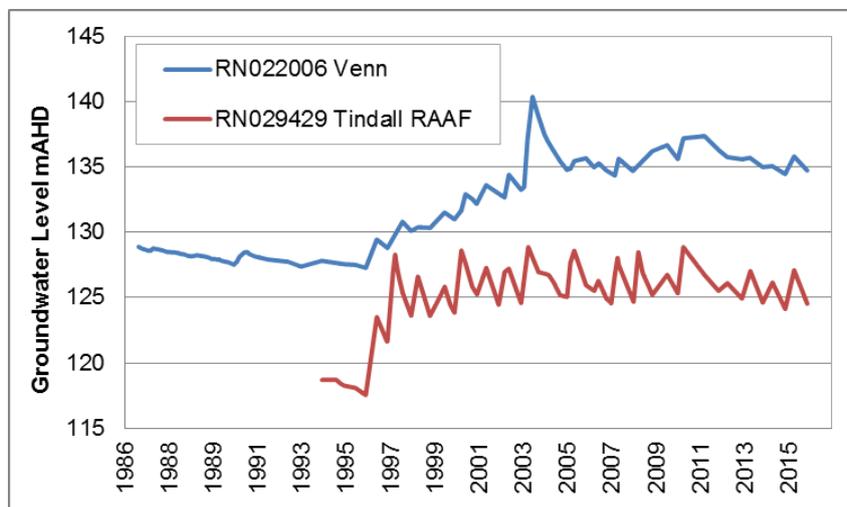


Figure 10 Groundwater levels in the Tindall Limestone Aquifer, Katherine

6 Timetable for Plan Implementation and Review

The focus of 2017 will be ongoing implementation of the Water Allocation Plan. Feedback during the mid-term review of the Plan indicated that stakeholders think that better communication and engagement about the Plan and how it is being implemented is required. Forming the Katherine Water Advisory Committee is a key step to opening lines of communication with the community about water resource management in our region. The Katherine Water Advisory Committee will meet three times in 2017 and will be an important link between the Department and key stakeholders.

In 2018, a review of the Water Allocation Plan will be conducted. This will assess how well the Outcomes and Objectives of the Plan have been met by evaluating the performance indicators and measures set out in the Plan. This will be a critical piece of work to inform the Committee's work to develop a new Water Allocation Plan by August 2019.