Northern Territory Government

DEPARTMENT OF LAND RESOURCE MANAGEMENT

End of Dry Season Stream Flow Measurements, Roper River, October 2014

Report .13/2015D

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May 2014

Report to provide an overview of monitoring undertaken in support of Water Allocation Planning assessments.

Bibliographic Reference
Wagenaar, D (October 2013), End of dry stream flow measurements, Katherine and Daly River, October 2014, Northern Territory Government Department of Land Resource Management, Technical Report No. 11/2013D

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Cover photo: Falls on Roper River Downstream of Mataranka Homestead G9030176. Sean Lawrie

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Summary

A snapshot monitoring exercise was conducted along the Roper River between the 13th and 30th Oct 2014 to identify spring and river flows, water quality and groundwater levels at the end of the 2014 dry season.

Collected data provides quantitative values for comparison against results from similar snapshot measurement exercises conducted in previous years and at the commencement of the 2014 dry season. The October 2014 stream flows at two primary monitoring locations are above the average annual minimum flows from 1961 to 2013. However annual minimum flows, particularly at the bottom of the river system have steadily declined since 2011.

Recharge patterns identified during this October 2014 exercise, support similar trends seen in previous end of dry monitoring exercises, conducted in October 2009 and 2013.

Aim

Late dry season snapshot measurements were undertaken on the Roper River to establish water quality and quantity conditions at the end of the dry season when river flows are at their annual minimum.

Snapshot measurements are used to:

1. Refine and calibrate hydrological models used to assess resource availability and impact of extraction allocations.
2. Verify model predictions at key river locations used for announced allocations on 1st May each year.
3. Refine the location of aquifer recharge/discharge zones along the river, and
4. Provide a dataset of comparable flow and water quality measurements at identical periods in the annual water cycle.

Introduction

Rising in the Mataranka area of the Northern Territory, the Roper River flows eastwards for 250 kilometres before discharging into the Gulf of Carpentaria. This study looks at the late dry season flow profile of the river with specific focus on headwaters which pass over the carbonate rocks of the Palaeozoic aged Daly Basin. The basal formation of the basin, the Tindal Limestone, forms a regional scale fractured and karstic aquifer representing the primary aquifer discharge zone. Groundwater discharges into the river as it cuts through the unconfined aquifer maintaining stream flow throughout the dry season.

A draft Water Allocation Plan (WAP) has been developed for the Tindal Limestone (Mataranka) aquifer to ensure water allocation is undertaken in a sustainable manner. The monitoring program developed in support of the WAP ensures that models used to predict the impact of future water use, are continually refined and calibrated, providing transparency and confidence to water licensing decisions. Monitoring data is critical for accurate assessment of the plan objectives. . The monitoring framework primarily consists of two data categories.

- Continuous data generated by data loggers connected to automated sensors, collecting parameter values on a fixed time or event driven basis. While expensive to collect, this data provides a time based continuous record, ideal for detailed analyses of variability.

- Discrete 'snapshot' monitoring providing single values of measured or sampled parameters at the time of collection. This opportunistic approach is applied to less critical locations or for parameters which are too complex to collect by automated sensors. Snapshot measurements are conducted at specific times to target certain conditions e.g. end of the dry season when flows are at their lowest for the year.

Observation Parameters and Locations

Measurements were carried out between the 13th and 30th Oct 2014. Requirements for the snapshot measurements at each monitoring location are detailed in the Mataranka Tindall Limestone Aquifer (Draft) Water Allocation Plan, Monitoring Program and summarised in Table 1.

Table 1

Measurement	Surface Water	Groundwater
Water Level	Gauge Board / Logger	Dip Tape / Logger
Discharge	Flow Measurement	Flow Measurement at Springs
Water Quality	Field parameters (Electrical Conductivity, Temperature, pH and Dissolved Oxygen), and Nutrients.	Nutrients.

Factors, which influence data quality, are summarised in **Appendix A**. Field Measurement Standards.

Surface water measurements were conducted at eleven monitoring points along the upper reaches of the Roper River, tributaries where the river intersects the Tindal Limestone aquifer and two sites further downstream beyond the aquifer extent, see Figure 1 and 2.

River Levels

Surface water levels at monitoring sites are based on gauge board readings or continuous logger data. The water level information together with the stream flow measurements are used to further develop the stage/discharge relationships of each monitoring site. Not all monitoring sites are equipped with gauge boards or loggers consequently some sites had no water levels recorded. Surface water level results are tabled in **Appendix B.**

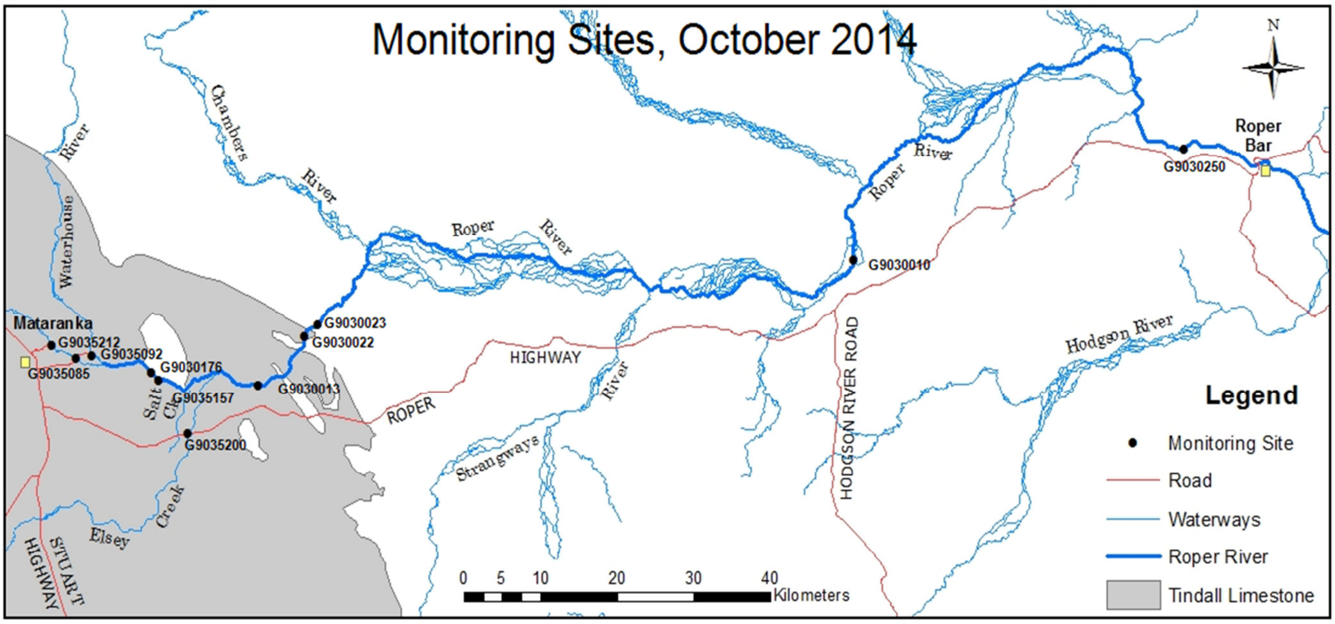


Figure 1: River Level and Flow Monitoring Sites, October 2014

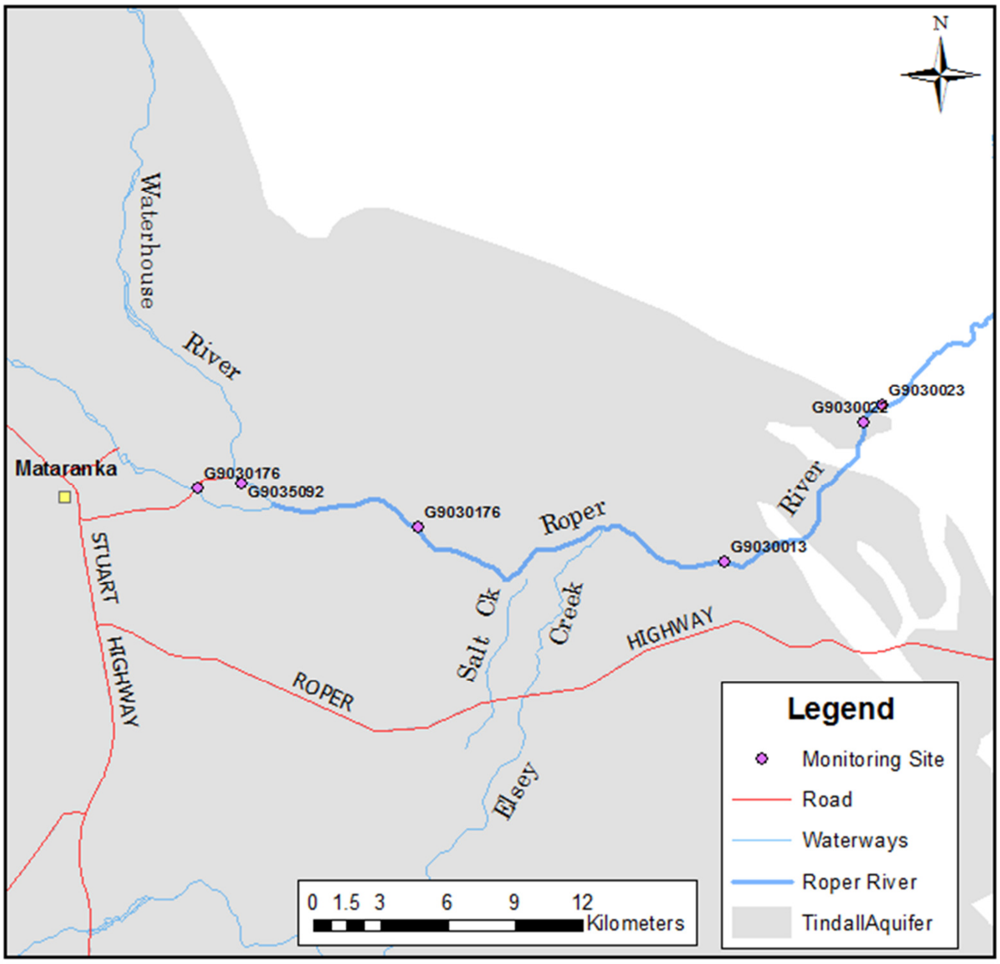


Figure 2: River Level and Flow Monitoring Sites Insert, October 2014

River Flows

Stream flow measurements were performed using propeller type current meters or acoustic doppler current profiler (ADCP) instruments. Current meters were selected where channel sections were very small or spring flows provided insufficient suspended sediment for backscatter detection by the ADCPs. Otherwise flows were measured using a range of ADCPs, hydraulic conditions determined what model of ADCP was selected, maximising the accuracy of flow measurements. All flow measurements were performed to National quality assurance protocols.

Spring and river flow results are tabled in **Appendix B.**

Groundwater Levels

The current monitoring program consists of 25 monitoring bores, all of which were plopped to determine a discrete standing water level (SWL) and depth below ground level. 16 of the 25 bores have data loggers installed, recording SWL every hour.

Groundwater levels are tabled in **Appendix B**

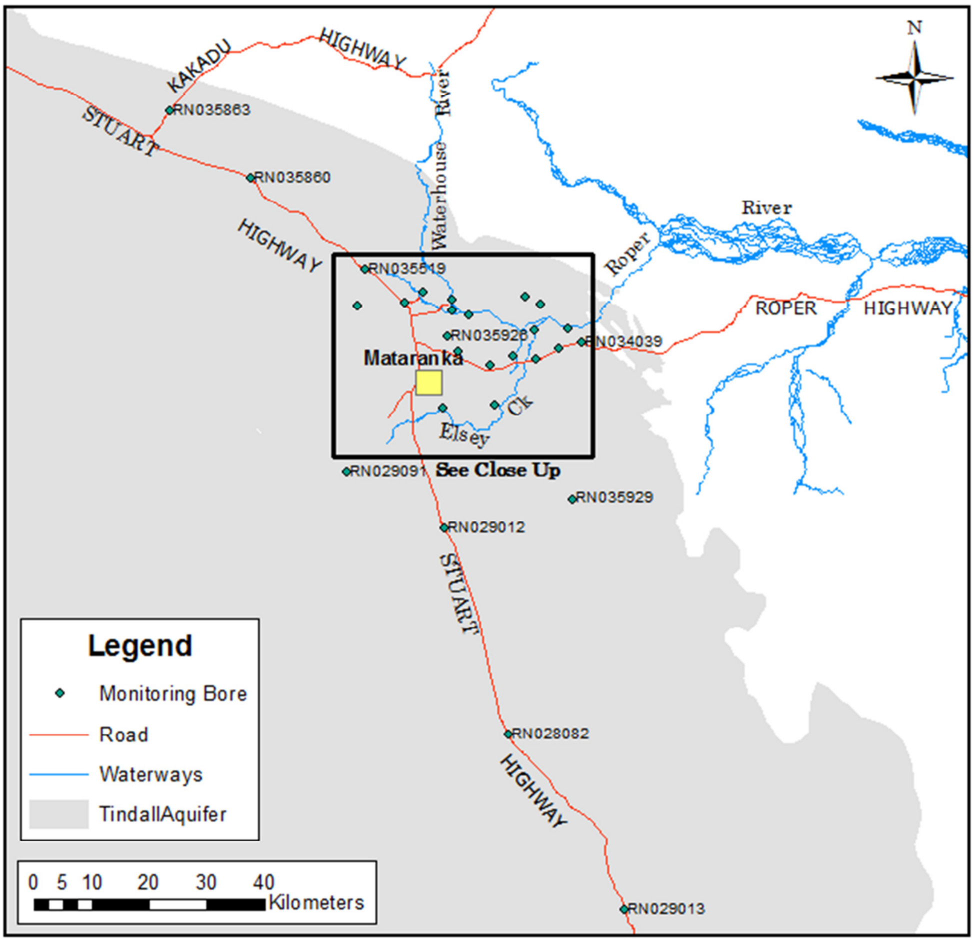


Figure 3: Groundwater Monitoring Sites, October 2014

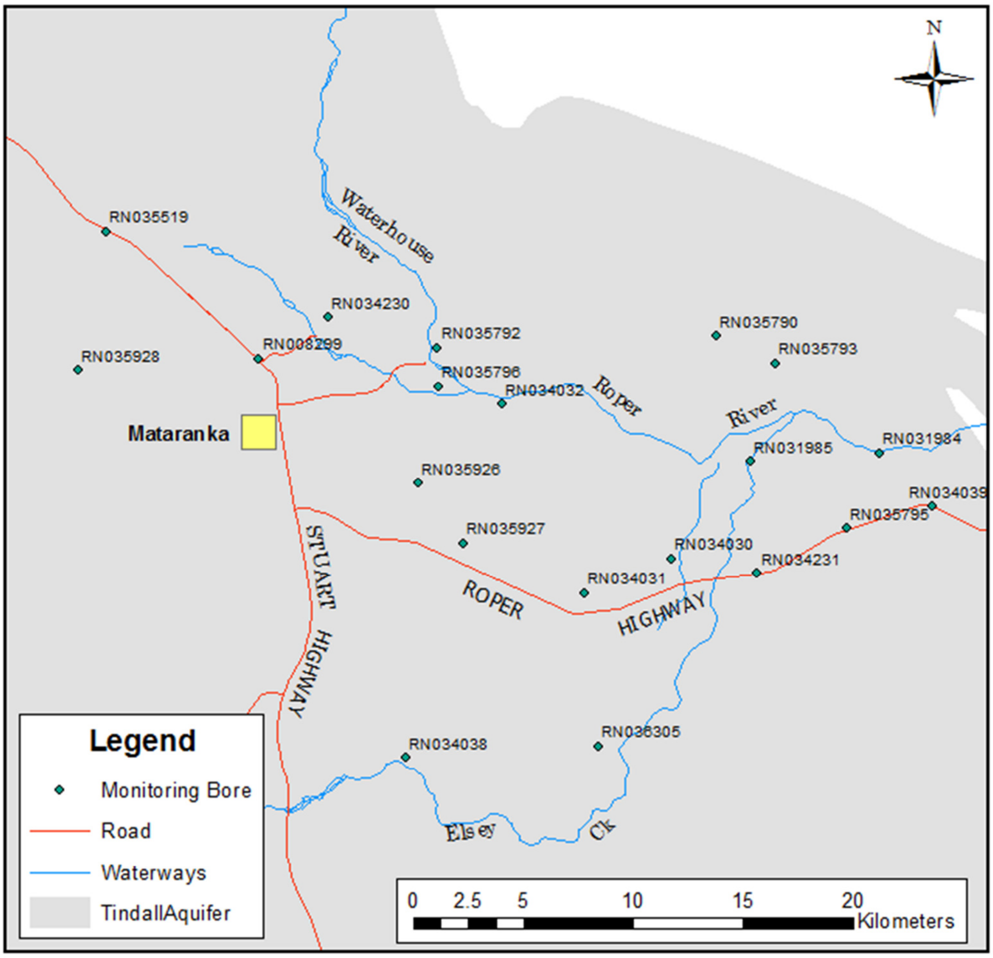


Figure 4: Groundwater Monitoring Sites Insert, October 2014

Water Quality

Water quality monitoring involved the taking of in-situ measurements with a Hydrolab Quanta multi-parameter sonde and collection of water samples which were subsequently analysed at the NATA accredited, Northern Territory Environmental Laboratories. Elements measured and sampled are summarised in Table 1.1.

Table 1.1

Hydro lab Quanta	Water Samples
• Electrical Conductivity (EC) • pH • Dissolved Oxygen (DO) • Temperature	• Turbidity • General Parameters • Total Nutrients • Filtered Nutrients

Water quality measurements were performed to the required standards and quality assurance protocol, taking into account site conditions. Probes were calibrated prior to and after the snapshot measurement exercise and results adjusted for sensor drift. In-situ field measurement results are presented in **Appendix C**.

Nutrients

Nutrients occur naturally in rivers, but can also originate from human activities such as fertilizer application, storm runoff from pastoral and agricultural land, and wastewater.

Water samples were collected for analysis of soluble (nitrite (NO2), nitrate (NO3), filterable reactive phosphorus (FRP), total nitrogen (TN) and total phosphorus (TN). Soluble nutrient samples were filtered through a 0.45 µm filter in the field. All samples were refrigerated immediately after collection and frozen prior to sending to the laboratory. Samples were analysed according to APHA standard methods. The results are presented in **Appendix D**.

Rainfall

Rainfall is one of the key criteria used by the Departments surface water and groundwater prediction models. Whilst the model is populated with gridded rainfall data supplied by the Bureau of Meteorology, some of this data is sourced from rain gauges located at DLRM gauging stations.

DLRM rainfall data was collected from all monitoring sites in the catchment during the snapshot exercise to identify if sufficient rainfall had occurred to cause local runoff that could influence field measurements.

Results and Discussion

Stream Flows

Flow measurements in cumecs (cubic meters per second) are depicted in Figure 5. Flow measurement results are tabled in **Appendix B**.

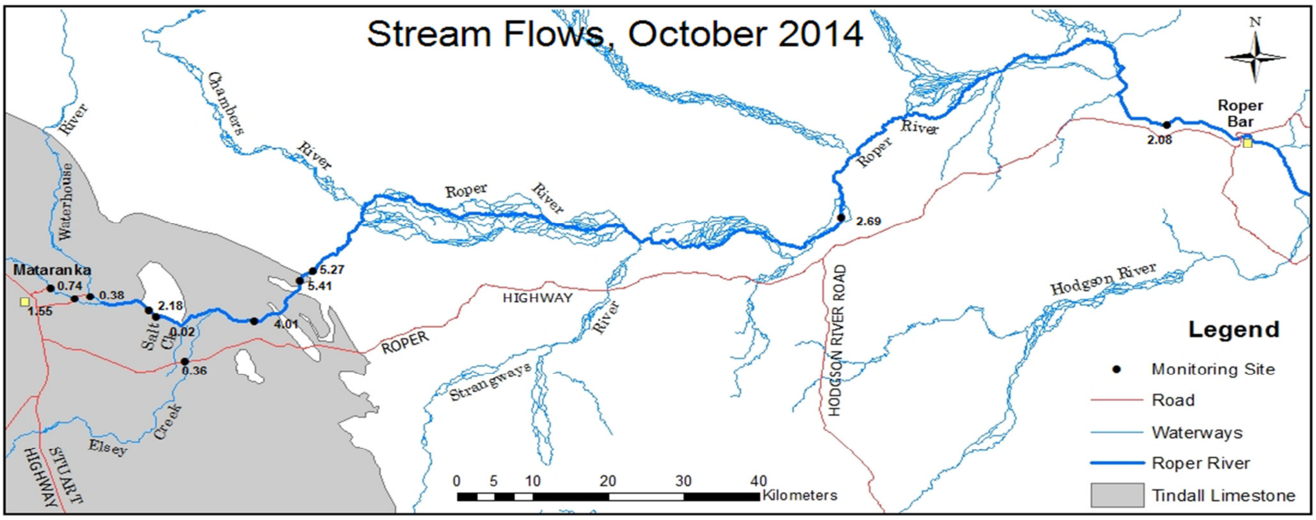


Figure 5: Measured Stream Flows (m^3/s), October 2014

All gauging's undertaken were of good or satisfactory quality. The measured discharge of 2.08 (m^3/s) at G9030250 deviates from the current rating by 24% due to a gravel bar control resulting in a variable cease to flow.

The gauged flow at G9030176 of 2.18 m^3/s deviates from the rating by 5%. This measurement follows a series of gauging's since 2008 that sit just below the rating curve, suggesting a review and possible adjustment to the rating is required.

Measurements performed in the Roper River from source to the edge of the Tindal Limestone comply with the continuity principle with increasing flow moving downstream. Beyond the Tindal Limestone, flows decreased the further downstream we measured. Significant losses occurred between WAP Site 17 (5.4 m3/s) and Judy Crossing (2.7 m3/s). See figure 6.

This trend is consistent with flows measured at the same locations in May 2014 and October 2013.

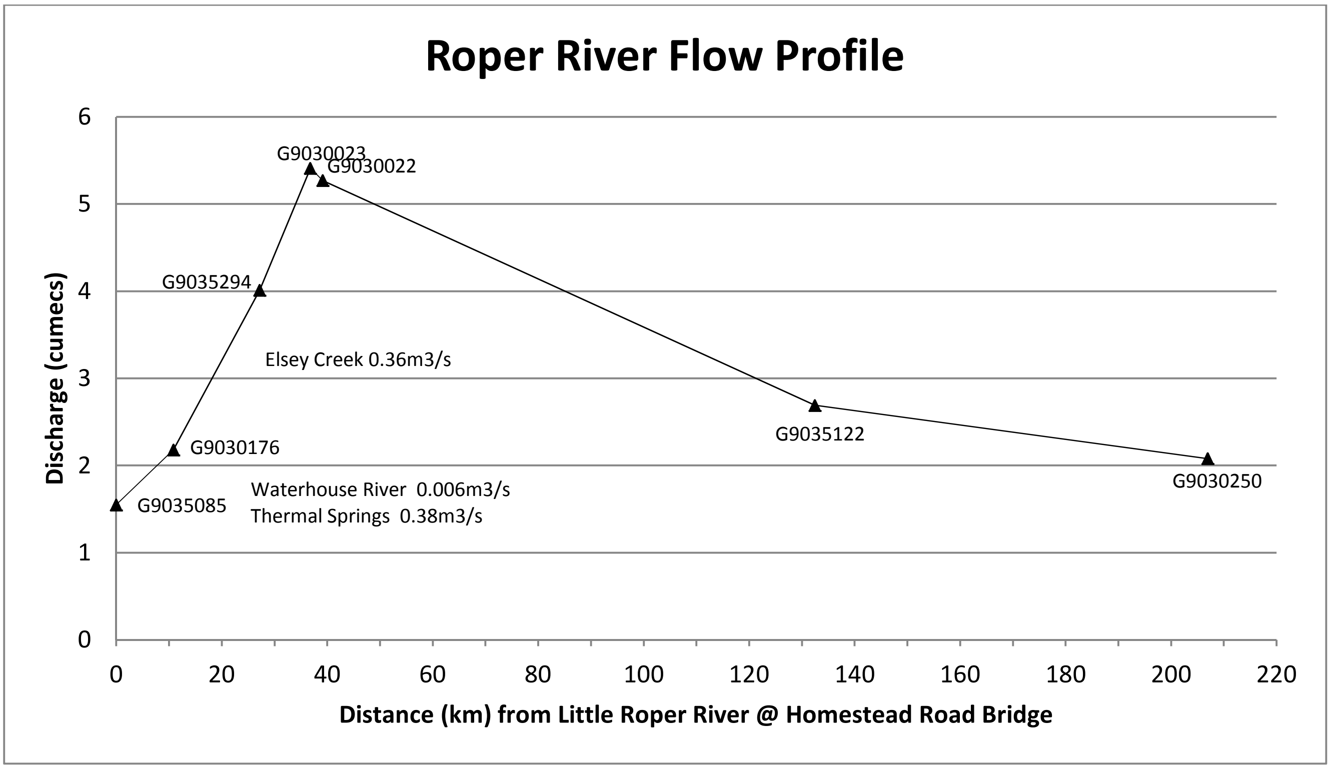


Figure 6: Stream Flow Profile, October 2014

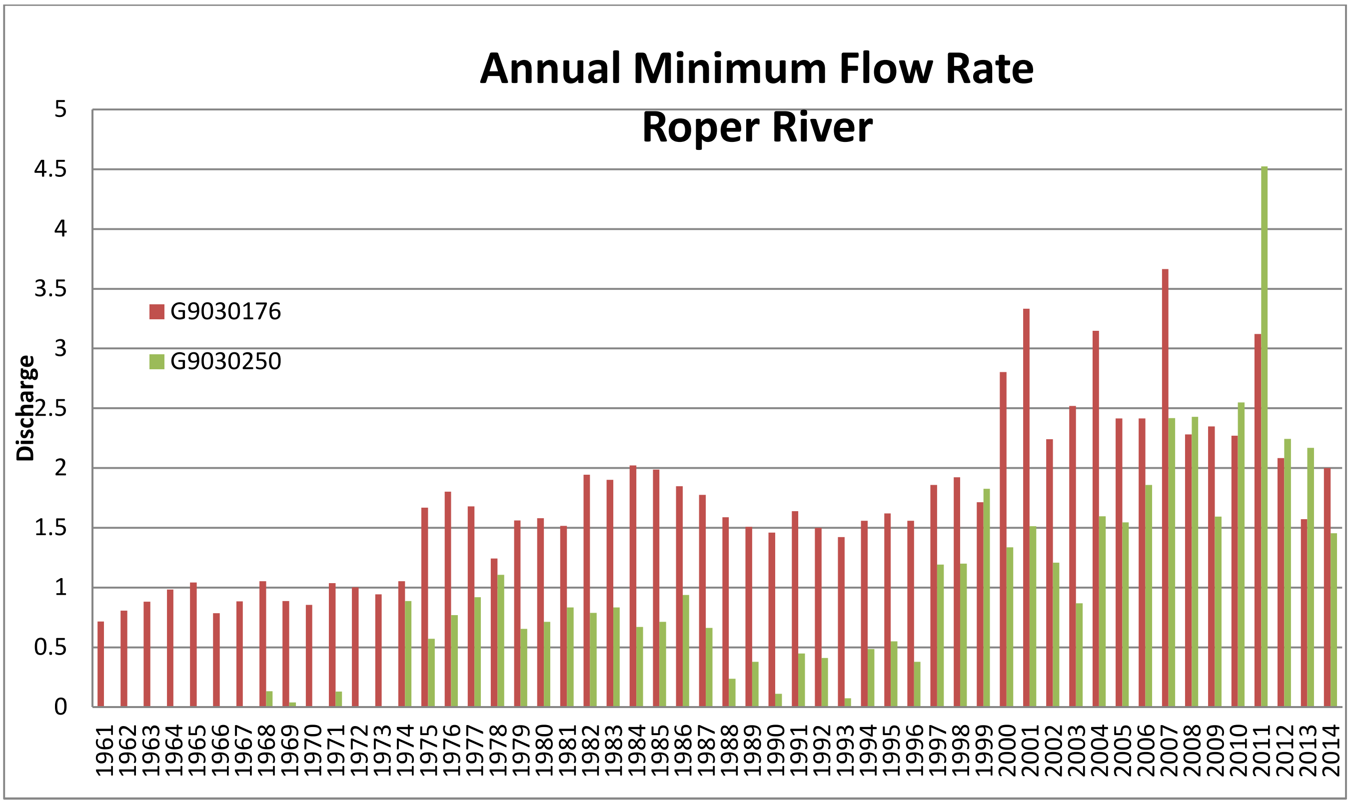


Figure 7: Roper River Annual Minimum Flow Rate

Annual minimum flow at Mataranka (G9030176) has steadily increased from a particularly dry period in the 1960's and early 70's, peaking in 2006 and then declining in the last few years. Near the end of the river at Red Rock (G9030250), minimum annual flows were also well below average in the 1960's and early 70's and again between 1988 and 1993. Similar to upstream, minimum annual flows have declined since 2010 but still remain above the long term average.

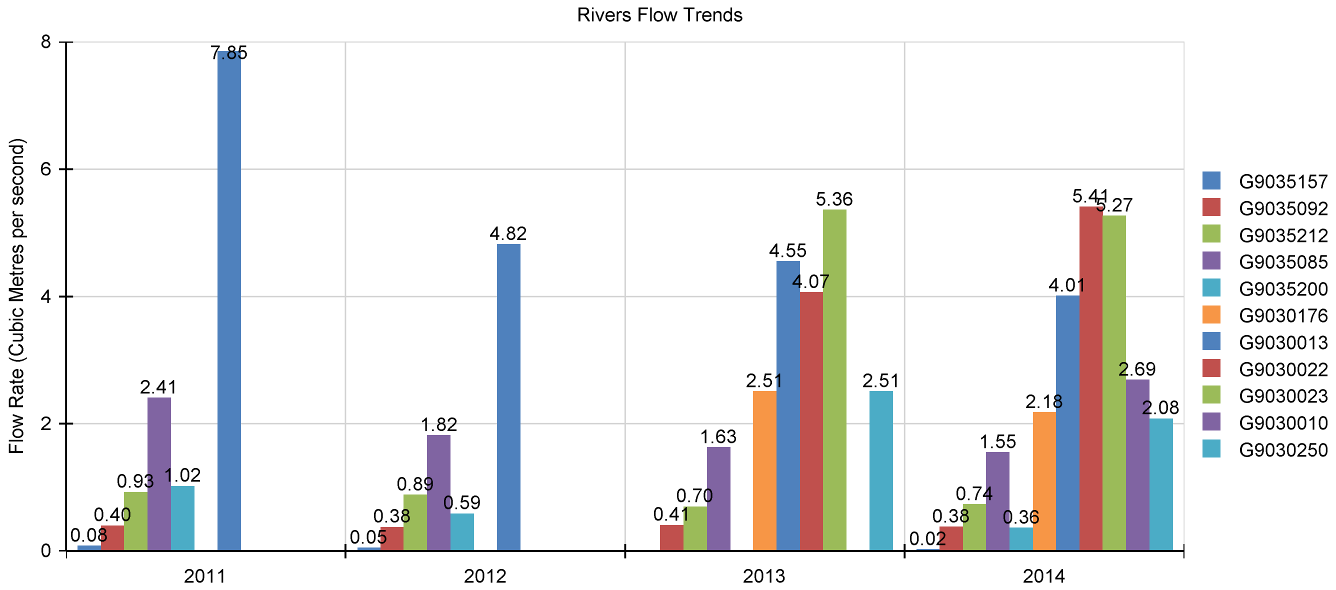


Figure 8: Gauging Trend in River Order.

On a site by site basis, flow gaugings undertaken at the end of the dry season, as depicted in Figure 8, verifies declining minimum flows since 2011.

Figure 8 (years 2011 and 2012) also depicts the continuity principal of flow increasing downstream. Expanding the monitoring program in the last two years, to include sites downstream of the plan area, has identified that the continuity principal does not occur downstream of G9030023. This site coincides with the end of the Tindall outcrop. At this point reduction in flow moving downstream is most likely due to evaporation, particularly where the river breaks into multiple shallow braided sections.

Rainfall

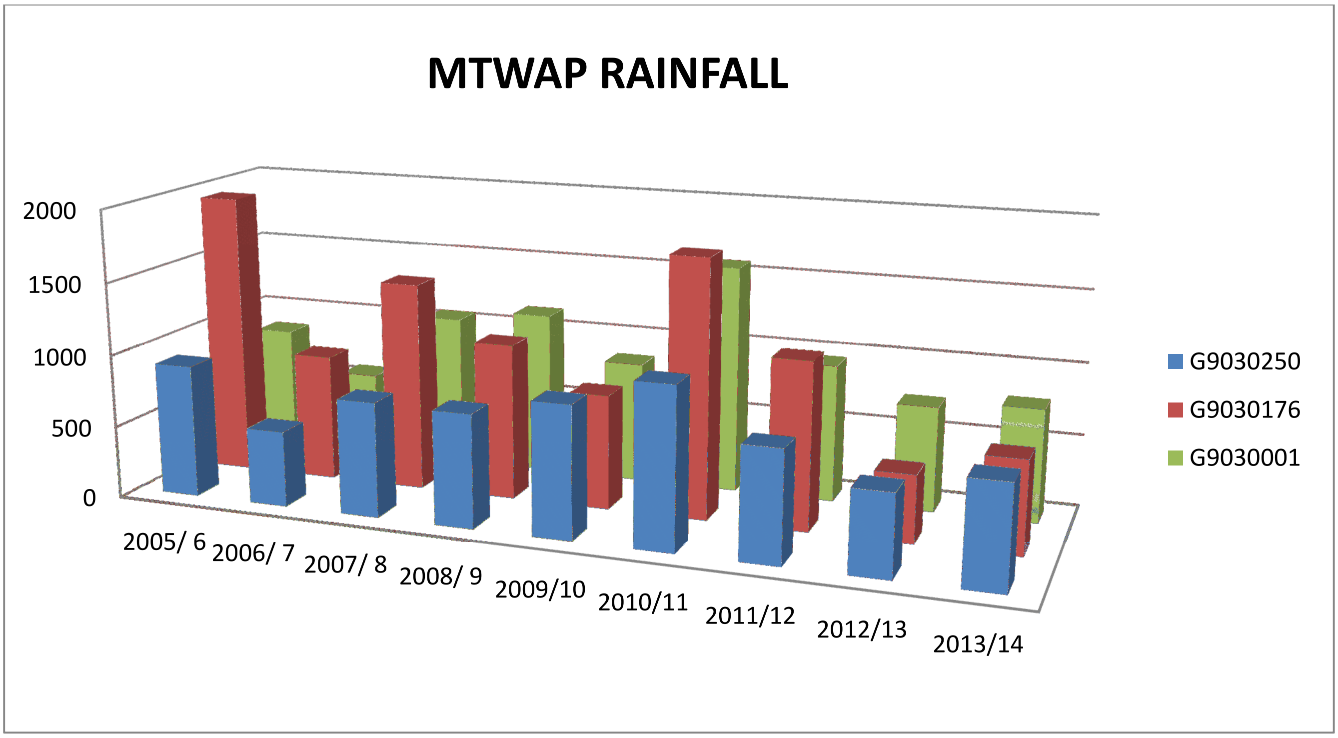


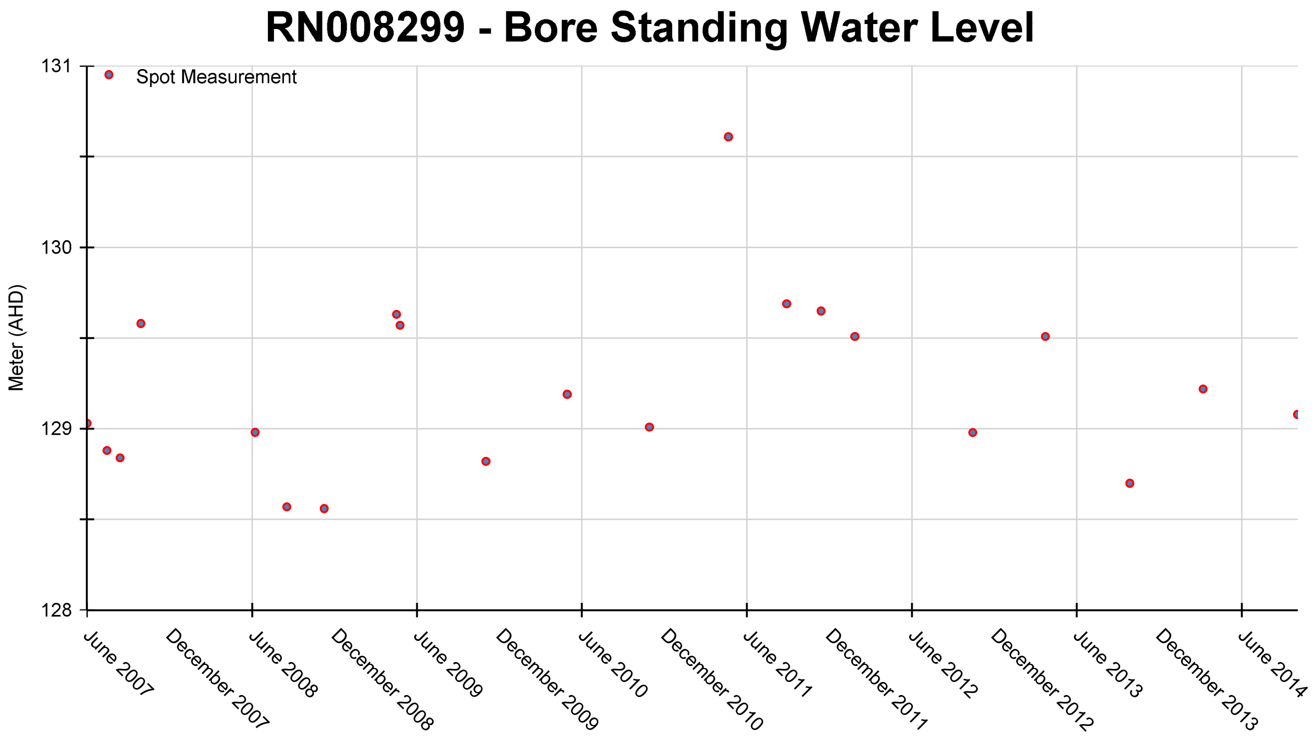
Figure 9: *Measured Rainfall, October 2014*

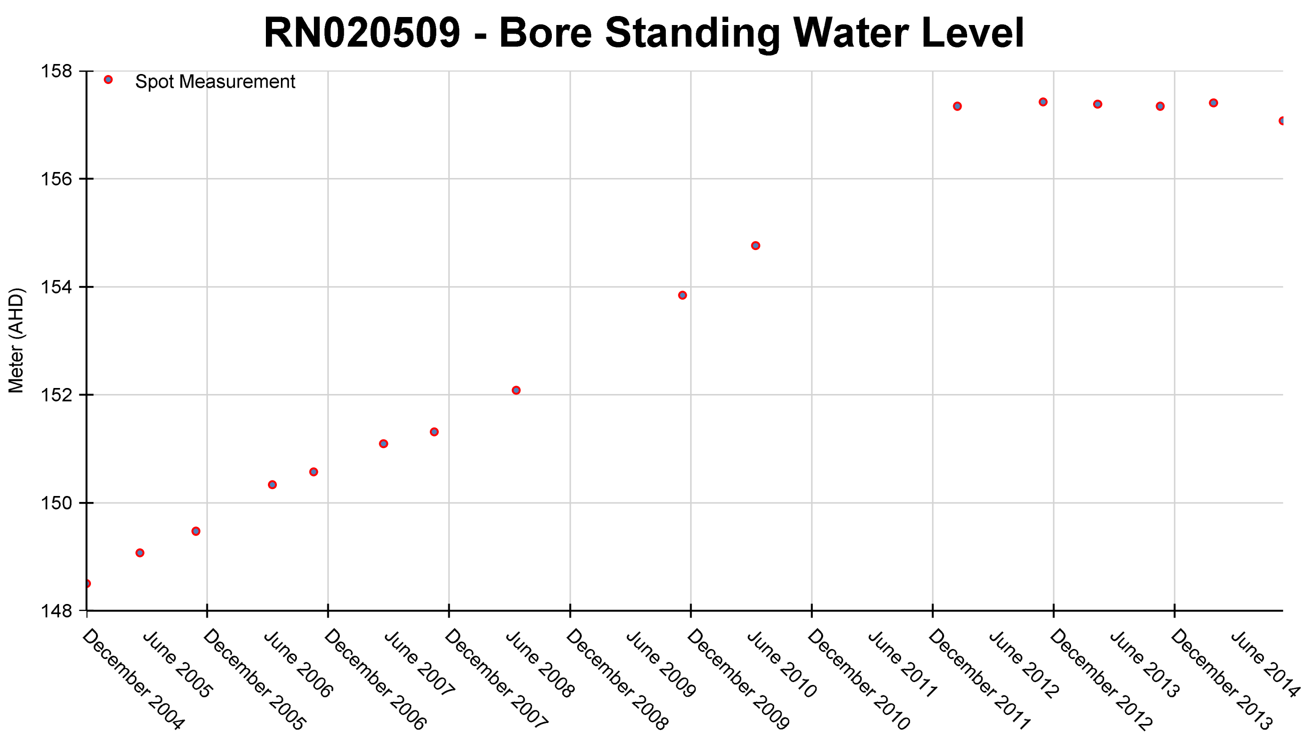
Plotted rainfall recorded at the gauging stations since 2005 shows that 2013/14 was a relatively low rainfall wet season consistently across the Mataranka area, similar to that experienced in 2012/13.

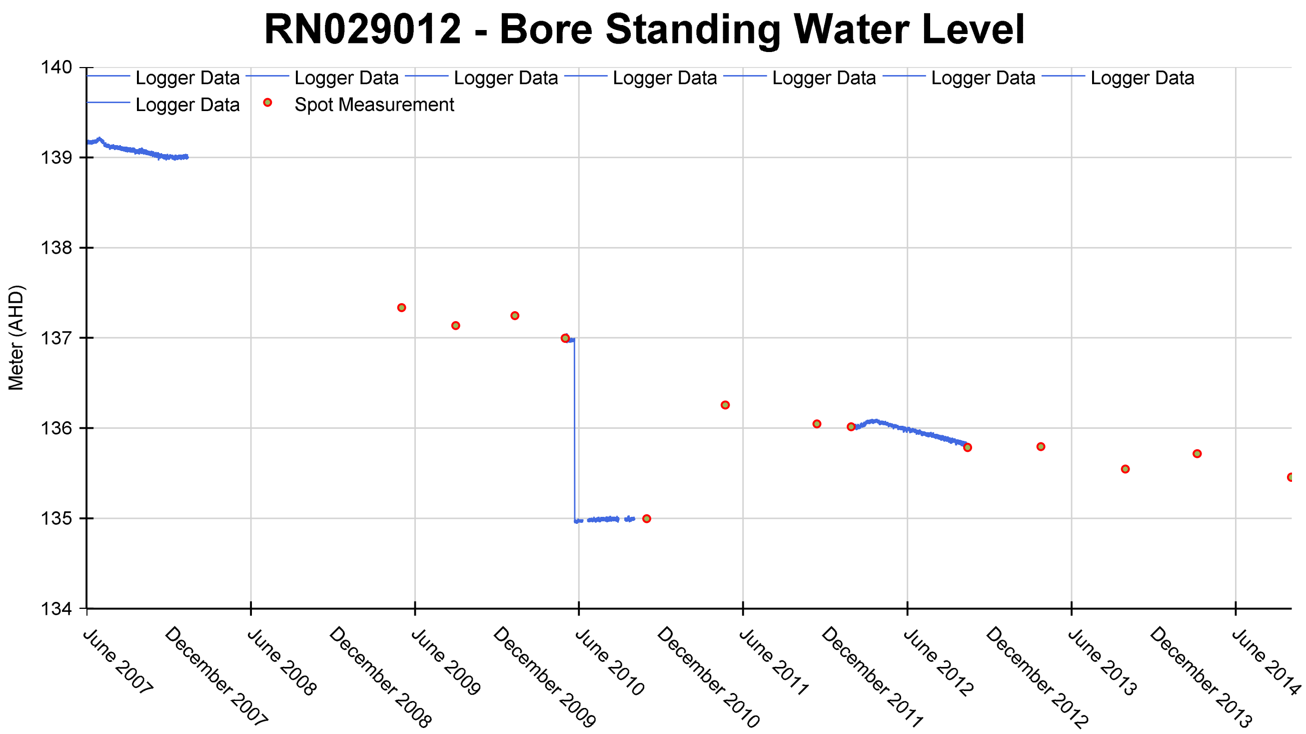
During this snapshot measurement exercise, the only rainfall recorded was 0.5mm at G9030001. Consequently there is high confidence that there was no runoff during the snapshot exercise that would have impacted on measurement results.

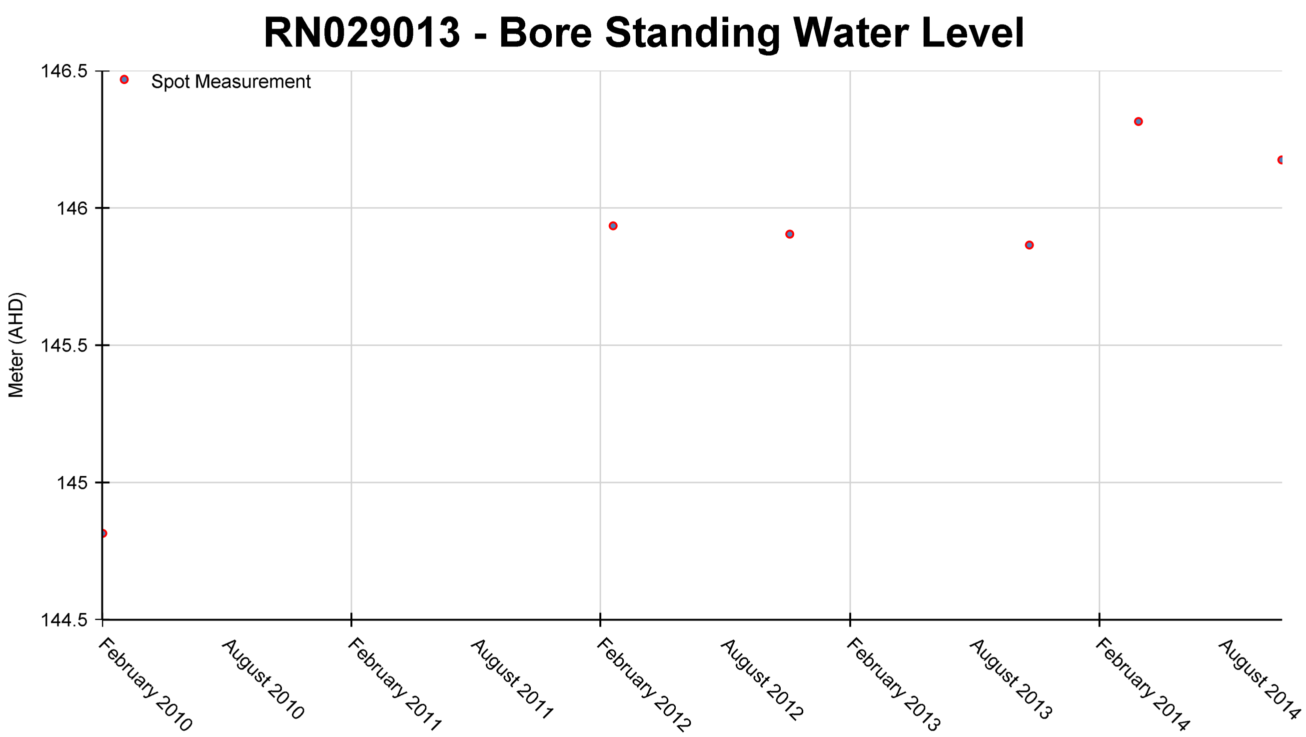
Groundwater Levels

Timeseries and discrete ground water levels in Australian Height Datum (AHD) are presented below. Timeseries data exists for bores equipped with data loggers, however all bores are plopped at least twice a year to verify the logger data or to provide spot measurements at the time of expected maximum and minimum groundwater seasonal variation.

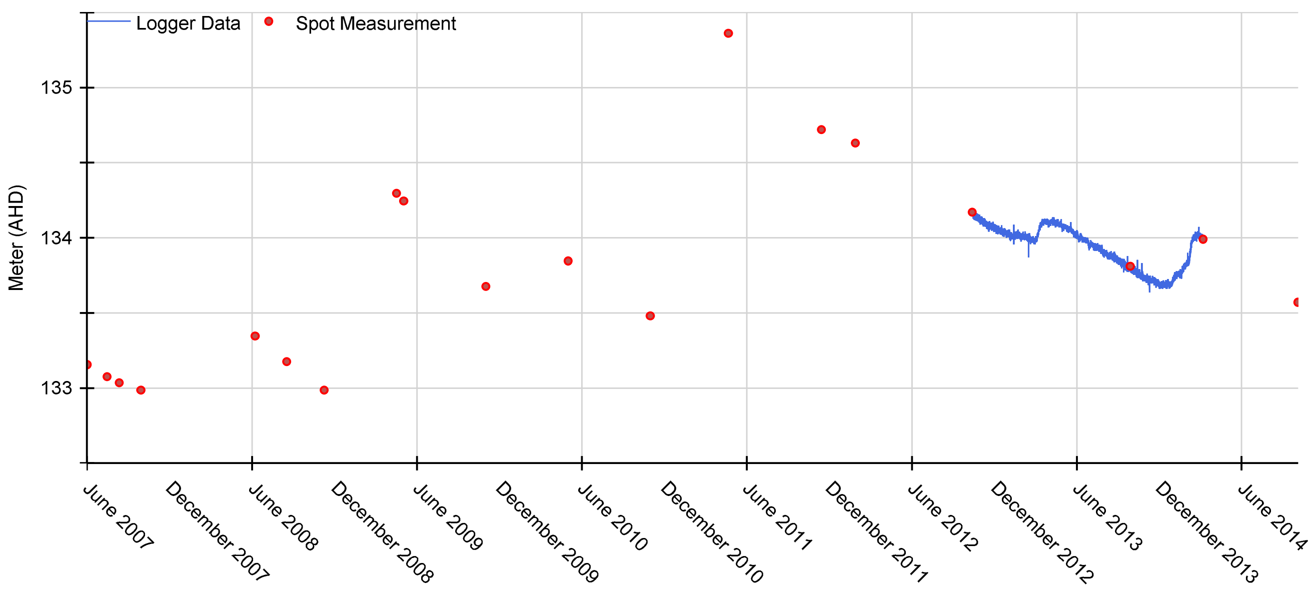




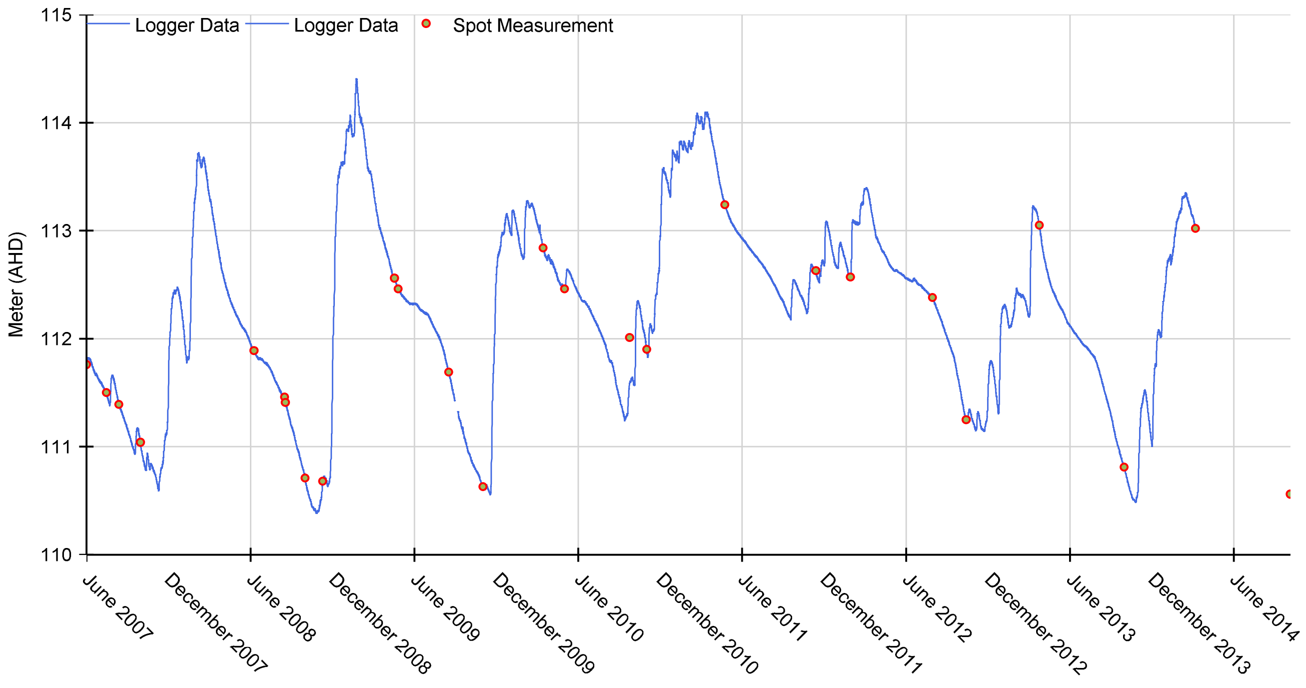

RN029012 - Bore Standing Water Level
Logger Data
Spot Measurement
Meter (AHD)
140
139
138
137
136
135
134
June 2007
December 2007
June 2008
December 2008
June 2009
December 2009
June 2010
December 2010
June 2011
December 2011
June 2012
December 2012
June 2013
December 2013
June 2014

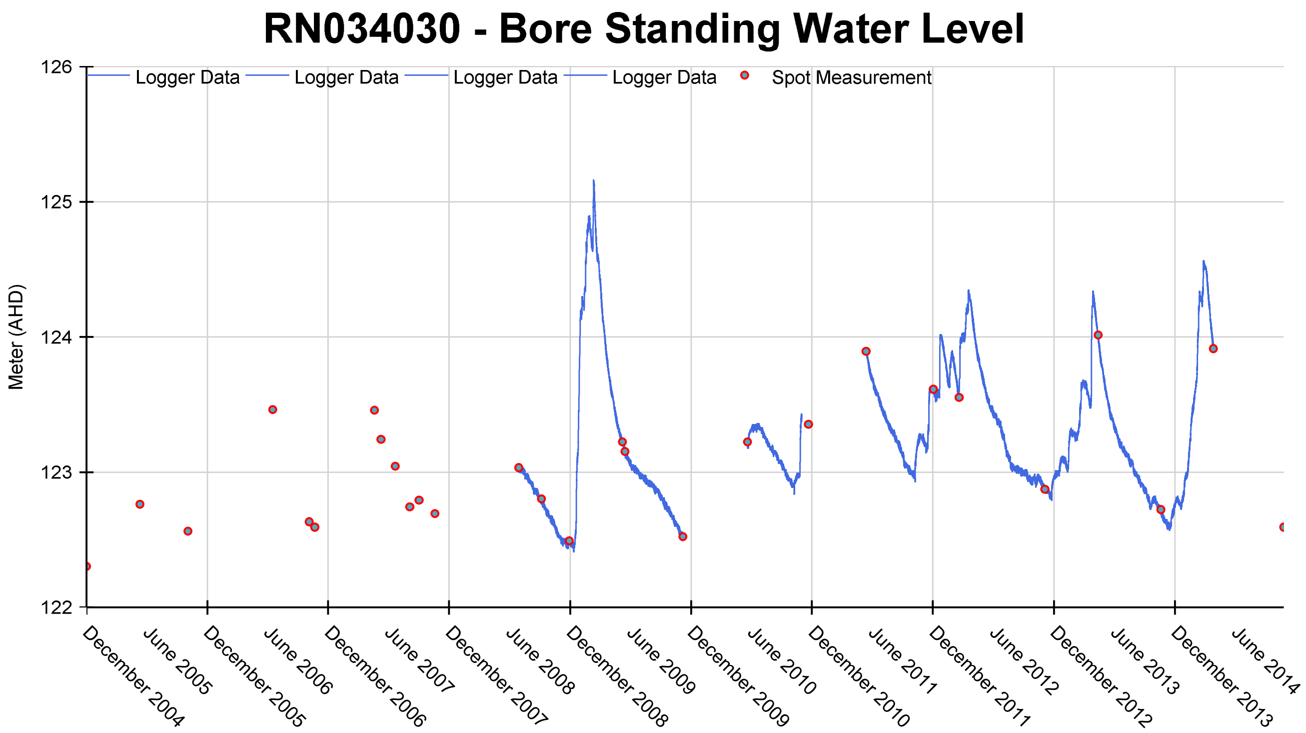

RN029013 - Bore Standing Water Level
Spot Measurement
Meter (AHD)
146.5
146
145.5
145
144.5
February 2010
August 2010
February 2011
August 2011
February 2012
August 2012
February 2013
August 2013
February 2014
August 2014

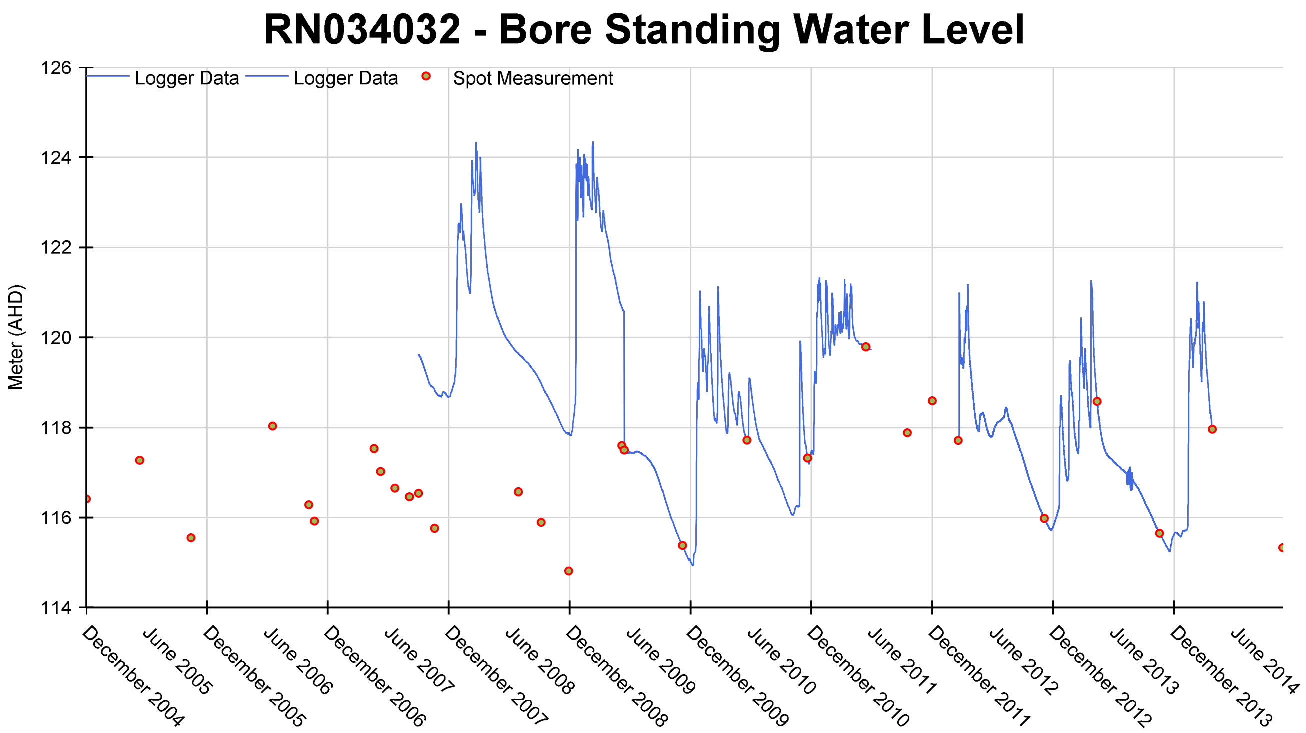
RN029091 - Bore Standing Water Level

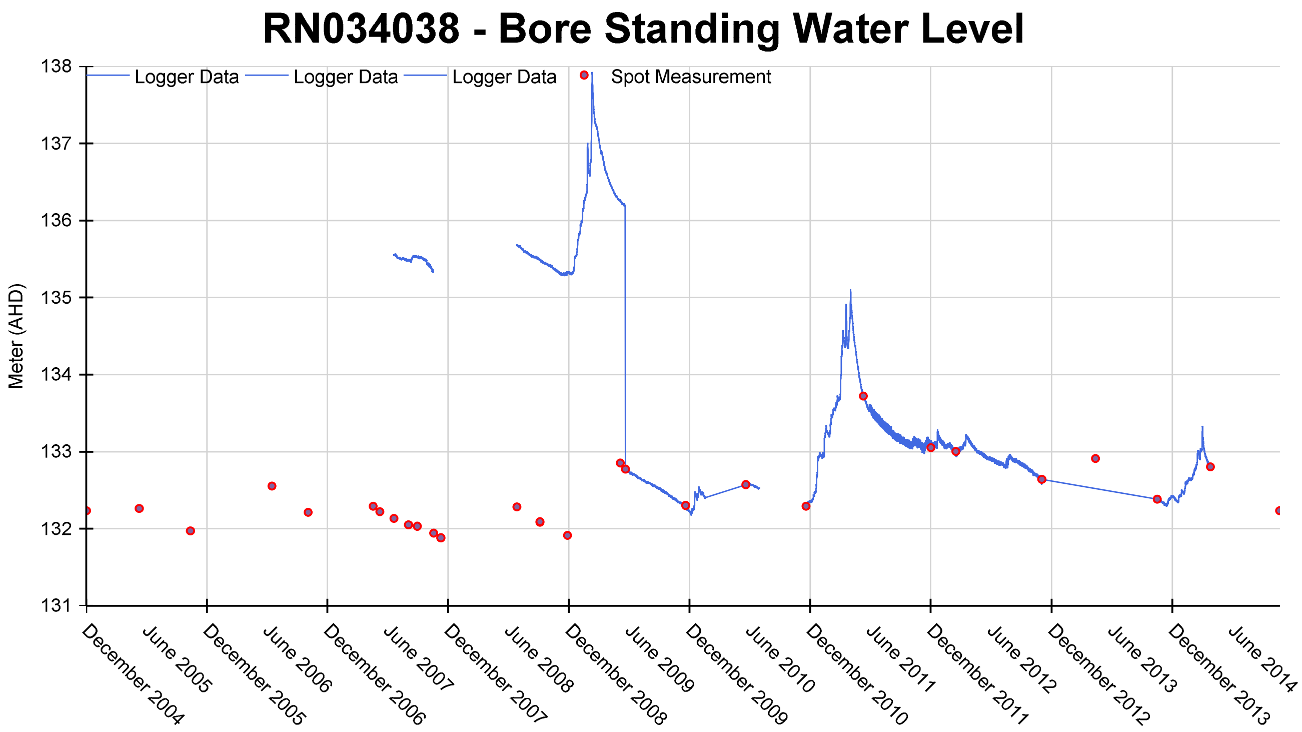


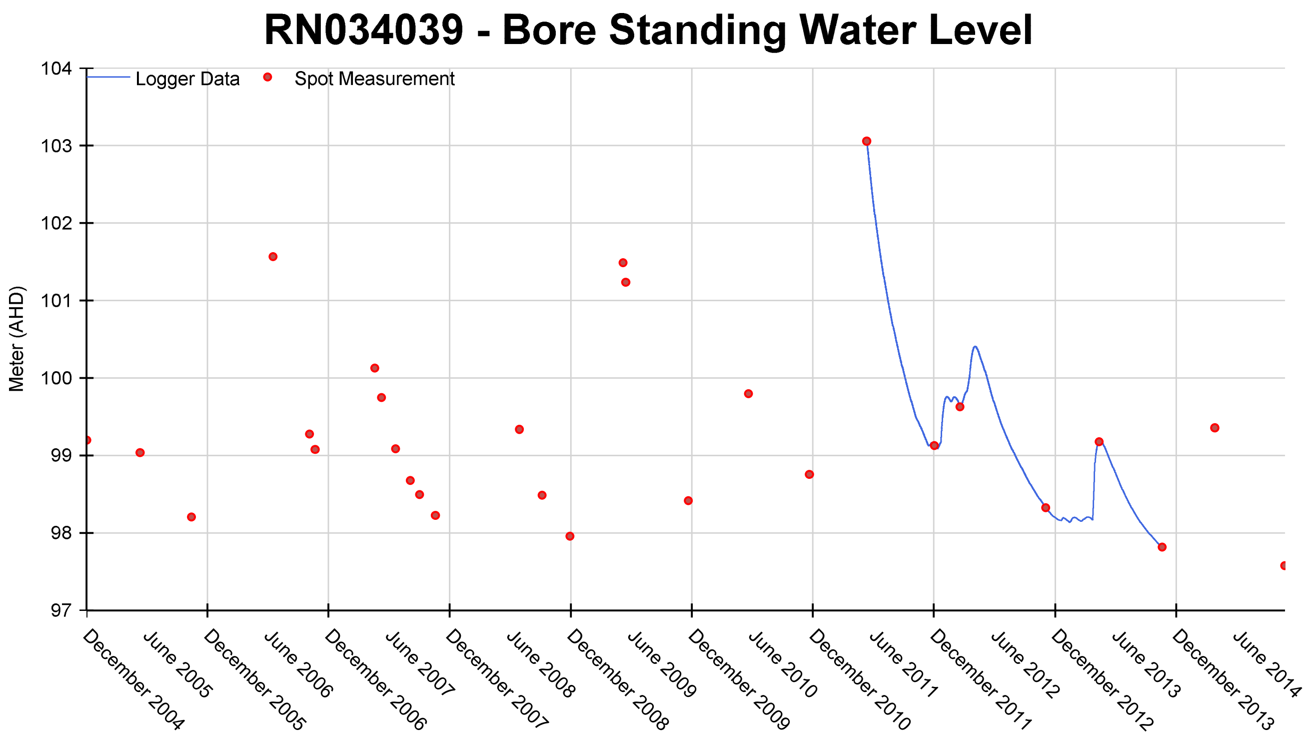
RN031985 - Bore Standing Water Level

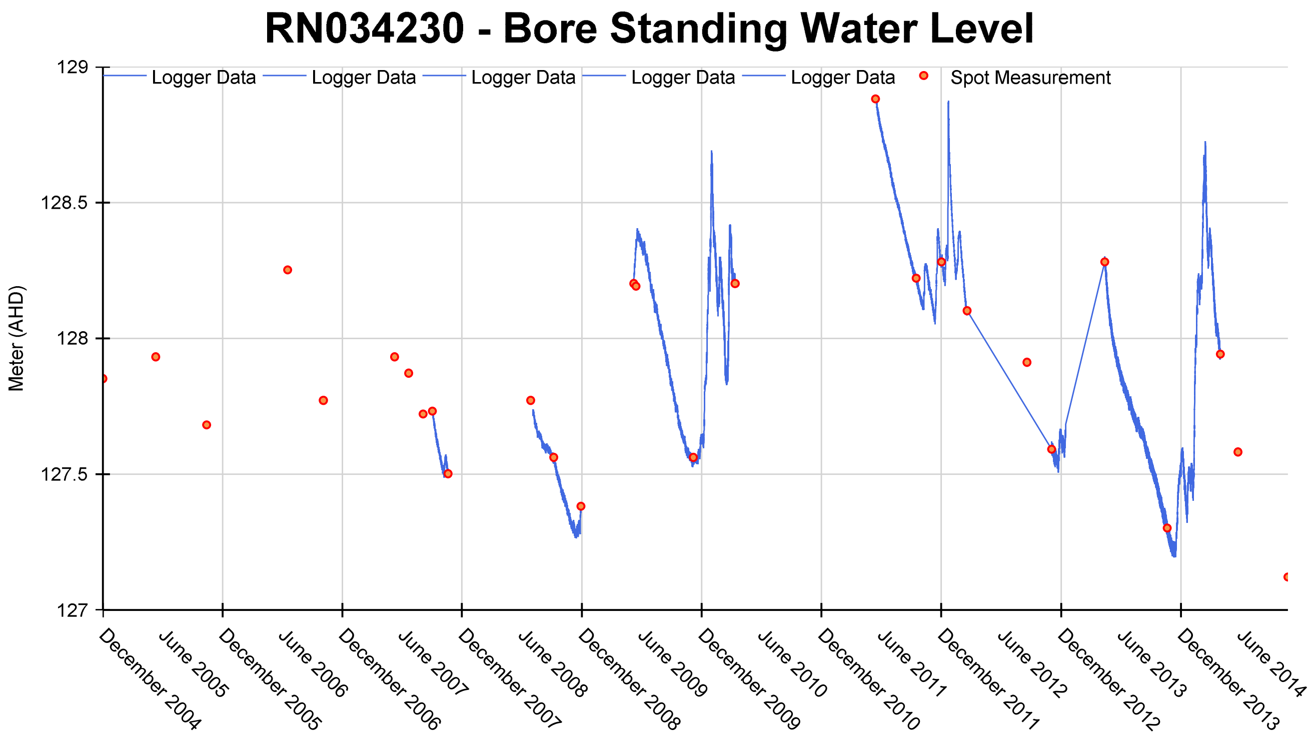


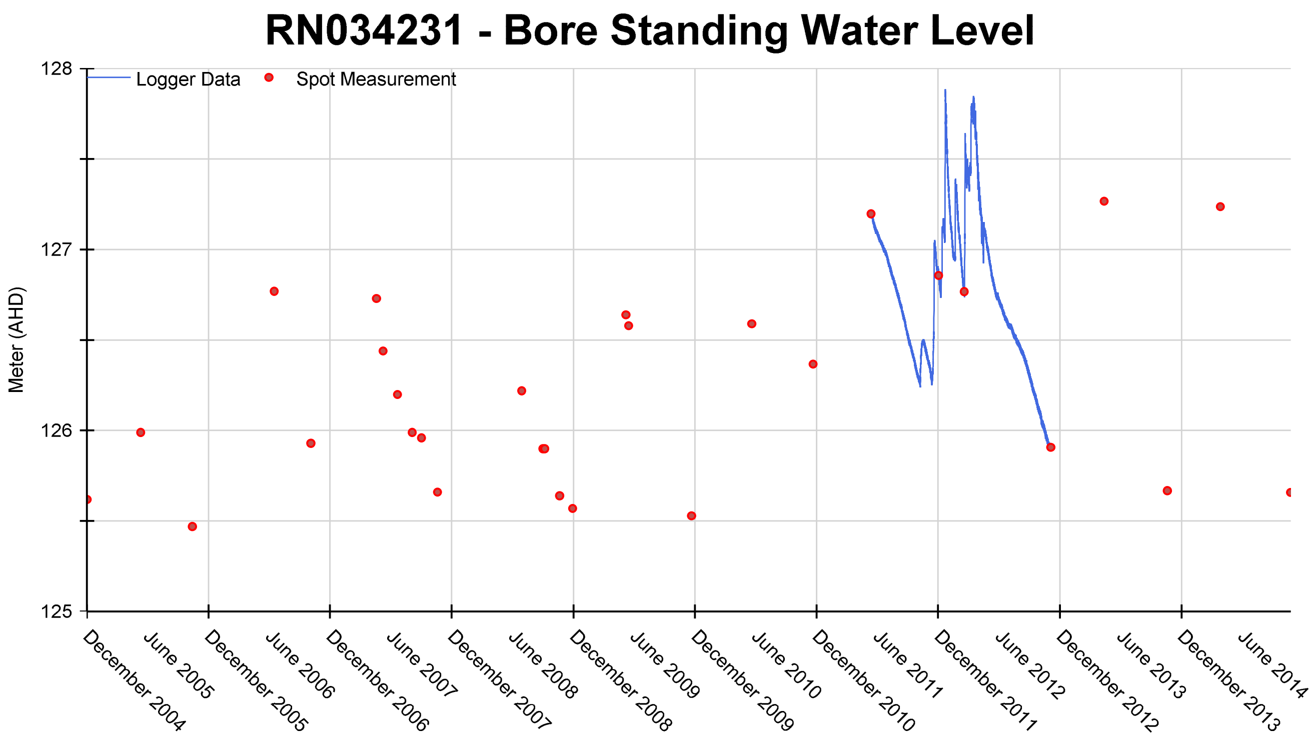

RN034030 - Bore Standing Water Level
Logger Data
Logger Data
Logger Data
Logger Data
Spot Measurement
Meter (AHD)
126
125
124
123
122
December 2004
June 2005
December 2005
June 2006
December 2006
June 2007
December 2007
June 2008
December 2008
June 2009
December 2009
June 2010
December 2010
June 2011
December 2011
June 2012
December 2012
June 2013
December 2013
June 2014


RN034032 - Bore Standing Water Level
Logger Data
Logger Data
Spot Measurement
Meter (AHD)
126
124
122
120
118
116
114
December 2004
June 2005
December 2005
June 2006
December 2006
June 2007
December 2007
June 2008
December 2008
June 2009
December 2009
June 2010
December 2010
June 2011
December 2011
June 2012
December 2012
June 2013
December 2013
June 2014


RN034038 - Bore Standing Water Level
Logger Data
Logger Data
Logger Data
Spot Measurement
Meter (AHD)
138
137
136
135
134
133
132
131
December 2004
June 2005
December 2005
June 2006
December 2006
June 2007
December 2007
June 2008
December 2008
June 2009
December 2009
June 2010
December 2010
June 2011
December 2011
June 2012
December 2012
June 2013
December 2013
June 2014


RN034039 - Bore Standing Water Level
Logger Data
Spot Measurement
Meter (AHD)
104
103
102
101
100
99
98
97
December 2004
June 2005
December 2005
June 2006
December 2006
June 2007
December 2007
June 2008
December 2008
June 2009
December 2009
June 2010
December 2010
June 2011
December 2011
June 2012
December 2012
June 2013
December 2013
June 2014


RN034230 - Bore Standing Water Level
Logger Data
Logger Data
Logger Data
Logger Data
Logger Data
Spot Measurement
Meter (AHD)
129
128.5
128
127.5
127
December 2004
June 2005
December 2005
June 2006
December 2006
June 2007
December 2007
June 2008
December 2008
June 2009
December 2009
June 2010
December 2010
June 2011
December 2011
June 2012
December 2012
June 2013
December 2013
June 2014


RN034231 - Bore Standing Water Level
Logger Data
Spot Measurement
Meter (AHD)
128
127
126
125
December 2004
June 2005
December 2005
June 2006
December 2006
June 2007
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December 2008
June 2009
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June 2010
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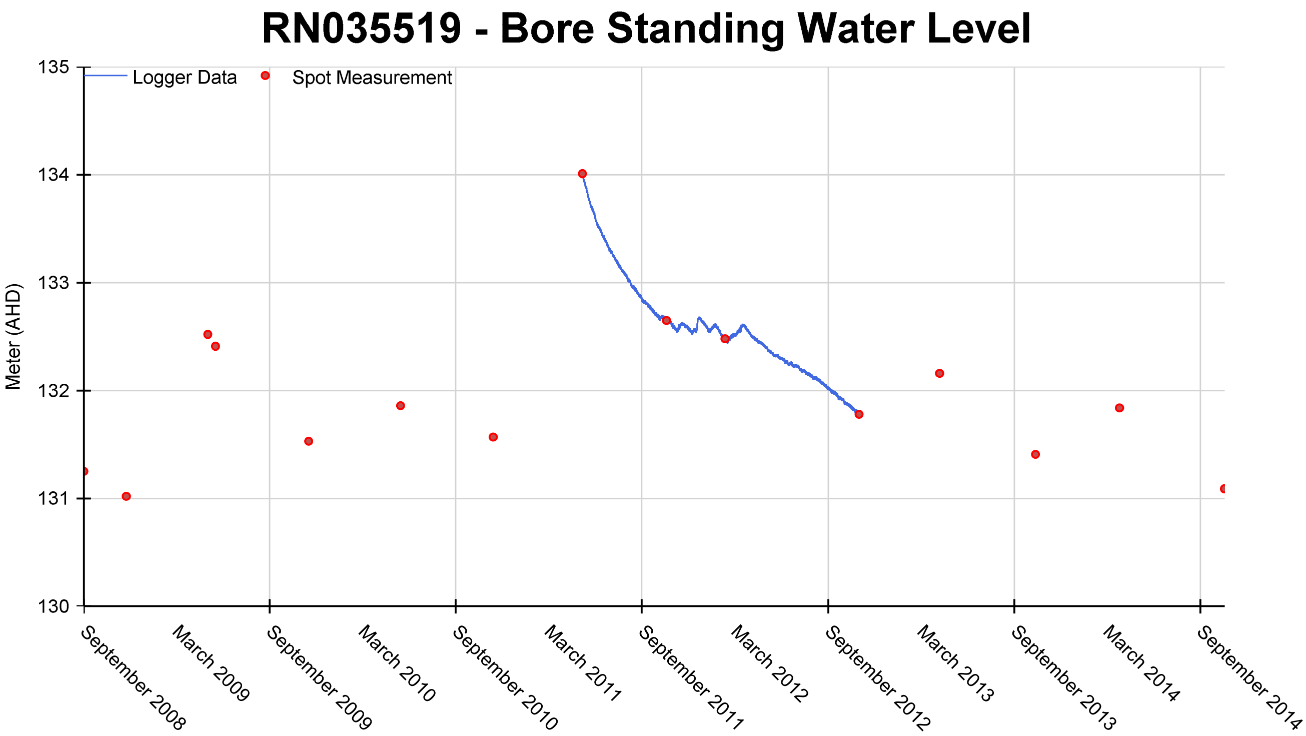
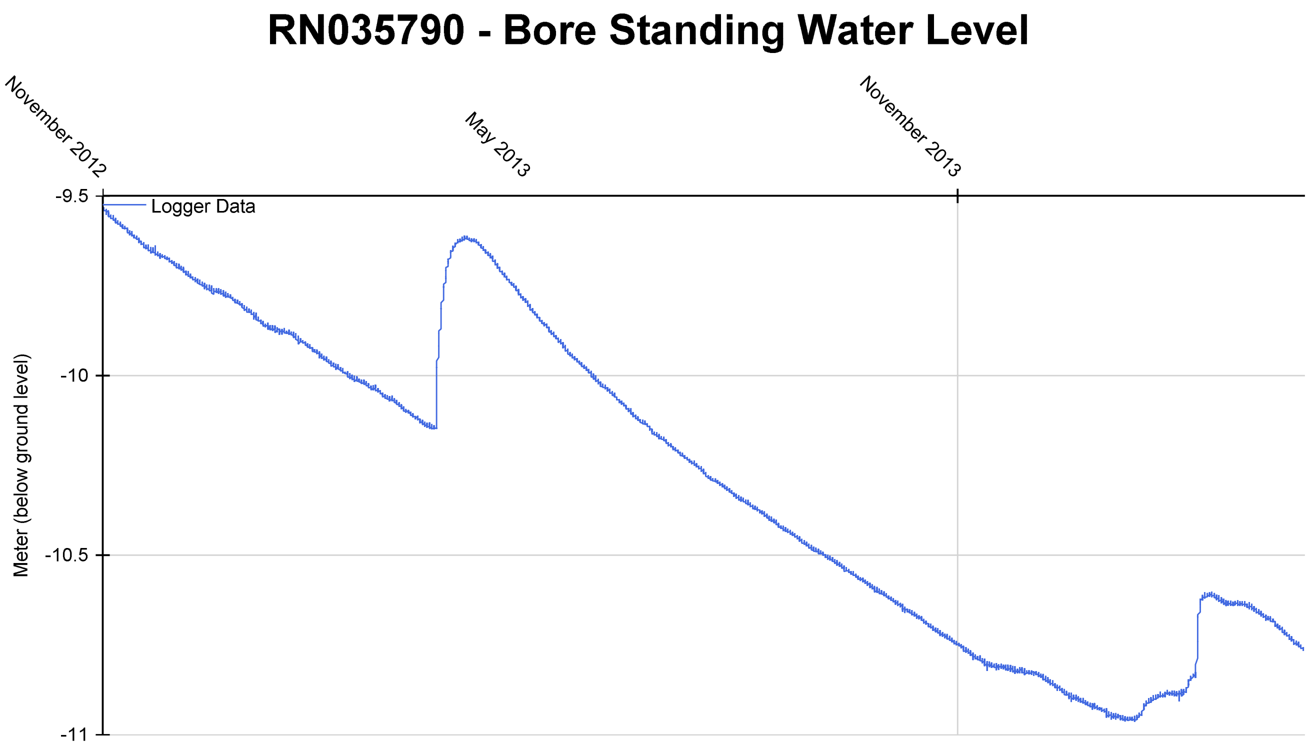
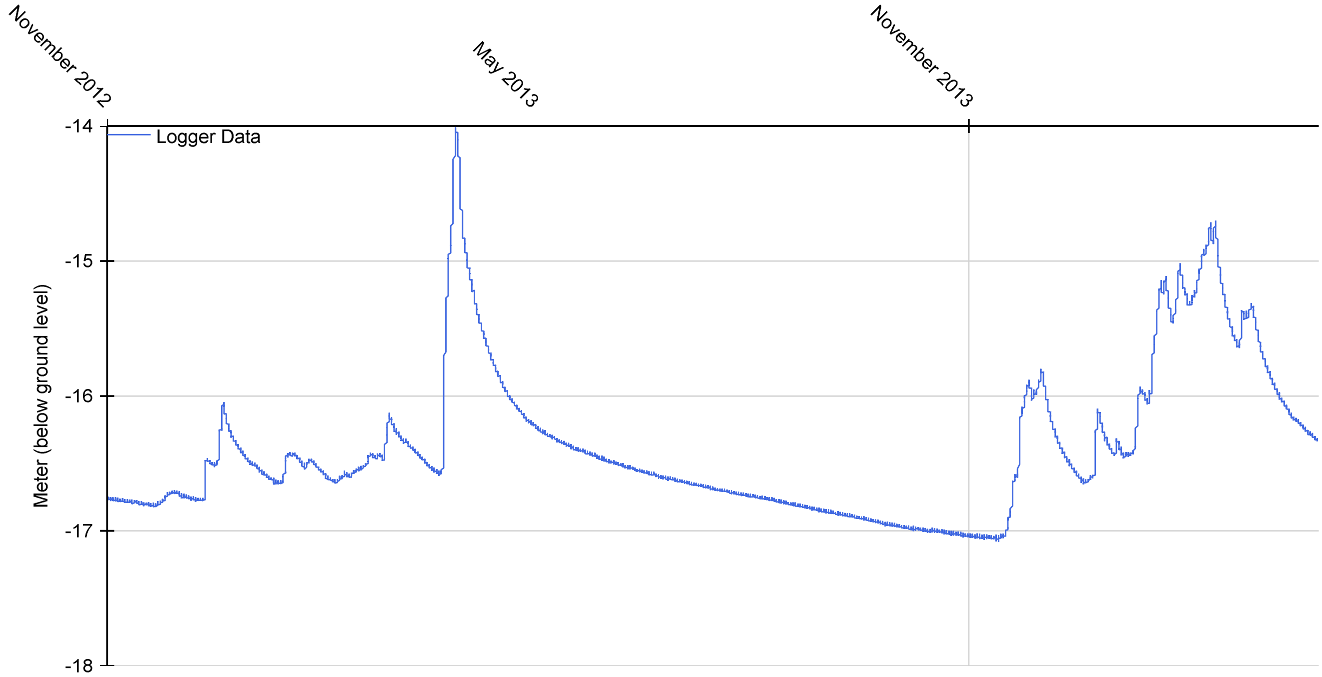
June 2012
December 2012
June 2013
December 2013
June 2014


RN035519 - Bore Standing Water Level
Logger Data
Spot Measurement
Meter (AHD)
135
134
133
132
131
130
September 2008
March 2009
September 2009
March 2010
September 2010
March 2011
September 2011
March 2012
September 2012
March 2013
September 2013
March 2014
September 2014

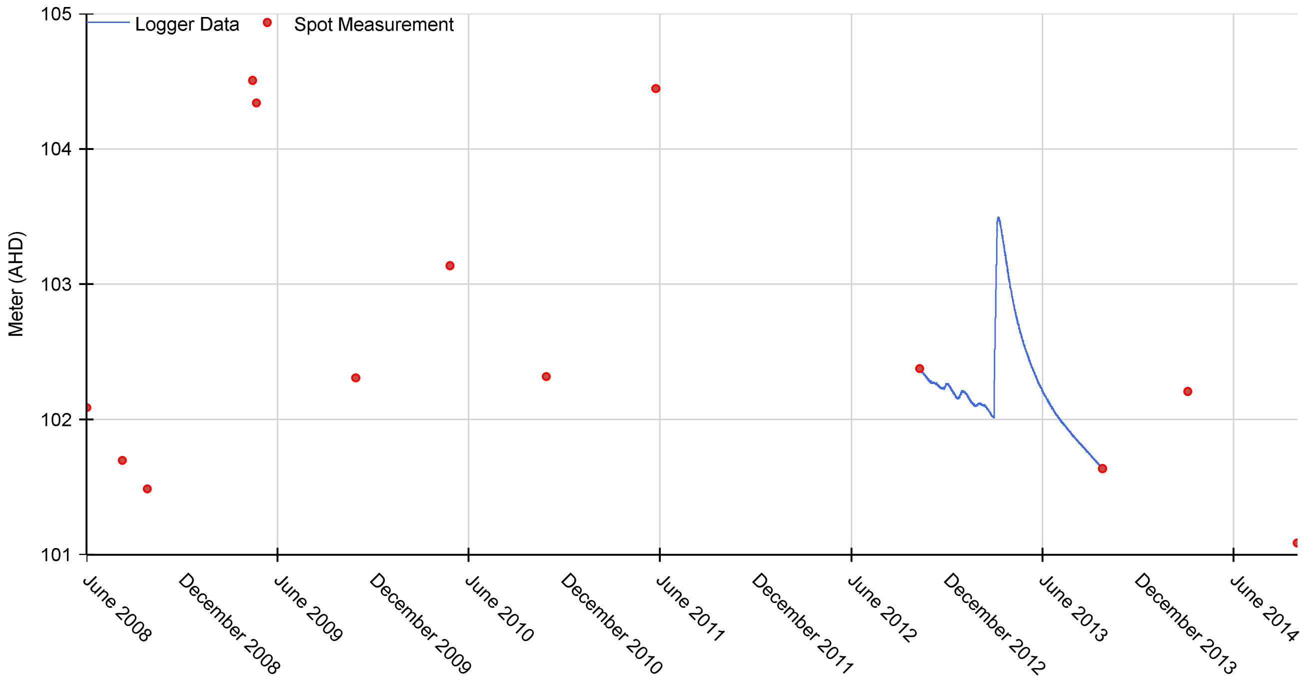

RN035790 - Bore Standing Water Level
November 2012
May 2013
November 2013
Logger Data
Meter (below ground level)
-9.5
-10
-10.5
-11

RN035792 - Bore Standing Water Level

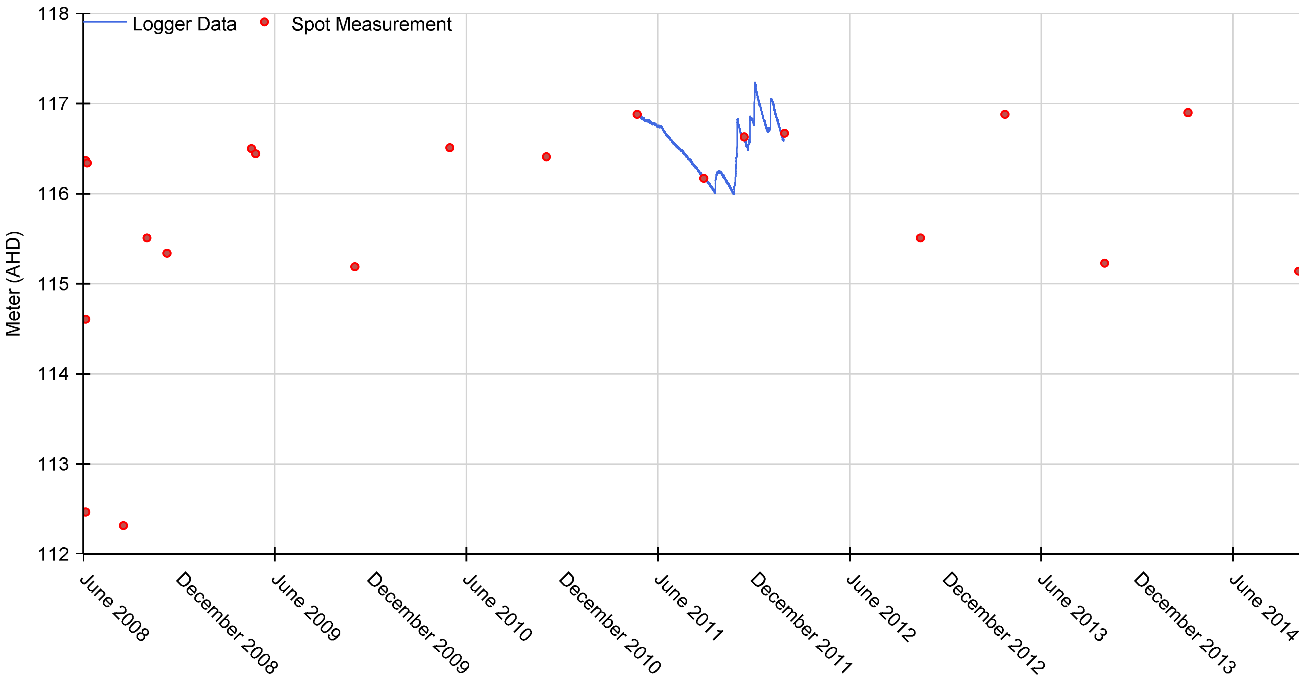


RN035790 and RN035792 have not yet been surveyed to Australian Height Datum, consequently depth values represent standing water level in meters below ground level.

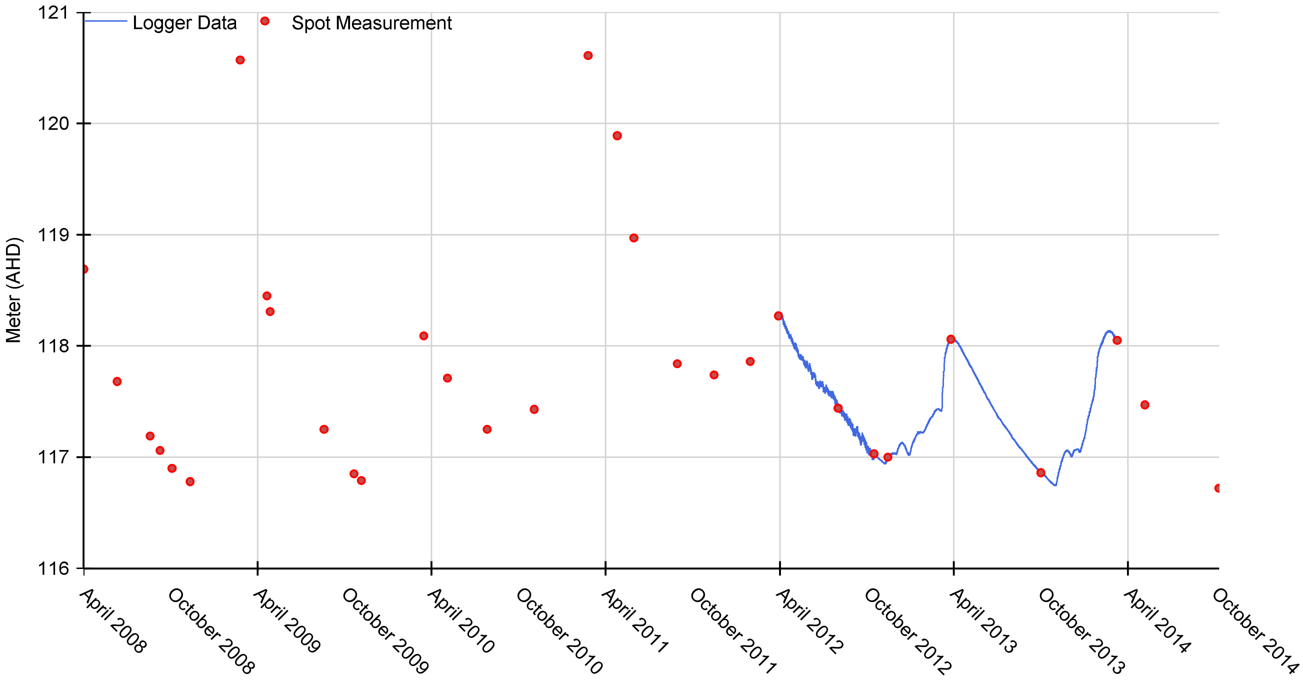
RN035793 - Bore Standing Water Level

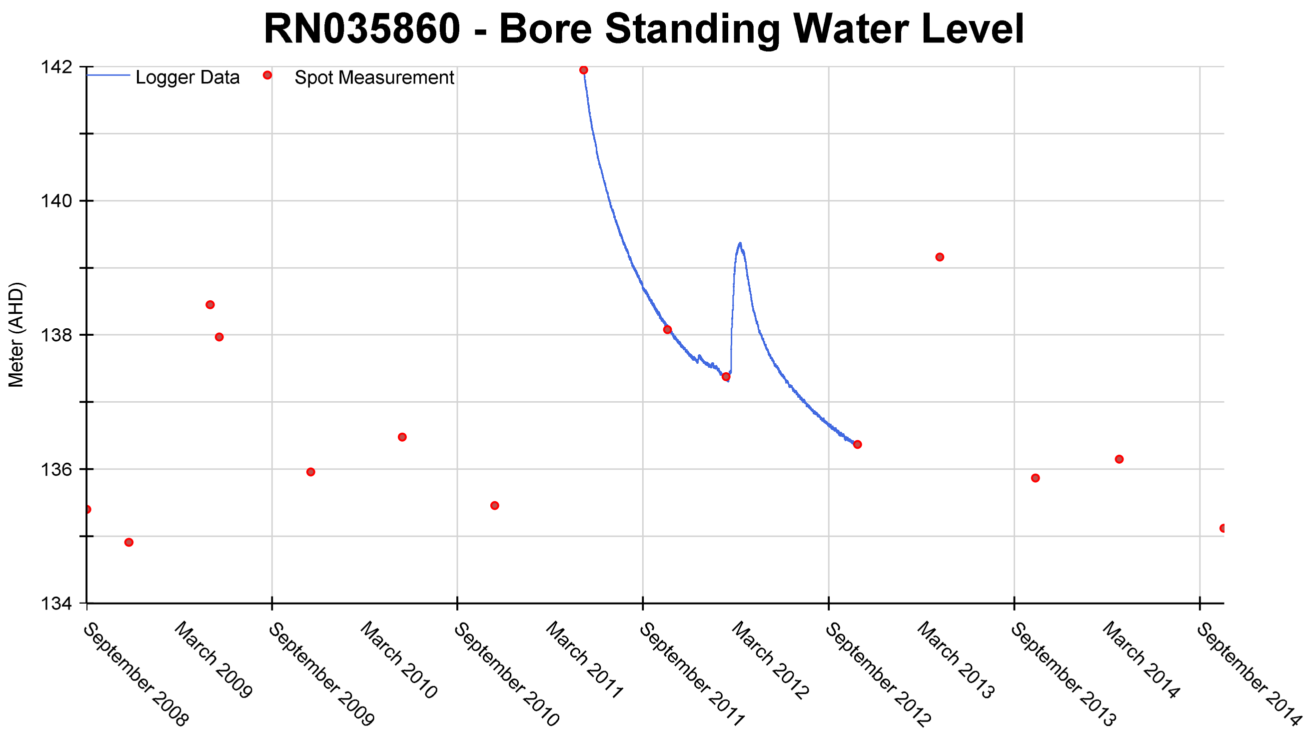


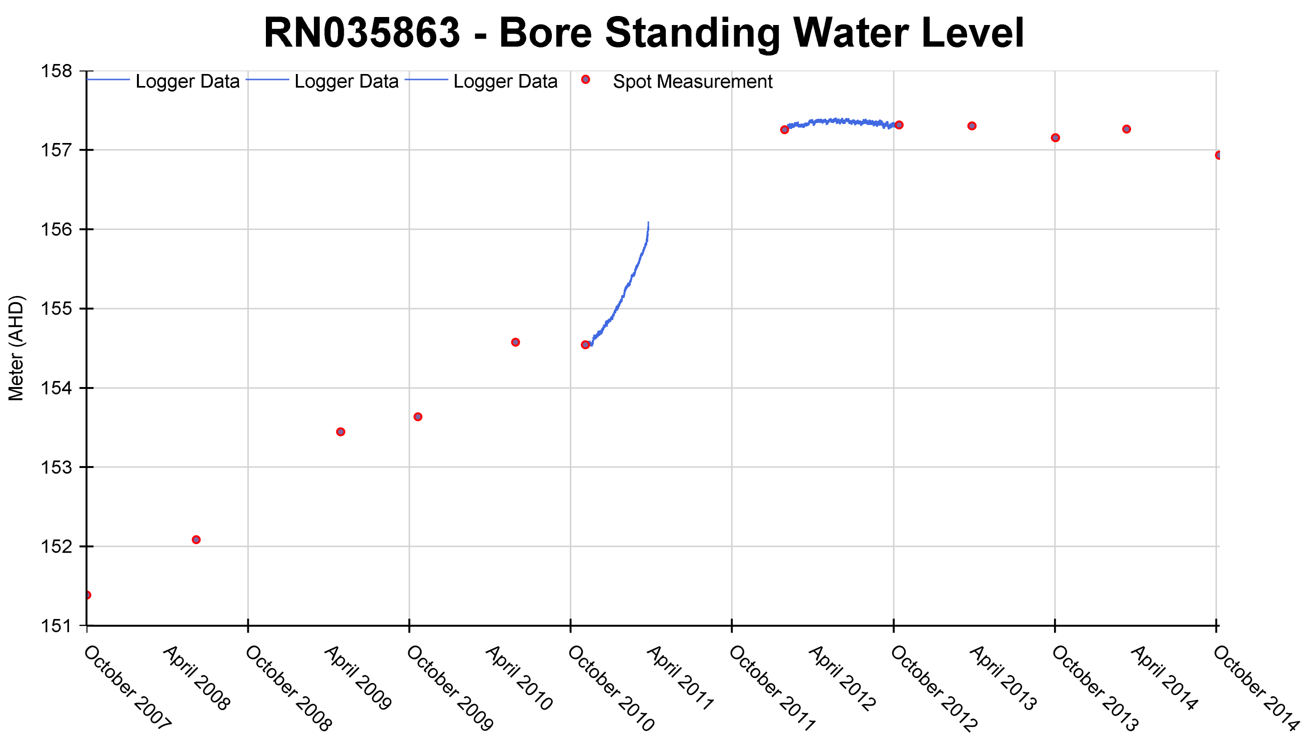
RN035795 - Bore Standing Water Level



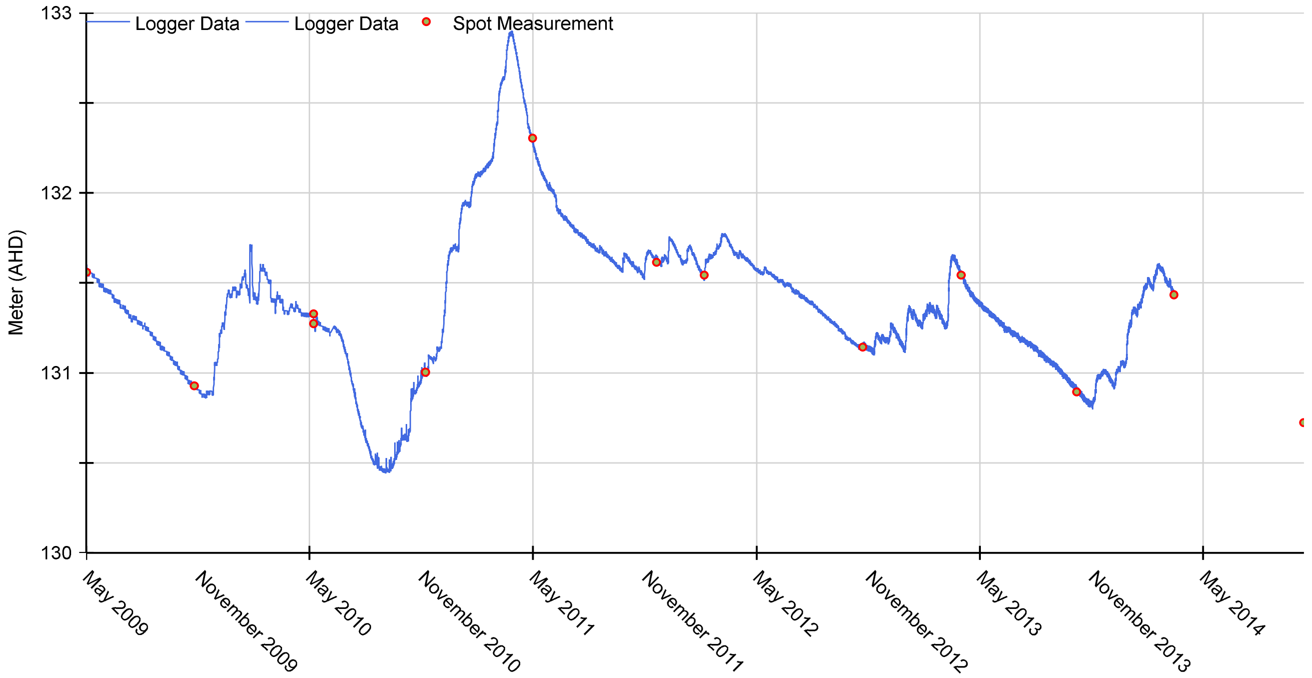
RN035796 - Bore Standing Water Level



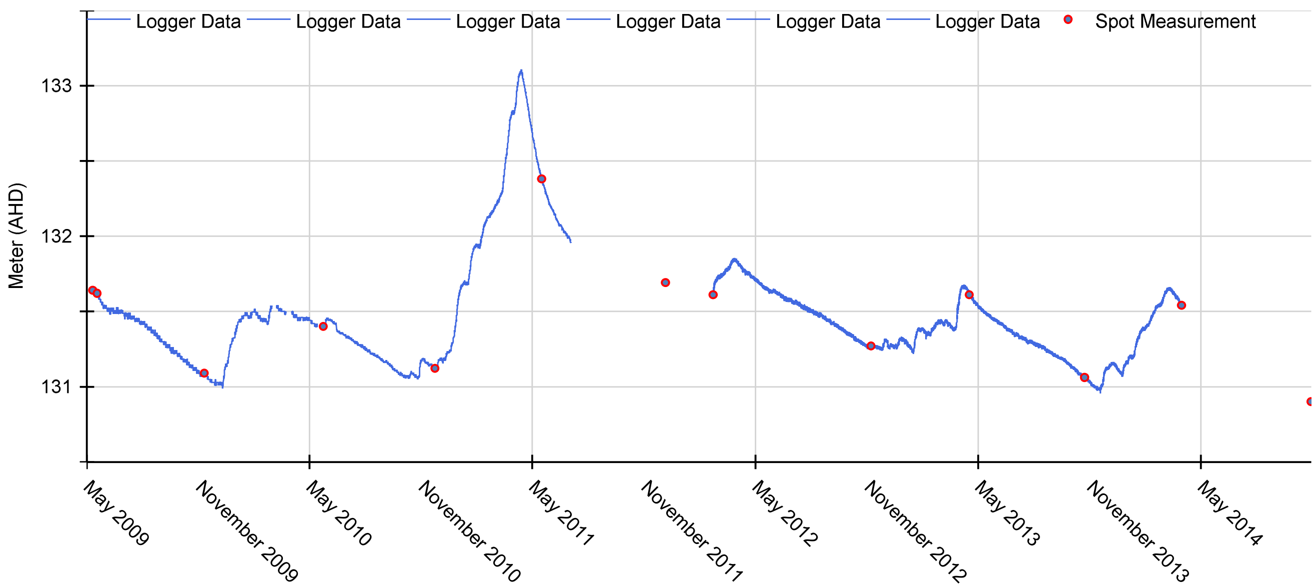

RN035860 - Bore Standing Water Level
Logger Data
Spot Measurement
Meter (AHD)
142
140
138
136
134
September 2008
March 2009
September 2009
March 2010
September 2010
March 2011
September 2011
March 2012
September 2012
March 2013
September 2013
March 2014
September 2014

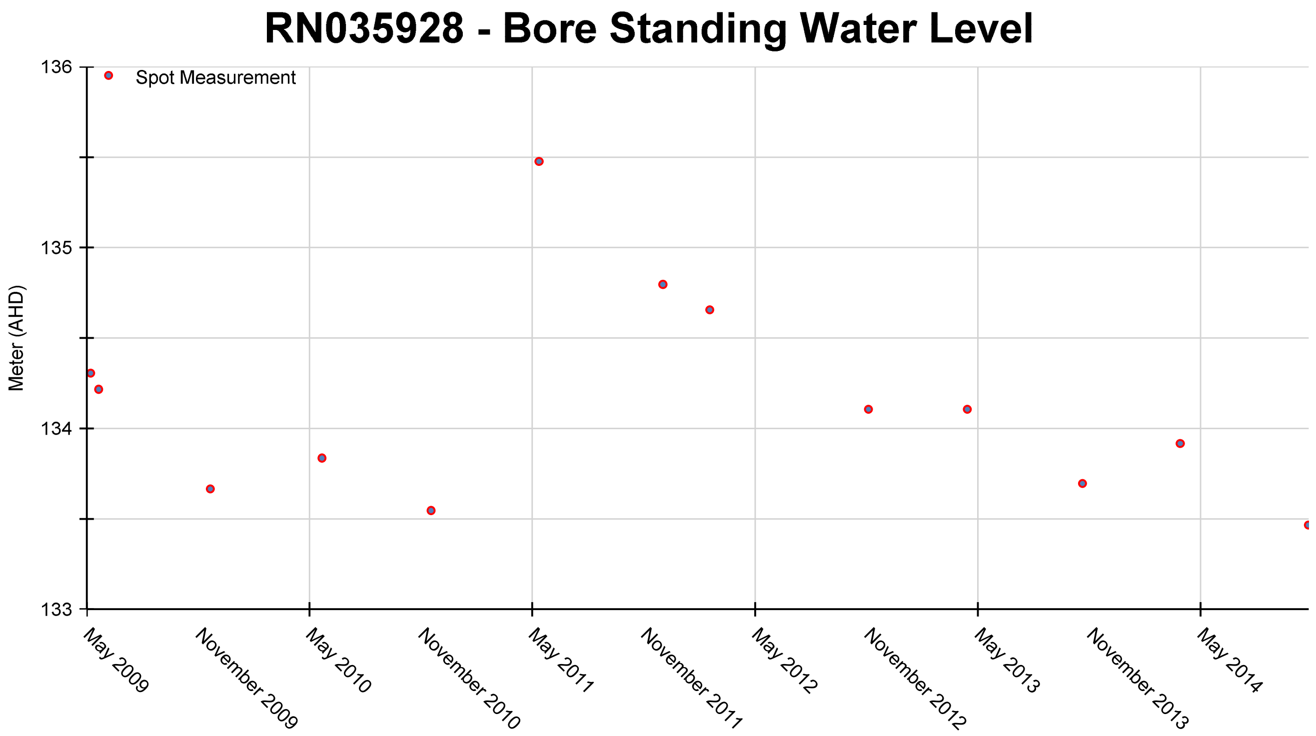

RN035863 - Bore Standing Water Level
Logger Data
Logger Data
Logger Data
Spot Measurement
Meter (AHD)
158
157
156
155
154
153
152
151
October 2007
April 2008
October 2008
April 2009
October 2009
April 2010
October 2010
April 2011
October 2011
April 2012
October 2012
April 2013
October 2013
April 2014
October 2014

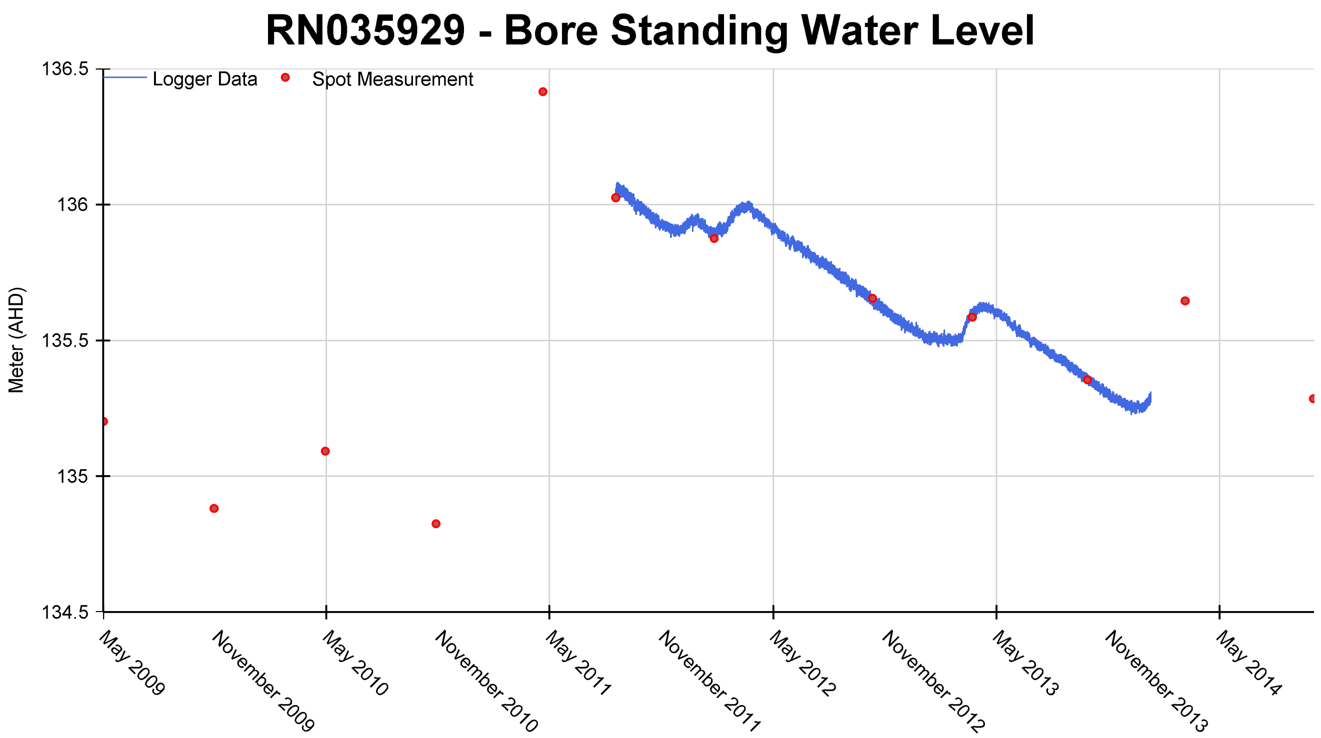
RN035926 - Bore Standing Water Level



RN035927 - Bore Standing Water Level




RN035928 - Bore Standing Water Level
Spot Measurement
Meter (AHD)
136
135
134
133
May 2009
November 2009
May 2010
November 2010
May 2011
November 2011
May 2012
November 2012
May 2013
November 2013
May 2014


RN035929 - Bore Standing Water Level
Logger Data
Spot Measurement
Meter (AHD)
136.5
136
135.5
135
134.5
May 2009
November 2009
May 2010
November 2010
May 2011
November 2011
May 2012
November 2012
May 2013
November 2013
May 2014

Water Quality

Electrical Conductivity (EC)

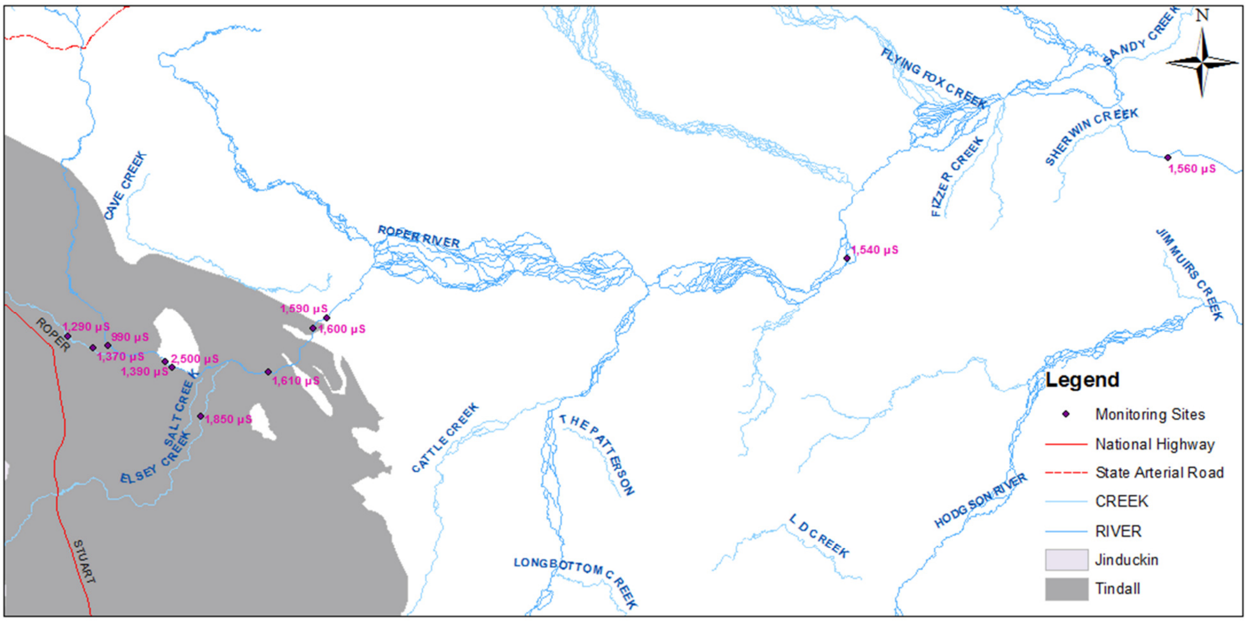


Figure 10: EC (µs/cm) October 2014

Electrical condutivity as an indicator of salinity is relatively uniform (1390 to 1850 µs/cm) with the exception of Rainbow Springs which was 990 µs/cm and Fig Tree Springs 2500 µs/cm.

Water Temperature

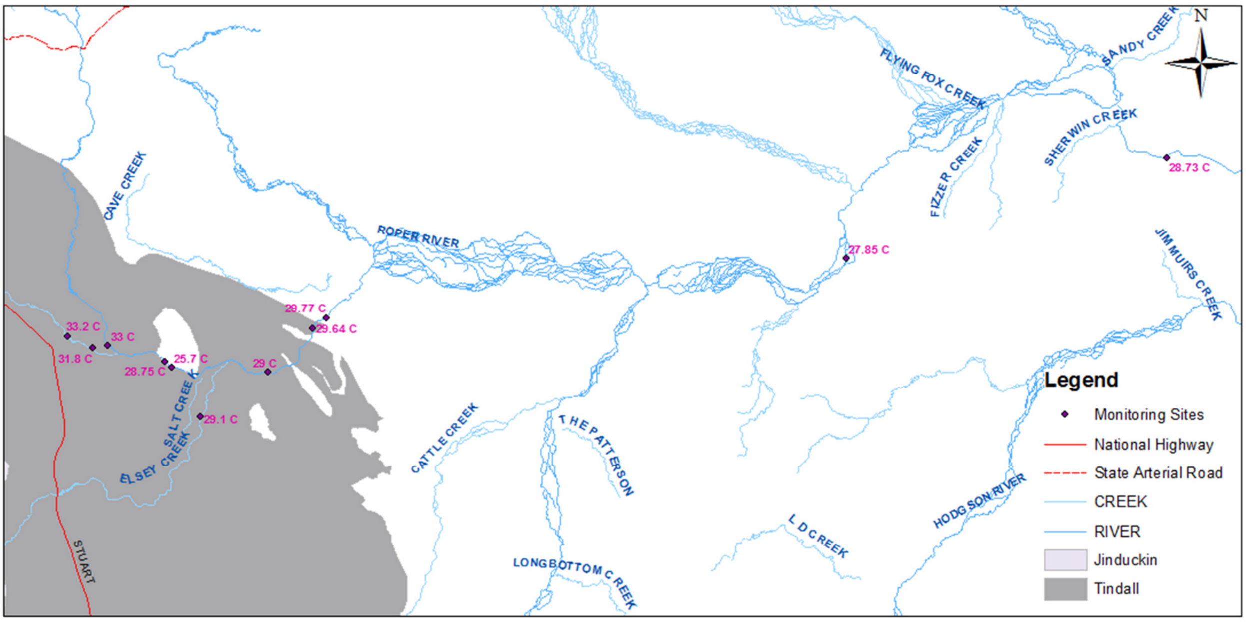


Figure 11: Temperature (deg C) October 2014

Recorded water temperature varies from 25.7 to 33.2 degrees centigrade with no particular spatial distribution pattern, nor was there a correlation with depth of pool that the sample was taken from. Water from Bitter and Rainbow Springs was warmer than the average river temperature, however water at Fig Tree Springs was a few degrees cooler.

pH

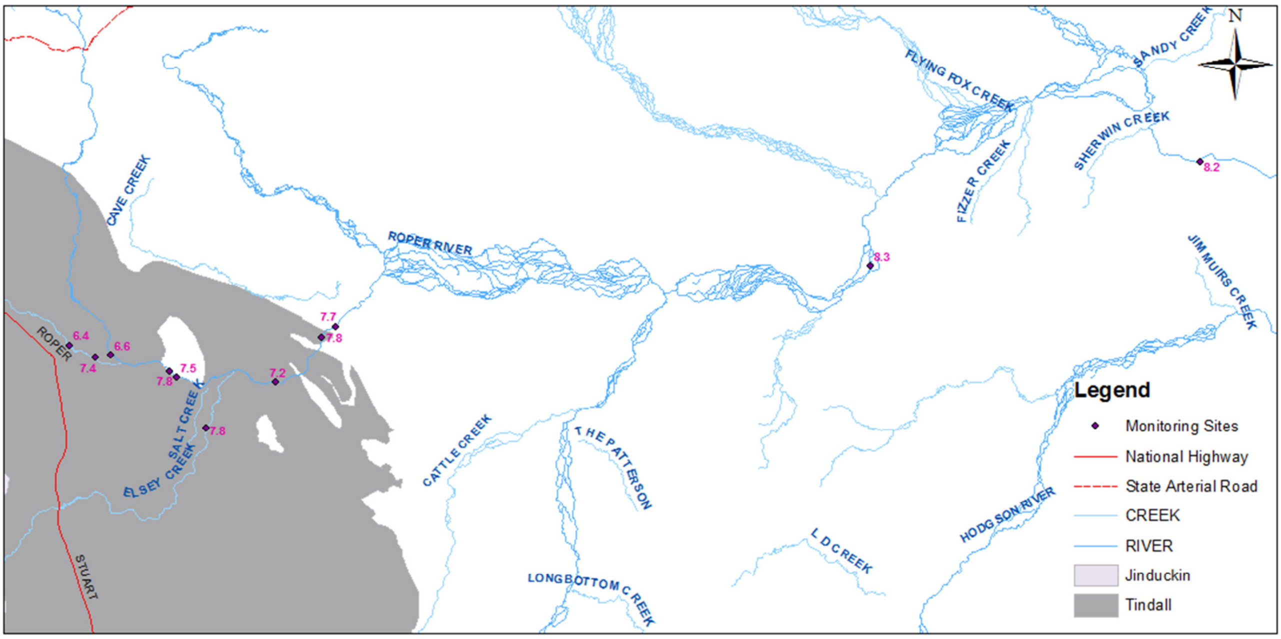


Figure 12: pH October 2014

Bitter Springs (G9035212) and Rainbow Springs (G9035092) are slightly acidic, reflective of the Limestone source. All other locations are slightly basic with pH increasing downstream of the Tindall source.

Turbidity

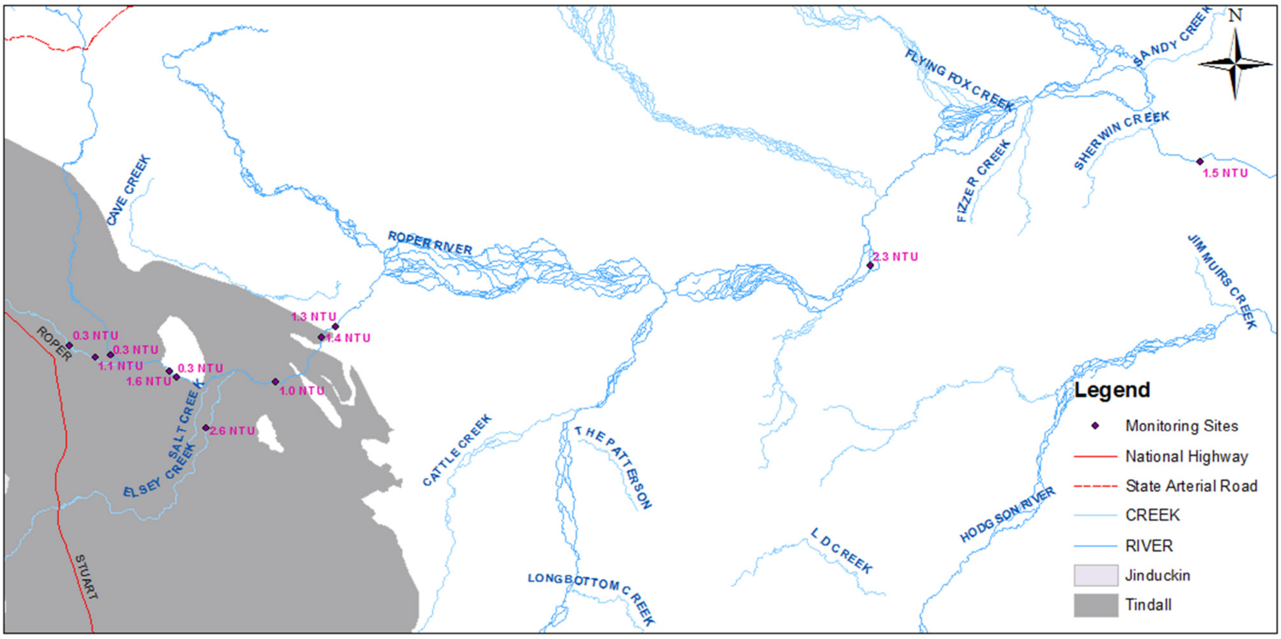


Figure 13: Turbidity (NTU) October 2014

Turbidity was low and relatively uniform at all river sites ranging from 1-2.6 NTU, reflective of the time period since rainfall and runoff last occurred. Each of the springs had particularly low values of 0.3 NTU.

Spring Flows

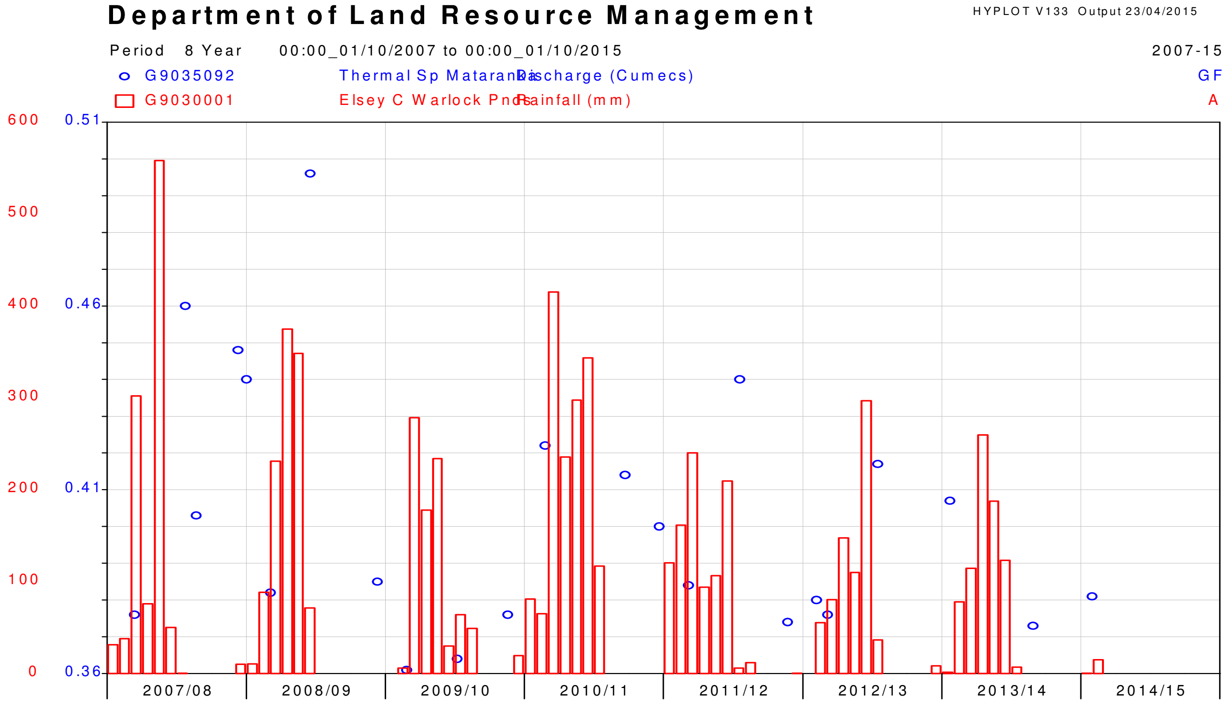


Figure 14: Mataranka Thermal Spring flow versus rainfall

In the 2007/08 and 2010/11 water years, gaugings at Mataranka thermal springs show a crude linear relationship between rainfall and spring flow during the wet and through the dry season. Where gaugings have been undertaken in the early wet season, the springs appear to react quite quickly. Note in 2014 there had only been 0.5mm rainfall recorded at Elsey Creek prior to the spring being gauged, therefore there is high confidence that the 0.38 m3/s flow from the spring reflects end of dry season conditions.

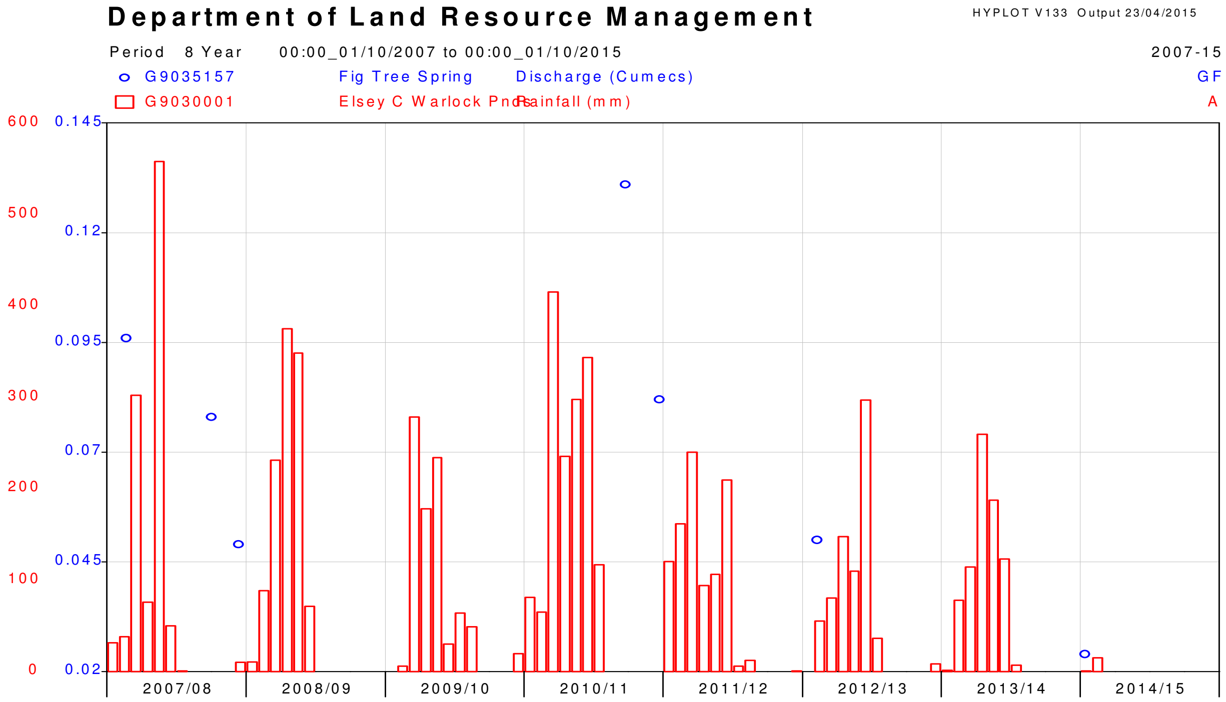


Figure 15: Fig Tree Spring flow versus rainfall

Whilst the spring flow data set is small, Fig Tree Spring has a significantly lower flow rate in late 2014 than that measured at any other time in the past. The flow measurements at the end of the 2008 and 2012 dry season were both undertaken prior to rainfall occurring at Elsey Creek. Further data is required to determine if 2014 is a particularly low flow year at Fig Tree Spring.

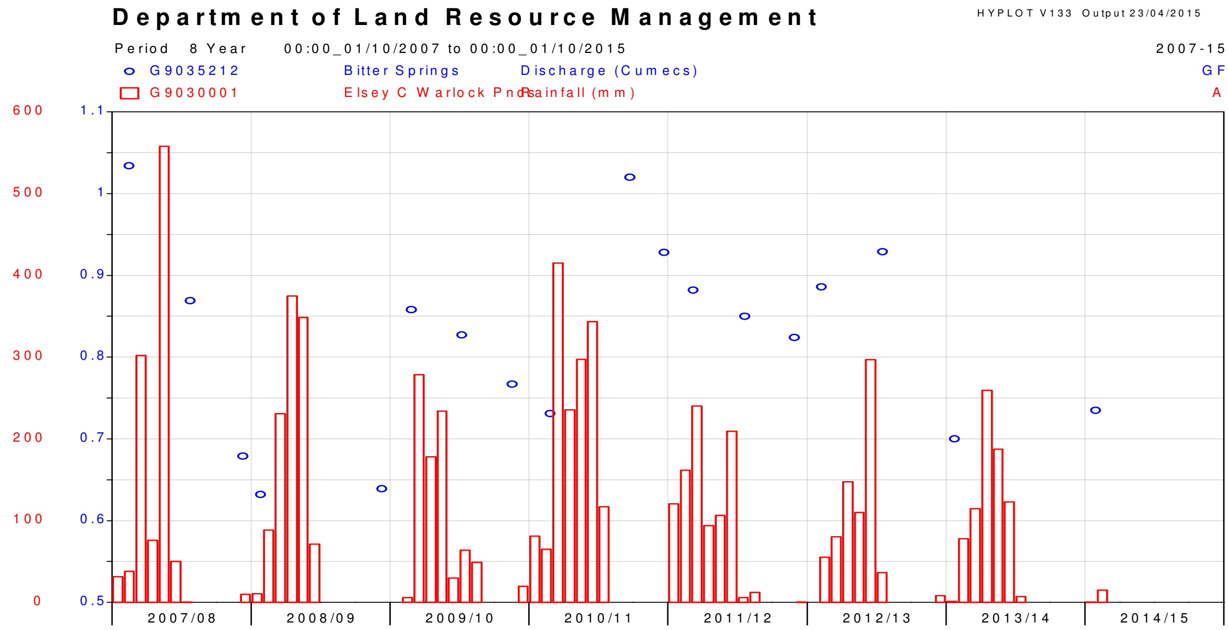


Figure 16: Bitter Spring flow versus rainfall

Bitter Spring gaugings in 20019/10 and 2011/12 show a linear recession relationship relative to rainfall at Elsey Creek. In contrast to Fig Tree Spring, Bitter Springs has an average flow at the end of the 2014 dry season relative to other years.

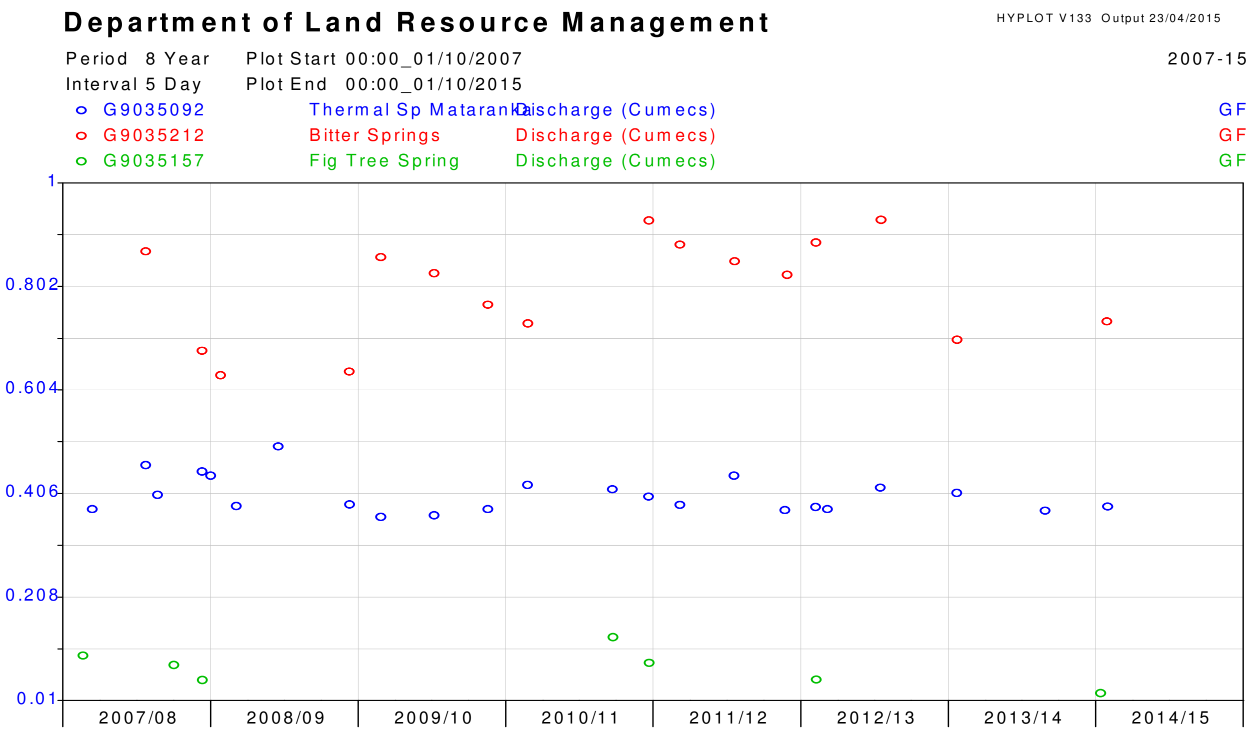


Figure 17: Comparative Spring Flow

Looked at collectively, Fig Tree Spring usually contributes 10-20% of the flow relative to that contributed by Mataranka Thermal Springs, which in turn contributes about 50% of the flow contributed by Bitter Springs. Bitter Springs appears to be the most reactive of the springs having the greatest flow rate seasonal variability.

References

1. Drysdale, R. N., Taylor, M. P. and Ihlenfeld, C. Factors controlling the chemical evolution of traverntine-depositing rivers of the Barkly karst, northern Australia. Hydrological Processes, 16, 2941-2962.

2. Karp, D. 2008. Surface and groundwater interaction the Mataranka area. Report 17/2008. Northern Territory Department of Natural Resources, Environment the Arts and Sport

3. Wagenaar, D and Tickell, S.J., 2013, Late dry season stream flows and groundwater levels, upper Roper River, October 2013 Northern Territory Government Department of Land Resource Management.

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Appendix A

Monitoring Requirements

Objectives

The monitoring objectives for the snapshot measurements are based on surface water and groundwater monitoring requirements as documented in Table 1.1.

Table 1.1

Measurement	Surface Water	Groundwater
Water Level	Gauge Board \ Survey	Dip Tape
Discharge	Flow Measurement	Flow Measurement at Springs
Water Quality	Field parameters (EC, temp, pH, turbidity and DO), Major Ions, Nutrients and Metals.	Field parameters (EC, temp, pH and DO), Major Ions, Nutrients and Metals.

The monitoring requirements for the snap shot measurement at each monitoring site are detailed in the *Monitoring Requirements* section of the Tindal Limestone Aquifer (Mataranka) WAP Monitoring Program.

Field Measurement Standards

Water Levels

Major factors that have an influence on the accuracy of water level measurements at surface water and groundwater monitoring sites are summarised in Table 1.2.

Table 1.2

Type	Conditions	Influences	Description
Surface Water	Hydraulic	Wave action	Waves created during high flows, wind and or turbulence at gauge plates
		Instrument Location	Point of measurement is a significant distance from gauge plates, especially during high flows.
		River Bend (outside)	Water level higher at the outside of the bend.
		River Bend (inside)	Water level lower at the inside of the bend.
		Velocity	High velocities creates turbulence, etc.
		Turbulence	Eddies \ turbulence created at gauge boards. Create difficulty in reading due to fluctuations in water level.
		Back Flow	Back flow creates difficulties in reading gauge plates
	Site	Sediment	Sediment deposition at gauge plates. Gauge plates can be buried under sediment.

Type	Conditions	Influences	Description
		Debris	Debris deposited at gauge plates. Difficult to take readings without maintenance work
	Gauge Plates	Unstable gauge posts	Unstable gauge posts create inaccuracies in the gauge plate heights.
		Unreadable gauge plates	Gauge plates that are in a bad condition is difficult to read and create inaccuracies in the readings
		Gauge Plate Numbers	Missing numbers create confusion and can create mistakes of up to 1m in gauge plate readings.
		Surveys	In correct surveys and adjustments on gauge plates causes error in gauge plate readings.
Ground water	Production Boreholes	Size of Well	Insufficient space to perform water level measurements with existing equipment
		Pumping	Pumping operations influences the water level measurements
	Casing Collar	Unstable casing	Unstable casing causes errors in the water level measurement
	Level Indicators	Equipment condition	Instruments with faded increments can cause errors in measurements.
		Increments	Course increments on tape measure will lead to different interpolation of values

Stream Flow

Factors influencing accuracy of discharge measurements are categorised under environmental and system influences. System influences are created by the type of instrumentation used and can be minimised if standards are followed. Environmental influences result from site conditions and actions by the operator and generally have a much greater impact on measurement accuracy. Environmental factors having an influence on flow accuracy are:

- Wind: The wind causes the water level to osculate which has a large effect on the flow if the wind direction is parallel with the flow direction.
- Large pools: Reduce velocity drastically
- Water vegetation: Influences the accuracy of depth and velocity measurements.
- Algae growth: Algae that floats in the water can influence the signal strength of the ADCP.

Consideration of the Hydraulic requirements of a monitoring section is essential for accurate discharge measurements. As far as possible, during the gauging section selection process the monitoring site needs to comply with the following:

- Uniform cross section
- Flow in the stream should be confined to a single well-defined channel with stable banks.

- Bends upstream of site must be avoided if possible
- Steep bed slopes upstream should be avoided if possible.
- Avoid deep pools that can influence the flow
- Avoid prominent obstructions in a pool or excessive plant growth that can affect the flow pattern.
- Turbulence \ eddies must be avoided.
- Negative \ back flow must be avoided at all times.

Water Quality

To minimise external factors influencing water quality measurement/sampling accuracy, the following protocols are adhered to:

- Instrument \ Sensor calibration.
- Compliance with water sampling procedure.
- Measurement undertaken as close as practical to the mid-point of the stream.
- Sensors as close to the surface as possible.
- Turbulence (waves, eddies) at the surface are avoided; the measurement point should be moved away from these areas as physical-chemical parameters will be affected.
- Standing water at the edges of streams should be avoided, as these are not representative of the stream.
- Deep pools with very low flow should be sampled as close as possible to the center of the main pool.

Appendix B – Water Levels and Flows

Surface water measurements

Site Number	Site Name	Flow m3/s	Height	Date	Rating Deviation %
G9030010	Roper River At Judy Crossing	2.69	N/A	28/10/2014	N/A
G9030013	Roper River - Elsey Homestead	4.01	1.325	27/10/2014	-88.820
G9030022	Roper River, WAP Site 17	5.41	N/A	29/10/2014	N/A
G9030023	Roper River, WAP Site 18	5.27	N/A	29/10/2014	N/A
G9030176	Roper River - D/S Mataranka Homestead	2.18	0.38	30/10/2014	4.583
G9030250	Roper River - Red Rock	2.08	1.47	27/10/2014	24.114
G9035085	Little Roper - Mataranka Homestead Crossing	1.55	N/A	30/10/2014	N/A
G9035092	Roper River - Rainbow Springs	0.38	1.01	30/10/2014	N/A
G9035157	Fig Tree Spring - Roper River Elsey Park	0.02	N/A	13/10/2014	N/A
G9035200	Elsey Ck - Roper Hwy., Waypoint 61	0.36	1.52	29/10/2014	N/A
G9035212	Bitter Springs - Swimming Access	0.74	0.52	28/10/2014	N/A

Groundwater measurements

Site Number	Site Name	Date	Depth Below Ground (m)	Water Level (m) AHD
RN008299	Mataranka	27/10/2014	5.37	129.079
RN028082	South Larrimah	28/10/2014	40.3	
RN029012	Elsey Station	28/10/2014	36.036	135.455
RN029013	Maryfield Station	28/10/2014	38.538	146.175
RN029091	Gorrie Station	28/10/2014	9.516	133.571
RN031985	Jilkminggan	29/10/2014	11.147	110.561
RN034030	Mataranka	30/10/2014	1.74	122.594
RN034031	Mataranka	30/10/2014	4.5	130.767
RN034032	Mataranka	30/10/2014	6.832	115.331
RN034038	Mataranka	28/10/2014	1.131	132.232
RN034039	Mataranka	29/10/2014	16.506	97.577
RN034230	Mataranka	27/10/2014	2.744	127.122
RN034231	Mataranka	29/10/2014	1.94	125.657
RN035519	Ngukurr	27/10/2014	7.83	131.089
RN035790	Mataranka-Elsey Station	29/10/2014	11.35	N/A
RN035792	Mataranka-Elsey National Park	29/10/2014	16.76	N/A
RN035793	Mataranka-Elsey Station	29/10/2014	8.985	101.087
RN035795	Roper Hwy	29/10/2014	7.12	115.138
RN035796	Mataranka Homestead Airstrip	30/10/2014	4.44	116.72
RN035860	Mataranka	27/10/2014	21.1	135.119
RN035926	Elsey National Park	30/10/2014	1.563	130.724
RN035927	Elsey National Park	30/10/2014	13.745	130.902
RN035928	Mataranka Station	30/10/2014	45.332	133.466
RN035929	Elsey Station	28/10/2014	26.123	135.285
RN036305	Elsey Station	29/10/2014	1.67	N/A

Appendix C – Water Quality Field Measurements

Site Number	Site Name	Date	Temp (C)	pH	D.O. (mg/L)	DO (% sat)	E.C. (µS/cm)	Turbidity (NTU)
G9030010	Roper River At Judy Crossing	28/10/2014	27.8	8.3	6.9	89	1,540	2.3
G9030013	Roper River - Elsey Homestead	27/10/2014	29.0	7.2	10.6	138	1,610	1.0
G9030022	Roper River, WAP Site 17	29/10/2014	29.6	7.8	8.6	114	1,600	1.4
G9030023	Roper River, WAP Site 18	29/10/2014	29.7	7.7	8.6	114	1,590	1.3
G9030176	Roper River - D/S Mataranka Homestead	30/10/2014	28.7	7.8	8.2	106	1,390	1.6
G9030250	Roper River - Red Rock	27/10/2014	28.7	8.2	7.8	101	1,560	1.5
G9035085	Little Roper - Mataranka Homestead Crossing	30/10/2014	31.8	7.4	5.3	73	1,370	1.1
G9035092	Roper River - Rainbow Springs	30/10/2014	33.0	6.6	0.5	7	990	0.3
G9035157	Fig Tree Spring - Roper River Elsey Park	13/10/2014	25.7	7.5	6.5	82	2,500	0.3
G9035200	Elsey Ck - Roper Hwy., Waypoint 61	29/10/2014	29.1	7.8	7.6	100	1,850	2.6
G9035212	Bitter Springs - Swimming Access	28/10/2014	33.2	6.4	0.7	10	1,290	0.3
RN035790	Mataranka-Elsey Station	29/10/2014						
RN035796	Mataranka Homestead Airstrip	30/10/2014						
RN035927	Elsey National Park	30/10/2014						

Appendix D – Water Quality - Nutrients

Site Number	Site Name	Date	Ammonium (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Phosphorous (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)
G9030010	Roper River At Judy Crossing	28/10/2014	< 0.001	< 0.001	0.003	< 0.001	0.13	< 0.005
G9030013	Roper River - Elsey Homestead	27/10/2014	< 0.001	0.001	0.003	< 0.001	0.08	0.005
G9030022	Roper River, WAP Site 17	29/10/2014	< 0.001	0.003	< 0.001	0.001	0.07	0.006
G9030023	Roper River, WAP Site 18	29/10/2014	< 0.001	0.003	< 0.001	< 0.001	0.16	0.007
G9030176	Roper River - D/S Mataranka Homestead	30/10/2014	0.015	0.002	0.03	0.003	0.11	< 0.005
G9030250	Roper River - Red Rock	27/10/2014	0.01	< 0.001	0.022	< 0.001	0.15	< 0.005
G9035085	Little Roper @ Mataranka Homestead Xing	30/10/2014	0.004	0.003	0.146	< 0.001	0.21	< 0.005
G9035092	Roper River at Rainbow Springs	30/10/2014	< 0.001	< 0.001	0.168	0.003	0.17	0.005
G9035157	Fig Tree Spring - Roper River Elsey Park	13/10/2014	< 0.001	0.001	0.078	< 0.001	0.13	< 0.005
G9035200	Elsey Ck @ Roper Hwy., Waypoint 61	29/10/2014	0.004	< 0.001	0.004	< 0.001	0.16	< 0.005
G9035212	Bitter Springs - Swimming Access	28/10/2014	0.003	< 0.001	0.301	0.001	0.3	< 0.005
RN035790	Mataranka-Elsey	29/10/2014	1.17	0.003	0.004	0.131	1.24	0.176
RN035796	Mataranka	30/10/2014	< 0.001	0.007	0.2	< 0.001	0.2	0.006
RN035927	Elsey National Park	30/10/2014	< 0.001	0.002	0.484	0.004	0.48	< 0.005