














POWER AND WATER CORPORATION

drinking water quality report

major and minor urban centres 2008

PowerWater

Contents

From the Managing Director

I am pleased to introduce Power and Water Corporation's seventh annual public Drinking Water Quality Report for major and minor urban centres. Power and Water supplies water to five major centres, 13 minor centres and 80 Indigenous communities across the Territory. This report summarises our performance for delivering safe water across the major and minor urban centres and complements our separate report on Indigenous communities.

Across the country, people are debating water quality issues and Power and Water, as a supplier, is constantly researching and implementing new ways to provide safe and aesthetically acceptable water supplies to all our customers regardless of where they live.

With large arid areas in the south, water is more often supplied from ground water sources that may have chemical characteristics requiring treatment or specific operational management. In the Top End, with high seasonal rainfall and tropical weather, we must closely monitor the water quality in our surface water reservoirs to draw the best quality water.

At Power and Water, we are committed to ensuring our drinking water is safe. We strive for continual improvement and work hard to maintain a high standard of consistency. Across major centres in 2007-08 Power and Water achieved 99.6 per cent compliance for bacteriological monitoring with only three samples out of 806 samples containing *Escherichia coli*. In minor centres Power and Water achieved 99.4 per cent compliance for bacteriological monitoring with only three samples out of 473 samples containing *Escherichia coli*.

In 2007-08, we have maintained certification to the internationally recognised quality management system standard ISO 9001. Our commitment will help ensure we continually improve our management system and the quality of water delivered to homes.

As the Northern Territory's major public water service provider, we are proud to share our performance and plans for the future.

Andrew Macrides
Managing Director
Power and Water Corporation

SECTION A:
Framework for Drinking Water Quality Management

The *Australian Drinking Water Guidelines* (the 2004 ADWG) were published by a joint committee of the National Health and Medical Research Council (NHMRC) and Agricultural Resource Management Council of Australia and New Zealand (ARMCANZ) in 2004. Based on the best available scientific evidence, these national guidelines provide a framework for good management of drinking water supplies and an authoritative reference on what defines safe, good quality water, how it can be achieved and assured.

Power and Water is committed to providing safe drinking water by adopting and implementing the Framework for Management of Drinking Water Quality included as a key part of the 2004 ADWG.

There are 12 elements to this Framework, which is based on a proactive approach to ensuring the safety of drinking water by managing all steps in water supply from catchment to consumer. The 12 elements are outlined below.

1. Commitment to drinking water quality management

Power and Water is committed to being a trusted provider of safe, good quality drinking water. This is outlined in our Drinking Water Quality Policy and Customer Contract. A copy of the Customer Contract is available at any Power and Water office or at www.powerwater.com.au

Summary of Power and Water's Drinking Water Quality Policy

We aim to provide you with a good quality, safe and reliable water supply. We will:

- Supply drinking water, appropriate to the environment in which the community is located, in accordance with parameters set by the Guidelines.
- Monitor the quality of drinking water in line with the Drinking Water Operational and Verification Monitoring Program and report the results to the Chief Health Officer, Department of Health and Community Services (DHCS).
- Develop contingency and response plans to deal with incidents that may adversely affect drinking water quality.
- Implement any arrangements notified by the Chief Health Officer in an emergency, to ensure the safety of supply.
- Respond promptly to any problem identified.
- Consult with the community where health-related physical, chemical or radiological parameters exceed the Guideline value.

While Power and Water has primary responsibility for providing safe drinking water through the Water Supply and Sewerage Services Act, a number of government agencies are also involved.

The Department of Health and Community Services (DHCS) has a key role in applying the 2004 ADWG and monitoring compliance with them in the interest of public health.

The Department of Natural Resources, Environment, and The Arts (DNRETA) also has a role in protecting water quality, including the regulation and management of water resources and the regulation of pollution control.

The Department of Primary Industry, Fisheries and Mines (DPIFM) undertakes independent analyses of water samples through its laboratories in Darwin and Alice Springs.

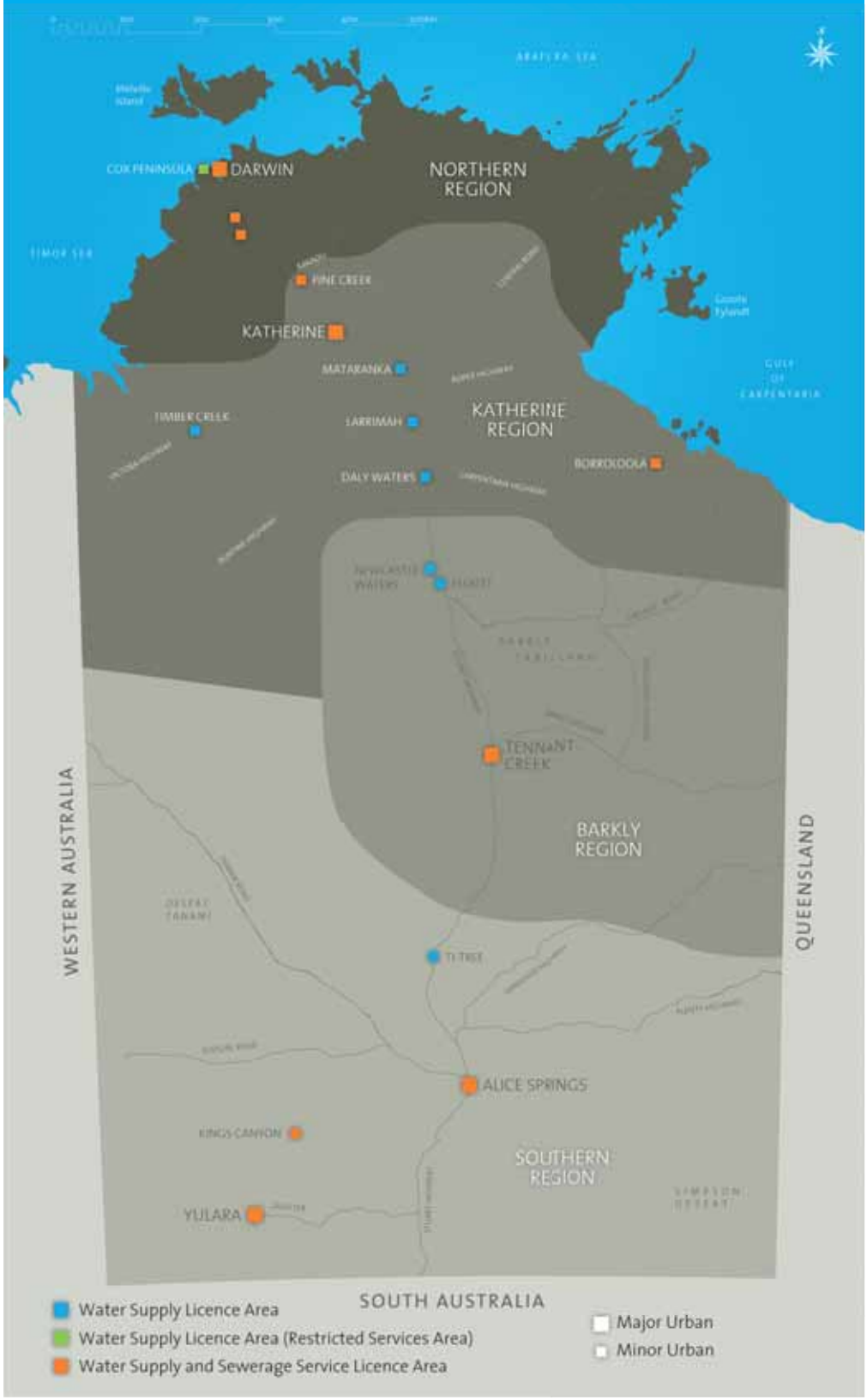
The Department of Planning and Infrastructure (DPI) has a major role in protecting water quality through land use planning.

These agencies coordinate and cooperate to ensure highest standard of water quality is achieved and maintained.

2. Assessment of the drinking water supply system

Power and Water supplies water to the five major centres and 13 minor centres illustrated in Figure 1 below.

FIGURE 1: Power and Water Corporation water supply service areas
(Only licensed areas and not remote Aboriginal communities are shown on this map)



Water sources

Apart from Darwin, Katherine and Pine Creek, our centres rely on ground water, particularly in the arid centre. In some cases, the ground water is more than 10,000 years old. Table 1 shows existing water sources for major and minor centres of the Northern Territory.

Most of Darwin's water supply comes from Darwin River Reservoir. To ensure good quality water, no development or uncontrolled public access is allowed within the catchment. Water is drawn down through the year, with the majority of use in the Dry Season (May to October) and recharged during the Wet Season (November to April). The balance of supply (about 10 per cent) is ground water from the McMinns and Howard East Borefields.

In 2007-08 Power and Water started investigating using Manton River Reservoir as an additional, permanent water supply for Darwin. This involved drawing down water and monitoring its quality, as well as studying the effects this use would have on the existing recreational uses of the reservoir. This study will continue in 2008-09.

Table 1: Summary of existing drinking water sources in major and minor centres

CENTRE	SOURCE (WITH LOCAL NAMES WHERE IN COMMON USE)
Adelaide River	Ground water
Alice Springs	Ground water (Roe Creek Borefield)
Batchelor	Ground water
Borroloola	Ground water
Daly Waters	Ground water
Darwin	Surface water (Darwin River Reservoir) + Ground water (10%)
Elliott	Ground water
Katherine	Surface water (Katherine River) + Ground water (30%)
Kings Canyon	Ground water
Larrimah	Ground water
Mataranka	Ground water
Newcastle Waters	Ground water
Pine Creek	Surface water (Copperfield Reservoir) + Ground water (40%)
Tennant Creek	Ground water (Kelly Well, Kelly Well West and Cabbage Gum Borefields)
Timber Creek	Ground water
Ti Tree	Ground water
Yulara	Ground water

Power and Water has developed a semi-quantitative risk assessment procedure to identify the water quality hazards that pose a risk to Territory water supplies and to provide a qualitative ranking of the risks. This is based on water quality measurements taken in all centres from 2003-08. The risk assessment generates a score for each centre.

This information is used to allocate resources to improve water quality. The results are in Section 12 – Review and Continual Improvement.

3. Preventative strategies for drinking water supply

Power and Water has adopted the multiple barrier principle to protect drinking water supplies. This means establishing a number of barriers to minimise the potential for water supply contamination. This is one of the key elements of the Framework for Management of Drinking Water Quality.

Table 2 summarises the current barriers in place in the major and minor centres to ensure the supply of safe drinking water.

Water quality sampling Darwin River Reservoir off-take tower

Table 2: Water quality barriers in major and minor centres

	Catchment Protection	Detention in Reservoirs/ Aquifers	Bore Head Integrity	Alternative Sources of Supply	Coagulation, Filtration or Membrane Filtration	Disinfection	Storage Tank Integrity and Cleaning	Maintenance of Positive Pressure in Reticulation	Back-FLow Prevention in Reticulation	Disinfection Residual at Customer's Tap
Adelaide River										
Alice Springs										
Batchelor										
Borroloola										
Cox Peninsula										
Daly Waters										
Darwin ground water										
Darwin surface water			N/A							
Elliott										
Katherine ground water										
Katherine surface water			N/A							
Kings Canyon										
Larrimah										
Mataranka										
Newcastle Waters										
Pine Creek ground water										
Pine Creek surface water										
Tennant Creek										
Timber Creek										
Ti Tree										
Yulara										

Notes: White indicates no barrier. Light beige a partial barrier and dark beige indicates full barrier. N/A – Not Applicable.

4. Operational procedures and process control

Formal operational procedures are critical to ensure the uninterrupted supply of high quality water across the Northern Territory. These ensure work is standardised and all data recording and reporting needs are identified.

Operating procedures are routinely reviewed and updated in line with Power and Water's drive for continual improvement and implementation of systems certified to comply with International Standards Organisation (ISO) standards, Environment (ISO14001), Quality (ISO9001) and Occupational Health and Safety (AS4801).

Specific points in each supply are monitored to provide information critical for the control of the supply. Power and Water uses a range of online monitoring equipment in each centre. This equipment provides continuous monitoring for chlorine, fluoride, conductivity, turbidity and pH.

A major focus of operational monitoring is the control of the chlorine disinfection process, specifically the maintenance of the effective chlorine residuals.

5. Verification of drinking water quality

Water quality monitoring

Power and Water's Water Quality Monitoring Program is used to verify the effectiveness of water quality management strategies. The program is based on the 2004 ADWG's recommendations but local knowledge may also influence monitoring.

Microbiological, physical, chemical and radiological samples are routinely collected from the distribution systems of all Territory water supplies.

Power and Water is using a three-year monitoring program, which was approved by the DHCS for 2006-09. The types of monitoring in the program include:

Microbiological monitoring

Waterborne disease-causing organisms (pathogens) pose a serious risk to human health. The risk from these can vary from day to day in water supplies so microbiological monitoring is used to assess the potential for their presence. Pathogens are difficult to detect, so indicator organisms are used to show whether faecal contamination may have occurred. The indicator organisms Power and Water monitors are:

- *Escherichia coli* (or *E. coli*):– indicates faecal contamination from warm-blooded animals, and hence, the potential for the presence of disease-causing micro-organisms; and
- Total coliforms: – a range of bacteria found in many soil and water environments. Total coliforms provide a measure of the effectiveness of the treatment system and a general indication of the cleanliness of the drinking water supply.

The 2004 ADWG require that for assessment of microbiological performance:

- At least a minimum number of routine samples have been tested for *E. coli*; and
- At least 98 per cent of scheduled samples (as distinct from repeat or special purpose samples) contain no *E. coli*.

Power and Water also monitors for the presence of the amoeba *Naegleria fowleri*. This is a small, free-living thermophylic amoeba found in damp soil and warm water. It can cause primary amoebic meningoencephalitis (PAM), a very rapid and often fatal infection if it comes in contact with certain parts of the human body – particularly, the system of membranes which envelops the central nervous system, when water is forced into the nose from swimming or diving. The testing for *N. fowleri* is included as part of the monitoring as the indicator organisms described above are not suitable indicators for the presence of *N. fowleri*.

Power and Water introduced an extensive monitoring program for *N. fowleri* in all major and minor centres in 2006-07 following its detection in South Australia and Western Australia and continued this into 2007-08.

The 2004 ADWG recommend an action level of two *N. fowleri* organisms per litre in the treated water system. The 2004 ADWG recommend controlling *N. fowleri* by maintaining a minimum free chlorine level of 0.5 mg/L. Power and Water aims to do this in all distribution systems (except Tennant Creek, where continuous chlorination is not practiced).

Power and Water monitors the level of *Burkholderia pseudomallei*, the organism that causes the disease melioidosis (commonly known as Nightcliff Gardener's Disease). The monitoring program was developed in 2006-07 in consultation with the DHCS, targeting the unchlorinated water supply in Tennant Creek. Monitoring continued in 2007-08.

Chemical and physical monitoring

Power and Water monitors many chemical and physical parameters to ensure that water is safe and pleasant to drink.

In general, the potential risk to human health increases as the levels of these chemical and physical parameters increase. Power and Water monitoring ensures the risk to human health is minimised. The safe levels of these chemicals in drinking water are specified in the 2004 ADWG, based on assumptions including water consumption and potential exposure to chemicals from other sources.

Radionuclides or radiation-emitting elements are sometimes found in drinking water supplies. In the Northern Territory these elements are natural and characteristic of the local hydrogeology. The 2004 ADWG define corrective action responses when response limits are exceeded:

- If the total annual dose is less than 0.5 mSv, Power and Water is only required to continue monitoring;
- If the total annual dose lies between 0.5 and 1.0 mSv, discussions should be held with the relevant health authority to determine the frequency of ongoing sampling (primary response level);
- If the total annual dose exceeds 1.0 mSv intervention is required. The water service provider and health authority should assess the results and examine options to reduce the levels of exposure (secondary response level).

Radionuclide monitoring was undertaken for a number of major and minor centres in 2007-08 as part of the three-year water monitoring program endorsed by the DHCS.

Disinfection by-products are formed when chlorine reacts with organic material in the water supply. Chlorine is the primary defence against disease-causing microbiological contaminants in public water systems. However, it does react with naturally occurring organic matter such as decaying leaves and other vegetation to produce several by-products, mostly trihalomethanes (THMs).

All minor and major centres were monitored for THMs in 2007-08 as part of the agreed three-year water monitoring program.

The concentration of THMs is typically proportional to the amount of organic material in the water. Surface water supplies usually have higher levels of naturally occurring organic matter than ground water supplies and hence higher THM levels after disinfection with chlorine.

Pesticides (insecticides and herbicides) are sometimes used in our catchments to control insects and weeds. DHCS requires testing for pesticides where there is the potential for water supply contamination. Pesticide monitoring was undertaken in Darwin River Reservoir as part of the catchment weed control program. Limited pesticide sampling of drinking water supplies was performed in 2006-07 and increased at all major and minor centres, except Borroloola, in early 2008.

Aesthetic parameters

Aesthetic parameters are measures of water quality which pose no threat to human health but can affect drinking water appearance, taste, feel and odour. This includes total dissolved solids (TDS), hardness (calcium and magnesium carbonates and sulphates), colour and pH.

In previous reports, Pine Creek chemical data analyses included data collected from Kybrook Farm. This has been discontinued for this report. Although the differences in reported parameters are minor, the exclusion of the Kybrook Farm data provides a more accurate assessment of water quality in the Pine Creek water supply system.

6. Incident and emergency response

Considered and controlled responses to incidents that can compromise water quality are essential for protecting public health providing best service to customers.

A response procedure, approved by the Chief Medical Officer, DHCS, exists for any microbiological sample that exceeds the agreed limit. Power and Water responses include re-sampling, flushing and manual disinfection with sodium hypochlorite. DHCS is notified immediately of any substantial microbiological failures.

Power and Water, the NT Police and DHCS have a protocol for dealing with contamination of potable water supplies.

7. Employee awareness and training

Power and Water ensures that all employees are appropriately trained and aware of their responsibilities. We use a corporation-wide system called VETtrak to manage employees' training requirements.

8. Community involvement and awareness

Power and Water seeks community involvement in and awareness of, water quality issues. We would like the community to:

- Understand issues associated with their drinking water quality;
- Help Power and Water ensure the security and integrity of their supply;
- Report water quality incidents.

Water quality specialists visit schools if requested and present classes on water science and other water-related subjects. Information on this, as well as our previous water quality reports, can be viewed at www.powerwater.com.au

9. Research and development

Power and Water is an active member of the Cooperative Research Centre for Water Quality and Treatment (CRCWQT), and leads the Regional and Rural Water Supplies Program. This program aims to:

- Address key issues that impact on the provision of good quality drinking water to regional and rural communities in Australia;
- Identify research that will provide affordable and sustainable solutions to water supply problems;
- Help represent regional and rural water supply areas in setting industry policy, regulation and strategic directions.

Power and Water has been directly involved in a range of research projects to improve water quality throughout the Territory, including:

- Application of Hazard Analysis Critical Control Point (HACCP) for Distribution System Protection;
- Understanding the Growth of Opportunistic Bacterial Pathogens within Distribution Mains;
- Disinfection Control within Distribution Systems;
- Drinking Water and Melioidosis;
- Investigation into Water Quality and Supply Issues in Indigenous Communities through a Technology Transfer Officer;
- Remote Community Water Management;
- Investigating the Defluoridation of Water Supplies;
- Case Studies Using On-line Monitoring Systems.

Power and Water has also commissioned a number of internal and external reports on water quality issues at various centres during 2007-08:

- Installation of UV Disinfection on Public Water Supplies Concept Design (2007), Hunter Water Australia Pty Ltd;
- Control of *Botryococcus Braunii* and other Algae from Darwin's Water Supply (2008), Worley Parsons;
- Dirty Water in Darwin Water Supply during Wet Season 2007-08: A Preliminary Investigation (2008), Power and Water Corporation.

10. Documentation and reporting

Recording water quality data and reporting performance is an integral part of any management system.

Documentation is routinely reviewed and updated in line with Power and Water's quality management system. This is part of the Integrated Management System we are implementing after achieving certification to Environment (ISO14001), Quality (ISO9001) and Occupational Health and Safety (AS4801) management systems in 2006.

To streamline data processing and improve data exchange between Power and Water and the Department of Primary Industry, Fisheries and Mines (DPIFM) laboratories, a new water quality database is being developed to ensure water quality data is easily accessible at all centres across the Territory.

Power and Water remains in close communication with the DHCS. In addition to internal reporting, the Department is immediately notified of any instances where water quality targets are not met.

This report is a crucial part of required documentation on water quality performance.

11. Evaluation and audit

Evaluating and auditing water quality management systems ensures successful management of water quality data and processes.

This report is an important part of the review and evaluation process. Audits ensure that operational procedures and processes are in place so that accurate water quality data is collected and appropriate management systems are maintained.

SAI Global conducted a series of surveillance audits on Power and Water in 2007-08. This included a surveillance audit of our water quality management system's drinking water testing processes in March 2008.

The audit emphasised the following observations;

- Water monitoring program complies with the requirements of the 2004 ADWG and is conducted correctly;
- Responses to failures are effective;
- Recording of response actions is thorough;
- Responses are completed in a timely manner;
- Annual report adequately details 2004 ADWG non-compliances;
- Sampling procedures are detailed and unambiguous;
- Safety, environmental and quality aspects are all addressed.

12. Review and continual improvement

Power and Water is committed to developing and improving its drinking water quality management system and the safety of drinking water supplies.

Power and Water has formed a Water Quality Network with SA Water (South Australia) and Water Corporation (Western Australia). The network provides a forum to share information, knowledge and discuss emerging issues. This allows us to benchmark our performance and identify other ways to improve drinking water quality.

Review of drinking water quality system

This annual report is an important way of identifying water quality issues but also helps identify where operational and management system improvements are needed.

Aquality tool

Aquality is an internet-based tool that helps measure the implementation of the 2004 ADWG – Framework for the Management of Drinking Water. Scores are calculated for each of the 12 elements of the Framework as well as implementation of the whole Framework. *Aquality* allows water utilities to undertake the scoring process online and compare with other Australian utilities.

In 2008, Power and Water continued to use *Aquality* to assess implementation of the Framework for elements 1 through 4.

Microbiological risk assessment

Microbiological water quality is the highest priority and is best protected by assessing the number and effectiveness of barriers that prevent the introduction of disease-causing organisms. Table 2 illustrates Tennant Creek has the fewest protective barriers and is thus an area of concern.

Power and Water completed initial investigations into an ultra-violet disinfection system in Tennant Creek as well as for ground water supplies in Darwin and Katherine. Ultra-violet disinfection would provide a significant barrier against microbiological contamination for the Tennant Creek supply but without chlorination there would be no residual disinfection protection downstream of the ultra-violet disinfection system.

Chemical, physical and radiological risk assessment

A risk based assessment method has been developed to prioritise improvements in chemical and physical water quality. It focuses on a scoring system for centres that exceed the 2004 ADWG values for one or more chemical physical or radiological parameters.

To assess risk, Power and Water combines likelihood and consequences. The likelihood of a parameter resulting in a problem is assumed to be proportional to the ratio of the measured value to the guideline value in the 2004 ADWG. That is, where a recorded value exceeds a 2004 ADWG value by double, then the likelihood is given a value of two.

The consequence of any exceedance is given a weighting according to its effect on human health. Weightings were developed in conjunction with DHCS and are based on:

- Relatively significant health impact: 10;
- Relatively minor health impact: 5;
- Relatively significant aesthetic impact: 3.

For example, under this system arsenic is given a weighting of 10 and salinity (TDS) is given a weighting of 3.

The final calculated risk for any particular centre is the sum of the scores for each individual parameter in exceedance of the 2004 ADWG value.

A prority list has been produced from the calculated risk score for each centre. Table 3 shows Tennant Creek, Kings Canyon and Daly Waters have the highest risk scores due to elevated levels of iodide and also for Tennant Creek fluoride. Extra monitoring was implemented for fluoride in 2007-08. There is some debate in the scientific community about the level of iodide intake in the general population. It is expected that in the next review of the 2004 ADWG the guideline will be increased.

Table 3: Relative risk scoring for all centres 2007-08

Rank	Location	Relative Risk Score	Health Parameters Exceeding 2004 ADWG and DHCS TDS Value
1	Tennant Creek	31.0	Iodide, Fluoride
2	Kings Canyon	28.1	Iodide, Selenium, TDS
3	Daly Waters	23.0	Iodide, Selenium, TDS
4	Mataranka	18.1	Iodide, TDS
5	Pine Creek	11.3	Arsenic,
6	Timber Creek	10.0	Barium, Fluoride,
7	Larrimah	9.3	Iodide, TDS
8	Alice Springs	7.5	Iodide,
9	Elliott	6.0	Iodide,
10	Newcastle Waters	5.5	Iodide,
11	Ti Tree	5.5	Iodide,
12	Adelaide River	0.0	Iodide,
13	Batchelor	0.0	
14	Borroloola	0.0	
15	Cox Peninsula	0.0	
16	Darwin	0.0	
17	Katherine	0.0	
18	Yulara	0.0	

SECTION B:
Drinking water quality and performance

Microbiological results summary

Bacteria

As part of the verification monitoring program, 1279 drinking water samples were collected for bacteriological analysis across the Northern Territory in 2007-08.

The 2004 ADWG require that no *E. coli* be detected in 98 per cent of samples collected from each system. Figure 2 shows that for 2007-08, all major centres complied including Tennant Creek, an un-chlorinated water supply.

FIGURE 2

Percentage of samples taken in major centres in which no *E. coli* were detected from 2004-08

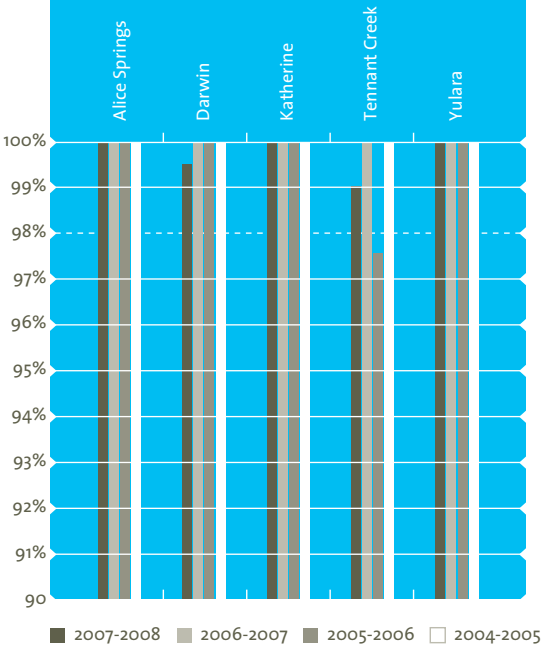
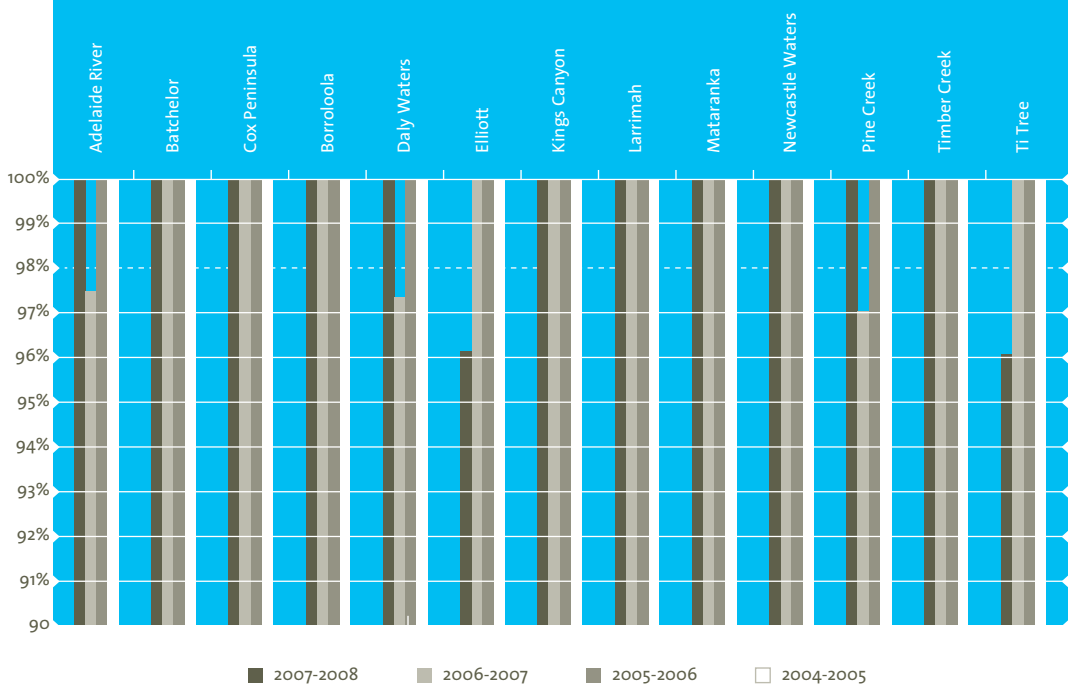


Figure 3 presents results for all the minor centres in the Northern Territory. Elliott and Ti Tree failed to pass *E. coli* performance targets in 2007-08 with *E. coli* detected in one sample from Elliott and in two samples from Ti Tree. All other minor centres achieved 100 per cent compliance in 2007-08, reflecting the upgraded chlorine dosing and monitoring facilities installed in the past three years, improved system operation and maintenance.

FIGURE 3

Percentage of samples taken in minor centres in which no *E. coli* were detected from 2004-08



Full details of bacteriological results from the 2007-08 year are outlined in Appendix 1.

Naegleria fowleri

The *N. fowleri* monitoring program in major centres continued in 2007-08, with 483 samples collected. Figure 4 shows that no samples from the treated water supply systems in major centres contained more than the 2004 ADWG action level of two organisms per litre.

Notwithstanding the above action level, Power and Water places high priority on its response to the detection of any thermophylic amoeba.

FIGURE 4

Percentage of samples taken in major centres that did not exceed the trigger value of two organisms/L of *Naegleria fowleri* in 2007-08

FIGURE 5

Percentage of samples taken in minor centres that did not exceed the trigger value of two organisms/L of *Naegleria fowleri* in 2007-08

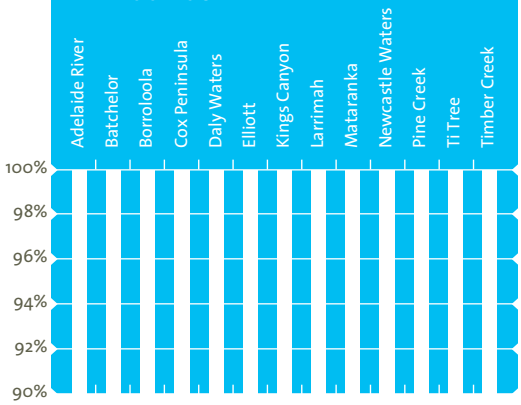


Figure 5 also illustrates that no exceedances were recorded in treated water samples from water supply systems in minor centres during the 12-month monitoring period, during which 137 water samples were collected.

Burkholderia pseudomallei

Burkholderia pseudomallei was not detected in any of the five water samples from the Tennant Creek water supply system during 2007-08.

Chemical and physical results summary

Health-related water quality parameters are reported as a 95th percentile, while aesthetic parameters are reported as an average as specified in the 2004 ADWG.

Full details of the health and aesthetic parameters for each major and minor centre are outlined in Appendix 1.

Radionuclides

The initial assessment of radioactivity in water supplies is the screening assessment to measure gross alpha and gross beta activity concentrations. To comply with the 2004 ADWG gross alpha and gross beta activity concentrations must be below the 2004 ADWG value of 0.5 Bq/L.

Water from nine minor centres and one major centre comply with the 2004 ADWG, with radioactivity levels below 0.5 Bq/L.

Supplies in Borroloola, Katherine, Ti Tree and Yulara were monitored for the specific radionuclides radium 226 and radium 228. However, gross alpha and beta concentrations are not available and annual dosage determinations could not be made.

Mataranka and Tennant Creek supplies are included in Power and Water's radiological monitoring program but were not sampled in this period due to a scheduling error.

Nine of the 14 bores supplying Alice Springs were below the gross alpha and gross beta activity concentration screening value of 0.5 Bq/L. Five bores exceeded 0.5 Bq/L for gross alpha but all were below 0.5 Bq/L for K-40 corrected gross beta.

Although Alice Springs supply was correctly monitored and samples collected some radiological parameters needed for the determination of annual dosage were not measured during analysis.

In the absence of these parameters the annual dosage is calculated assuming all gross alpha radioactivity is radium 226 and all gross beta is radium 228. When this calculation is applied to data from all bores the potential maximum radiological dose is 0.41 mSv/yr, below the 2004 ADWG value of 1.0 mSv/yr.

Kings Canyon water supply has radioactivity levels higher than other Northern Territory water supplies. In July 2007, Queensland Health Scientific Services completed a report on the radiological properties of the water used for domestic and industrial purposes and subsequent wastewater treatment.

This study determined the combined total average dose per annum to be 0.69 mSv/yr. Although this value exceeds the guideline level for intervention (0.5 mSv/yr) the total annual dose guideline value (1.0 mSv/yr) has not been exceeded.

In response, the supply was sampled monthly during 2007-08. The annual radiological dose can be estimated from the average of the potential maximums calculated for each monitoring point within the supply. Using this approach, the potential maximum annual radiological dosage (95th percentile) is 0.88 mSv/yr. Power and Water will improve aeration at Kings Canyon and investigate advanced treatment systems to further reduce radionuclide levels.

Radiological monitoring and data assessment procedures put in place during the writing of this report will enable dose calculation reporting in the 2009-10 report for water supplies where activity screening concentrations are exceeded.

Trihalomethanes

The 2004 ADWG set a value of 0.25 mg/L for trihalomethanes (THMs). THMs were measured for reference in Power and Water supplies in 2002-03. Values ranged from less than 0.08 mg/L in Darwin to less than 0.004 mg/L in Alice Springs. These concentrations were well below the recommended values in the 2004 ADWG. Follow-up samples in 2007-08 showed THMs ranged from <0.004 mg/L in most other centres to 0.124 mg/L in Darwin. These levels remain below values in the 2004 ADWG and appear to be relatively stable.

Herbicides and pesticides

In 2007 the herbicide glyphosate was used to control the noxious aquatic weed *Olive hymenachne* in Darwin River Reservoir. The reservoir's water was monitored during and after this exercise and glyphosate was not detected.

In 2007-08, 23 samples from all Power and Water potable water supplies in the Northern Territory except Borroloola were analysed for 43 pesticides commonly used in the Northern Territory including organochlorine, organophosphate and triazine pesticides, insecticides and acidic herbicides.

Pesticide analysis of all samples reported no sample contained levels exceeding the limit of detection and all water supplies complied with the 2004 ADWG.

Customer satisfaction

Water quality customer complaints

Power and Water records water quality customer complaints. Table 4 shows the total number of complaints and the number of complaints per 1,000 customer properties.

Table 4: Water quality complaints 2003-08

	Total Number of Complaints				
LOCATION	**2003-04**	**2004-05**	**2005-06**	**2006-07**	**2007-08**
Darwin	76	121	112	147	373
Alice Springs	8	3	8	5	1
Katherine	DNA	6	7	2	DNA
TOTAL	**84**	**130**	**127**	**154**	**374**
Complaints per 1000 properties	2.40	3.22	2.13	2.44*	6.13*

DNA – Data not available
* calculated number of properties based on WSAA reporting guidelines.

Power and Water reports the number of customer complaints to the Water Services Association of Australia (WSAA) for publication, as do other Australian water utilities.

The nature of discoloured water complaints concerning the Darwin water supply is largely governed by changes in water quality and demand associated with the Wet and Dry Seasons. Like many water supply reservoirs, Darwin River Reservoir is subject to stratification. This is due to the sun heating the upper layers of the reservoir so that distinct layers or strata of water of different temperature are formed. The water at a lower depth is colder and of lower aesthetic quality due to complex chemical processes in the water. This is not normally a problem as water to supply Darwin is drawn from the warmer, more aesthetically acceptable water near the surface.

Stratification can be disrupted by strong winds, cloudy days, or seasonal changes. As a result of this disruption, water of lower aesthetic quality from the lower part of the reservoir may come to the surface and be drawn into the supply system. Once in the supply system, this lower quality water can precipitate out iron and manganese compounds that appear unsightly and cause immediate complaints. During the Wet Season, as water demand drops, these compounds may settle out in the distribution system since flows are low. However, at the beginning of the next Dry Season, as flows in the distribution system

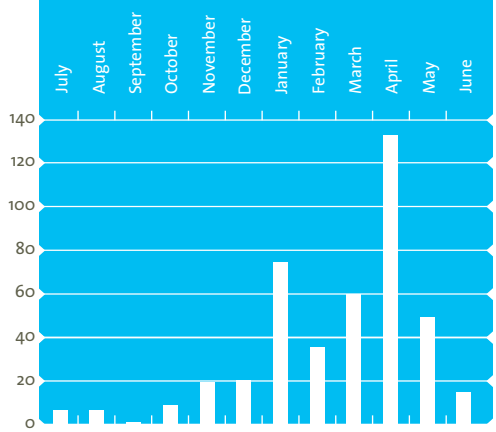
increase, they are stirred up and become the cause of further customer complaints. The levels of iron and manganese in the drinking water do not constitute a health risk due to the relatively short duration of the discoloured water events.

This is illustrated by the number of drinking water complaints from Darwin as shown in Figure 6.

Power and Water works to avoid this situation, primarily through a mains flushing program in all major centres. Mains are flushed before anticipated increased demands associated with seasonal changes. When a customer reports discoloured water, Power and Water flushes the mains in their street.

FIGURE 6

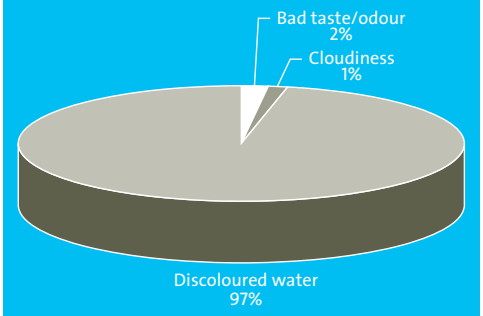
Number of monthly drinking water quality customer complaints for Darwin 2007-08



Customers have also complained about odour and taste (mainly related to fluctuating high chlorine levels), cloudy water or floating particles. Figure 7 shows a breakdown of customer complaints for 2007-08.

FIGURE 7

Types of drinking water customer complaints for Darwin 2007-08



Taste and odour complaints often relate to varying chlorine levels due to changing water demand. The chlorine residual in the reticulation network is regularly monitored and adjusted if required. Online water quality monitoring units have been installed in most major and minor centres to improve monitoring across the whole network.

Sometimes a customer will report cloudy or milky water. This is generally due to the presence of dissolved air in the water. Milkiness or cloudiness in water most commonly occurs after water mains repairs. Repressurising of water mains causes trapped air to be dissolved. When a tap is turned on minute air bubbles are released causing the water to appear milky. This cloudy water will clear rapidly when left to stand.

In the Darwin supply, harmless white algae is sometimes observed.

If there is some doubt as to the cause of a water quality problem an investigation is carried out and, when necessary, water samples are taken and analysed.

Recorded emergencies / incidents

No water quality emergencies were recorded in 2007-08. However, significant investment in upgrading of facilities and security systems continues to occur to further reduce risks.

There were five incidents in which *E. coli* was detected:

- Darwin: 10/06/2008 and 28/05/2008,
- Elliot: 07/01/2008,
- Tennant Creek: 17/03/2008, and
- Ti Tree 29/10/2007.

Response included manual chlorination of tanks, flushing of mains and resampling of the water supply as agreed with the DHCS. All resamples tested negative for *E. coli*.

Darwin River Reservoir pump-station.

APPENDICES

Appendix 1: Water Quality Results Tables

Table A1: Bacteriological monitoring in major centres 2007-08

Location	Parameter (mpn/100mL)	Target Level	Total No. of Samples Required	Total No. of Samples Collected*	Total Exceedences (no.)	% Samples Passing Reporting Level
Alice Springs	*E. coli*	<1 in 98% samples	104	104	0	100.0
	Total coliforms	<10 in 95% samples	104	104	0	100.0
Darwin	*E. coli*	<1 in 98% samples	364	440	2	99.5
	Total coliforms	<10 in 95% samples	364	440	2	99.5
Katherine	*E. coli*	<1 in 98% samples	104	105	0	100.0
	Total coliforms	<10 in 95% samples	104	105	1	99.0
Tennant Creek	*E. coli*	<1 in 98% samples	104	105	1	99.0
	Total coliforms	<10 in 95% samples	104	105	16	84.8
Yulara	*E. coli*	<1 in 98% samples	52	52	0	100.0
	Total coliforms	<10 in 95% samples	52	52	0	100.0

*Centres with samples below the required number fell short due to laboratory closure and logistical error.

Table A2: Bacteriological monitoring in minor centres 2007-08

Location	Parameter (mpn/100mL)	Target Level	Total No. of Samples Required	Total No. of Samples Collected*	Total Exceedences (no.)	% Samples Passing Reporting Level
Adelaide River	*E. coli*	<1 in 98% samples	24	24	0	100.0
	Total coliforms	<10 in 95% samples	24	24	1	95.8
Batchelor	*E. coli*	<1 in 98% samples	52	51	0	100.0
	Total coliforms	<10 in 95% samples	52	51	0	100.0
Cox Peninsula	*E. coli*	<1 in 98% samples	52	53	0	100.0
	Total coliforms	<10 in 95% samples	52	53	1	98.1
Borroloola	*E. coli*	<1 in 98% samples	24	24	0	100.0
	Total coliforms	<10 in 95% samples	24	24	0	100.0
Daly Waters	*E. coli*	<1 in 98% samples	24	24	0	100.0
	Total coliforms	<10 in 95% samples	24	24	1	95.8
Elliott	*E. coli*	<1 in 98% samples	24	26	1	96.2
	Total coliforms	<10 in 95% samples	24	26	2	92.3
Kings Canyon	*E. coli*	<1 in 98% samples	52	104	0	100.0
	Total coliforms	<10 in 95% samples	52	104	1	99.0
Larrimah	*E. coli*	<1 in 98% samples	24	24	0	100.0
	Total coliforms	<10 in 95% samples	24	24	1	95.8
Mataranka	*E. coli*	<1 in 98% samples	24	24	0	100.0
	Total coliforms	<10 in 95% samples	24	24	1	95.8
Newcastle Waters	*E. coli*	<1 in 98% samples	24	23	0	100.0
	Total coliforms	<10 in 95% samples	24	23	1	95.7

Table A2: Bacteriological monitoring in minor centres 2007-08 (cont.)

Location	Parameter (mpn/100mL)	Target Level	Total No. of Samples Required	Total No. of Samples Collected*	Total Exceedences (no.)	% Samples Passing Reporting Level
Pine Creek	*E. coli*	<1 in 98% samples	24	24	0	100.0
	Total coliforms	<10 in 95% samples	24	24	1	95.8
Timber Creek	*E. coli*	<1 in 98% samples	24	21	0	100.0
	Total coliforms	<10 in 95% samples	24	21	0	100.0
Ti Tree	*E. coli*	<1 in 98% samples	24	51	2	96.1
	Total coliforms	<10 in 95% samples	24	51	0	100.0

*Centres with samples below the required number fell short due to laboratory closure and logistical error.

Darwin River Reservoir off-take tower.

Table A3: Health, aesthetic and other parameters in major centres 2007-08

Parameter / Location	Guideline Value[3]	Units	Alice Springs	Darwin	Katherine	Tennant Creek	Yulara
Health Parameters - 95th Percentile Values[1]							
Antimony	0.003	mg/L	<0.0002	<0.0002	0.0005	<0.0002	<0.0002
Arsenic	0.007	mg/L	0.0010	<0.0005	<0.0005	0.0030	<0.0005
Barium	0.7	mg/L	0.10	<0.05	<0.05	<0.05	0.05
Boron	4	mg/L	0.14	<0.02	<0.02	0.52	0.68
Cadmium	0.002	mg/L	<0.0002	<0.0002	<0.0002	0.0008	0.0012
Chlorine(free)	5	mg/L	DNA	1.67	0.81	DNA	0.65
Chromium	0.05	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	2	mg/L	0.22	0.05	0.03	0.03	0.15
Fluoride	1.5	mg/L	0.5	0.7	0.5	**1.8**	0.1
Iodide	0.1	mg/L	**0.15**	0.02	<0.01	**0.35**	0.06
Lead	0.01	mg/L	0.006	0.002	<0.001	<0.001	<0.001
Manganese	0.5	mg/L	0.024	0.030	<0.005	<0.005	<0.005
Mercury	0.001	mg/L	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
Molybdenum	0.05	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Nickel	0.02	mg/L	0.006	<0.002	<0.002	<0.002	0.004
Nitrate	50	mg/L	8	4	1	36	38
Radiological[4]	1.0	mSv/yr	0.38	PASS	DNA	DNA	DNA
Selenium	0.01	mg/L	0.004	<0.001	<0.001	0.006	<0.001
Silver	0.1	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	500	mg/L	67	17	14	88	342
THMs[5]	0.25	mg/L	<0.004[A]	0.124[C]	0.065[C]	NA	<0.004[A]
Uranium	0.02	mg/L	0.00956	0.00003	0.00017	0.00883	0.00008
Aesthetic Parameters - Mean Values[2]							
Aluminium	0.2	mg/L	0.03	<0.02	0.03	<0.02	<0.02
Chloride	250	mg/L	73	10	10	94	43
Chlorine (free)	0.6	mg/L	DNA	**0.92**	0.58	DNA	0.48
Copper	1	mg/L	<0.10	0.03	0.02	0.02	0.08
Hardness	200	mg/L $CaCO_3$	**220**	35	107	171	24
Iron	0.3	mg/L	0.06	0.13	0.07	0.06	0.04
Manganese	0.1	mg/L	0.009	0.018	<0.005	<0.005	<0.005
pH	6.5 - 8.5	pH units	7.9	7.2	7.7	7.8	7.0
Sodium	180	mg/L	78	3	6	116	37
Sulfate	250	mg/L	57	3	5	53	60
TDS[3]	800	mg/L	466	53	129	619	155
Zinc	3	mg/L	0.05	0.01	0.01	0.01	0.05
Other Parameters - Mean Values[2]							
Alkalinity	*	mg/L	257	33	107	276	20
Beryllium	*	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bromide	*	mg/L	0.42	0.03	0.01	0.76	0.27
Calcium	*	mg/L	47	7	25	26	6
Electrical conductivity	*	µS/cm	820	88	222	958	261
Magnesium	*	mg/L	25	4	11	26	2
Potassium	*	mg/L	6.4	0.8	1.0	30.6	4.3
Silica	*	mg/L	17	6	10	39	5
Tin	*	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Table A4: Health, aesthetic and other parameters in minor centres 2007-08

Parameter / Location	Guideline Value[3]	Units	Adelaide River	Batchelor	Borroloola	Cox Peninsula	Daly Waters	Elliott	Kings Canyon	Larrimah	Mataranka	Newcastle Waters	Pine Creek	Ti Tree	Timber Creek
Health Parameters - 95th Percentile Values[1]															
Antimony	0.003	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	DNA	<0.0002	<0.0002
Arsenic	0.007	mg/L	0.0030	<0.0005	<0.0005	<0.0005	0.0021	0.0014	0.0040	0.0014	0.0024	<0.0005	**0.0079**	<0.0005	0.0010
Barium	0.7	mg/L	<0.05	<0.05	<0.05	<0.05	0.08	0.15	<0.05	<0.05	<0.05	0.25	DNA	0.10	**1.26**
Boron	4	mg/L	<0.02	<0.02	0.04	<0.02	0.39	0.32	0.32	0.20	0.26	0.26	DNA	0.30	0.12
Cadmium	0.002	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	DNA	<0.0002	<0.0002
Chlorine (free)	5	mg/L	0.27	0.43	0.64	0.69	1.34	1.04	0.52	0.48	0.61	0.40	0.97	0.30	0.45
Chromium	0.05	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	DNA	<0.005	<0.005
Copper	2	mg/L	0.52	0.04	0.61	0.02	0.01	0.01	0.23	0.01	0.04	0.02	DNA	0.01	0.08
Fluoride	1.5	mg/L	0.3	0.2	0.1	DNA	0.4	0.9	0.5	0.3	0.4	1.0	0.6	0.9	**1.5**
Iodide	0.1	mg/L	<0.01	<0.01	0.02	<0.01	**0.26**	**0.12**	**0.40**	**0.12**	**0.13**	**0.11**	DNA	**0.11**	0.03
Lead	0.01	mg/L	0.003	<0.001	0.005	<0.001	<0.001	<0.001	0.008	<0.001	0.004	<0.001	DNA	<0.001	<0.001
Manganese	0.5	mg/L	0.242	0.003	0.017	0.005	0.041	0.005	0.005	0.005	0.010	0.005	DNA	0.003	0.005
Mercury	0.001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0004	<0.0001	<0.0001	<0.0001	DNA	<0.0001	<0.0001
Molybdenum	0.05	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	DNA	<0.005	<0.005
Nickel	0.02	mg/L	<0.002	<0.002	<0.002	<0.002	0.004	0.006	0.010	<0.004	<0.004	<0.004	DNA	<0.004	0.015
Nitrate	50	mg/L	1	1	1	DNA	12	16	4	4	3	10	1	**52**	1
Radiological[4]	1.0	mSv/yr	PASS	PASS	DNA	PASS	PASS	PASS	0.88	PASS	DNA	PASS	PASS	DNA	PASS
Selenium	0.01	mg/L	<0.001	<0.001	<0.001	<0.001	**0.010**	0.005	**0.010**	0.007	0.008	<0.001	DNA	0.003	<0.001
Silver	0.1	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	500	mg/L	7	19	3	DNA	245	82	200	140	167	45	22	50	21
THMs[5]	0.25	mg/L	<0.004[A]	<0.004[A]	<0.004[A]	<0.004[A]	0.098[B]	<0.004[A]	<0.004[A]	<0.004[A]	0.011[B]	<0.004[A]	0.021[B]	<0.004[A]	<0.004[A]
Uranium	0.02	mg/L	0.00003	0.00037	0.00022	0.00002	0.00698	0.00586	0.00247	0.00247	0.00322	0.00497	DNA	0.00671	0.00214

Parameter / Location	Guideline Value[3]	Units	Adelaide River	Batchelor	Borroloola	Cox Peninsula	Daly Waters	Elliott	Kings Canyon	Larrimah	Mataranka	Newcastle Waters	Pine Creek	Ti Tree	Timber Creek
Aesthetic Parameters - Mean Values[2]															
Aluminium	0.2	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	DNA	<0.02	<0.02
Chloride	250	mg/L	17	6	10	DNA	**348**	161	243	186	187	52	10	59	27
Chlorine (free)	0.6	mg/L	0.13	0.24	0.50	0.39	0.51	0.28	0.25	0.32	0.38	0.19	**0.63**	0.24	0.35
Copper	1	mg/L	0.33	0.01	0.14	0.02	<0.01	<0.01	0.09	<0.01	0.03	<0.01	DNA	<0.01	0.02
Hardness	200	mg/L $CaCO_3$	79	**201**	13	DNA	**587**	**381**	**348**	**513**	**512**	**318**	96	**206**	**430**
Iron	0.3	mg/L	**0.89**	0.01	0.04	<0.02	0.27	0.24	0.18	0.25	**2.12**	0.03	DNA	<0.01	0.07
Manganese	0.1	mg/L	**0.123**	<0.005	0.006	<0.005	0.014	<0.005	<0.005	<0.005	<0.005	<0.005	DNA	<0.005	0.029
pH	6.5 - 8.5	pH units	6.8	7.6	**6.3**	DNA	7.4	7.8	7.1	7.6	7.6	7.8	7.2	8.0	7.4
Sodium	180	mg/L	20	5	6	DNA	**218**	89	112	119	139	54	25	64	21
Sulfate	250	mg/L	4	4	1	DNA	207	62	178	117	139	27	9	38	9
TDS[3]	800	mg/L	169	218	49	DNA	**1339**	767	**815**	**892**	**937**	550	186	520	478
Zinc	3	mg/L	0.07	0.05	0.38	0.03	<0.001	<0.001	0.07	0.03	0.13	0.02	DNA	<0.001	<0.001
Other Parameters - Mean Values[2]															
Alkalinity	*	mg/L	103	205	32	DNA	432	348	124	449	473	374	132	214	445
Beryllium	*	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	DNA	<0.001	<0.001
Bromide	*	mg/L	0.08	0.03	0.04	0.01	3.00	0.98	2.09	1.28	1.59	0.28	DNA	0.43	0.17
Calcium	*	mg/L	14	27	4	DNA	128	81	70	118	115	71	16	47	63
Electrical conductivity	*	µS/cm	256	382	65	DNA	2132	1235	1364	1514	1603	883	289	734	854
Magnesium	*	mg/L	13	34	1	0	64	45	44	54	55	34	13	22	66
Potassium	*	mg/L	1.0	0.5	1.1	DNA	26.9	22.0	23.8	12.3	18.5	28.3	1.6	19.4	6.8
Silica	*	mg/L	17	18	9	DNA	25	26	16	30	28	48	27	66	17
Tin	*	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	DNA	<0.01	<0.01

Legend for tables A3 and A4

Values at or exceeding the guideline value are shown in bold.

[1] 95th percentile of all health related values where data is available from 2003-2008. If data is limited Radiological values are not reported as the 95th percentile but as the maximum value.

[2] Mean of all aesthetic values where available from 2003-2008.

[3] 2004 Guideline value for health and aesthetic parameters. TDS value set by DHCS.

[4] Supplies in which the gross alpha and gross beta values are below the screening level of 0.5 Bq/L automatically comply with the 2004 ADWG. Further analysis to identify specific radionuclides and the calculation of an annual dosage are not required. These supplies are reported as PASS. Supplies for which there is insufficient, incomplete or where the only available data is outdated are reported as Data Not Available (DNA). The 2004 ADWG require radiological data from groundwater supplies used in annual reporting be from a period not more than 2 years earlier than the reporting period and for surface water not more than 5 years.

[5] Trihalomethanes (THMs) are reported as the 95th percentile, below the limit of detection or, if there is limited data available, as the maximum value.

[A] Limit of detection = 0.004 mg/L.

[B] Maximum value measured.

[C] 95th percentile.

N/A	Not applicable	*	No guideline value applicable
mSv/year	Millisieverts per year	µS/cm	Microsiemens per centimetre
mg/L	Milligrams per litre	DNA	Data not available

Glossary of acronyms

ADWG	Australian Drinking Water Guidelines Referred to in this report as "2004 ADWG"
AWWARF	American Water Works Association Research Foundation
CRC	Cooperative Research Centre
DNA	Data not available
DPI	Department of Planning and Infrastructure
DHCS	Department of Health and Community Services
DPIFM	Department of Primary Industry, Fisheries and Mines
DNRETA	Department of Natural Resources, Environment and The Arts
ESO	Essential Services Officer
GIS	Geographical Information System
HACCP	Hazard Analysis and Critical Control Point
N/A	Not applicable
NT	Northern Territory
SCADA	Supervisory Control and Data Acquisition
TDS	Total Dissolved Solids
THMs	Trihalomethanes
WIMS	Work Information Management System
WSAA	Water Services Association of Australia
UTC	Unable to calculate

Units of measure

Bq/L	becquerel per litre
µg/L	micrograms per litre
mg/L	milligrams per litre
mSv/yr	millisieverts per year
ML	megalitres
µS/cm	microsiemens per centimetre

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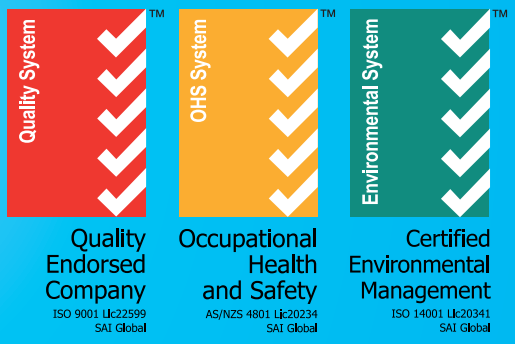

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