POWER AND WATER CORPORATION

2010 annual drinking water quality report

PowerWater

Contents

From the Managing Director

Power and Water has an obvious lead role to play to ensure a safe and sustainable supply of good quality drinking water for Territorians.

We deliver water to customers right across the 1.3 milllion square kilometres of the Northern Territory, from the Central Australian deserts to the tropics of the north, in major centres and remote communities.

Our sources are as varied as underground aquifers dating back 10,000 years and above-ground reservoirs that overflow nearly every year in the tropical Wet Season.

Across these varied conditions, Power and Water has an established program of monitoring at local water sources and throughout its distribution systems to ensure the quality of the water delivered to customers.

Multiple barriers against contamination provide the maximum protection for water supplies and we continue to identify and carry out suitable improvements to our systems right across the Territory.

A second chlorination unit was installed in Ti Tree this year, providing valuable backup to the single existing unit and improving security of safe supply.

This annual report provides further details on our water quality management system and the results of our water quality monitoring for 2009-10.

However, our communities continue to grow and change and this report also outlines our priorities for future investment and continual improvement.

Work to raise the spillway of Darwin River Dam, increasing its capacity by near 20 per cent, is nearing completion in readiness for the 2010-11 Wet Season rains.

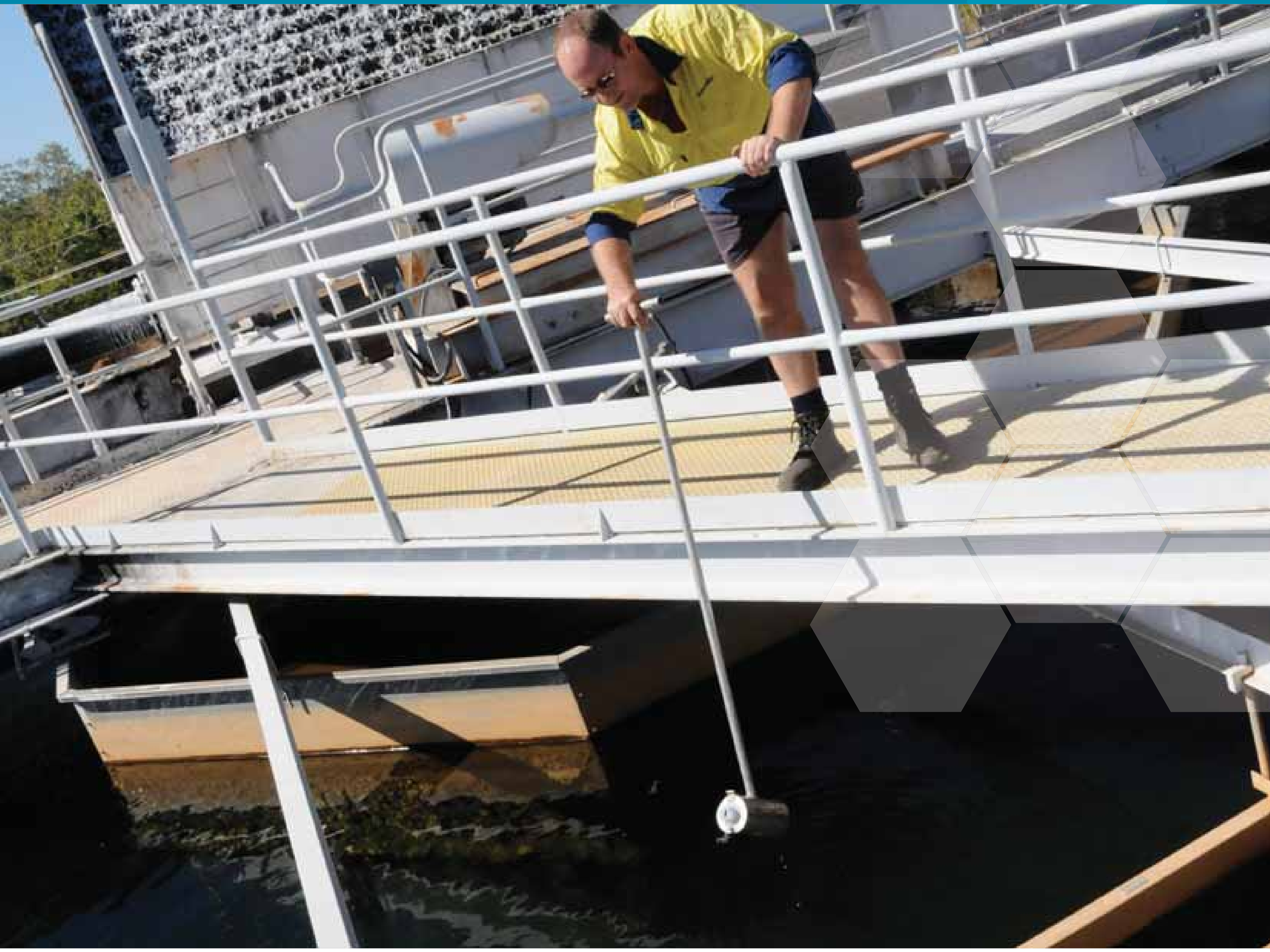
Investigations into returning Manton Dam to service as a surface water supply also continued this year. These projects combined are part of a strategy to secure a quality water supply for the Darwin region.

Sustainable water supply continues to be a priority for utilities across Australia and Power and Water faces the same issues.

We have and will continue to work with our communities to encourage responsible use of this precious resource.

Andrew Macrides, Managing Director

Section A: Framework for Drinking Water Quality Management



ABOVE ▸ JASON BIRD COLLECTING A WATER SAMPLE FROM THE CLARIFIER AT THE KATHERINE WATER TREATMENT PLANT

The *Australian Drinking Water Guidelines* (the 2004 ADWG) were published by a joint committee of the National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC) 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 the 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 in this report.

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

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.

Department Health and Families (DHF) 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, The Arts and Sport (NRETAS) 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 Resources (DoR) undertakes independent analyses of water samples through its laboratories in Darwin and Alice Springs.

The Department of Construction and Infrastructure (DCI) 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.

Summary of Power and Water's Drinking Water Quality Policy

We aim to provide our customers 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 2004 ADWG.
- 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, DHF.
- 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.

ABOVE ▸ WATER QUALITY TECHNICIANS DANIEL GUINEA AND JORDAN PHASEY CALIBRATING FIELD EQUIPMENT

2. Assessment of the Drinking Water Supply System

Power and Water supplies water to five major centres and 14 minor centres illustrated in Figure 1 below.

FIGURE 1: POWER AND WATER CORPORATION WATER SUPPLY SERVICE AREAS

Major centres have larger and usually more complex infrastructures. Power and Water provides the technical services to maintain these supplies. With these resources in place, major centres are able to extend these services to minor centres functioning both as a technical and administrative hub.

Water Sources

With the exception of Darwin, Katherine and Pine Creek, our centres rely solely 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. The reservoir 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 (at least 10 per cent) is ground water from the McMinns and Howard East borefields.

In 2007-08 Power and Water began investigations into the use of Manton River Reservoir as an additional permanent water supply for Darwin. This involved drawing down the reservoir and monitoring major potable water quality parameters, as well as studying the effects this use would have on the existing recreational uses of the reservoir. This investigation continued through 2009-10.

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

Centre	Source*
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
Gunn Point	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

*With local names where in common use.

Power and Water has developed a semi-quantitative risk assessment method to identify the water quality hazards that pose a risk to Territory water supplies and to provide a relative ranking of the risks. This assessment is based on water quality measurements of health and aesthetic parameters taken in all centres from 2005 to 2010.

The assessment generates a score for each centre which enables them to be ranked according to the scale of the risks.

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

ABOVE ▸ COPPERFIELD DAM RESERVOIR AT PINE CREEK

Power and Water has adopted the multiple barrier principle to protect drinking water supplies. This requires the establishment of 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.

Table 2: Water quality barriers in major and minor centres

Centre	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								N/A	N/A	
Daly Waters										
Darwin Ground Water										
Darwin Surface Water			N/A							
Elliott										
Gunn Point										
Katherine Ground Water										
Katherine Surface Water			N/A							
Kings Canyon										
Larrimah										
Mataranka										
Newcastle Waters										
Pine Creek Ground Water										
Pine Creek Surface Water			N/A							
Tennant Creek										
Timber Creek										
Ti Tree										
Yulara										

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

4. Operational Procedures and Process Control

Power and Water has documented procedures to ensure the uninterrupted supply of quality drinking water across the Northern Territory. Operators have access to these procedures via Power and Water's intranet.

Operating procedures are routinely reviewed and amended in accordance with Power and Water's commitment to continual improvement and implementation of systems certified to comply with International Standards Organisation (ISO) standards, Environment (AS/NZS ISO 14001:2004), Quality (AS/NZS ISO 9001:2008) and Occupational Health and Safety (AS/NZS ISO 4801:2001).

Operational monitoring is included as a component of Power and Water's monitoring program and addresses chemical, physical and biological parameters relevant to water quality.

Critical control points in each supply are monitored using a range of online monitoring systems in each centre. Apart from monitoring the status and performance of infrastructure, these systems provide continuous monitoring for chlorine, fluoride, conductivity, turbidity and pH. In-field measurements, such as temperature and chlorine residuals help to identify performance issues and corrective actions.

Corrective actions and preventative actions cover all aspects of operation and include health, safety and quality. Corrective actions specific to a procedure usually form part of that procedure. Corrective actions can be linked to operational monitoring providing a formalised response to deviations from set point values at critical control points.

Materials used by Power and Water that contact potable water must comply with AS/NZS 4020:2005 – Testing of products for use in contact with drinking water.

Suppliers of chemicals used by Power and Water for water treatment are required to provide an analysis report of the chemical to be supplied. Chemicals must comply with the relevant ANSI/AWWA standard and the management system at site of manufacture of the chemical must be certified to ISO 9001.

5. Verification of Drinking Water Quality

Water Quality Monitoring

Power and Water's Drinking Water Operational and Verification Program 2009-11 is used to verify the effectiveness of water quality management strategies. The program is based on the 2004 ADWG's recommendations but knowledge of specific water quality issues for a water supply may require an increase in monitoring frequency or monitoring of additional parameters.

Microbiological, physical, chemical and radiological samples are scheduled to be collected from the source, storage and distribution systems of all Territory water supplies.

Power and Water has designed and implemented a two-year monitoring program, which was approved by the DHF for the period 2009-11. 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 pathogens in water supplies can vary significantly within a short period of time so frequent microbiological monitoring is used to assess the potential for their presence.

The primary source of pathogens is faecal material either directly from animals or from sewage. Pathogens are difficult to detect. The analytical procedures are complex, protracted and require a specific test for each pathogen. The time taken for these analyses makes it impractical to directly test for pathogens so indicator organisms are used to show whether contamination with faecal material may have occurred. The indicator organisms Power and Water monitors are:

- *Escherichia coli* (or *E. coli*): indicates faecal contamination from warm-blooded animals, including humans and hence, the potential for the presence of disease-causing micro-organisms; and
- Total coliforms: a range of bacteria found in many soil and aquatic 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*.

The number of routine samples collected for *E. coli* testing is defined in the 2004 ADWG and is based on the population served by each water supply.

Power and Water monitors for the presence of *Naegleria fowleri*. *N. fowleri* is a free-living ameboflagellate found in soil and aquatic environments. This amoeba causes primary amoebic meningoencephalitis (PAM), a very rapid and usually fatal infection acquired when water contaminated with *N. fowleri* enters the nasal passages.

Testing for *N. fowleri* is included separately in the monitoring program 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 the detection of this organism in South Australia and Western Australia. Monitoring was continued through 2009-10 (Refer to section **B1 Drinking water quality and performance** for discussion of 2009-10 results).

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).

During the 2009-10 monitoring period *N. fowleri* was not detected in any monitored water supply in the Northern Territory.

Power and Water monitors for the presence of *Burkholderia pseudomallei* in reticulated water. *B. pseudomallei* is the agent responsible for the disease melioidosis. This primarily tropical disease causes a potentially fatal human infection that generally manifests itself as a localised soft tissue infection, pneumonia, abscesses of the liver and spleen, or acute, rapid and often fatal septicaemia.

The monitoring program was developed in 2006-07 in consultation with the Department of Health and Community Services and focussed on the Tennant Creek water supply which is not chlorinated. Monitoring was continued during 2009-10 (Refer to section **B1 Drinking water quality and performance** for discussion of 2009-10 results).

To date *B. pseudomallei* has not been detected in the Tennant Creek water supply.

Chemical and Physical Monitoring (Health Parameters)

Power and Water monitors numerous chemical and physical parameters to ensure that water supplied to customers is safe to drink.

In general, the potential risk to human health increases as the levels of these chemical and physical parameters increase. Monitoring by Power and Water ensures any risk to human health is identified and quickly 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 guideline limits are exceeded:

- If the total annual dose is less than 0.5 mSv, Power and Water will continue monitoring in accordance with 2004 ADWG;
- If the total annual dose lies between 0.5 and 1.0 mSv, discussions should be held with the relevant health authority (DHF) to determine the frequency of ongoing sampling (Primary response level)
- If the total annual dose exceeds 1.0 mSv intervention is required. Power and Water and DHF should assess the results and examine options to reduce the levels of exposure (Secondary response level).

Radionuclide monitoring was continued for a number of major and minor centres in 2009-10 as part of the three-year *Drinking Water Monitoring Program* endorsed by DHF.

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. During the disinfection process chlorine reacts with naturally occurring organic matter such as decaying leaves and other vegetation to produce several by-products, mostly trihalomethanes (THMs).

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.

Selected minor and major centres were monitored for THMs in 2009-10 as part of the agreed three-year *Drinking Water Monitoring Program*.

Pesticides (insecticides and herbicides) are sometimes used in our catchments to control insects and weeds. DHF requires testing for pesticides where there is the potential for water supply contamination.

Results from the pesticide monitoring program from 2007-09 showed pesticides were not detectable in any water supply, more precisely, the level of pesticides in all supplies was below the level of detection.

In respect of these results, pesticide monitoring of drinking water supplies during 2009-10 was restricted to Darwin and Katherine supplies.

Chemical and Physical Monitoring (Aesthetic Parameters)

Numerous chemical and physical parameters are monitored by Power and Water in order to supply customers with aesthetically acceptable drinking water.

Aesthetic parameters are the chemical and physical characteristics 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 sulfates), colour, pH and a few common metals. The aesthetic quality will affect the acceptance of drinking water by the consumer and is usually the first change in water quality observed by the consumer.

ABOVE ▸ DARWIN RIVER RESERVOIR BEFORE RAISING THE WALL AND SPILLWAY

6. Incident and Emergency Response

Appropriate and systematic responses to incidents that can compromise water quality are essential to protect public health and provide best service to customers.

A response procedure, approved by the Chief Health Officer, DHF, exists for any microbiological exceedance of the agreed limit. Power and Water responses include re-sampling, mains flushing and manual disinfection of storage tanks with sodium hypochlorite. DHF is notified promptly of any substantial microbiological failure. The management of more serious incidents may trigger the use of Power and Water's *Corporate Crisis and Recovery Manual*.

7. Employee Awareness and Training

Power and Water ensures that all employees are appropriately trained and aware of their responsibilities. Procedures and documentation are frequently reviewed and training requirements are identified and programmed into training schedules. Training is monitored to ensure staff knowledge and skills are current.

In 2009 Water Services recruited a specialist training officer resulting in the following developments:

- New training service providers identified;
- Training and development plans for operational staff put into effect;
- Training and development plans created for professional, technical and administrative staff;
- New Training Management System to replace VETtrak identified;
- Renewal timeframes for compliance training established;
- Compliance training requirements linked to job position.

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 by reporting:
  - problems with water quality;
  - damage to water supply or sewage infrastructure;
  - suspicious activity or unauthorised access to Power and Water's facilities.

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

Customers are informed of current and predicted water quality issues through placement of newspaper advertisements.

Power and Water sponsors various community activities and technical events to promote awareness of water quality by:

- Sponsoring the Water in the Bush conference hosted by the Northern Territory branch of Australian Water Association (AWA);
- Providing grants as part of the annual Power and Water Melaleuca Awards;
- Staging open days at their facilities, such as Darwin River Dam;
- Making presentations at major events including regional shows, the Tropical Garden Spectacular in Darwin and the Sustainability Festival in Alice Springs; and
- Publishing pamphlets to promote better understanding of the Territory's various water issues.

9. Research and Development

Water Quality Research Australia Limited (WQRA) is a national research centre established to succeed the Cooperative Research Centre (CRC) for Water Quality and Treatment when the CRC ended on 30 June 2008. WQRA undertakes collaborative research of national application on drinking water quality, recycled water and relevant areas of wastewater management. The main focus of the research program is on urban water issues related to public health and acceptability aspects of water supply, water recycling and aspects of wastewater management. WQRA also has an education program, utilising the most successful elements of the CRC program.

Power and Water Managing Director Andrew Macrides is Power and Water's industry membership representative for WQRA.

Power and Water, as a member of WQRA, plays an active role in 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 maintains direct involvement in a range of research projects to improve water quality throughout the Territory. Power and Water has also commissioned a number of internal and external reports on water quality issues during 2009-10. These are listed on page 13.

Manton Reservoir Return to Service

This is an internal Power and Water project.

During 2009-10 Power and Water continued to investigate seasonal water quality trends in Manton reservoir. The study focused on water quality variation through the water column and seasonal algal population trends, specifically blue green algae (cyanobacteria) populations.

Modelling of seasonal vertical hydraulics has been completed in preparation for artificial mixing of the reservoir.

Artificial mixing by aeration has the capacity to significantly improve the quality of water in Manton reservoir by:

- Altering the consecution of phytoplankton populations during the year;
- Precipitation of iron and manganese by oxidation: and
- Displacement of low quality water in deeper sections of the reservoir with rainfall inflow.

Water Chemical Database

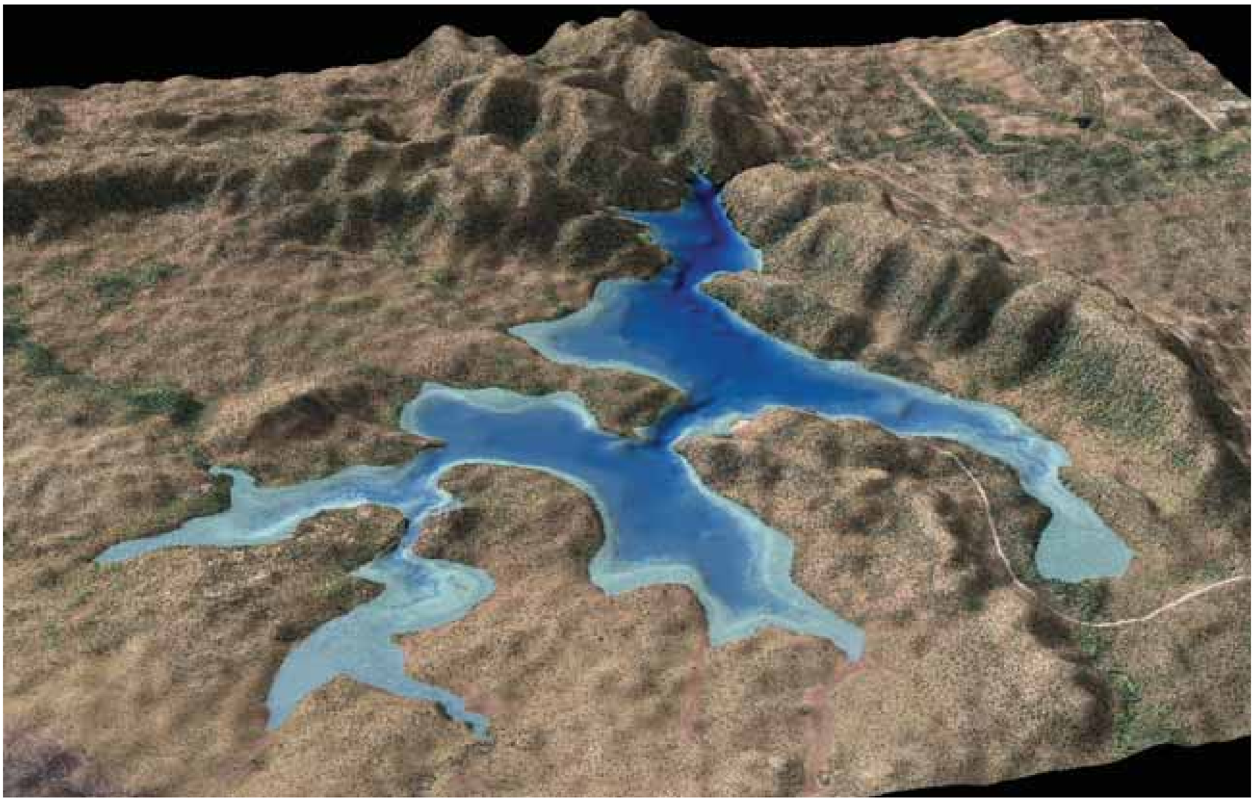
WQRA 1013 – Water Chemical Database is an external water quality project supported by Power and Water.

This project will develop a water quality data management system to support assessment of monitoring data against the ADWG and provide a facility to support analysis of water quality information and add value to interpretation of results. The system is designed for use in small, remote communities.

Toxic Cyanobacteria Update

WQRA 1022 – Cyanosurvey – A National Update on Toxic Cyanobacteria and their Distribution 2009-11 is an external water quality project supported by Power and Water.

The project will undertake a national survey of cyanobacteria and compare against any existing records to identify changes in the distribution of algal species. Another aspect is to assess the toxicity and relate this information to water quality and to validate a range of analytical methods for species identification and toxin production.



ABOVE ▸ MANTON DAM 3D PERSPECTIVE – WITH 3D BATHYMETRY

10. Documentation and Reporting

The majority of Power and Water's documentation is stored electronically.

Power and Water's Integrated Management System (IMS) integrates all of Power and Water's systems and processes into one complete framework, enabling the organisation to work as a single unit with unified objectives.

Core components of the IMS are the maintenance of documentation and the dissemination of information through a formalised reporting system.

Data generated from the drinking water quality monitoring program is maintained in a purpose-specific Oracle database.

Operational data from the online monitoring supervisory control and data acquisition system (SCADA) is made available to operators through a data historian application. This process information system (PI System) allows operators to record, analyse, and monitor the real-time status of water supply infrastructure and water quality.

Research and development data is maintained in the Corporation's electronic data management system (TRIM).

Technical and operational details of the water supply system including technical drawings and maps are contained in the Facilities Information System (FIS).

All of the above information is accessible through the Power and Water intranet.

Power and Water is currently expanding its asset management capabilities to standardise the management of its assets with prioritisation on maintenance planning and reporting. This will ensure accuracy and completeness of data, and ensure data is up to date. The existing Work Information Management (WIMS) and Facility Information Systems (FIS) will be replaced.

The evaluation of replacement systems for the current FIS and WIMS is complete and implementation should begin next financial year. IBM Maximo Asset Management and Esri will replace the current WIMS and FIS applications.

Power and Water provides information to the public via its website. This includes technical information, guides to water conservation and media releases.

Power and Water reports to the Water Services Association of Australia (WSAA) the national body of the Australian urban water industry. The information provided by Power and Water forms part of the National Performance Report and affords the Territory and Australian public with a reliable and transparent source of information on urban water utilities.

This report, Power and Water's Annual Drinking Water Quality Report 2010, provides an objective account of the quality of Northern Territory potable water supply to consumers, regulatory bodies and stakeholders.

The intrinsic relationship between potable water and public health means Power and Water and DHF share common responsibilities and are required to work together to resolve water quality health-related issues. Protocols are in place to ensure any exceedance of the 2004 ADWG is reported promptly to DHF by Power and Water.

11. Evaluation and Audit

The evaluation and audit of Power and Water's water quality management system ensures successful management of water quality data and processes.

The preparation of the 2009-10 *Annual Drinking Water Quality Report* is a valuable component 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.

Power and Water's certifications to ISO 9001 (Quality Endorsed Company), AS/NZS 4801 (Occupational Health and Safety) and ISO 14001 (Certified Environmental Management) require annual independent external audits. The 2009 annual audit was conducted in November by SAI Global.

Information obtained from these audits and annual reports have lead to more comprehensive and targeted reforms to the *Drinking Water Monitoring Program* which contribute to our program of continual improvement.

ABOVE ▸ WATER QUALITY TECHNICIAN JORDAN PHASEY CALIBRATING A CHLORIMETER

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. Although the network group meets only twice a year information exchange is continuous as required.

Review of Drinking Water Quality System

This annual report has a significant role in the identification of water quality issues and helps to identify where operational and management system improvements are needed.

Aquality

Aquality is an internet-based tool that measures 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 results with other Australian utilities.

In 2009-10 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 assigned the highest precedence and is assured by assessing the number and effectiveness of barriers that prevent the introduction of disease-causing organisms. Table 2 shows Tennant Creek has the least number of protective barriers so is monitored more frequently to ensure system security.

The decline in Tennant Creek microbiological water quality, reported in the two previous annual reports, continued during 2009-10. Remediation by manual dosing storage tank water with sodium hypochlorite and flushing of the reticulation system is not an appropriate long term solution. The security of the Tennant Creek water supply, through the implementation of a permanent barrier, is a high priority for Power and Water. Power and Water has been directed to seek advice from DoH and the Northern Territory Government as to how best secure the Tennant Creek water supply.

A risk assessment of Katherine ground water initiated in 2007 concluded a barrier was required to provide protection against pathogens that may enter the aquifer through various pathways such as sinkholes and private bores located within the protection zone(s) of the bore heads. A UV system has been recommended as it has the capacity to deactivate chlorine resistant pathogens such as *Giardia* cysts, *Cryptosporidium* oocysts and some viruses. The UV system would also act as a second disinfection barrier against a range of chlorine sensitive pathogens.

UV disinfection is only a part of the current refurbishment of the Katherine water treatment plant. The UV system must be located so both river and bore water are treated effectively and potential scaling problems limiting the effectiveness of the UV process must be resolved.

Priority has been given to refurbishment of the treatment plant's sand filters which is scheduled for completion in early 2011.

McMinns storage tanks receive chlorinated water from Darwin River Dam, McMinns and Howard Springs borefields.

These storage tanks allow for blending of source waters, sedimentation of iron and manganese and provide retention that extends chlorine contact time.

It had been suspected that water movement through the tanks was not displacing all of the water in the tanks. This was restricting mixing and sedimentation and reducing holding time. Following investigations and confirmation of this short circuiting, baffle curtains were placed in the tank to direct water into dead spots and improve flow and turn over.

In 2009 the Ti Tree water supply chlorine dosing system was duplicated to ensure system safety and security. In the past faults in the dosing system left the supply at risk to microbial contamination. The new system provides both backup and improved system monitoring with the addition of telemetry and connection to SCADA.

ABOVE ▸ CONSTRUCTION OF THE RAISED SPILLWAY AT DARWIN RIVER DAM 2010

Chemical, Physical and Radiological Risk Assessment

A risk assessment procedure 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 statistically-derived value to the 2004 ADWG value. That is, where a statistically-derived value exceeds a guideline value by double, 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 DHF (at that time the Department of Health and Community Services) and are as follows:

- Relatively significant health impact: 10;
- Relatively minor health impact: 5; and
- 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.

For each water supply the risk contributed by each parameter exceeding the 2004 ADWG is calculated. The values of each of these risks are then summed and a final risk value for that water supply obtained.

The risk calculation is based on the 95th percentile for chemical health parameters and average concentration for aesthetic values. Radiological values used in this assessment are the 95th percentile or where data is limited, the maximum potential annual radiation dose.

The total risk value for each water supply is compared to the total risk value of all other water supplies. The results are compiled to rank water supplies according to the scale of the risks from lowest to highest.

This provides a means for determining priorities for further action. Actions may include collection of additional water quality data, carrying out more detailed studies, or investigation into alternative sources of supply and water treatment options.

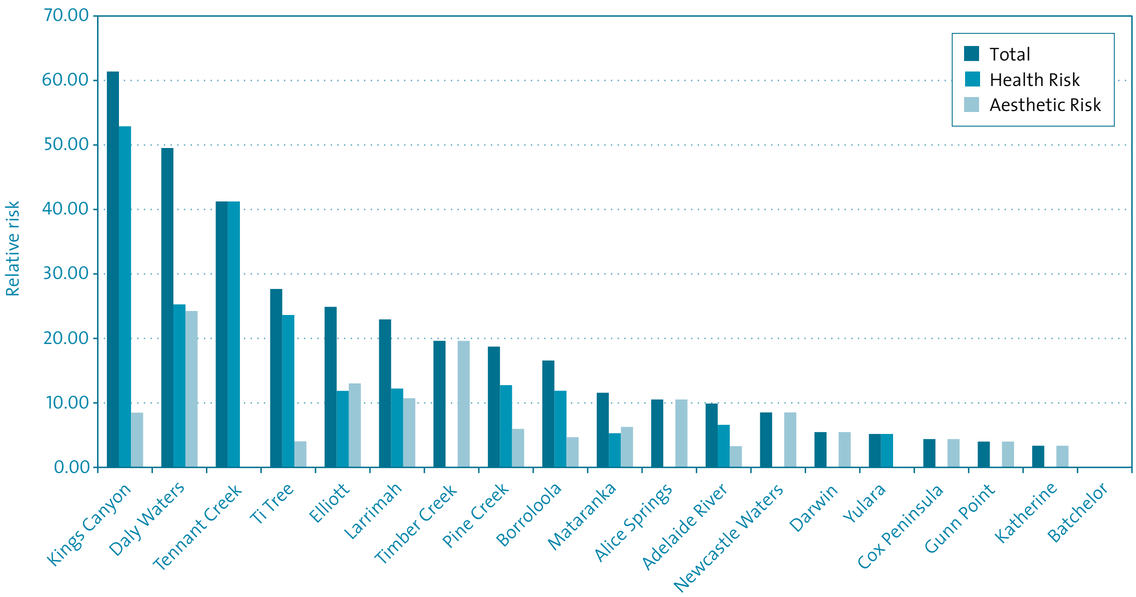
Table 4 shows Kings Canyon, Daly Waters and Tennant Creek have the highest risk scores. The primary water quality parameters of concern for Kings Canyon are iodide and radiological, for Daly Waters iodide and hardness and for Tennant Creek fluoride and iodide. Six of the 19 water supplies have slightly elevated levels of iodide.

Figure 2 shows the contribution of health and aesthetic parameters to the total risk for each supply.

Table 4 : Relative risk scoring for all water supplies 2009-10

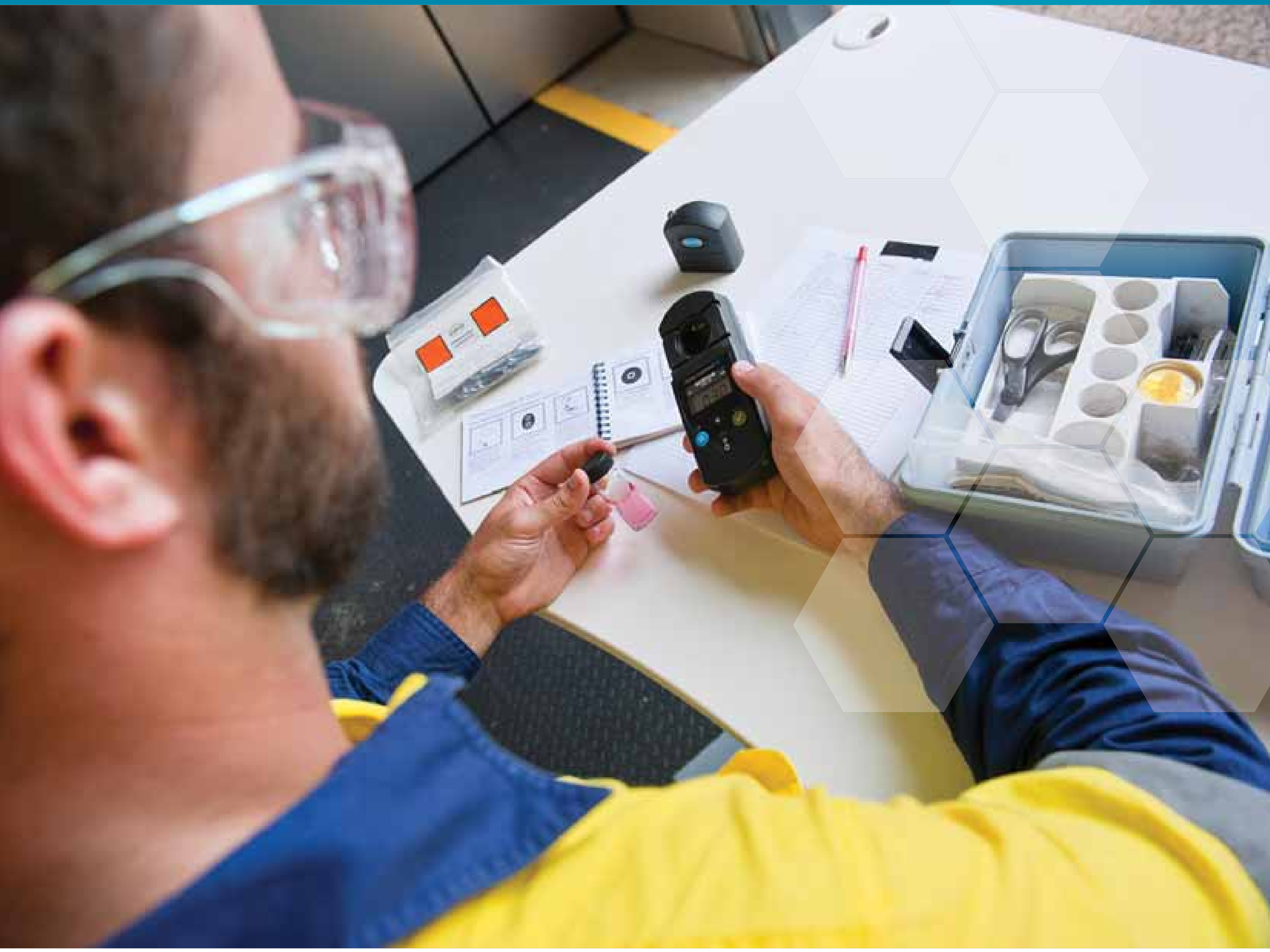
Rank	Centre	Relative Risk Score	Parameters Exceeding 2004 ADWG and DHF TDS Value 2009-10
1	Kings Canyon	61.4	Iodide, radiological, hardness, TDS
2	Daly Waters	49.5	Iodide, Chloride, Chlorine (free), hardness, Sodium, TDS
3	Tennant Creek	41.2	Fluoride, Iodide
4	Ti Tree	27.7	Iodide, Nitrate, Chlorine (free)
5	Elliott	24.9	Iodide, Chlorine (free), hardness
6	Larrimah	23.0	Iodide, hardness, TDS
7	Timber Creek	18.7	Barium, hardness
8	Pine Creek	16.6	Arsenic, Chlorine (free)
9	Borroloola	11.6	Radiological, Chlorine (free), pH
10	Mataranka	10.5	Hardness, TDS
11	Alice Springs	9.9	Radiological, hardness
12	Adelaide River	9.6	Iron, Manganese
13	Newcastle Waters	8.5	Chlorine (free), hardness
14	Darwin	5.5	Chlorine (free)
15	Yulara	5.2	Nitrate
16	Cox Peninsula	4.4	Chlorine (free)
17	Gunn Point	4.0	Chlorine (free)
18	Katherine	3.4	Chlorine (free)
19	Batchelor	0.0	

FIGURE 2: RELATIVE RISK SCORES SHOWING CONTRIBUTING PROPORTIONS FROM HEALTH AND AESTHETIC PARAMETERS



POWER AND WATER CORPORATION ▸ 2010 ANNUAL DRINKING WATER QUALITY REPORT

Section B: Drinking Water Quality and Performance



Microbiological results summary

Bacteria

As part of the monitoring program in 2009-10, 1352 drinking water samples were collected for bacteriological assessment across the Northern Territory. This number includes 1148 scheduled verification samples but excludes resamples, and operational samples.

Water supplies with specific bacteriological water quality issues were monitored more intensely by either increasing the number or frequency of sample collection increasing the total number of samples collected.

The 2004 ADWG require that no *E. coli* be detected in 98 per cent of samples collected from each system. Figure 3 shows that for 2009-10, all major centres except Tennant Creek, an unchlorinated water supply, achieved the 98 per cent *E. coli* free target.

LEFT ▸ WATER QUALITY TECHNICIAN DANIEL GUINEA CALIBRATING A MULTI-PARAMETER SUBMERSIBLE PROBE

FIGURE 3: PERCENTAGE OF SAMPLES TAKEN IN MAJOR CENTRES IN WHICH NO *E. COLI* WERE DETECTED FROM 2006-10

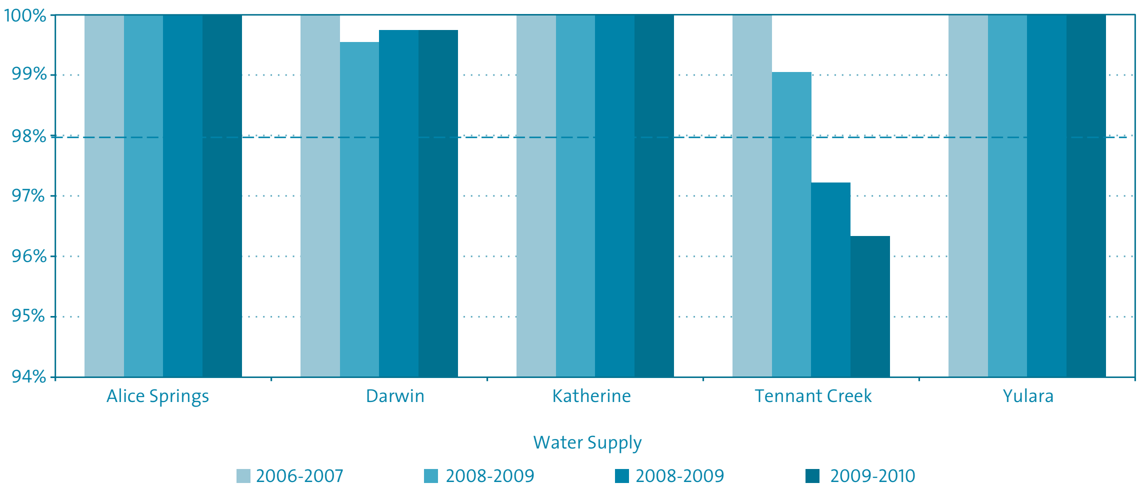
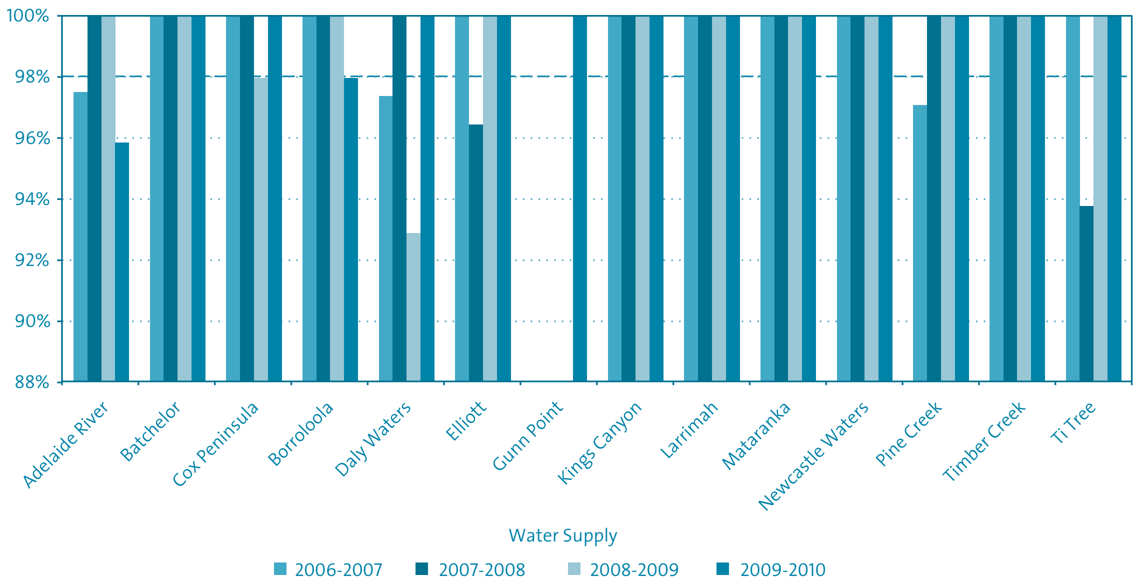


Figure 4 presents results for all the minor centres in the Northern Territory.

Adelaide River failed to pass *E. coli* performance targets in 2009-10 with *E. coli* detected in one of 24 samples. *E. coli* was detected in one sample from Cox Peninsula but this supply passed the *E. coli* performance target with 98 per cent of samples free of *E. coli*. All other minor centres achieved 100 per cent compliance in 2008-09, reflecting the upgraded chlorine dosing and monitoring facilities installed over the past four years, and improved system operation and maintenance.

FIGURE 4: PERCENTAGE OF SAMPLES TAKEN IN MINOR CENTRES IN WHICH NO *E. COLI* WERE DETECTED FROM 2006-10



Naegleria fowleri

In the 2008-09 report results of the *N. fowleri* monitoring program were presented with source and reticulation samples combined. For this report results of source and reticulation monitoring are presented separately. The assessment of the effectiveness of chlorine to control the growth of *N. fowleri* requires chlorinated (reticulated) and non-chlorinated (source) waters to be assessed separately.

For the 2009–10 period 408 samples were collected from major water supplies, 361 from the reticulation and 47 from source waters. A total of 106 samples were collected from minor water supplies, 91 from the reticulation and 15 from source waters.

Table 5 show the results of *N. fowleri* monitoring in major and minor supplies.

N. fowleri was detected only in the Darwin reticulation system. Two *N. fowleri* were detected in a litre sample taken at Manton Dam Park Tap sampling point on the 04 August 2009. At the time the free chlorine residual was low. Remedial action included mains flushing and re-establishment of an effective free chlorine residual. Follow-up investigations did not find *N. fowleri* present at that location.

All other reticulations and sources monitored during the 2009-10 period were free of *N. fowleri*.

The 2004 ADWG action level focuses on *N. fowleri* but any detection of any thermophilic amoeba is considered significant. The detection of thermophilic amoeba indicates conditions in the water supply are conducive for the growth of *N. fowleri* and further investigation or remedial action may be warranted.

This year (2009-10) was the first time the nonpathogenic species *Naegleria carteri* has been detected in NT water supplies.

Table 5: Thermophylic amoeba detections, monitored supplies 2009-10

Centre	Total samples 2009-10	Amoeba positive samples	*Naegleria* spp. positive samples	*Naegleria carteri* positive samples	*Naegleria lovaniensis* positive samples	*Naegleria fowleri* positive samples
Alice Springs Reticulation	18	2	0	0	0	0
Cox Peninsula Reticulation	51	1	1	1	0	0
Darwin Reticulation	214	67	27	0	25	2
Darwin Source (dam)	19	2	0	0	0	0
Gunn Point Reticulation	25	1	1	0	1	0
Katherine Reticulation	24	0	0	0	0	0
Pine Creek Reticulation	15	5	1	0	1	0
Pine Creek Source (dam)	5	1	0	0	0	0
Tennant Creek Reticulation	96	7	5	0	5	0
Tennant Creek Source (bores)	22	8	6	0	6	0
Yulara Reticulation	9	0	0	0	0	0
Yulara Source (bores)	6	1	1	0	1	0

Burkholderia pseudomallei

Burkholderia pseudomallei is the agent responsible for melioidosis and despite being ubiquitous throughout the tropics its ecology is poorly understood.

Epidemiological evidence has established melioidosis can be contracted by exposure to contaminated soil or water where the bacteria enter via skin cuts and lesions. Other routes of transmission, specifically gastrointestinal, have not been confirmed. Despite its apparent ubiquity there have been few waterborne outbreaks.

There has been a confirmed case of a waterborne fatal infection in tropical Western Australia. *B. pseudomallei* was isolated from the domestic water supply, but not from soil or surface water samples. In each case, victims had an underlying chronic disease, and other possible contributory factors included unusual rainfall patterns, acidic water and ineffective levels of chlorine in the supply.

The 2009-11 *Drinking Water Monitoring Program* includes *B. pseudomallei* as an investigative and research activity.

Monitoring sites and frequency are in response to the identification of clusters of melioidosis cases.

The Tennant Creek supply is an exception. As this supply is not chlorinated it has been continuously monitored for the past four years. *B. pseudomallei* was not detected in the Tennant Creek water supply in the 2009-10 monitoring period.

B. pseudomallei has not been detected in any monitored water supply in the past four years, however Power and Water is working with Menzies School of Health Research (MSHR) to further develop the current monitoring program.

Chemical and Physical Results Summary

Health-related water quality parameters are reported as a 95th percentile. If data is limited, values are not reported as the 95th percentile but as the maximum value.

Aesthetic parameters are reported as an average as specified in the 2004 ADWG.

Radionuclides

All water supplies are investigated to gain an initial measure of gross alpha and gross beta activity concentrations. The 2004 ADWG recommend further radiological measurements be undertaken to ascertain the total annual radiation dose if the gross activities are higher than 0.5 Bq/L. The 2004 ADWG recommend the total annual radiation dose not exceed 1.0 mSv/year.

The likely worst case leading to the highest exposure is where the gross alpha and gross beta activities are due entirely to radium-226 (an alpha emitter) and radium-228 (a beta emitter).

To calculate the precise radiation dose, all radioactive species in the water supply must be identified and their activity concentrations determined. Generally radium-226 and radium-228 are the major radionuclides contributing to the gross alpha and beta values. When radium-226 and radium-228 do not account for all gross alpha and beta values other radionuclides present must be identified and their levels determined.

If the analysis fails to include all radionuclides the total annual radiation dose is calculated by treating the gross alpha value as if it were due entirely to radium-226 and the K40 corrected gross beta value as if it were due entirely to radium-228.

As descibed above, this treatment calculates the maximum possible exposure.

This approach derives its validity from the knowledge that radium-226 and radium-228 are the most consequential radionuclides present in water and on a concentration-based comparison contribute more to the annual dosage than any other radionuclide.

ABOVE ▸ WATER SAMPLE COLLECTION AT DARWIN RIVER RESERVOIR OFF-TAKE TOWER

The annual radiation dose calculated by this method is a conservative solution and produces a total annual radiation dose estimate in excess of the true value.

An estimation of the total annual radiation dose cannot be made without values for gross alpha and gross beta activities. Estimates made using only radium-226 and radium-228 underestimate the true value.

To comply with 2004 ADWG radiological data used in the calculation of the total annual radiation dose must be no more than two years outside the reporting period for ground water supplies and no more than five years for surface water.

Annual Assessment

Water from 11 minor centres and three major centres complied with the 2004 ADWG screening level, with radioactivity levels below 0.5 Bq/L. Fifteen water supplies passed annual radiological assessment, three supplies failed and one supply was not monitored.

All water supplies except Yulara were sampled and tested for gross alpha and gross beta. Yulara water supply was not sampled in this period due to a scheduling error.

On occasion samples collected from Borroloola, Katherine, Kings Canyon, Pine Creek and Ti Tree water supplies were not analysed for all required parameters. Some samples were analysed for radium-226 and radium-228 but not for gross alpha and gross beta. As the radiological data for these water supplies is incomplete the precise total annual radiological dose cannot be determined when screening levels are exceeded. If reported, the total annual radiation dose for these supplies is reported as the worst case estimate as outlined above.

Alice Springs bores were assessed for radioactivity levels in June 2008 and February 2010. Eleven of the 16 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 and two of these bores also exceeded 0.5 Bq/L for K-40 corrected gross beta. The total annual radiation dose estimate is reported as the maximum value of all 16 bores.

Kings Canyon water supply has higher levels of radionuclides than other Northern Territory water supplies and is intensely monitored. Despite the large amount of radiological data available for this water supply, all radionuclides contributing to the radioactivity of this supply were not identified. The total annual radiation dose for the Kings Canyon water supply is reported as the worst case estimate.

The result for Borroloola is based on a small data set. Only one of the four valid samples exceeded the total annual radiation dose of 1.0 mSv/year. The reported value is the maximum value calculated.

Pine Creek results are influenced by the result from a single sample which exceeded the gross alpha but not the gross beta activity level of 0.5 Bq/L. The reportable total annual radiation dose (95^{th} percentile) for the Pine Creek water supply is below the maximum acceptable value of 1.0 mSv/year.

Radiological monitoring and data assessment procedures put in place during the writing of this report will enable dose calculation reporting in the 2010-11 report for water supplies where activity screening concentrations are exceeded.

Trihalomethanes

THMs in Power and Water supplies were initially measured for reference in 2002-03. Values ranged from less than 0.004 mg/L in Alice Springs to less than 0.08 mg/L in Darwin. These concentrations were well below the maximum guideline value of 0.25 mg/L 2004 ADWG level.

Monitoring of water supplies in 2009-10 showed THMs concentrations ranged from less than 0.004 mg/L for eight water supplies to a maximum of 0.069 mg/L in the Darwin water supply. The 2009-10 level of THMs in the Darwin water supply is approximately 50 per cent less than the levels for the previous 12-month period.

For the 2009-10 period the levels of THMs in all other water supplies remain at the levels measured in previous years and appear to be stable. The low levels of THMs measured and the low potential for the formation of THMs in NT water supplies is supported by the low level of THM precursors, total organic carbons (TOC), in these waters.

The highest values are Darwin, Katherine and Pine Creek supplies all of which use surface water.

Herbicides and pesticides

The 2004 ADWG health values for pesticides are very conservative and include a range of safety factors. The values are derived from the acceptable daily intake (ADI) and set at about 10 per cent of the ADI for an adult weight of 70 kg for a daily water consumption of two litres.

Although guideline values have been provided for a large number of pesticides, most are unlikely to be present in Australian drinking water supplies. The pesticide

ABOVE ▸ MEASURING CHLORINE RESIDUALS WITH A PORTABLE CHLORINE METER

monitoring program focuses on 43 commonly used pesticides including organochlorine, organophosphate and triazine pesticides, insecticides and acidic herbicides.

Monitoring is undertaken on water supplies that have previously been found to contain pesticides or where local pesticide usage suggests a water supply may be at risk.

Good management of surface water sources and bores reduce the risk of drinking water becoming contaminated with pesticides. Bores are required to be constructed to standards that guarantee bore head Integrity and prevent surface water (potentially containing pesticides) entering the bore. Surface waters (dams and rivers) are managed to strictly control pesticide use in their catchments.

Occasionally weed problems in reservoirs and catchments can only be managed effectively through the use of herbicides. Dicamba (Banvel, 3,6-dichloro-2-methoxybenzoic acid) is a moderate to low toxicity herbicide used to control weeds and mimosa in the Darwin River Reservoir catchment. Dicamba is moderately persistent in soil and breaks down to very simple substances such as carbon dioxide and water. Its reported half-life in soil ranges from one to six weeks. This herbicide is applied two – three times a year as part of the mimosa control program. Usually pesticide monitoring is executed in conjunction with weed management programs to ensure pesticide levels remain within 2004 ADWG values. The synchronisation of herbicide application to herbicide monitoring was not achieved during the 2008-09 or the 2009-10 periods.

Although monitored for several years, pesticides in the Northern Territory water supplies have not been detected despite limited use in some areas. In consideration of these results pesticide monitoring during 2009-10 was restricted to Darwin and Katherine water supplies. These supplies are considered potentially vunerable to pesticide contamination due to agricutural activities close to production bores and surface water sources.

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

Customer Satisfaction

Water Quality Customer Complaints

Appearance, taste and odour are monitored as they are generally the characteristics by which customers judge water quality.

Power and Water records all water quality complaints made by customers.

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.

Table 6 shows the total number of complaints and the number of complaints per 1,000 customer properties.

Table 6 : Water quality complaints 2005-10

		Total Number of Complaints				
CENTRE	**Properties**[A]	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009–10**
Adelaide River	99[B]	DNA	DNA	DNA	1	1
Alice Springs	11398[C]	8	5	1	4	5
Darwin	49757[C]	112	147	373	355	123
Katherine	2294[B]	7	2	DNA	DNA	1
Total	**53288**	**127**	**154**	**374**	**360**	**130**
Complaints per 1000 properties (all NT)		2.13	2.44	6.13	5.77	2.44

DNA Data not available
[A] *2009-10*
[B] *Properties based on number of electrical meters*
[C] *As reported to WSAA in 2009-10 NPR*

The pattern of complaints made about the Darwin water supply is largely governed by changes in water quality associated with the seasonal variation in reservoir water quality and customer demand.

As with many water supply reservoirs, Darwin River Reservoir is subject to stratification.

Stratification is the development of distinct layers of water of different temperature or density at various depths in a water body and the restriction of mixing between these layers. Stratification develops when the upper layers of the reservoir are heated by solar radiation faster than the heat can disperse into the lower depths of the reservoir. The generated difference in the surface and bottom densities limit circulation between these layers and can lead to these layers having significantly different water qualities.

Atmospheric oxygen is absorbed by water at the interface between air and water. Algal photosynthesis near the surface also supplies oxygen to the water. Oxygen at the bottom of a reservoir is consumed by the decomposition of organic material. As water circulation is restricted due to stratification, oxygen consumed in the lower layers is not replenished from the surface resulting in oxygen depletion at the bottom of the reservoir.

The decomposition of organic material under anaerobic conditions lowers the pH and encourages production of hydrogen sulphide. This process reduces iron and manganese in the sediments to soluble forms.

Once the reservoir has stratified, a large amount of energy is required to disrupt the layered structure. De-stratification occurs with a decrease in surface temperature, in-flow and wind-induced mixing, processes that cause the layers to mix and bring low quality anoxic water from the bottom of the reservoir to the surface where it is drawn into the supply. This dissolved manganese and iron reduce the aesthetic quality of water making it unpleasant to drink and causing staining of laundry.

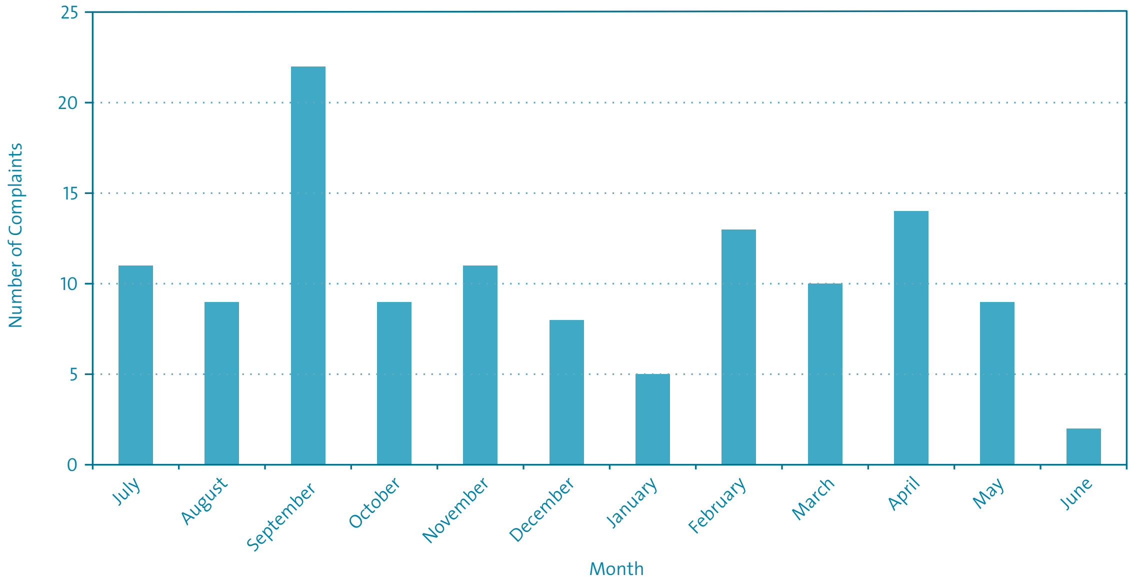
After entering the reticulation supply system, this lower quality water can precipitate iron and manganese compounds creating discoloured water resulting in customer dissatisfaction and complaints. During the Wet Season, as water demand drops and flow rates are reduced, these compounds can settle out in the distribution system. However, at the beginning of the next Dry Season, as flows in the distribution system increase, they are mobilised by the higher velocity water 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.

The frequency of drinking water complaints for the Darwin water supply during the 2009–10 period is shown in Figure 5.

Power and Water works to minimise the frequency and the magnitude of these events, primarily through a mains flushing program in major centres where customers frequently report discoloured water. Mains are flushed before anticipated increased demands associated with seasonal changes. When a customer reports discoloured water, Power and Water flushes the mains supplying the customer's residence.

Water quality is monitored at a number of locations in the Darwin water supply to gauge the extent of discoloured water and determine whether routine flushing is required.

FIGURE 5 NUMBER OF MONTHLY DRINKING WATER CUSTOMER COMPLAINTS FOR DARWIN 2009-10



Customers have also complained about cloudy water, floating particles, odour, taste and high chlorine levels. High chlorine levels manifest themselves as chlorinous taste and odour complaints. Figure 6 shows a breakdown of customer complaints for 2009-10.

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 as required. Online water quality monitoring units have been installed in most major and minor centres to improve monitoring across the entire network.

Objectionable tastes and odours can result from compounds produced by certain types of algae, cyanobacteria (blue-green algae), bacteria and sometimes protozoa.

A number of organic compounds causing tastes and odours can be produced as by-products when water is disinfected with chlorine.

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. When left to stand, this cloudy water will clear rapidly. Other causes of cloudy water are tap aerators and hot water systems.

Occasionally harmless white algae can be observed in the Darwin water supply. These algae grow naturally in Darwin River Reservoir and their original green colour is lost during the disinfection process.

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

As a response to the detection of *Naegleria fowleri* in some NT water supplies, free chlorine residuals are now maintained at a minimum of 0.5 mg/L. This level of chlorine is objectionable to some customers who have complained about the chlorinous taste.

Comment on Darwin water quality 2009-10

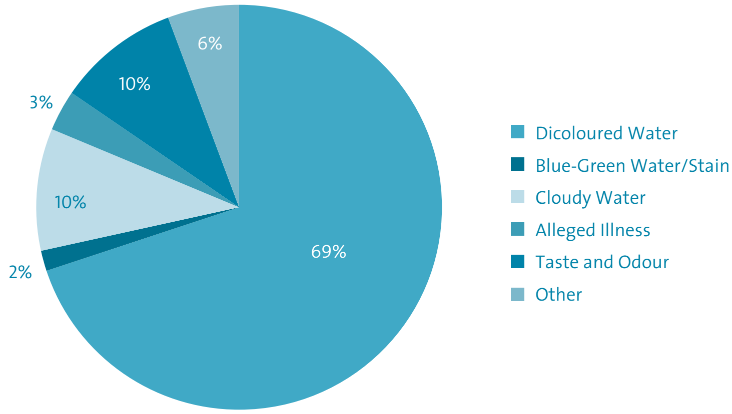
There was a major reduction in the number of complaints received for the 2009-10 year compared with previous years.

There was also a significant reduction in THMs and a corresponding reduction in TOC.

These reductions can be attributed to an increase in the quality of raw water drawn from the reservoir.

Higher and prolonged incident radiation on the reservoir during the reporting period preserved its strongly stratified state preventing mixing and maintaining high quality water at the surface.

FIGURE 6: BREAKOWN OF CUSTOMER COMPLAINTS FOR DARWIN 2009–10 SHOWING MAJOR WATER QUALITY ISSUES



Recorded emergencies/ incidents

No water quality emergencies were recorded in 2009–10. Significant investment in the upgrading of facilities and securing of systems continues reducing risks and the potential for contamination or failure.

In the 2009–10 year there were six incidents in which *E. coli* was detected in water supplies:

• Adelaide River	one sample	19/04/2010;
• Darwin	one sample	01/03/2010;
• Cox Peninsula[1]	one sample	02/09/2009;
• Tennant Creek	one sample	23/11/2009;
• Tennant Creek[2]	two samples	27/01/2010;
• Tennant Creek[2]	two samples	29/01/2010;
• Tennant Creek	one sample	08/02/2010.

[1] Not investigated
[2] Single incident

ABOVE ▸ OVERLOOKING DARWIN RIVER RESERVOIR

Response to these incidents included manual chlorination of tanks, flushing of mains and re-sampling of the water supply as agreed with DHF. Following remedial action water supplies were tested and all results were negative for *E. coli*.

Appendices

ABOVE ▸ DARWIN RIVER DAM WALL

Appendix 1: Water quality results tables

Table A1: Bacteriological monitoring in major centres 2009-10

Centre	Parameter (mpn/100 mL)	Target Level	Total No. of Samples Required	Total No. of Samples Collected*	Total Exceedances (No.)	Samples Passing Reporting Level (%)
Alice Springs	*E. coli*	<1 in 98% of samples	104	105	0	100.0
	Total coliforms	<10 in 95% of samples	104	104	0	100.0
Darwin	*E. coli*	<1 in 98% of samples	364	385	1	99.7
	Total coliforms	<10 in 95% of samples	364	385	3	99.2
Katherine	*E. coli*	<1 in 98% of samples	104	103	0	100.0
	Total coliforms	<10 in 95% of samples	104	103	1	99.0
Tennant Creek	*E. coli*	<1 in 98%of samples	104	118	4	96.6
	Total coliforms	<10 in 95% of samples	104	118	25	78.8
Yulara	*E. coli*	<1 in 98% of samples	52	53	0	100.0
	Total coliforms	<10 in 95% of samples	52	53	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 2009-10

Centre	Parameter (mpn/100 mL)	Target Level	Total No. of Samples Required	Total No. of Samples Collected*	Total Exceedances (no.)	Samples Passing Reporting Level (%)
Adelaide River	*E. coli*	<1 in 98% of samples	24	24	1	95.8
	Total Coliforms	<10 in 95% of samples	24	24	2	91.7
Batchelor	*E. coli*	<1 in 98% of samples	52	55	0	100.0
	Total Coliforms	<10 in 95% of samples	52	55	0	100.0
Borroloola	*E. coli*	<1 in 98% of samples	24	21	0	100.0
	Total Coliforms	<10 in 95% of samples	24	21	0	100.0
Cox Peninsula	*E. coli*	<1 in 98% of samples	52	52	1	98.1
	Total Coliforms	<10 in 95% of samples	52	52	3	94.2
Daly Waters	*E. coli*	<1 in 98% of samples	24	23	0	100.0
	Total Coliforms	<10 in 95% of samples	24	23	0	100.0
Elliott	*E. coli*	<1 in 98% of samples	24	101	0	100.0
	Total Coliforms	<10 in 95% of samples	24	101	2	98.0
Gunn Point	*E. coli*	<1 in 98% of samples	24	25	0	100.0
	Total Coliforms	<10 in 95% of samples	24	25	0	100.0
Kings Canyon	*E. coli*	<1 in 98% of samples	52	104	0	100.0
	Total Coliforms	<10 in 95% of samples	52	104	2	98.1
Larrimah	*E. coli*	<1 in 98% of samples	24	26	0	100.0
	Total Coliforms	<10 in 95% of samples	24	26	0	100.0
Mataranka	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	0	100.0
Newcastle Waters	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	0	100.0
Pine Creek	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	0	100.0
Ti Tree	*E. coli*	<1 in 98% of samples	24	66	0	100.0
	Total Coliforms	<10 in 95% of samples	24	66	0	100.0
Timber Creek	*E. coli*	<1 in 98% of samples	24	19	0	100.0
	Total Coliforms	<10 in 95% of samples	24	19	0	100.0

Table A3: Health, aesthetic and other parameters in major centres 2009-10

Parameter/Centre	Guideline Value[1]	Units	Alice Springs	Darwin	Katherine	Tennant Creek	Yulara
Health Parameters – 95th Percentile Values[2]							
Antimony	0.003	mg/L	<0.0002	<0.0002	0.0004	0.0002	0.0002
Arsenic	0.007	mg/L	<0.0005	<0.0005	0.0006	0.0027	0.0006
Barium	0.7	mg/L	0.10	<0.05	0.06	<0.05	0.06
Boron	4	mg/L	0.13	<0.02	0.02	0.52	0.76
Cadmium	0.002	mg/L	<0.0002	<0.0002	0.0002	0.0009	0.0009
Chlorine (free)	5	mg/L	0.99	1.88	0.93	DNA	0.72
Chromium	0.05	mg/L	<0.005	<0.005	0.006	0.006	0.006
Copper	2	mg/L	0.12	0.41	0.09	0.08	0.13
Fluoride	1.5	mg/L	0.5	0.8	0.6	**1.6**	0.1
Iodide	0.1	mg/L	0.09	0.02	0.01	**0.36**	0.05
Lead	0.01	mg/L	0.003	0.002	0.002	0.001	0.001
Manganese	0.5	mg/L	<0.005	0.053	0.006	0.006	0.006
Mercury	0.001	mg/L	<0.0001	<0.0001	0.0001	0.0001	0.0001
Molybdenum	0.05	mg/L	<0.005	<0.005	0.006	0.006	0.006
Nickel	0.02	mg/L	0.006	<0.002	0.002	0.002	0.003
Nitrate	50	mg/L	8	3	1	47	**52**
Radiological[4]	1.0	mSv/yr	**1.32**	PASS	PASS	PASS	DNA
Selenium	0.01	mg/L	0.002	<0.001	0.001	0.005	0.001
Silver	0.1	mg/L	<0.01	<0.01	0.01	0.01	0.01
Sulfate	500	mg/L	73	11	11	79	309
THMs[5]	0.25	mg/L	DNA	0.069	0.038	DNA	0.006
Uranium	0.02	mg/L	0.00910	0.00010	0.00020	0.00878	0.00006
Aesthetic Parameters – Mean Values[3]							
Aluminium	0.2	mg/L	0.02	<0.02	0.03	<0.02	<0.02
Chloride	250	mg/L	74	8	8	96	70
Chlorine (free)	0.6	mg/L	0.59	**1.10**	**0.67**	DNA	0.45
Copper	1	mg/L	0.04	0.07	0.02	0.02	0.05
Hardness	200	mg/L ($CaCO_3$)	**220**	53	176	172	31
Iron	0.3	mg/L	0.04	0.09	0.06	0.06	0.04
Manganese	0.1	mg/L	<0.005	0.025	<0.005	<0.005	<0.005
pH	6.5-8.5	pH units	8.0	7.6	7.9	7.8	7.7
Sodium	180	mg/L	80	3	5	125	56
Sulfate	250	mg/L	58	3	5	53	61
TDS	800	mg/L	452	65	175	610	217
Zinc	3	mg/L	0.02	0.01	0.01	0.01	0.04

Table A3: Health, aesthetic and other parameters in major centres 2009-10

Parameter/Centre	Guideline Value[1]	Units	Alice Springs	Darwin	Katherine	Tennant Creek	Yulara
Other Parameters – Mean Values[3]							
Alkalinity		mg/L	241	53	153	277	19
Beryllium		mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bromide		mg/L	0.32	0.02	0.02	0.73	0.38
Calcium		mg/L	48	10	37	27	7
Electrical conductivity		μS/cm	815	112	307	966	378
Magnesium		mg/L	25	6	16	25	3
Potassium		mg/L	5.9	0.4	0.8	30.1	6.4
Silica		mg/L	18	13	16	62	11
Tin		mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

NOTES:

Parameter	Assessment
Radiological	Results are reported as **Pass** if screening levels of gross alpha and gross beta (K corrected) are less than 0.5 Bq/L. Annual dosage calculation is not required. Data used in this assessment is not more than 2 years older than the starting date of the reporting period for bores and 5 years for surface water. Annual dosage is reported as 95th percentile for large data sets and maximum value for small data sets. Data covers the period 2005-10
THMs	THMs are reported maximum values as data sets are small.
Health	Assessment is reported as 95th percentile. Data covers the period 2005-10
Aesthetic and Other	Assessment is reported as mean. Data covers the period 2005-10
Exceedances	In bold

ABOVE ▸ WILSON LEE INSPECTING THE OFF-TAKE TOWER AT DARWIN RIVER RESERVOIR

Table A4 : Health, aesthetic and other parameters in minor centres 2009-10

Parameter / Centre	Guideline Value[1]	Units	Adelaide River	Batchelor	Borroloola	Cox Peninsula	Daly Waters	Elliott	Gunn Point	Kings Canyon	Larrimah	Mataranka	Newcastle Waters	Pine Creek	Ti Tree	Timber Creek
Health Parameters – 95th Percentile Values[2]																
Antimony	0.003	mg/L	<0.0002	0.0002	0.0003	<0.0002	0.0002	0.0002		0.0005	0.0002	<0.0002	0.0002	<0.0002	0.0002	0.0002
Arsenic	0.007	mg/L	0.0030	0.0006	0.0006	<0.0005	0.0014	0.0006		0.0044	0.0009	<0.0005	<0.0005	**0.0081**	0.0013	0.0010
Barium	0.7	mg/L	<0.05	0.06	0.06	<0.05	0.08	0.17		0.06	<0.05	0.05	0.27	<0.05	0.10	**1.79**
Boron	4	mg/L	<0.02	0.02	0.04	<0.02	0.44	0.35		0.35	0.22	0.26	0.29	<0.02	0.36	0.13
Cadmium	0.002	mg/L	<0.0002	0.0002	0.0003	<0.0002	0.0002	0.0002		0.0004	0.0002	<0.0002	0.0002	<0.0002	0.0002	0.0002
Chlorine (free)	5	mg/L	0.87	0.93	0.84	1.35	1.14	2.61	1.47	0.72	0.78	0.66	1.48	1.41	1.25	0.75
Chromium	0.05	mg/L	<0.005	0.006	0.006	<0.005	0.006	0.006		0.013	0.006	<0.005	0.006	<0.005	0.006	0.006
Copper	2	mg/L	0.64	0.05	0.58	0.13	0.10	0.02		0.46	0.03	0.04	0.03	0.07	0.06	0.05
Fluoride	1.5	mg/L	0.4	0.2	0.1	<0.1	0.4	0.9		0.5	0.3	0.4	0.9	0.6	0.8	1.4
Iodide	0.1	mg/L	<0.01	0.01	0.02	<0.01	**0.25**	**0.12**		**0.41**	**0.12**	0.09	0.09	**0.10**	**0.17**	0.03
Lead	0.01	mg/L	0.002	0.001	0.005	0.002	0.003	0.003		**0.010**	0.001	<0.001	0.001	0.003	0.001	0.003
Manganese	0.5	mg/L	0.241	0.006	0.016	0.007	0.180	0.006		0.008	0.006	0.009	0.006	0.202	0.006	0.228
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	<0.0001	0.0001	0.0001
Molybdenum	0.05	mg/L	<0.005	0.006	0.006	<0.005	0.006	0.006		0.006	0.006	<0.005	0.006	<0.005	0.006	0.006
Nickel	0.02	mg/L	<0.002	0.002	0.002	0.003	0.004	0.004		0.012	0.002	0.004	0.002	<0.002	0.002	0.008
Nitrate	50	mg/L	<1	2	1	9	12	39		9	5	3	10	1	**64**	1
Radiological[4]	1.0	mSv/yr	PASS	PASS	**1.06**	PASS	PASS	PASS	PASS	**2.37**	PASS	PASS	PASS	0.81	PASS	PASS
Selenium	0.01	mg/L	<0.001	0.001	0.001	<0.001	**0.008**	0.003		0.009	0.003	<0.001	0.001	<0.001	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	12	13	4	28	214	295		210	119	117	184	94	104	6
THMs[5]	0.25	mg/L	<0.004	<0.004	0.018	<0.004	0.019	<0.004	DNA	0.005	<0.004	<0.004	<0.004	0.029	0.005	<0.004
Uranium	0.02	mg/L	0.00003	0.00042	0.00024	0.00003	0.00787	0.00620		0.00264	0.00274	0.00336	0.00537	0.00019	0.00925	0.00218

Table A4 : Health, aesthetic and other parameters in minor centres 2009-10

Parameter / Centre	Guideline Value[1]	Units	Adelaide River	Batchelor	Borroloola	Cox Peninsula	Daly Waters	Elliott	Gunn Point	Kings Canyon	Larrimah	Mataranka	Newcastle Waters	Pine Creek	Ti Tree	Timber Creek
Aesthetic Parameters – Mean Values[3]																
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	0.03	0.02	<0.02
Chloride	250	mg/L	27	8	10	11	**342**	154		243	190	173	44	12	65	30
Chlorine (free)	0.6	mg/L	0.48	0.48	**0.67**	**0.88**	**0.73**	**1.42**	**0.80**	0.40	0.42	0.51	**0.86**	**0.94**	**0.81**	0.48
Copper	1	mg/L	0.14	0.02	0.12	0.04	0.02	0.01		0.09	0.01	0.02	0.02	0.02	0.02	0.02
Hardness	200	mg/L ($CaCO_3$)	100	160	23	8	**528**	**396**		**363**	**490**	**479**	**281**	125	200	**398**
Iron	0.3	mg/L	**0.62**	0.05	0.15	0.03	0.21	0.11		0.20	0.11	0.17	0.06	0.16	0.04	0.07
Manganese	0.1	mg/L	**0.12**	<0.005	0.006	0.005	0.039	<0.005		<0.005	<0.005	0.006	<0.005	0.072	<0.005	0.029
pH	6.5-8.5	pH units	7.1	11.5	**6.3**	6.8	7.4	7.9		6.9	7.6	7.7	7.8	7.1	8.0	7.3
Sodium	180	mg/L	27	5	6	8	**216**	94		115	120	132	52	31	65	22
Sulfate	250	mg/L	5	5	1	12	195	166		176	112	123	38	26	43	5
TDS	800	mg/L	189	215	54	50	**1321**	785		**811**	**901**	**892**	541	217	511	457
Zinc	3	mg/L	0.03	0.03	0.29	0.05	0.01	0.01		0.07	0.04	0.02	0.02	0.01	0.03	0.02
Other Parameters – Mean Values[3]																
Alkalinity		mg/L	101	214	40	20	431	359		125	432	475	383	139	211	444
Beryllium		mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromide		mg/L	0.07	0.01	0.02	0.01	1.85	0.73		1.41	1.00	0.79	0.15	0.05	0.44	0.13
Calcium		mg/L	17	29	6	3	130	88		71	123	116	68	20	45	62
Electrical conductivity		µS/cm	322	392	78	59	2089	1294		1361	1450	1533	879	356	772	858
Magnesium		mg/L	14	36	1	0	62	44		44	54	52	33	17	22	63
Potassium		mg/L	1.1	0.3	1.1	1.0	24.7	22.1		23.6	12.2	17.8	29.0	1.4	18.5	6.8
Silica		mg/L	34	19	13	23	34	52		18	38	35	55	40	94	21
Tin		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

NOTES:

Parameter	Assessment
Radiological	Results are reported as **Pass** if screening levels of gross alpha and gross beta (K corrected) are less than 0.5 Bq/L. Annual dosage calculation is not required.
	Data used in this assessment is not more than 2 years older than the starting date of the reporting period for bores and 5 years for surface water.
	Annual dosage is reported as 95th percentile for large data sets and maximum value for small data sets.
	Data covers the period 2005-10
THMs	THMs are reported maximum values as data sets are small.
Health	Assessment is reported as 95th percentile. Data covers the period 2005-10
Aesthetic and Other	Assessment is reported as mean. Data covers the period 2005-10
Exceedances	In bold

LEGEND (TABLE A3 & A4)

N/A	Not applicable	*	No guideline value applicable
mSv/yr	millisieverts per year	µS/cm	microsiemens per centimetre
mg/L	milligrams per litre	DNA	Data not available

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

All values reported preceded with "<" indicate the value is below the level of detection of the analytical method.

Supplies for which there is insufficient data, incomplete data or where the only data available is outdated are reported as data not available (DNA).

1 2004 ADWG value for health and aesthetic parameters. TDS value set by DHCS.

2 95th percentile of all Health related values where data is available from 2005-10.
Free Chlorine values are reported as the 95th percentile for 2009-10 period.
If data is limited radiological values are not reported as the 95th percentile but as the maximum value.

3 Mean of aesthetic and other values where data is available from 2005-10.

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.

5 Trihalomethanes (THMs) are reported as the maximum value of the data available from 2005-10.

Glossary of acronyms

ADI	Acceptable daily intake
ADWG	Australian Drinking Water Guidelines (2004) Referred to in this report as "2004 ADWG"
ANSI	American National Standards Institute
AWA	Australian Water Association
AWWA	American Water Works Association
CRC	Cooperative Research Centre
DCI	Department of Construction and Infrastructure (from 4 December 2009)
DHCS	Department of Health and Community Services (until 1 July 2008)
DHF	Department of Health and Families (from 1 July 2008)
DNA	Data not available
DNRETAS	Department of Natural Resources, Environment, The Arts and Sport
DoR	Department of Resources (from 4 December 2009)
MSHR	Menzies School of Health Research
N/A	Not applicable
NHMRC	National Health and Medical Research Council
NPR	National Performance Report
NRMMC	National Resources Management Council
NT	Northern Territory
PAM	Primary amoebic meningoencephalitis
PI System	Process information system for the management of real time data and events
SAI Global	Standards Australia International (Global)
SCADA	Supervisory control and data acquisition
TDS	Total dissolved solids
THMS	Trihalomethanes
TOC	Total organic carbons
TRIM	Power and Water's electronic document management system
UV	Ultra violet
WQRA	Water Quality Research Australia
WSAA	Water Services Association of Australia

Units of measurement

Bq/L	Becquerel per litre
µg/L	micrograms per litre
mg/L	milligrams per litre
mpn/100mL	Most probable number per 100 millilitre
mSv/yr	millisieverts per year
ML	megalitres
µS/cm	microsiemens per centimetre

Standards

AS/NZS ISO 14001:2004

Environmental management systems – Requirements with guidance for use

The objective of this Standard is to specify requirements for an environmental management system (EMS) to enable an organization to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organization subscribes, and information about significant environmental aspects.

AS/NZS ISO 9001:2008

Quality management systems – Requirements

This Standard promotes the adoption of a process approach when developing, implementing and improving the effectiveness of a quality management system, to enhance customer satisfaction by meeting customer requirements. For an organization to function effectively, it has to determine and manage numerous linked activities. An activity or set of activities using resources, and managed in order to enable the transformation of inputs into outputs, can be considered as a process. Often the output from one process directly forms the input to the next.

AS/NZS 4801:2001

Occupational health and safety management systems – Specification with guidance for use

The objective of this Standard is to set auditable criteria for an occupational health and safety management system. The Standard is a specification that aims to encompass the best elements of such systems already widely used in Australia and New Zealand.

AS/NZS 4020:2005

Testing of products for use in contact with drinking water

This Standard specifies requirements for the suitability of products for use in contact with drinking water, with regard to their effect on the quality of water. These products include all items such as pipes, fittings, components, and materials used in coating, protection, lining, jointing, sealing and lubrication applications in the water supply and plumbing industry. Chemicals and media used directly for treating raw water to provide a suitable drinking water supply (e.g. lime, coagulants, activated carbon, ion-exchange resins) are not covered by this Standard.

Head Office
2nd Level, Mitchell Centre, 55 Mitchell Street, Darwin NT 0800, GPO Box 1921, Darwin NT 0801

Customer Service Office
Ground Floor, Mitchell Centre, Monday – Friday (except public holidays) 8.00am – 4.30pm
Saturday 9.00am – 12.00pm

Call 1800 245 092 | ABN 15 947 352 360 | www.powerwater.com.au