POWER AND WATER CORPORATION

DRINKING WATER QUALITY ANNUAL REPORT 2011





PowerWater

WE VALUE SAFETY
INTEGRITY
TEAMWORK
COMMITMENT
COMMUNICATION

CONTENTS

FROM THE MANAGING DIRECTOR

Power and Water plays an important role in ensuring the safe and sustainable supply of good quality drinking water for Territorians.

We deliver water to customers across the 1.3 million 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 that are more than 10,000 years old 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.

These improvements include the installation of a second chlorination unit at Ti Tree, providing valuable backup to the 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 2010-11. However, as our communities continue to grow and change, the 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 was completed in readiness for the 2010-11 Wet Season. 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 in the years to come.

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

We 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

The *Australian Drinking Water Guidelines* (the 2004 ADWG) are the primary reference on drinking water quality in Australia. These Guidelines 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.

A draft of the ADWG was released in 2009 and the NHMRC issued revised sections in draft form for public comment. The comment period closed on 15 January 2010. During the course of writing this report the new ADWG were released on 28 October 2011. In response this annual report has been extended to address changes to the Guidelines specifically the increased emphasis on multiple barriers and assessment of their performance.

ABOVE > DARWIN RIVER DAM SPILLWAY IN FLOOD AFTER CYCLONE CARLOS FEBRUARY 2011.

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

Department of Health (DoH) has a key role in applying the 2004 ADWG and monitors compliance against them in the interest of public health. During 2010 11, collaborative work continued between Power and Water and DoH on a *Memorandum of Understanding for Drinking Water (MoU)*. The MoU seeks to define the roles, responsibilities, and obligations of both organisations with the aim of improving drinking water quality management. The MoU was approved in July 2011.

ABOVE > MANTON RIVER RESERVOIR FROM DARWIN RIVER RESERVOIR

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 in its laboratories in Darwin and Alice Springs.

The Department of Construction and Infrastructure (DCI) also 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 Monitoring Program and report the results to the Chief Health Officer, DoH.
- 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.

In May 2011 a review of the policy was initiated. This will be completed in the first half of 2011 12.

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.

This year Garawa, a town camp of Borroloola, is included in this report. While the Mabunji Aboriginal Resource Centre is the custodian of the Garawa water supply infrastructure it is operated by Power and Water's Essential Services Officer (ESO) based at Borroloola. The Borroloola ESO also collects routine water samples from the Garawa supply. To assist the Mabunji Aboriginal Resource Centre Power and Water monitors Garawa potable water quality by appending it to the Borroloola water quality monitoring program.

TABLE 1: SUMMARY OF EXISTING DRINKING WATER SOURCES IN MAJOR AND MINOR CENTRES

Centre[1]	Source
Adelaide River	Ground water
Alice Springs	Ground water (Roe Creek borefield)
Batchelor	Ground water
Borroloola[2]	Ground water
Cox Peninsula	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

[1] With local names where in common use.

[2] The water source for the Borroloola town camp Garawa is groundwater and is separate from the Borroloola source.

WATER SOURCES

The primary water source for centres across the Northern Territory is ground water. Exceptions are Darwin, Katherine and Pine Creek which also access surface water. Table 1 lists existing water sources for major and minor centres in 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 permitted within the catchment. The reservoir is drawn down through the year with the majority of use in the Dry Season (May to October) with subsequent recharging 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.

RAISING THE DARWIN RIVER DAM FULL SUPPLY LEVEL (EMBANKMENT AND SPILLWAY WORKS)

A major project completed in 2010-11 increased the capacity of Darwin River Reservoir by approximately 17 per cent. The spillway was reinforced and raised by approximately 1.3 metres. A prolonged Wet Season and record-breaking rainfall from Cyclone Carlos caused the newly raised dam to spill for the first time on 16 February 2011.

In a period of five days, the dam rose from 85 per cent of capacity to 106 per cent of capacity. At this level peak discharge was approximately 11,000 mega litres per day or 25 per cent of annual consumption. A special investigation is currently operating to assess the impact of this project on water quality (refer page 18).

Investigations into the use of Manton River Reservoir as an additional permanent water supply for Darwin began in 2007-08.

Power and Water instigated the bathometric measurement and modelling of Manton Dam Reservoir and is currently investigating "in reservoir" strategies for the improvement of water quality. This work continued through 2010-11.

Power and Water has developed a semi-quantitative risk assessment method to identify and rank water quality hazards posing risks to Territory water supplies. This assessment is based on water quality measurements of health and aesthetic parameters taken in all centres from 2006 to 2011 and generates a score for each centre. This score enables them to be ranked according to the scale of the risks and this information is used to allocate resources to improve water quality. The assessment is presented in Section 12 - Review and continual improvement (refer page 22).

The multiple barrier approach is universally recognised as the foundation for ensuring safe drinking water

3. PREVENTATIVE STRATEGIES FOR DRINKING WATER SUPPLY

Hazards may occur or be introduced throughout the water system and preventive measures as well as the activities and processes used to control hazards should be comprehensive and have the capacity to prevent hazards or reduce them to acceptable levels from catchment to consumer.

Preventive measures should focus on catchments rather than rely on downstream processes. The extent of water treatment required is determined by the effectiveness and robustness of the measures implemented to protect the water source. The significance of the protection of water sources cannot be overstated.

Identification and implementation of preventive measures requires consideration of the important principle of the multiple barrier approach. Many preventive measures may control more than one hazard and some hazards may require more than one preventive measure for effective control. The drinking water system must have, and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the water supply. The types of barriers required and the range of preventive measures employed will be different for each water supply and determined by characteristics of the source water and surrounding catchment.

It is important to appreciate the barriers that comprise a multi-barrier system are not restricted to physical barriers. A barrier may be comprised of several components including:

- physical structures;
- processes (which include maintenance);
- policies;
- engagement/agreement with stakeholders;
- legislation/ regulation; and
- assessment (to determine effectiveness)

Power and Water has adopted the multiple barrier principle to protect drinking water supplies. The strength of the multiple barrier approach is that a failure of one barrier may be compensated for by the remaining barriers, minimising the likelihood of contaminants passing through the entire treatment system. The multiple barrier approach is universally recognised as the foundation for ensuring safe drinking water. The placement of barriers in a conventional multiple barrier system is shown in figure 2 below.

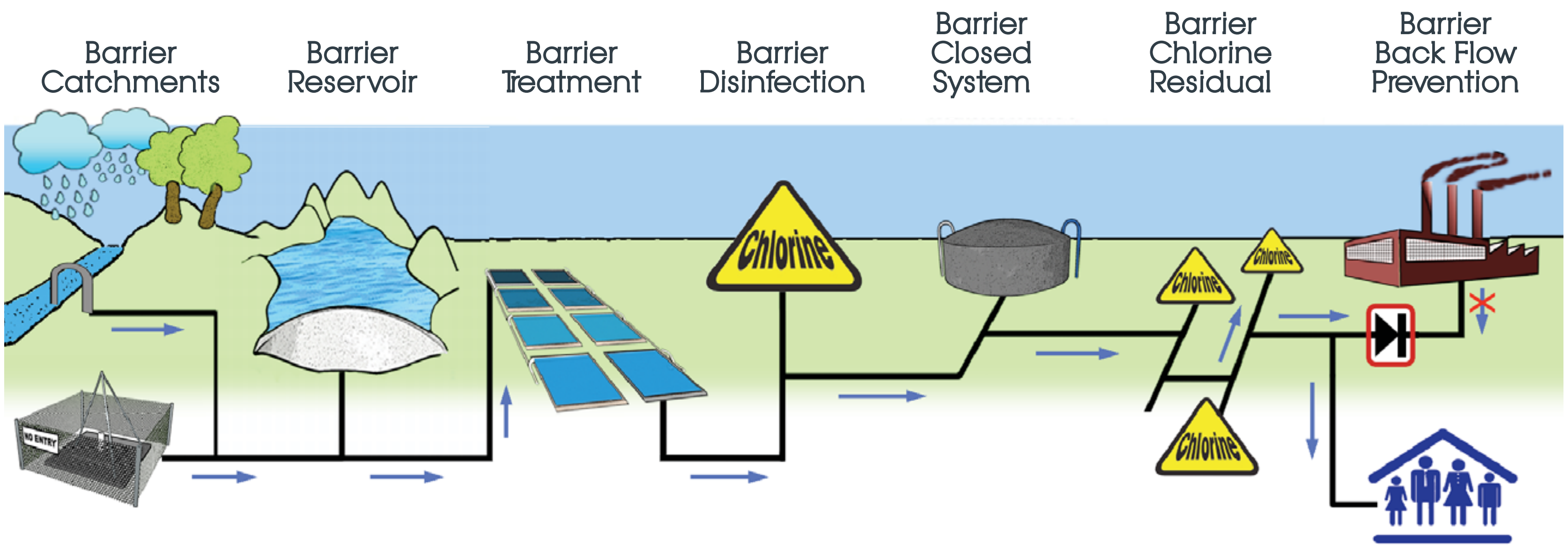
Microbial pathogens represent the most pervasive and consistent proven risk to drinking water safety. A drinking water supply that is not explicitly and effectively secured from potential pathogen contamination is inherently unsafe. Because pathogens are efficiently disseminated via drinking water throughout a community, effective public health protection must involve more than one barrier to disease transmission by this route.

Pathogens have the potential to enter a water supply at almost any point within the system, therefore barriers need to be present at all vulnerable sections of the water supply system. These barriers need to be robust to withstand the inevitable vagaries of human error and the challenges presented by nature and circumstance.

In most water supply systems the majority of barriers are placed to protect against microbial contamination.

Table 2 summarizes the multiple barriers in place in major and minor centres to mitigate hazards and ensure the supply of safe drinking water.

FIGURE 2: MULTIPLE BARRIERS AGAINST PATHOGENIC AND CHEMICAL HAZARDS



Barrier	Water Quality Management Objective	Examples of hazards
Catchments	Minimise introduction of hazards into source water	Examples of hazards: • Hydrocarbons • Iron and Manganese
Reservoir	Minimise introduction of hazards and remove some hazards	Examples of hazards: • Hydrocarbons • Iron and Manganese
Treatment	Remove most hazards	Examples of hazards: • Iron • Pathogens • Turbidity
Disinfection	Neutralise microbiological hazards	Example of hazards: • Pathogens
Closed System	Prevent introduction of hazards	Example of hazards: • Pathogens
Chlorine Residual	Neutralise microbiological hazards througout systems	Example of hazards: • Pathogens
Back Flow Prevention	Prevent introduction of hazards	Examples: • Pathogens • Chemicals

Adapted from original diagram by SA Water

TABLE 2: WATER QUALITY BARRIERS IN MAJOR AND MINOR CENTRES

Centres	Catchment protection	Detention in reservoirs and aquifers	Bore head protection Zone	Bore head integrity	Coagulation, filtration or membrane filtration	Disinfection	Storage tank integrity and cleaning	Maintenance of positive pressure in reticulation	Back-flow prevention in reticulation	Disinfection residual to customer's meter
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										

KEY

Presence of Water Quality Barrier

Absence of Water Quality Barrier

4. OPERATIONAL PROCEDURES AND PROCESS CONTROL

Power and Water has documented procedures in place 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.

Power and Water's systems and processes are based on International Standards Organisation (ISO) standards Environment (AS/ NZS ISO 14001:2004), Quality (AS/NZS ISO 9001:2008) and Occupational Health and Safety (AS/ NZS 4801:2001). Power and Water continues to routinely review and enhance its systems and processes in accordance with Power and Water's commitment to continual improvement.

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.

To support the MoU between DoH and Power and Water Corporation for the management of drinking water quality, Power and Water are continuing to develop the *Protocol for the Notification of Drinking Water Quality and Supply Reportable Incidents and Events*. This Protocol will ensure relevant persons are notified promptly of water quality incidents and events through a structured and coordinated response.

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

Corrective 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* or other relevant standards.

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 the site of manufacture of the chemical must be certified to ISO 9001.

5. VERIFICATION OF DRINKING WATER QUALITY

WATER QUALITY MONITORING

Power and Water designed and implemented a 12 month monitoring program for the year 2010-11, which was submitted for approval to DoH in May 2010.

Power and Water's *Drinking Water Monitoring Program 2010-11* is used to verify the effectiveness of water quality management strategies. The program is based on the 2004 ADWG's recommendations, however, knowledge of specific water quality issues for a water supply may require an increase in monitoring frequency or monitoring of additional parameters.

Microbiological samples are collected from locations closer to the point of supply to the customer, typically from within the reticulation system (e.g. from fire hydrants) or at customers' taps. Physical, chemical and radiological properties are generally subject to less variation. As a consequence, physical and chemical samples are generally collected from locations post-treatment while radiological samples are normally collected at sources.

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 therefore 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 and 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, therefore indicator organisms are used to determine if contamination with faecal material has 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 requires 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 2010-11 (refer page 28).

The 2004 ADWG recommend an action level of two *N. fowleri* organisms per litre in the treated water system.

The 2004 ADWG also 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 has not been implemented.

During the 2010-11 monitoring period *N. fowleri* was detected in the Darwin supply. Details are presented on page 27.

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. Monitoring was continued during 2010-11 (refer page 29).

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.

The potential risk to human health increases as the levels of chemical and physical parameters increase. Monitoring by Power and Water

ABOVE > DARWIN RIVER RESERVOIR IN FLOOD FEBRUARY 2011

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. The results of this monitoring is presented in the appendices tables A3 and A4 pages 38-41.

RADIONUCLIDES

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 (DoH) to determine the frequency of ongoing sampling (Primary response level); and
- If the total annual dose exceeds 1.0 mSv intervention is required. Power and Water and DoH should assess the results and examine options to reduce the levels of exposure (Secondary response level).

Details of the radiological assessment are reported on page 29.

DISINFECTION BY-PRODUCTS

Chlorine introduced into a water supply as a disinfectant reacts with naturally occurring organic matter such as decaying leaves and other vegetation to produce several by-products of disinfection, primarily trihalomethanes (THMs).

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

All major and minor centres were monitored for THMs in 2010-11 as part of the *Drinking Water Monitoring Program*.

PESTICIDES

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

Results from the pesticide monitoring program from 2007-10 revealed that 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 2010-11 was restricted to Darwin and Katherine supplies. The results for all samples from these supplies were below the level of detection.

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. Results for the annual assessment of aesthetic parameters are shown in tables A3 and A4 pages 38-41.

6. INCIDENT AND EMERGENCY RESPONSE

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

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

Emergencies and incidents during 2010-11 year are reported on page 35.

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 schedules. Training is continually monitored to ensure staff knowledge and skills are current.

TRAINING TO NATIONAL STANDARDS

The Power and Water Corporation is committed to gaining industry training to either Certificate III or IV for all the Water Operators. Certificates III and IV in Water Operations provide training for operators in the water industry and the opportunity for specialisations in water treatment, wastewater treatment, water supply distribution (network), trade waste, catchment operations, irrigation, dams safety, dams operations and source protection, river groundwater diversions and licensing, and construction and maintenance.

OHS CONSTRUCTION INDUCTION WHITE CARD 'WORK SAFELY IN THE CONSTRUCTION INDUSTRY'

The *Northern Territory Code of Practice for Induction for Construction Work* commenced as an approved Code of Practice in the Northern Territory on 31 October 2009. Power and Water has a legal obligation under the *NT Workplace Health and Safety Act* for the health and safety of its employees as well as contractors performing works at its various work sites. Power and Water initiated the identification and training of all relevant employees in relation to this legislative requirement and set an initial completion date for 1 September 2010. The majority of Power and Water's Water Services staff completed this requirement in the 2010-11 reporting period.

WATER SERVICES ESSENTIAL SERVICE OPERATOR (ESO) TRAINING COURSE

Training course was held in Katherine for the Katherine Region ESOs in November 2010. The course focused primarily on chlorine awareness, dosing system checks and chlorine measurement, safety and water quality.

In April 2011 the Water Industry Operators Association presented a seminar to Power and Water's Water Services' staff titled *Water Quality Awareness and Distribution System Management*. Valuable knowledge was shared with Water Service's staff and the concept of disinfection performance assessment presented in this seminar has been adopted by the Power and Water's Water Quality Section and will be the subject of an investigation over the next 12 months.

FIGURE 3

AN EXAMPLE OF A TYPICAL NEWSPAPER ADVERTISEMENT INFORMING CUSTOMERS OF WATER QUALITY ISSUES

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; and
- 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 unauthorized 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.

In Darwin advertisements are placed to inform customers of predicted seasonal water quality changes that may produce discoloured water. In Tennant Creek advertisements are placed to notify customers that risks identified during routine monitoring are to be remediated by manual dosing of the supply with chlorine.

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 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 2010-11.

MANTON RIVER RESERVOIR RETURN TO SERVICE

This is an internal Power and Water project.

During 2010-11 Power and Water continued to investigate seasonal water quality trends in Manton River 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 River 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.

DARWIN RIVER RESERVOIR MONITORING PROGRAM

In 2010 Power and Water increased the level of the spillway at the dam by 1.3 metres with a resultant increase in its capacity of approximately 17 per cent and its surface area of 20 per cent. The increase in surface area constitutes a significant inundation of surrounding vegetation with obvious potential water quality issues. Following unprecedented rainfall in early 2011, Darwin River Reservoir filled to the new capacity shortly after completion of the infrastructure, elevating the risks to water quality.

ABOVE > DOWNSTREAM FROM DARWIN RIVER DAM OVERFLOW

This project is a 12 month limnological monitoring program to assess any changes in Darwin River Reservoir that might impair water quality in the supply source due to the increase in the spillway height.

Water quality parameters may include but have not been confined to:

- colour;
- turbidity;
- iron and manganese;
- changes in the seasonal concentrations and ratios of nutrients;
- algal biomass of dominant groups including *Botryococcus braunii;* and
- aquatic and terrestrial weeds specifically *Olive hymenachne* and *Mimosa pigra*.

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.

This project will:

- Identify changes in distributions of cyanobacterial species since 1991 in order to support an up-to-date risk assessment and help predict future trends in species distribution and changes in toxicity;
- Cross-validate a range of analytical methods for detection of toxic species and toxin production; and
- Develop a compendium of national data on cyanobacterial species and strain distribution, linking water quality parameters, toxicity, morphology and genetic characterisation to support current risk assessment and future climate change studies.

Project outcomes:

- Within two years, produce up-to-date data on toxic cyanobacterial species and strain distributions in Australia;
- During the project, provide a series of reports to individual industry partners on their specific risk profiles from toxic cyanobacteria;
- At the end of the project (two years) report on the changes that have occurred in the Murray-Darling Basin since 1991, with trend analysis to support conclusions about future changes due to climate change; and
- Extrapolation of conclusions to the national level where possible, and to the local level when project findings can be integrated to historical monitoring data.

This project concludes December 2011.

10. DOCUMENTATION AND REPORTING

The majority of Power and Water's documentation and records are 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 Power and Water'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.

The evaluation of replacement systems for the current FIS and Work Information Management System (WIMS) was completed by the Asset Management Capability Project steering committee last financial year. IBM was announced as the successful tenderer in September 2009. IBM Maximo Asset Management and ESRI will replace the current WIMS and FIS applications. Development and testing was undertaken during 2010 11 with implementation planned for the 2011 12 year.

The Asset Management Capability Project is critical to Power and Water to ensure:

- There is a consistent approach to managing assets;
- Data is accurate, complete and regularly updated;
- The current outdated and inflexible systems WIMS and FIS are replaced; and
- Greater focus on maintenance planning and reporting is needed.

ABOVE > NEWLY RAISED SPILLWAY AT DARWIN RIVER DAM 2011

Maximo will enable customer service to systematically record customer queries and complaints. Power and Water's Water Quality Section has constructed call scripts that will ensure correct categorisation of complaints received from customers and simplify the collation of this data in preparation for the submission to the *National Performance Report* (NPR).

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 National Water Commission and the information provided forms part of the *National Performance Report* (NPR) and affords the Northern Territory and Australian public with a reliable and transparent source of information on urban water utilities.

Power and Water's *Annual Drinking Water Quality Report 2011* provides an objective account of the quality of Northern Territory potable water supplied to consumers, regulatory bodies and stakeholders.

The intrinsic relationship between potable water and public health means Power and Water and DoH 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 DoH 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 *Annual Drinking Water Quality Report 2011* 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 six monthly independent external audits. The 2011 audit was conducted in May by SAI Global.

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

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.

In early 2011 a new position of Water Quality Information Management Officer (WQIMO) was recruited to the Water Quality Section, This position is to ensure water quality results from laboratories are scrutinized prior to transfer into the database. The WQIMO also reports on the execution of the monitoring program by documenting sample collections and submissions, significantly reducing sample collection failures.

The WQIMO is also responsible for the development of the *Water Quality Monitoring Data Management Manual*.

This manual outlines the process required for validating water quality data for entry into the water quality database. Validation of data is a key aspect of quality management ensuring accuracy and constancy of records.

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. The network group met in Adelaide in April 2011 and was attended by Water Services' staff.

The topics addressed at the meeting were:

- Specific water quality challenges to each water utility;
- Aquality – Elements 10, 11 and 12 of the 2004 ADWG;
- Case studies of water quality incidents;
- Delivery of major projects addressing water quality issues.

REVIEW OF DRINKING WATER QUALITY SYSTEM

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

MICROBIOLOGICAL WATER QUALITY

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 therefore is monitored more frequently to ensure system security.

A referendum held on Saturday, 29 May 2004 in Tennant Creek resulted in a strong community rejection of chlorination as a means of disinfecting the drinking water (75% against, 25% for).

Power and Water maintains that continuous chlorination is the preferred method to disinfect drinking water and that without it there exists an elevated and unnecessary level of risk to public health which must be accepted. However, Power and Water respects that the people of Tennant Creek have voiced their opinion strongly against chlorination.

A significant improvement in Tennant Creek microbiological water quality was reported for the 2010-11 period with more than 98% of programmed samples free from *E. coli*. However, failures due to *E. coli* are still remediated by manual dosing storage tank water with sodium hypochlorite and flushing the reticulation system. This approach is not an appropriate long term solution and does not improve long term protection of the water supply for the community of Tennant Creek.

Power and Water continues to work with DoH to review disinfection practice in Tennant Creek and routinely publishes a monthly public notice highlighting manual chlorine dosing practice.

MICROBIOLOGICAL RISKS

N. fowleri presents a significant health risk to consumers. To control this risk, Power and Water has set a minimum free chlorine residual of 0.5 mg/L to be maintained in all supplies at all times. The effectiveness of this control can be assessed by monitoring the free chlorine residual and recording all incidents where the free chlorine residual falls below 0.5 mg/L. In a water supply the ability to maintain a free chlorine residual above 0.5 mg/L is a direct measure of the ability to control the *N. fowleri* risk in that supply.

Maintaining a minimum free chlorine residual of 0.5 mg/L has the inevitable consequence that the free chlorine level will frequently exceed the aesthetic guideline value of 0.6 mg/L. Free chlorine has therefore been excluded as an aesthetic parameter in the risk assessment.

Although Tennant Creek has no significant chemical, physical or radiological risk factors, the greatest risk to this water supply is microbiological as this supply does not have continuous chlorination. Power and Water continues to work with DoH to review management of microbiological risks and is considering the introduction of an Ultra Violet disinfection system.

INFRASTRUCTURE DEVELOPMENT

Power and Water completed the refurbishment of the Katherine water treatment plant sand filters in March 2011. This project included the replacement of filter sand and nozzles, structural repairs, and replacement of auxiliary equipment. The project was undertaken to improve the plant's efficiency including improvements in water quality.

The drilling of a new borefield at Elliott was completed in July 2010 providing four new production bores. Septic systems located within the protection zone of the original borefield are believed to be the primary cause of microbiological water quality failures in the Elliott supply. This new water source also addresses the issues of elevated hardness and iodide in the original source. These bores are scheduled to be brought online in 2012.

Elevated levels of iron and manganese in the Adelaide River water supply often exceed the 2004 ADWG aesthetic value. Customer complaints relating to discoloured water, in particular staining of laundry, increased during the 2010-11 period. The current system employed to minimise this problem is sequestration of the iron and manganese with sodium silicate. The aim has been to prevent the iron and manganese precipitating out of the water at the consumer's tap. As the sequestration of iron and manganese has only been partly effective, Power and Water has commissioned a consultant to design a water treatment plant for the Adelaide River supply that will remove the iron and manganese before water enters the distribution system. Construction should commence in the second half of 2012.

Infrastructure improvements to the Tennant Creek water supply were completed in 2010-11.

To allow repairs and routine cleaning of the Cabbage Gum ground level tank the decommissioned elevated tank was replaced. As part of the same project new pumps were installed at Cabbage Gum to supply the distribution tanks. Inlet and outlet pipe work on the distribution tanks was upgraded to improve displacement of water through the tanks. Modifications to the tank pipe work included connection points for the anticipated installation of a UV disinfection system.

CHEMICAL, PHYSICAL AND RADIOLOGICAL RELATIVE 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.

Power and Water combines likelihood and consequences to assess risk. The likelihood of a parameter resulting in a problem is assumed to be proportional to the ratio of the annual assessed value to the 2004 ADWG value. That is, where the annual assessed 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 the DoH's predecessor 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 value 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. The percentile is a value calculated from a set of measurements. The percentile dictates what percentage of all the measurements are below this value. The 95th percentile is the value below which 95 per cent of the measurements are found.

If a valid 95th percentile is not available the maximum value is used. The total risk value for each water supply is compared to the total risk value of all other water supplies. The results are then compiled to rank water supplies according to the scale of the risks from highest to lowest.

This method 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 3 shows Kings Canyon, and Timber Creek have the highest risk scores.

The primary water quality issue for Kings Canyon is iodide which is greater than four times the 2004 ADWG value. In the 2011 ADWG, the health guideline value for iodide has been raised from 0.1 mg/L to 0.5 mg/L. In this report, the 2010-11 ADWQR, the level of iodide reported for the Kings Canyon's water supply is 0.43 mg/L. Although this level exceeds the 2004 ADWG value it would not exceed 2011 ADWG value.

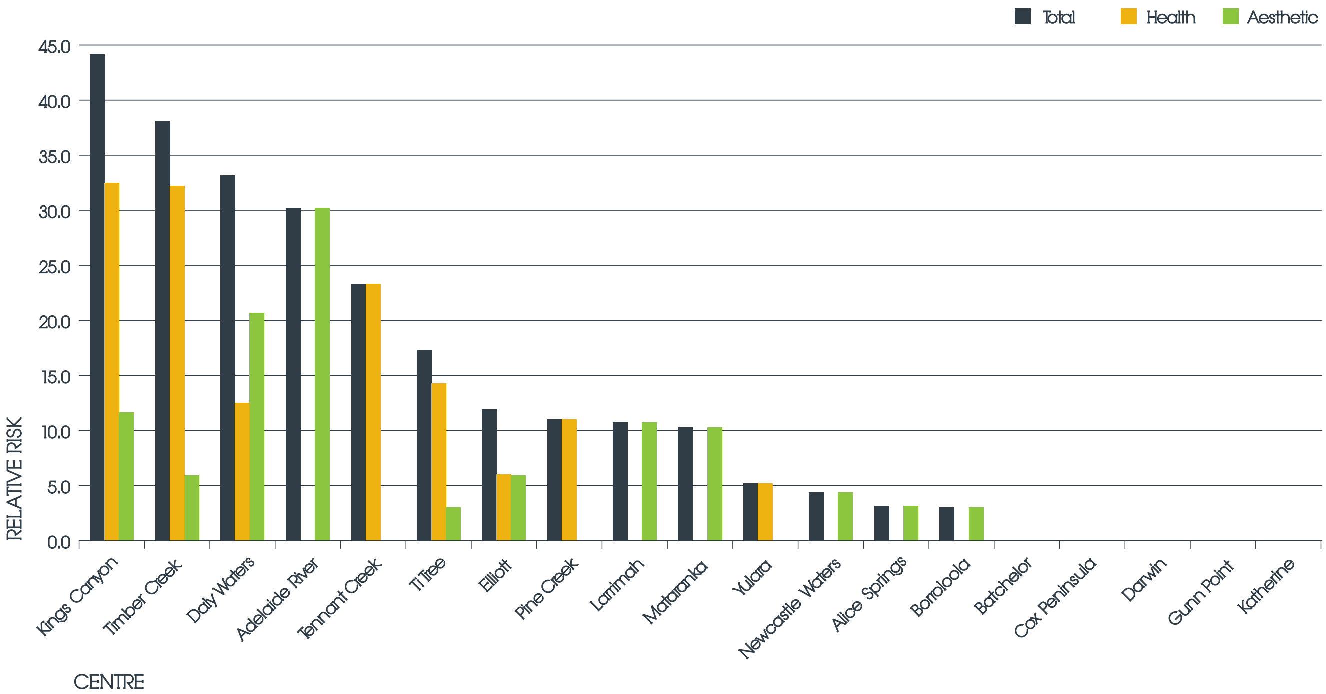
Five other of the 19 water supplies have slightly elevated levels of iodide.

The primary water quality issues for Timber Creek are barium and lead which are approximately twice 2004 ADWG value.

TABLE 3: RELATIVE RISK SCORING FOR ALL WATER SUPPLIES 2010-11

Rank	Centre	Relative Risk Score	Parameters Exceeding 2004 ADWG and DoH TDS Value 2010 11
1	Kings Canyon	44.1	Chloride, Hardness, Iodide, Lead, TDS
2	Timber Creek	38.1	Barium, Lead, Hardness
3	Daly Waters	33.2	Chloride, Hardness, Iodide, Sodium, TDS
4	Adelaide River	30.2	Chloride, Hardness, Sodium, TDS, Iodide
5	Tennant Creek	23.3	Fluoride, Iodide
6	Ti Tree	17.3	Hardness, Iodide, Nitrate
7	Elliott	11.9	Hardness, Iodide,
8	Pine Creek	11.0	Arsenic,
9	Larrimah	10.7	Hardness, TDS
10	Mataranka	10.3	Hardness, TDS
11	Yulara	5.2	Nitrate
12	Newcastle Waters	4.4	Hardness
13	Alice Springs	3.2	Hardness
14	Borroloola	3.0	pH
15	Batchelor	0.0	None
16	Cox Peninsula	0.0	None
17	Darwin	0.0	None
18	Gunn Point	0.0	None
19	Katherine	0.0	None

FIGURE 4: RELATIVE RISK SCORES SHOWING CONTRIBUTING PROPORTIONS FROM HEALTH AND AESTHETIC PARAMETERS FOR 2010-11



SECTION B: DRINKING WATER QUALITY AND PERFORMANCE

MICROBIOLOGICAL RESULTS SUMMARY

BACTERIA

MICROBIOLOGICAL MONITORING OBJECTIVE

Microbiological monitoring under the risk management approach is used for operational purposes and as a final check to verify water quality. Tests of microbial quality are a valuable adjunct to assessing source water protection, treatment, and the integrity of the barriers through to the consumer's tap. Monitoring of drinking water quality should be regarded as the final check that the barriers and preventive measures implemented to protect public health are working effectively.

Disinfection with chlorine provides a major barrier against microbiological hazards. The condition of this barrier can be determined by measurement of chlorine residuals however this is not an assessment of the effectiveness of the barrier. Microbial indicators can be used for verifying the effectiveness of disinfection, treatment and for assessing system cleanliness.

MONITORING PROGRAM

Verification or compliance monitoring is performed routinely but less frequently than operational monitoring. Where operational monitoring provides information to maintain a treatment within defined parameters, verification monitoring is performed deeper into the distribution system to determine the quality of water received by consumers. The possibility for water quality to diminish increases the further into the distribution system it travels. A treatment system may be operating within required parameters but this is not a guarantee that quality can be maintained to the farthest points of the distribution system at all times. Occasionally unsatisfactory water quality is recorded.

Whether from a supply breach or loss of adequate disinfection, undesirable microorganisms in water can be delivered to consumers. Ideally verification monitoring will identify such failures.

LIMITATIONS OF MONITORING

Power and Water's *Drinking Water Monitoring Program 2010-11* requires that samples are representative of the quality of water supplied to consumers be collected and analysed for *E. coli* at a minimum frequency determined by the population served by the supply. The results from this monitoring provide an appraisal of the status and effectiveness of the disinfection system and in the extreme case whether this barrier has been compromised. The confidence provided by this appraisal diminishes as the number of samples collected decrease and every time *E. coli* is detected.

Although the objective of disinfection is to eradicate microorganisms, it is unrealistic to expect results from a monitoring program to show a water supply system to have zero indicator bacteria at all times. It is common in most water supplies that:

- at times *E. coli* maybe detected and remedial action required;
- there is no absolute certainty disinfection is 100 per cent effective; and
- human error may result in sample collection and laboratory mistakes.

The complete absence of *E. coli* detections in any water supply system is an unreasonable expectation. The 2004 ADWG allows one failure (*E. coli* detection) in 50 samples or that 98 per cent of samples contain no *E. coli*.

COMPLIANCE PERFORMANCE

Performance can be regarded as satisfactory if over the preceding 12 months:

- at least the minimum number of programmed samples have been tested for *E. coli*;
- samples tested are representative of the quality of water supplied to consumers; and
- at least 98 per cent of programmed samples contain no *E. coli* (excludes repeat or special purpose samples).

Figure 5 shows for 2010-11 all major centres achieved the 98 per cent *E. coli* free target.

Tennant Creek was the only major centre to record *E. coli* detections but was able to comply with the target.

FIGURE 5

PERCENTAGE OF SAMPLES TAKEN IN MAJOR CENTRES IN WHICH NO *E. COLI* WERE DETECTED FROM 2007-11

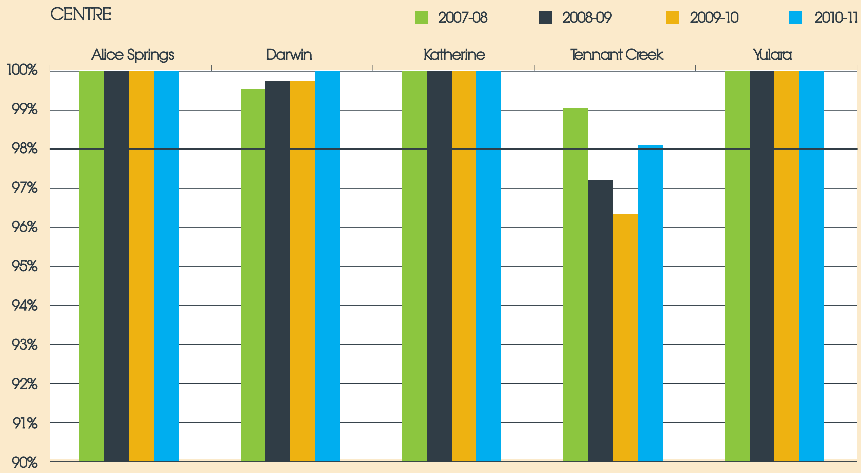
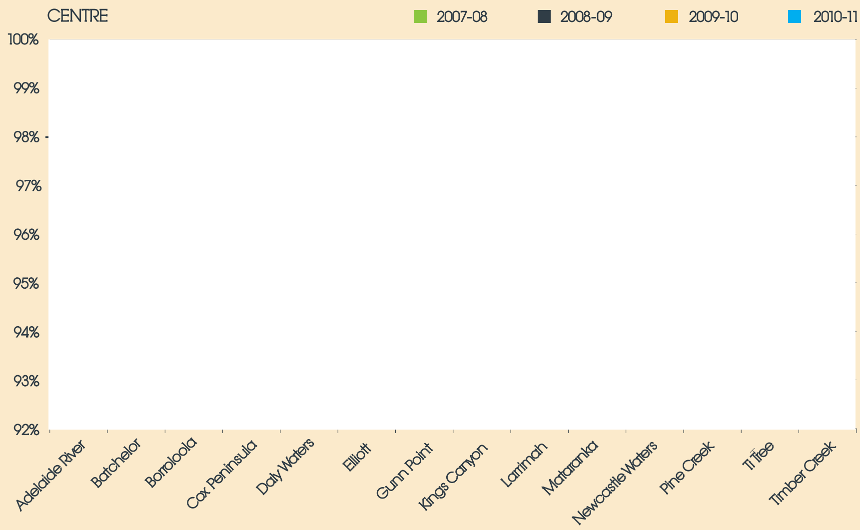


Figure 6 presents results for all the minor centres in the Northern Territory 2010-11. *E. coli* was detected in Cox Peninsula, Elliott and Newcastle Waters water supplies. Elliott and Newcastle Waters failed to meet the 98 per cent *E. coli* free target.

FIGURE 6

PERCENTAGE OF SAMPLES TAKEN IN MINOR CENTRES IN WHICH NO *E. COLI* WERE DETECTED FROM 2007-11



MONITORING PERFORMANCE

The Power and Water's *Drinking Water Monitoring Program 2010-11* scheduled 1448 drinking water samples to be collected for bacteriological assessment from 19 centres across the Northern Territory. The collection and assessment of all programmed samples was not achieved. Bad weather, communication failure and logistical issues contributed to only 98.3 per cent of these samples being collected. Some centres were more successful than others. Detail of the performance of individual centres is presented in Appendices tables A1 and A2. (refer pages 36-37)

NAEGLERIA FOWLERI

Since the initial detection of *N. fowleri* in the Darwin distribution system in 2005, Power and Water have undertaken extensive monitoring of water supplies and implemented procedures to control this amoeba.

Providing a chlorine residual throughout the distribution system can provide protection against contamination and limit the regrowth of *N. fowleri*. Free chlorine at 0.5 mg/L or higher will control *N. fowleri*, provided the disinfectant persists at that concentration throughout the water supply system. Power and Water now require all continuously chlorinated water supplies to maintain a minimum free chlorine residual, throughout the entire supply, not less than 0.5 mg/L.

The effectiveness of chlorine to control the growth of *N. fowleri* is better understood when comparisons can be made between non-chlorinated (source) waters and chlorinated (distribution system) water. For the 2010-11 period a total of 563 routine samples were collected from water supplies across the Territory. The program included samples from source waters and distribution systems. Special investigations were instigated during tank cleaning in Darwin. Samples of sediment and water were collected from several storage tanks in the Darwin distribution system.

Table 4 show the results from 2010-11 *N. fowleri* monitoring program.

N. fowleri was detected only in the Darwin distribution system. *N. fowleri* was detected on four occasions at the Manton Dam Park Tap sampling point. 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 distribution systems and sources monitored during the 2010-11 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. Naegleria spp other than *N. fowleri* were detected in the Darwin, Gunn Point and Tennant Creek distribution systems, and Darwin groundwater. Naegleria spp were not detected in surface waters.

Special investigations during sediment removal from six tanks in the Darwin distribution system found *N. fowleri* present in the sediment of four tanks. These results are reported in table 4. In response the cleaning of tanks was completed, dosed to 1 mg/L free chlorine and held off-line until laboratory results confirmed them to be clear of *N. fowleri*. Long term strategies to control *N. fowleri* in tanks include an increase in the frequency of tank cleaning to minimise sediment accumulation.

The Manton Dam Park Tap is the drinking water supply for visitors to Manton Dam. As this site is at the end of the distribution system and is used infrequently, the free chlorine residual is often inadequate. As a consequence there have been several detections of *N. fowleri* over the past few years. Power and Water has improved the free chlorine residual at this site by installing an automatic irrigation system which routinely draws water through the pipeline displacing chlorine depleted water.

TABLE 4: THERMOPHYLIC AMOEBA DETECTIONS, MONITORED SUPPLIES AND INVESTIGATION 2010-11

		POSITIVE SAMPLES									
Centre Routine Monitoring	**Samples collected**	**Amoebae* Total**	**Amoebae* Total (solids)**	**Acanthamoeba group III**	**Hartmannella**	**Willaertia magna**	**Naegleria sppTotal**	**Naegleria spp Total (solids)**	**Naegleria australiensis**	**Naegleria lovaniensis**	**Naegleria fowleri**
Alice Springs Distribution	3	0	N/A	0	0	0	0	N/A	0	0	0
Cox Peninsula Surface Water	8	0	N/A	0	0	0	0	N/A	0	0	0
Cox Peninsula Distribution	51	3	N/A	0	3	0	0	N/A	0	0	0
Darwin Distribution	208	54	N/A	1	54	0	11	N/A	1	10	4
Darwin Source Bores	10	2	N/A	0	1	0	1	N/A	0	1	0
Darwin Source Reservoir	12	1	N/A	0	1	0	0	N/A	0	0	0
Gunn Point Distribution	22	1	N/A	0	1	0	1	N/A	0	1	0
Katherine Distribution	28	0	N/A	0	0	0	0	N/A	0	0	0
Pine Creek Source Dam	2	0	N/A	0	0	0	0	N/A	0	0	0
Pine Creek Distribution	6	0	N/A	0	0	0	0	N/A	0	0	0
Tennant Creek Distribution	205	28	N/A	4	10	0	15	N/A	0	15	0
Yulara Distribution	6	0	N/A	0	0	0	0	N/A	0	0	0
Yulara Source Bores	2	0	N/A	0	0	0	0	N/A	0	0	0
TOTAL SAMPLES	**563**										
Investigation Monitoring											
Darwin Tank Sediments	8	0	7	1	4	3	3	2	0	1	5
Darwin Tank and Hydrant	7	3	N/A	1	2	1	0	N/A	0	0	0

*Amoeba detection refers to samples found to contain amoeba. No reference is made to the number of amoeba detected in samples.

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. Human infections have a high mortality rate. The latent phase between infection and disease can be extremely long, up to months or even years, and relapse is quite common. Other routes of transmission, specifically gastrointestinal, have not been confirmed. Despite its apparent ubiquity there have been few waterborne outbreaks.

Power and Water's Drinking Water Monitoring Program 2010-11 includes *B. pseudomallei* as an investigative and research activity. Initially monitoring sites and frequency were in response to the identification of clusters of melioidosis cases. During 2010-11 Power and Water worked closely with Menzies School of Health Research (MSHR) to identify water supplies likely to be at risk of colonisation by *B. pseudomallei*.

Recent research has confirmed an association between *B. pseudomallei* and bore water which has low salinity, high iron levels, low pH and low hardness. This finding aids in identifying water supplies at risk of contamination with this pathogenic bacterium. Borroloola source waters have pH values as low as 5.1, iron levels as high as 12.2 mg/L, very soft water with hardness measured as low as 4.5 mg/L ($CaCO_3$) and low salinity EC = 50μS/cm (2010-11 values) and was therefore considered vulnerable to *B. pseudomallei* colonization. Water samples collected from the Borroloola water supply were negative for *B. pseudomallei*.

Clinical literature documents infection by the inhalation of contaminated dust suggesting water supplies open to the environment are at risk. Components of the Katherine water treatment plant, particularly the aerator and reactivator, are uncovered, unsealed and therefore susceptible to dust. Samples were collected from points within the Katherine water treatment plant and distribution system. *B. pseudomallei* was detected in the treatment plant filter sand and treatment plant clarifier sludge but not in water leaving the treatment plant.

As the Tennant Creek water supply is a non-chlorinated supply it lacks a crucial barrier against bacterial contamination. Power and Water has continuously monitored this supply for the past five years. As in previous years *B. pseudomallei* was not detected in the Tennant Creek water supply in the 2010-11 monitoring period.

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

CHEMICAL AND PHYSICAL RESULTS SUMMARY

Health-related water quality parameters are reported as the 95th percentile. If data is limited values are reported as the maximum value. Aesthetic parameters are reported as an average as specified in the 2004 ADWG.

Details of the health and aesthetic parameters for each major and minor centre are shown in the Appendices tables A3 and A4. (refer pages 38-41)

RADIOLOGICAL

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 mSv/year.

To precisely calculate the annual radiological 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.

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).

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 described previously, this treatment of the assessment 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. 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.

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

When a water supply passes both the gross alpha and potassium-40 corrected gross beta screening assessment or, the estimated annual dose is below 0.5 mSv/year, sampling can be less frequent – every two years for groundwater supplies, every five years for surface water supplies.

All water supplies included in this report draw some, if not all water, from ground water sources. As radiological data from groundwater is valid for two years, supplies monitored during 2009-10 may not have been required to be monitored during 2010-11. The radiological results presented in this report therefore cover the period 2009-11.

Water from 12 minor centres and four major centres complied with the 2004 ADWG screening level, with radioactivity levels below 0.5 Bq/L. All 19 centres passed annual radiological assessment with no water supply exceeding the annual guideline limit of 1.0 mSv/year.

Water for the Borroloola town camp Garawa is drawn from ground water. This source was not assessed for radiological characteristics during the two year period leading up to this report.

Eleven bores supplying Alice Springs passed annual radiological assessment at the screening level.

Four bores exceeded either 0.5 Bq/L for gross alpha or 0.5 Bq/L for K-40 corrected gross beta. No bore exceeded the annual guideline limit of 1.0 mSv/year. The annual radiological dose is reported as 0.43 mSv/year, the maximum value measured in all of the 15 bores.

Kings Canyon's water supply has higher levels of radionuclides than other Northern Territory water supplies and is intensely monitored. Eighty one samples were collected from the Kings Canyon supply during 2010-11. Four of these samples exceeded the 1.0 mSv/year limit with the highest value, 1.24 mSv/year, recorded at the ground tank outlet. The annual radiological dose for the two year monitoring period is 0.99 mSv/year (95th percentile).

The annual radiological dose for Borroloola is calculated from a small data set. The gross alpha level of four samples was greater than 0.5 Bq/L and failed the screening level. The annual radiological dose for the Borroloola water supply is reported as 0.37 mSv/year the maximum value recorded.

Results for the radiological assessment of all supplies are shown in the Appendices tables A3 and A4. (refer pages 38-41)

TRIHALOMETHANES

THMs in Power and Water supplies were initially measured in 2002-03 to establish a baseline data set. 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 2004 ADWG level of 0.25 mg/L.

During the 2010-11 monitoring period all water supplies except Tennant Creek and Ti Tree were assessed for THMs.

The concentration of THMs for these water supplies ranged from <0.004 to 0.070 mg/L. Tennant Creek is not included in this assessment as it is not a continuously chlorinated supply.

Long term THM levels (2006-2011) are shown in the Appendices tables A3 and A4. (refer pages 38-41)

THMs in all water supplies remain at levels similar to those measured in previous years and appear to be stable.

The low levels of THMs measured in NT water supplies is due to the low level of total organic carbons (TOC), the precursors of THMs, in these waters. The highest levels of THMs

ABOVE > MEASURING CHLORINE RESIDUALS WITH A PORTABLE CHLORINE METER

are in 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 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) from 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 to three times a year as part of the mimosa control program.

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 2010-11 was restricted to Darwin and Katherine water supplies. These supplies are considered potentially vulnerable to pesticide contamination due to agricultural activities close to production bores and surface water sources. Results for all samples collected from these supplies were below the level of detection.

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 and reports them to the National Water Commission for publication, as do other Australian water utilities.

Table 5 shows the total number of water quality specific complaints received during 2010-11.

TABLE 5: WATER QUALITY COMPLAINTS 2006-2011

		Total Number of Complaints				
Centre	Properties (2010-11)	2006-07	2007-08	2008-09	2009-10	2010-11
Adelaide River	102[A]	DNA	DNA	1	1	3
Alice Springs	11510[B]	5	1	4	5	22
Darwin	50694[B]	147	373	355	123	134
Katherine	2163[A]	2	DNA	DNA	1	48
Tennant Creek	1237[A]	DNA	DNA	DNA	DNA	0
Total	**65706**	**154**	**374**	**360**	**130**	**207**
Complaints per 1000 properties (all NT)		2.44	6.13	5.77	2.44	3.15

[A] Properties based on number of meters
[B] As reported to NWC in 2010-11 NPR
DNA Data not available

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 subsequent 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.

Soluble iron and manganese entering the distribution system can be oxidized and precipitate out of solution creating discoloured water resulting in customer dissatisfaction and complaints. During the Wet Season, as water demand drops and flow rates are reduced, oxidised iron and manganese can settle out in the distribution system. At the beginning of the next Dry Season, as flows in the distribution system increase, the settled iron and manganese 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.

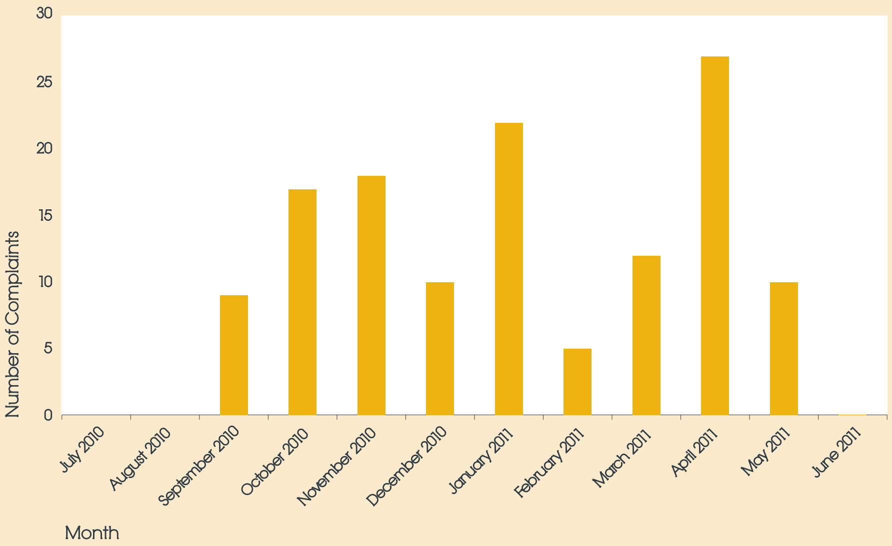
The frequency of drinking water complaints for the Darwin water supply during 2010-11 is shown in Figure 7.

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. If a customer reports discoloured water, Power and Water flushes the mains supplying the customer's residence.

In addition to this, water quality is monitored at a number of locations in the Darwin water supply to gauge the extent of discoloured water and determine when routine flushing is required.

FIGURE 7

NUMBER OF MONTHLY DRINKING WATER CUSTOMER COMPLAINTS FOR DARWIN 2010-11



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 8 shows a breakdown of customer complaints for 2010-11.

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 centres to improve monitoring across the entire network.

Objectionable tastes and odours can also 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 most commonly occurs after water mains repairs and 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.

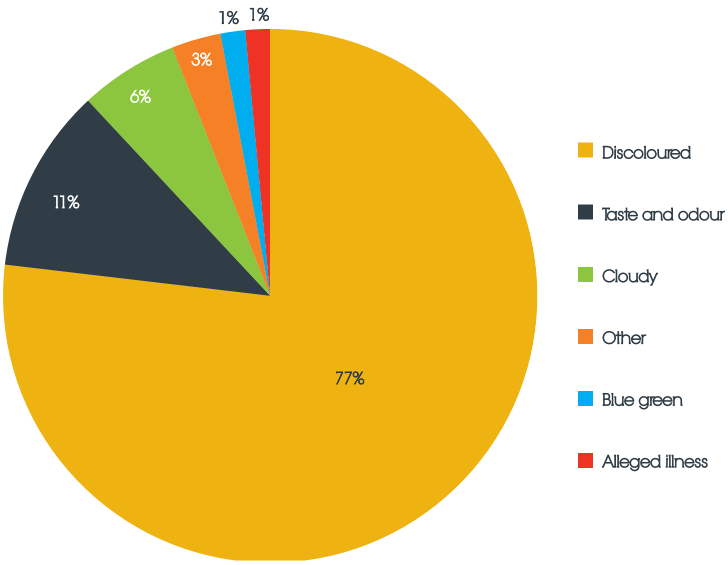
If there is doubt as to the cause of a water quality problem an investigation is carried out and, when necessary, water samples are taken and analysed.

As a response to the detection of *N. 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.

While Darwin water quality complaints remained the same as last year a marked increase from Alice Springs and Katherine were received. All complaints received in Katherine related to discoloured water on two distinct occasions each event lasting approximately one week. One event has been attributed to a sudden rise in chlorine concentration and the second to replacement of valves requiring excavation and cutting of major pipe work. Complaints received in Alice Springs related to discoloured and cloudy water and attributable to mains repairs.

FIGURE 8

BREAKDOWN OF CUSTOMER COMPLAINTS FOR DARWIN 2010-11 SHOWING MAJOR WATER QUALITY ISSUES



RECORDED EMERGENCIES/ INCIDENTS

No water quality emergencies were recorded in 2010-11. Continual investment in the upgrading of facilities and securing of systems has reduced risks and the potential for contamination or failure.

In the 2010-11 year there were five incidents in which *E. coli* was detected in water supplies:

Response to these incidents included manual chlorination of tanks, flushing of mains and re-sampling of the water supply as agreed with DoH. Water supplies were tested immediately following remedial action and all supples were negative for the presence of *E. coli*.

TABLE 6

E. COLI INCIDENTS 2010-11

Water Supply Centre	Samples with *E. coli* detected	Date of Detection	Number of *E. coli* in sample
Elliott[1]	2 samples	07/03/2011	3 and 6
Newcastle Waters	1 sample	09/05/2011	3
Tennant Creek	1 sample	17/01/2011	1
Tennant Creek	1 sample	28/03/2011	1

[1] Single incident

APPENDICES

TABLE A1: BACTERIOLOGICAL MONITORING IN MAJOR CENTRES 2010-11

Centre	Parameter (mpn/100 mL)	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% of samples	104	104	0	100.0
	Total Coliforms	<10 in 95% of samples	104	104	0	100.0
Darwin	*E. coli*	<1 in 98% of samples	468	**465**	0	100.0
	Total Coliforms	<10 in 95% of samples	468	**465**	0	100.0
Katherine	*E. coli*	<1 in 98% of samples	104	104	0	100.0
	Total Coliforms	<10 in 95% of samples	104	104	0	100.0
Tennant Creek	*E. coli*	<1 in 98% of samples	104	104	2	98.1
	Total Coliforms	<10 in 95% of samples	104	104	18	82.7
Yulara	*E. coli*	<1 in 98% of samples	52	52	0	100.0
	Total Coliforms	<10 in 95% of samples	52	52	0	100.0

*Numbers in bold indicate samples collected are less than the number specified in the monitoring program.

TABLE A2: BACTERIOLOGICAL MONITORING IN MINOR CENTRES 2010-11

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	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	0	100.0
Batchelor	*E. coli*	<1 in 98% of samples	52	52	0	100.0
	Total Coliforms	<10 in 95% of samples	52	52	2	96.1
Borroloola	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	0	100.0
Cox Peninsula	*E. coli*	<1 in 98% of samples	52	**51**	1	98.0
	Total Coliforms	<10 in 95% of samples	52	**51**	1	98.0
Daly Waters	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	2	91.7
Elliott	*E. coli*	<1 in 98% of samples	104	**91**	2	97.8
	Total Coliforms	<10 in 95% of samples	104	**91**	2	97.8
Garawa[1]	*E. coli*	<1 in 98% of samples	24	**18**	0	100.0
	Total Coliforms	<10 in 95% of samples	24	**18**	0	100.0
Gunn Point	*E. coli*	<1 in 98% of samples	12	22	0	100.0
	Total Coliforms	<10 in 95% of samples	12	22	0	100.0
Kings Canyon	*E. coli*	<1 in 98% of samples	104	**100**	0	100.0
	Total Coliforms	<10 in 95% of samples	104	**100**	0	100.0
Larrimah	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	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	1	95.8
Newcastle Waters	*E. coli*	<1 in 98% of samples	24	**23**	1	95.7
	Total Coliforms	<10 in 95% of samples	24	**23**	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	**20**	0	100.0
	Total Coliforms	<10 in 95% of samples	24	**20**	0	100.0
Timber Creek	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	1	95.8

[1] Although Garawa is not a Power and Water minor centre it is included in this table for convenience.

TABLE A3: HEALTH, AESTHETIC AND OTHER PARAMETERS IN MAJOR CENTRES 2010-11

Parameter/Centre	Guideline Value[1]	Units	Alice Springs	Darwin	Katherine	Tennant Creek	Yulara
HEALTH PARAMETERS - 95TH PERCENTILE VALUES							
Antimony	0.003	mg/L	0.0002	0.0002	0.0002	0.0002	0.0002
Arsenic	0.007	mg/L	0.0005	0.0005	0.0007	0.0026	0.0006
Barium	0.7	mg/L	0.10	0.05	0.05	0.05	0.06
Boron	4	mg/L	0.13	0.02	0.02	0.52	0.84
Cadmium	0.002	mg/L	0.0002	0.0002	0.0002	0.0009	0.0008
Chlorine (free)	5	mg/L	1.11	1.71	0.84	**N/A**	0.66
Chromium	0.05	mg/L	0.005	0.005	0.005	0.006	0.006
Copper	2	mg/L	0.16	0.33	0.08	0.08	0.15
Fluoride	1.5	mg/L	0.5	0.8	0.5	**1.6**	0.1
Iodide	0.1	mg/L	0.09	0.02	0.01	**0.36**	0.05
Lead	0.01	mg/L	0.005	0.002	0.002	0.001	0.002
Manganese	0.5	mg/L	0.005	0.047	0.014	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	0.005	0.006	0.006
Nickel	0.02	mg/L	0.005	0.002	0.002	0.002	0.003
Nitrate	50	mg/L	8	3	1	49	**52**
Radiological[4]	1.0	mSv/yr	0.43	PASS	PASS	PASS	PASS
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	62	12	12	59	438
THMs[5]	0.25	mg/L	<0.004	0.101	0.065	<0.004	0.014
Uranium	0.02	mg/L	0.00901	0.00009	0.00022	0.00875	0.00005
AESTHETIC PARAMETERS - MEAN VALUES							
Aluminium	0.2	mg/L	0.02	0.02	0.04	<0.02	<0.02
Chloride	250	mg/L	79	9	8	101	134
Chlorine (free)	0.6	mg/L	**0.76**	**0.62**	**0.67**	**N/A**	0.52
Copper	1	mg/L	0.05	0.06	0.02	0.02	0.06
Hardness	200	mg/L ($CaCO_3$)	**210**	50	166	170	25
Iron	0.3	mg/L	0.04	0.09	0.28	0.06	0.04
Manganese	0.1	mg/L	0.005	0.023	0.006	<0.005	<0.005
pH	6.5-8.5	pH units	8.0	7.6	7.8	7.8	7.7
Sodium	180	mg/L	79	3	5	125	59
Sulfate	250	mg/L	51	3	5	47	106
TDS	800	mg/L	443	64	187	609	224
Zinc	3	mg/L	0.02	0.01	0.01	0.01	0.06
OTHER PARAMETERS - MEAN VALUES							
Alkalinity		mg/L	237	49	156	278	35
Beryllium		mg/L	0.001	0.001	0.001	<0.001	<0.001
Bromide		mg/L	0.28	0.02	0.02	0.73	0.67
Calcium		mg/L	46	10	38	26	20
Electrical conductivity		uS/cm	803	109	318	971	604
Magnesium		mg/L	24	6	16	25	8
Potassium		mg/L	5.9	0.4	0.8	29.3	9.6
Silica		mg/L	18	13	18	74	11
Tin		mg/L	0.01	0.01	0.01	<0.01	<0.01

LEGEND (TABLE A3 & A4)

Radiological	Results are reported as 'Pass' if screening levels of gross alpha and gross beta (K corrected) are less than 0.5 Bq/L. Water supplies passing the screening level do not require an annual dosage assessment. Where assessment is required data used is not more than two years older than the starting date of the reporting period for bores and five 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 2006-11.
THMs	Reported as the maximum values as data sets are small.
Health parameters	Assessments are reported as the 95th percentile. Data covers the period 2006-11. Exceedances are shown bold
Aesthetic and Other parameters	Assessments are reported as the mean. Data covers the period 2006-11. Exceedances are shown bold
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 - supplies for which there is insufficient data, incomplete data or where the only data available is outdated are reported as data not available (DNA).
<	All values reported preceded with "<" indicate the value is below the level of detection of the analytical method.
1	2004 ADWG value for health and aesthetic parameters. TDS value set by DoH.

TABLE A4: HEALTH, AESTHETIC AND OTHER PARAMETERS IN MINOR CENTRES 2010-11

Parameter/Centre	Guideline Value[1]	Units	Adelaide River	Batchelor	Borroloola	Cox Peninsula	Daly Waters	Elliott
HEALTH PARAMETERS - 95TH PERCENTILE VALUES								
Antimony	0.003	mg/L	0.0013	0.0002	0.0002	0.0002	0.0004	0.0002
Arsenic	0.007	mg/L	0.0057	0.0006	0.0006	0.0005	0.0012	0.0005
Barium	0.7	mg/L	0.05	0.06	0.06	0.05	0.08	0.17
Boron	4	mg/L	0.02	0.02	0.05	0.02	0.44	0.34
Cadmium	0.002	mg/L	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002
Chlorine (free)	5	mg/L	1.88	1.16	0.96	1.41	1.28	1.67
Chromium	0.05	mg/L	0.005	0.006	0.006	0.005	0.006	0.005
Copper	2	mg/L	0.48	0.17	0.83	0.12	0.27	0.02
Fluoride	1.5	mg/L	0.4	0.2	0.1	0.1	0.5	0.8
Iodide	0.1	mg/L	0.01	0.01	0.02	0.01	**0.25**	**0.12**
Lead	0.01	mg/L	0.002	0.001	0.004	0.003	0.003	0.003
Manganese	0.5	mg/L	0.246	0.006	0.033	0.008	0.153	0.005
Mercury	0.001	mg/L	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001
Molybdenum	0.05	mg/L	0.005	0.006	0.006	0.005	0.006	0.005
Nickel	0.02	mg/L	0.002	0.002	0.004	0.003	0.005	0.004
Nitrate	50	mg/L	7	2	1	8	12	41
Radiological4	1.0	mSv/yr	PASS	PASS	0.37	PASS	PASS	PASS
Selenium	0.01	mg/L	0.001	0.001	0.001	0.001	0.007	0.003
Silver	0.1	mg/L	0.01	0.01	0.01	0.01	0.01	0.01
Sulfate	500	mg/L	3	2	3	28	234	852
THMs5	0.25	mg/L	0.007	<0.004	0.013	<0.004	0.019	<0.004
Uranium	0.02	mg/L	0.00006	0.00042	0.00024	0.00003	0.00784	0.00623
AESTHETIC PARAMETERS - MEAN VALUES								
Aluminium	0.2	mg/L	0.02	0.02	0.02	0.02	0.02	0.02
Chloride	250	mg/L	28	11	11	10	**358**	153
Chlorine (free)	0.6	mg/L	**1.12**	**0.70**	**0.77**	**0.83**	**0.87**	**1.12**
Copper	1	mg/L	0.10	0.04	0.15	0.04	0.05	0.01
Hardness	200	mg/L ($CaCO_3$)	100	191	22	8	**526**	**396**
Iron	0.3	mg/L	**0.74**	0.06	0.16	0.03	0.21	0.10
Manganese	0.1	mg/L	**0.118**	0.004	0.012	0.005	0.032	0.005
pH	6.5-8.5	pH units	7.1	7.6	**6.5**	6.7	7.5	8.0
Sodium	180	mg/L	26	5	6	7	**215**	95
Sulfate	250	mg/L	2	1	1	12	193	245
TDS	800	mg/L	188	224	53	51	**1310**	782
Zinc	3	mg/L	0.03	0.02	0.04	0.05	0.02	0.01
OTHER PARAMETERS - MEAN VALUES								
Alkalinity		mg/L	110	214	37	20	433	359
Beryllium		mg/L	0.001	0.001	0.001	0.001	0.001	0.001
Bromide		mg/L	0.06	0.01	0.02	0.01	1.74	0.76
Calcium		mg/L	17	31	7	3	127	88
Electrical conductivity		uS/cm	323	408	80	54	2107	1300
Magnesium		mg/L	14	34	1	0	61	44
Potassium		mg/L	1.0	0.3	1.1	1.0	24.9	22.1
Silica		mg/L	35	30	14	22	38	57
Tin		mg/L	0.01	0.01	0.01	0.01	0.01	0.01

[2] Although Garawa is not a Power and Water minor centre it is included in this table for convenience.

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	Garawa[2]	Gunn Point	Kings Canyon	Larrimah	Mataranka	Newcastle Waters	Pine Creek	Ti Tree	Timber Creek
	DNA	<0.0002	0.0005	0.0005	0.0005	0.0002	0.0002	0.0002	0.0002
	DNA	<0.001	0.0044	0.0005	0.0005	0.0005	**0.0077**	0.0010	0.0010
	DNA	<0.3	0.06	0.05	0.05	0.28	0.05	0.10	**1.83**
	DNA	<0.02	0.36	0.23	0.26	0.28	0.02	0.37	0.13
	DNA	<0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
	0.85	1.42	0.78	0.76	0.82	1.16	1.19	1.25	0.66
	DNA	<0.005	0.013	0.005	0.005	0.005	0.005	0.005	0.006
	DNA	<0.02	0.49	0.06	0.08	0.03	0.07	0.01	0.04
	DNA	0.4	0.5	0.2	0.4	0.9	0.6	0.8	1.4
	DNA	<0.01	**0.43**	0.10	0.09	0.09	0.09	**0.17**	0.03
	DNA	<0.002	**0.011**	0.001	0.002	0.001	0.003	0.001	0.002
	DNA	0.045	0.006	0.005	0.008	0.005	0.179	0.005	0.193
	DNA	<0.0001	0.0004	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
	DNA	<0.005	0.006	0.005	0.005	0.005	0.005	0.005	0.006
	DNA	<0.004	0.013	0.004	0.003	0.007	0.002	0.002	0.007
	DNA	<1	10	4	3	10	1	**58**	1
	DNA	PASS	0.99	PASS	PASS	PASS	PASS	PASS	PASS
	DNA	<0.001	0.009	0.002	0.003	0.001	0.001	0.002	0.001
	DNA	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	DNA	4	200	100	143	144	73	102	6
	DNA	0.016	0.005	0.005	0.011	<0.004	0.029	0.005	0.007
	DNA	0.00109	0.00270	0.00262	0.00334	0.00524	0.00022	0.00942	0.00219
	DNA	<0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	DNA	13	**261**	203	174	49	13	71	30
	0.61	**0.85**	0.54	**0.60**	**0.64**	**0.68**	**0.76**	**0.99**	0.48
	DNA	<0.02	0.09	0.02	0.03	0.02	0.03	0.02	0.02
	DNA	166	**365**	**487**	**470**	**293**	121	**202**	**395**
	DNA	0.07	0.21	0.06	0.17	0.05	0.14	0.04	0.06
	DNA	0.045	0.004	0.005	0.005	0.005	0.058	0.005	0.023
	DNA	8.7	6.9	7.6	7.7	7.9	7.1	8.0	7.3
	DNA	11	115	114	130	53	30	66	22
	DNA	3	177	100	119	48	27	43	5
	DNA	184	**809**	**914**	**862**	539	216	514	454
	DNA	0.18	0.06	0.04	0.03	0.02	0.02	0.02	0.02
	DNA	185	129	447	470	380	142	210	442
	DNA	<0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	DNA	0.01	1.39	0.97	0.81	0.17	0.05	0.40	0.13
	DNA	23	71	119	114	67	20	45	61
	DNA	370	1380	1549	1516	883	360	786	867
	DNA	26	44	51	51	33	17	22	62
	DNA	3.9	23.6	11.6	17.6	29.3	1.4	18.3	6.7
	DNA	12	21	43	40	58	42	94	22
	DNA	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

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
AS/NZS	Australian/New Zealand Standards
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)
DNA	Data not available
DNRETAS	Department of Natural Resources, Environment, The Arts and Sport
DoH	Department of Health
DoR	Department of Resources
DRD	Darwin River Dam
EMS	Electronic management system
ESO	Essential service operator
FC/TC	Free chlorine/Total chlorine ratio
FIS	Facilities Information System
IBM	International Business Machines
IMS	Information Management System
ISO	International Organization For Standardization
ML	mega litres
MSHR	Menzies School of Health Research
N/A	Not applicable
NF	*Naegleria fowleri*
NHMRC	National Health and Medical Research Council
NPR	National Performance Report
NRMMC	National Resources Management Council
NT	Northern Territory
NWC	National Water Commission
OHS	Occupational Health and Safety
PAM	Primary amoebic meningoencephalitis
PI System	Process information system for the management of real time data and events
PWC	Power and Water Corporation
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
WIMS	Work information management system
WIOA	Water industry operators Association
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	mega litres
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.

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