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Delivering drinking water to Dajarra, North West Queensland

Tim O'Rourke

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

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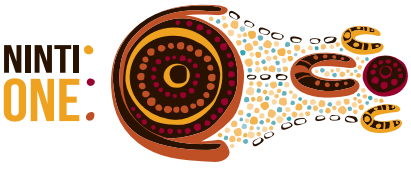

Contributing author information

Tim O'Rourke is an architect and a senior research assistant at the Aboriginal Environments Research Centre, The University of Queensland.

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For additional information please contact

Ninti One Limited

Publications Officer

PO Box 3971

Alice Springs NT 0871

Australia

Telephone +61 8 8959 6000 Fax +61 8 8959 6048

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Contents

Acknowledgements 1
Summary 3
Introduction 7
1. Research background 7
    1.1 Research questions and project aims 7
    1.2 Research methods 8
2. Water supply and demand in North West Queensland 9
    2.1 Water supply to settlements in arid regions 9
    2.2 Water quality guidelines 10
    2.3 Water reforms and the administration of supply 11
    2.4 Water demand in remote settlements 12
3. The township of Dajarra 14
    3.1 Population at Dajarra 15
    3.2 Climate 16
    3.3 Local government 17
    3.4 Services at Dajarra 18
    3.5 Employment and CDEP 19
    3.6 Aboriginal housing and buildings at Dajarra 19
    3.7 Energy 20
    3.8 Service demand in Dajarra 20
4. Dajarra's problem water and water problems 21
    4.1 History of the town supply 21
    4.2 Water use 23
    4.3 The consequences of the Dajarra water supply 23
    4.4 Potential effect on community health 24
    4.5 Evaporative airconditioners 25
    4.6 Rainwater supply 26
    4.7 Proposals to improve the Dajarra water supply 28
5. Desert Services that Work: Demand Responsive Services to Desert Settlements 32
    Research question 1 32
    Research question 2 33
    Research question 3 34
    Research question 4 35
    Research question 5 37
Conclusion 38
Recommendations 41
References 43

Figures and graphs

Figure 1: Map of North West Queensland 14
Figure 2: Examples of the corrosive effect of Dajarra bore water on structural steel and the scale that affects plumbing fixtures..... 25
Figure 3: Roof-mounted evaporative airconditioners on the State housing 26
Figure 4: The plastic drums on the three corners of this house in Dajarra are used to collect rainwater for drinking 27
Figure 5: Rainwater tanks installed at the rear of the Jimberella offices, in November 2008 31
Figure 6: Rainwater tanks installed at the rear of the Jimberella offices, in March 2009 32

Tables

Table 1: Population change in Dajarra, 1981–2006 15
Table 2: Populations of settlements in North West Queensland and eastern Northern Territory, 2006..... 15
Table 3: Mean daily maximum and minimum temperatures for selected locations in the region 16
Table 4: Mean rainfall (in mm) for selected locations in the study region 16
Table 5: Organisations and agencies providing services in Dajarra, identified by the residents 18
Table 6: Example data for routine water quality monitoring of Dajarra town water (17 April 2007). 24

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Summary

Desert Knowledge CRC established Core Project 5 – Desert Services that Work – to conduct research into the services delivered to desert settlements. Under Core Project 5 (CP5), between 2006 and 2008, Stephen Long, of the Aboriginal Environments Research Centre at The University of Queensland, examined the essential services to three Aboriginal communities in settlements in the Georgina River region of North West Queensland and eastern Northern Territory: Urandangi, Dajarra and Wunara. Long's research focused on service demand and identified problems with services to these settlements. In Dajarra, the supply of drinking water was a long-term problem that affected the quality of life in the town. As a critical service that required substantial improvement, the Dajarra water problem was selected as a case study for the second stage of CP5, which provides the data for this report.

Dajarra is a small, remote town in North West Queensland that has an unusually high proportion (about 84%) of Aboriginal inhabitants by Australian demographic standards. The hard, saline bore water reticulated to the town fails to meet the standards of the Australian Drinking Water Guidelines and Dajarra residents rely on alternative sources for their potable supply. Domestic collection of rainwater is the preferred source of water for drinking, although in Dajarra only 60% of Aboriginal households had functional tanks in 2009. Water from the town supply also has both direct and indirect effects on housing and infrastructure. The use of the bore water adversely affects the maintenance and longevity of housing and household items, and energy consumption in Dajarra. In 2009, the quality of the town water supply undermined the economic, social and environmental sustainability of Dajarra.

Core Project 5 addressed five research questions at sites across arid zone Australia (see Moran 2006):

- What are characteristics of the interplay between demand and supply of services, according to the perceptions of consumers and service providers engaged at the local interface?
- What are the conditions that permit successful practice to develop between consumers and service-providers?
- At what scales of governance should different service delivery functions be assigned to optimise both demand and supply based criteria?
- What are the service type and delivery style priorities of consumers within a specified budget framework, and what is their capacity to participate and willingness to contribute to services?
- What are the critical issues and strategies to improve the service system, including the strengths and weaknesses of different technology and governance options?

In this report, the specific aim is to identify solutions to the problem of adequate drinking water supply and the array of problems associated with the current town supply. Dajarra has a history of an inadequate supply of water, which is also of sub-standard quality, and the history of this problem casts some light on service interactions between the Aboriginal population and service agencies. In responding to the research questions, the second aim of this report is to elicit recommendations that could improve the supply of services to Aboriginal communities and organisations in the arid regions of Australia.

The report summarises the history of the water supply and the attempts that have been made to ameliorate the problems associated with both the quality and quantity of drinking water supplied as an essential service by the Cloncurry Shire Council and, indirectly by the two public housing organisations in Dajarra. The project also describes the levels of governance and the various service providers involved in the supply of water and Aboriginal housing to Dajarra. The study was informed by a combination of surveys, interviews, consultants' reports, and a review of relevant literature.

The water problem in Dajarra consists of two interrelated parts: the municipal supply of town water and the use of rainwater as the primary source of drinking water. This report indicates that the town supply of quality water has remained a problem because of the perceived cost of producing potable water, combined with a limited financial, technical and administrative capacity at the municipal level, and a history of political inaction. To their credit, the Cloncurry Shire Council acted on problems with the water supply in the 2000s; however, the infrastructure spending improved the storage, treatment and distribution system of the non-potable groundwater.

The drinking water problem is one of geography and standards. Political will to fix the problem is affected by a general acceptance of lower service standards in remote settlements. In 2001, a report on the water supply identified a potential new bore field, seven kilometres to the north of Dajarra, that could possibly be the source of better quality water. Without a new bore field, technical solutions (reverse osmosis) can solve the Dajarra water problem, but this would require a relatively large capital expenditure and recurring costs.

As the primary source of drinking water, rainwater harvesting in Dajarra is poorly planned and substantially below the collection capacities of all but the three new houses completed in 2009. Approximately 40% of Aboriginal housing in Dajarra has no supply of potable water because of the contamination of rainwater tanks by the roof-mounted evaporative airconditioners. The supply of rainwater for drinking in Aboriginal households is largely the responsibility of the housing providers: Queensland State Housing and Jimberella Housing Cooperative (the Aboriginal Community's corporate body), funded through the Australian Government. A project to install rainwater tanks to public buildings in 2008 demonstrates a need to build and maintain the technical capacity of the Cloncurry Shire Council.

Potable water supply and security would be improved by the installation of optimal rainwater collection systems to all houses, and the removal and repositioning of the roof-mounted evaporative airconditioners. Simple adjustments to the collection system would prevent contamination of the rainwater tanks; however, the area available for water collection would only be 25% of total roof surface. Some technical expertise is needed to improve the rainwater collection and, in contrast to costly solutions to the reticulated groundwater supply, this option could be implemented relatively quickly.

This case study and other research that examines water suppy and Aboriginal settlements (Grey-Gardner 2008a; Beard 2009) argue for the participation of the community in planning and implementation of improvements to the water supply. There is a role for the Jimberella Housing Cooperative in training people to manage, maintain and monitor the residential rainwater harvesting systems. This role would build on Jimberella's capacity as an information provider to both the community and government as a local archive of service data. At the residential level, there is a need to increase the responsibility of tenants for the maintenance and use of rainwater tanks for drinking water supply. Dajarra residents want increased levels of engagement with the Cloncurry Shire Council, and an increase in the participation of a Dajarra workforce in municipal services.

The recommendations from this report range from relatively simple remedial building work to proposals for the exploration and future implementation of costly capital works. Drawing on the findings from the study and the responses to the Core Project 5 research questions, the recommendations identify methods to improve service delivery to the people of Dajarra, include the following:

- Roof-mounted evaporative airconditioners contaminate domestic rainwater supply and this practice should be discontinued.
- Both State and Jimberella housing need to be fitted with optimised rainwater harvesting systems that comply with current standards and are subject to a regime of maintenance and testing. With training, support and minimal equipment, Dajarra people will be able to install and maintain rainwater systems across the town.
- Jimberella should be supported to retain ownership and management of the Cooperative's current

housing stock and community buildings. This support from the State Government needs to include ongoing financial and training assistance to improve the capacity of Jimberella as a multi-service provider in the region.

- Jimberella has maintained a repository of files and corporate memory on the history of service interactions between Dajarra residents and service providers. It is essential to maintain and increase this capacity to help prevent waste and repetition of poor practice in service delivery.
- The Jimberella Housing Cooperative should explore various options to expand the type and amount of services that they currently provide. Given Aboriginal mobility patterns in the region, Jimberella has the potential to offer services to communities that have cultural and historical ties to Dajarra (for example, Urandangi and Duchess). Increasing the capacity of Jimberella, and the scale of its customer base, could lead to the delivery of mainstream services.
- Cloncurry Shire Council, with funding support, needs to explore the options for a better quality groundwater source, as indicated in an earlier consultancy report (PPK 2001). This was the primary recommendation of a report on the Dajarra water supply in 2001 (Maunsell Australia 2001: 35).
- The consumption of town water in Dajarra needs to be reduced through programs that change water use behaviour and improve and maintain the distribution system. The continued use of the current groundwater requires optimal plumbing hardware in association with a regular, local maintenance regime.
- New buildings for Dajarra require a delivery method that integrates infrastructure and settlement planning with design solutions and technologies that reduce the consumption of energy and make optimal use of groundwater. All new buildings, and renovations to existing stock, need to include a dual reticulation system for future potable water supply.

Introduction

Dajarra is a small, remote town in North West Queensland that has an unusually high proportion (about 84%) of Aboriginal inhabitants by Australian demographic standards. The supply of drinking water to the residents of Dajarra is a chronic problem that affects the quality of life and, potentially, the health of the people residing in the town. Sub-artesian bores are used for reticulated water supply in the town. The highly mineralised bore water fails to meet the standards of the Australian Drinking Water Guidelines, and Dajarra residents rely on alternative sources for their potable supply. Domestic collection of rainwater is the preferred source of water for drinking and cooking, although in Dajarra only 60% of Aboriginal households had functional tanks in 2009. The problem became acute during the extended drought in 2007 and 2008, when a tanker truck was used to fill rainwater tanks to maintain supplies of drinking water.

Water from the town supply also has both direct and indirect effects on housing and infrastructure. The use of the bore water adversely affects the maintenance and longevity of housing and household items, and energy consumption in Dajarra. In 2009, the quality of the town water supply undermined the economic, social and environmental sustainability of Dajarra.

This problem of securing adequate supplies of drinking water in not unique to Dajarra. The quantity and quality of water supply to remote Aboriginal communities is a common problem across the arid regions of Australia (Beard 2009: 10; Bailie et al. 2004: 410; FaHCSIA 2007: 213; FRDC 1994), the majority of which rely on groundwater sources (Grey-Gardner 2008a: 5). This report uses a case study of the Dajarra water supply to examine the delivery of services to a remote, Aboriginal town in North West Queensland. The history and consequences of this chronic problem of the supply of an essential service to a small town in an arid region offer responses to the research questions raised in the Core Project 5 (CP5) strand of the Desert Knowledge Cooperative Research Centre (DKCRC).

1. Research background

1.1 Research questions and project aims

This study of the Dajarra water supply grew out of an overview of service delivery to three Aboriginal communities associated with the Georgina River region on the North West Queensland–Northern Territory border (Long 2008). The project was developed as a part of Core Project 5 (CP5) in the Desert Knowledge Cooperative Research Centre. The researchers in Core Project 5 – Desert Services that Work: Demand Responsive Services to Desert Settlements – addressed five research questions at sites across arid zone Australia (see Moran 2006):

- What are characteristics of the interplay between demand and supply of services, according to the perceptions of consumers and service providers engaged at the local interface?
- What are the conditions that permit successful practice to develop between consumers and service-providers?
- At what scales of governance should different service delivery functions be assigned to optimise both demand and supply based criteria?
- What are the service type and delivery style priorities of consumers within a specified budget framework, and what is their capacity to participate and willingness to contribute to services?
- What are the critical issues and strategies to improve the service system, including the strengths and weaknesses of different technology and governance options?

In this report, responses to these research questions are derived from an analysis of the interactions that take place in Dajarra between the Aboriginal residents and service providers. In Dajarra, the municipal supply of poor quality water represents a sub-standard service to a regional Queensland town rather than a failure of service delivery specific to a remote Aboriginal settlement on communal title land (see Grey-Gardner 2008a; Beard 2006, 2009). Responses to these research questions, therefore, largely draw on the relationship of the water supply to Aboriginal housing and energy use, and the implications of these services for the environmental health and the sustainability of the community, combined with the relative novelty of Dajarra as an 'Aboriginal town'. Dajarra has a history of an inadequate supply of water, which is also of sub-standard quality, and the history of this problem casts some light on service interactions between the Aboriginal population and service agencies. The Aboriginal people of Dajarra, their interaction with service providers, legislation and policy relating to services, and Dajarra's unique social and physical properties provide responses to the project research questions.

In addition to responding to the research questions, the second aim of this report is to elicit recommendations that could improve the supply of services to Aboriginal communities and organisations in the arid regions of Australia. This approach follows the aim of Core Project 5, to 'deliver practical benefits' to the communities that are the subject of the research (Moran et al. 2006). In the research reported here, the specific aim is to identify solutions to the problem of adequate drinking water supply and the array of problems associated with the current town supply. Overall, this could be stated as an aim to improve the sustainability of households and of the community in Dajarra.

1.2 Research methods

This report focuses on the supply side of the water services to Dajarra. In the first part of this project, Stephen Long's study of the demand for services in Dajarra described the effects of poor quality town water, particularly as perceived by the Aboriginal residents (Long 2007, 2008). Long's research drew on interviews, surveys on the quality and use of water, and observations of the use of housing by Aboriginal people in Dajarra over periods of fieldwork across a decade. In Long's earlier study of services to Aboriginal people in Dajarra, members of the Jimberella Cooperative prioritised the town water supply in a list of services that required improvement (2007: 11). This was followed by recreation facilities, housing and the desire to establish an outstation on the Georgina River.

The second phase of the project, the main subject of this report, focused on the specific problems associated with the town water supply. This includes the history of the water supply and the attempts that have been made to ameliorate the problems associated with both the quality and quantity of drinking water supplied as an essential service by the Shire Council and, indirectly, by the two public housing organisations in Dajarra. The project also describes the levels of governance and the various service providers involved in the supply of Aboriginal housing and water to Dajarra. The study was informed by a combination of interviews, consultants' reports, and a review of literature.

During this phase of the project, interviews were conducted with Dajarra community leaders, the Dajarra School principal, the Mayor of Cloncurry Shire, and the local State Member of Parliament. Staff at the Mt Isa office of FaHCSIA provided information on the history of attempts to resolve the problem of the water supply in Dajarra. Bureaucrats from State departments and statutory authorities gave background information to recent legislation and the aims of policy that related to water and Aboriginal programs. Ms Julia Shadlow-Bath, the Community Relations Adviser from local mining company Incitec Pivot Limited, provided information on the contribution of this company's effort to fund improvements to infrastructure in Dajarra.

A video was used to record semi-structured interviews with eight Aboriginal residents of Dajarra (Jimberella Cooperative 2010). This process revealed data on the history of the supply of water in Dajarra as well as further information and Aboriginal perceptions on the problems associated with the

use of bore water, particularly in relation to housing. Aboriginal leader Keith Marshall was instrumental in both arranging the interviews and questioning his fellow Dajarra residents on camera about their knowledge of the history and consequences of the water problem.

The effects of the town water on infrastructure were recorded during visual inspections of the housing and public buildings in Dajarra in 2008 and 2009. Two consultancy reports completed in 2001 (Maunsell Australia 2001; PPK 2001) described the town water quality, its effects on the reticulation system and options to improve the supply. Contributing specifically to the current project, Beth Rounsefell, an environmental engineer from The University of Queensland, visited Dajarra to produce a brief, largely qualitative audit of energy, water and waste disposal for Aboriginal houses and the Jimberella community hall and offices (Rounsefell 2009). Despite the duration of the Dajarra water problem, it was difficult to source documentation relating to the administration and supply of the water service, community meetings and reports by consultants.

As a country town with a proportionally high Aboriginal population, service delivery and demand in Dajarra have structural and policy differences to discrete Aboriginal settlements that have experienced a period of self-government, for example in Queensland, Deed of Trust in Grant (DOGIT) communities such as Doomadgee and Kowanyama. There are some commonalities across specific services, such as public housing and various Aboriginal health programs, but Aboriginal people living in regional towns have historically relied on mainstream services, rather than those delivered through forms of Aboriginal legislation. Literature on water and other services to remote, discrete communities, from across the desert region, is therefore not always directly relevant to Dajarra.

2. Water supply and demand in North West Queensland

2.1 Water supply to settlements in arid regions

Poor quality drinking water and water shortages are not uncommon in settlements across regional Queensland, and in towns and discrete Aboriginal settlements in other states (Pearce et al. 2008; Beard 2006) and the Northern Territory (ABS 2007). The majority of inland settlements depend on bore water for drinking and domestic use (Grey-Gardner 2008a: 5-6; ABS 2007). Chronic water supply problems are due to the poor quality of groundwater supplies, inadequate or poorly maintained distribution infrastructure and treatment systems and low yielding aquifers. Sourcing sustainable water supplies for desert settlements is compounded by low and extremely variable rainfall and extremely high evaporation rates. The three communities – Dajarra, Urandangi and Wunara – used as case studies in Long's report (2007) all experienced both acute and long-term problems with their water supply.

Although groundwater sources have permitted the settlement of much of inland Australia, insufficient data on the properties of aquifers mean that sustainable extraction yields are yet to be determined or are difficult to model accurately (CSIRO 2007: 8; CSIRO 2009). The sustainable use of groundwater depends on factors such as the age of the water and its rate of movement, the extent and recharge of groundwater resources and the natural aquifer discharge. The majority of arid settlements are dependent on groundwater for their viability, yet the available evidence indicates that rates of extraction[1] exceed those of recharge for many aquifers (NWC 2009: 89; Maru & La Flamme 2008: 9). The future effects of climate change add a further degree of uncertainty to the sustainable use of groundwater in Australia (CSIRO 2007: 29).

1 The National Water Commission recognises the need for increased research into groundwater systems, although the available data show that: 'The vast majority of the water systems currently identified by jurisdictions as overallocated and/or overused are groundwater systems' (NWC 2009: 89).

2.2 Water quality guidelines

The Australian Drinking Water Guidelines (ADWG) establish a reference for safe, good quality water quality (NHMRC 2004). Developed by the National Health and Medical Research Council (NHMRC) and the Natural Resource Management Ministerial Council, the ADWG and its *Framework for Management of Drinking Water Quality* provides the public, the water supply industry and health authorities with guidance on what constitutes good quality drinking water. Based on quality and risk management principles, implementation of the *Framework* by drinking water suppliers should ensure safety at the point of use (Nadebaum et al. 2004).

Grey-Gardner (2008b: 150) endorsed the relevance and suitability of the risk management approach to remote Aboriginal settlements for the following reasons:

1. external response to poor water quality events is particularly slow due to difficulty in accessing laboratories, contractors, technical advice and parts
2. health facilities are usually difficult to access so there is an increased risk of water-borne illness
3. regular inspection of water supply infrastructure is routine in small settlements simply for security of supply, so additional steps to protect water quality are not particularly onerous
4. the cost of incremental change to water supply systems to progressively target risk factors is more affordable than large-scale installation of 'safe' water treatment and infrastructure

Despite general endorsements of the ADWG and its approach to water quality, the limitations in technical capacity of smaller drinking water suppliers and local councils can compromise the implementation of the *Framework* (Nadebaum et al. 2004). The complexity of the *Framework* has led to the development of a number of planning tools aimed at smaller-scale water suppliers (see Grey-Gardner 2008a: 9).

A major revision of the ADWG (NHMRC 2004) was released for public comment in late 2009, driven in part by the increase in the use of recycled wastewater for drinking and the consequences of a significant supply failure:

> A single urban supply water quality incident, such as the outbreak of Cryptosporidium which occurred in Sydney in 1998, can cost as much as $350 m, justifying investments in treatment and distribution water quality research to improve the management of potable water supplies and the protection of source waters. (CSIRO 2007: 31)

Some of the key initiatives and challenges taken up by the revision process include:

- more extensive guidance on types of monitoring, including operational, validation and verification
- revisions to many factsheets, including those about pesticides, inorganics, metals, disinfection by-products and microbial parameters
- discussion of emerging issues, such as endocrine disruptors and pharmaceuticals in drinking water.

This focus is in keeping with findings by CSIRO (2007) that water supply authorities were concerned with the risk of pathogens, potential contaminants from agriculture and mining, and risk factors associated with the use of recycled water, such as endocrine disruptors.

Samples of the town supply in Dajarra, collected at the School and the Health Clinic in 2007, exceeded the ADWG for Chloride, Total Hardness, Sodium, and Total Dissolved Solids (as tested by Queensland Health). High values of these chemicals affect the taste or aesthetic quality of water. Various samples show that the Dajarra town water is unpalatable; however, health-based guidelines are not proposed for each of these specific chemical characteristics. Although the ADWG proposes no health-based guideline value for sodium, it does warn that 'Medical practitioners treating people with severe hypertension or congestive heart failure should be aware if the sodium concentration in the patient's drinking water

exceeds 20 mg/L.' Sodium was measured at 209mg/L at the Health Clinic and 387 mg/L at the West End in Dajarra in 2007; see Table 5. The ADWG recognises the effects of high concentrations of these chemicals on water reticulation systems.

2.3 Water reforms and the administration of supply

Over the last decade in Queensland, the management of surface and groundwater has undergone extensive legislative review and regulation, resulting in the *Water Act 2000* (Qld), followed by the *Water Supply (Safety and Reliability) Act 2008* (Qld), and new regulatory bodies under these Acts, administered by the Department of Environment and Resource Planning (DERM).

The *Water Act 2000* introduced major changes to the way in which the State allocates and regulates water resources. A major policy shift involved the planning and regulation of water supply based on catchments and hydrological studies that model surface water flows. The *Water Act* also places a greater emphasis on demand management, developed in response to drought, population growth and mismanagement of water resources in the last decades of the twentieth century.

Despite recognition of 'the interests of Aboriginal people and Torres Strait Islanders and their connection with the landscape in water planning' (*Water Act 2000*, s.10), Native Title rights to water are effectively denied under the Act, with all ownership of water vested in the State.[2] Decisions under the Act must not adversely affect the 'cultural values, including, for example, cultural values of local Aboriginal communities', and provisions in the Act can be used to protect culturally significant water assets, such as waterholes. This follows general policy principles that allow for Aboriginal participation in natural resource management and catchment planning.

Under the *Water Act 2000*, 'water resource plans' (WRP) were prepared for the majority of catchments in Queensland, as well as one for the Great Artesian Basin. These are ten-year plans that are developed, first in draft form for comment and feedback, after consultation with water users in the catchment. The Act sets out the conditions for the establishment of 'community reference panels', which 'must include representatives of cultural, economic and environmental interests in the proposed plan area' (*Water Act 2000*, s. 41). The *Water Resource (Georgina and Diamantina) Plan 2004* was approved on 5 August 2004 and covers the catchment in which Dajarra is situated.

The Australian Government, through the Council of Australian Governments (COAG), the *Intergovernmental Agreement on a National Water Initiative 2004*, and the National Water Commission (NWC) monitor the performance of the states and territories with respect to water management and the implementation of policy. The Australian Government also provides a forum for cross-boundary arrangements, including intergovernmental agreements for both the Lake Eyre Basin and the Great Artesian Basin. These agreements rely on cross-jurisdictional consensus rather than affecting the statutory responsibilities of the states. The Lake Eyre Basin Agreement does, however, provide for Aboriginal participation in the Community Advisory Committee, with six out of 17 members representing Aboriginal interests in 2009.

One of the difficulties for water planning has been to model groundwater systems and integrate this data with the models of surface water – also frequently lacking comprehensive and up-to-date data (CSIRO 2007: 38). In 2009, only one WRP in Queensland included an integrated model of surface and groundwater resources.[3] The National Water Commission recognises the need for increased research (and research capability) into groundwater and the management of sustainable extraction across the continent; Australian Government funding has supported NWC initiatives in this area.

2 Water is defined as water in watercourse, lake or spring, underground water, overland flow water, and water collected in a dam (*Water Act 2000*, s. 19).

3 This was for the Pioneer Catchment on the central east coast of Queensland.

The Queensland Department of Environment and Resource Management is also responsible for developing four Regional Water Supply Strategies, including one for North West Queensland, with a draft due in 2010. The aims of the Regional Water Supply Strategy include highest value and best use of water, measuring demand and increasing water use efficiency, and determining potential water demand requirements over a longer time frame. It is a recommended that this DKCRC report inform this draft regional water strategy.

While the emphasis of the *Water Act 2000* was on planning, allocation and the commodification of water, the *Water Supply (Safety and Reliability) Act 2008* was drafted to regulate drinking water quality across the State with the primary purpose of protecting public health. Regulatory provisions on water quality in the *Water Act 2000* were transferred to this new Act. This Act was accompanied by amendments to the *Public Health Act 2005,* which includes provisions relating to drinking water quality and safety, particularly the monitoring and reporting of *Escherichia coli* (the most specific indicator of recent faecal contamination of water).

The regulations of the *Water Supply (Safety and Reliability) Act 2008* apply to service providers registered with the Department of Environment and Resource Management, including those involved in treating, transmitting or reticulating water for drinking purposes. The regulations were introduced in two stages in which providers were required to: (i) carry out an initial drinking water quality monitoring and reporting program, which began on 2 January 2009 (Stage one); and (ii) develop and implement a drinking water quality management plan (Stage two) (DERM 2009). The service providers, which would include most regional municipal councils, including the Cloncurry Shire, report to the Office of the Water Supply Regulator, the chief executive of DERM. (In all other states and territories drinking water quality standards are the responsibility of the state or territory health departments.)

In part, the increase in the use of water recycling systems to produce drinking water necessitated the *Water Supply (Safety and Reliability) Act 2008.* Prior to this Act, the State did not regulate water quality and the public was protected by common law obligations of the water service providers and an implicit duty of care. During 2009, the State Government began an audit of local government water service providers across Queensland to collect data on water quality and treatment systems across the State.

2.4 Water demand in remote settlements

The majority of arid region settlements are dependent on groundwater (Grey-Gardner 2008b: 150), with some towns having a history of unrestricted water use associated with high yielding aquifers (Maru & La Flamme 2008: 9). This apparent abundance, in combination with desert lifestyles, has led to very high levels of water consumption in towns such as Alice Springs:

> Alice Springs has some of the lowest-cost water in Australia, with no restrictions on water use. Current water use is 10,500 million litres a year, which is about 959 litres per person per day. An Alice Springs household uses more than twice as much water (535 kilolitres per household per year) as the average Australian urban household (213 kilolitres per household per year), which places the town near the top of the water consumption range (113–552 kilolitres per year) for all cities and towns (WSAA 2007a, 2007b). Bore levels have dropped 50 metres since 1964, and continue to drop at slightly over one metre per year. (Maru & La Flamme 2008: 10)

Even settlements in arid regions that rely on catchment water storage, such as Mount Isa and Cloncurry, have historically very high levels of per capita consumption of town water (Maunsell Australia 2001: 15). High per capita consumption in the desert regions is related to a number of factors. Evaporative airconditioners, which are common in arid climates, can use upwards of 75L/hour in the summer months (GHD 2003: 10). In the western Queensland towns of Mt Isa, Longreach and Winton, water consumption by evaporative airconditioners accounted for about 30% of total household water usage

(GHD 2003: 11). One of the main factors influencing water use in evaporative systems is the water quality: the higher the mineral salt content, the greater the water consumption through increased 'bleed' and inefficiency.

Water use on gardens in arid regions also contributes to relatively high per capita consumption rates. In settlements such as Dajarra, hoses and sprinklers are used to maintain lawns and minimise air-borne dust. The extent of care of gardens and lawns varies between Dajarra households, but it is not uncommon to see sprinklers and hoses left on all day, independent of the season. Long (2007) recorded the perceptions of householders on outdoor water use, finding that the majority of surveyed residents expressed concern over excessive use: '[some] people think they are from Scotland'. Over the summer months, children frequently spend hours of playtime under sprinklers and improvised pools and water slides.

In Dajarra the water supply is not metered at the household, although the Cloncurry Shire measures flow from the town reservoir. A report on the Dajarra town supply in 2001 estimated the consumption at over 3000L per person per day, although excessive wastage from a decayed distribution system was contributing to the high water use figures (Maunsell Australia 2001: 15). Water restrictions were in place throughout the Shire in 2008 and applied in Dajarra. General observations and discussions with residents suggest that the restrictions on garden use were largely ignored by a substantial number of households (see Long 2007). Despite evidence of general overuse of water, just less than half of the Dajarra residents in Long's survey voiced the need for conservation measures that included restrictions.

Management of consumer demand for water has in recent years been successful in urban centres across Australia, with up to 20% reduction in residential consumption (WSAA 2009: 12). This reduction in demand is influenced by a number of factors, including pricing, temporary and permanent restrictions with enforcement, household rebates (tanks and water-saving fittings), and extensive marketing campaigns using a variety of media aimed at compliance with restrictions and water conservation through behavioural change.

For remote settlements such as Dajarra, the main impediment to water conservation based on pricing is the capacity to pay, as communities largely dependent on welfare struggle to meet basic needs in high cost living environments (Pearce et al. 2008: 9). The majority of participants (18 out of 20) in Long's Dajarra survey were opposed to metered water rates for varying reasons, including the poor quality of the water. Only two survey participants thought users should pay for water to curb excessive use (Long 2008: 75).

In many locations across Australia (including Brisbane, Melbourne and Sydney), water storage volumes or percentages are used as 'triggers' for different stages of urban water restrictions (Chong et al. 2007: 29). This approach is easy to justify and public information on usage and capacity forewarns consumers of impending changes to water restrictions. This level of public engagement by water authorities, based on clear empirical data demonstrating the need to conserve water, is not relevant to groundwater supplies in remote Australia.

In framing the research questions for this project, Moran defined demand as 'an informed expression of need for a particular service in a context of limited resources, in consideration of the tradeoffs that consumers are prepared to make to receive the service, and where opportunity costs are weighed against benefits' (2006: 6). In Dajarra in 2009, there was little incentive to change behaviours that affect demand for town water, although there was a long history of careful management of the limited supplies of drinking water, either from household rainwater tanks or soaks in the creek. Low yields from the town bores and the high rates of extraction of groundwater to supply the reservoir suggest the need for long-term water conservation program in Dajarra. This may need to be a staged process with a range of measures. The implementation of a comprehensive education and public awareness campaign would be a useful start.

3. The township of Dajarra

Dajarra is a small, remote town located 150 kilometres south of Mt Isa, which is the regional business and service centre for North West Queensland. Situated toward the eastern edge of the extensive Georgina drainage basin, Dajarra was established on Carbine Creek in 1917 as a railhead to the Great Western Railway. The Carbine is an intermittent creek that drains a small range of low hills, part of the North West highlands. Water for stock tanks and the railway was originally sourced from the Carbine's alluvial aquifer (this contrasts with the pattern of pastoral station development which colonised the area in the late nineteenth century through the appropriation of permanent waterholes, starting on the Georgina River in the 1860s – see Long 2005).

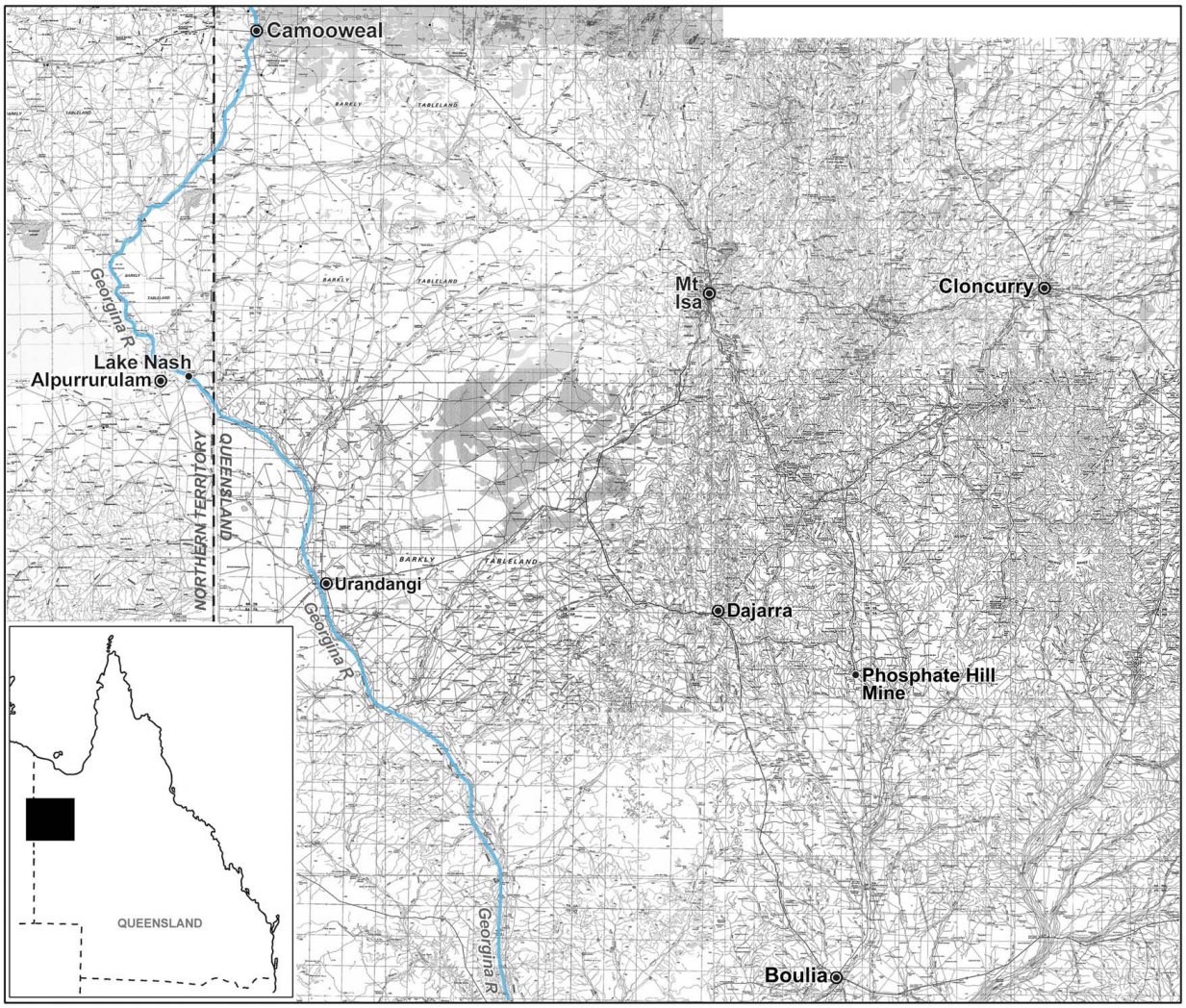

Figure 1: Map of North West Queensland

Dajarra lies in the Aboriginal cultural region associated with the Georgina River (Memmott et al. 2006: 10), named the 'north-west cultural region' by Memmott (1991). Aboriginal people from the Georgina River region began to migrate to Dajarra in the 1930s. In the 1960s and early 1970s, the State 'resettled' Aboriginal people from the Georgina River to Dajarra. The closure of the police station at Urandangi, and mandatory schooling for children, were reasons given for the forced movement of Aboriginal people to Dajarra. Roughly equidistant between Boulia and Mt Isa, Dajarra has developed into an important social and service town for Aboriginal people from the greater local area (Long 2005, 2007).

3.1 Population at Dajarra

Aboriginal people made up about 85% (151) of the population of the 178 residents of Dajarra, as of the 2006 census. This high Aboriginal proportion of the population is unusual in Queensland towns. The demographic composition of Dajarra compares with discrete Aboriginal settlements such as Doomadgee and Mornington Island, although these communities have much higher overall populations. In contrast to many of the discrete Aboriginal communities of the Gulf and Cape York Peninsula, over the last decade the population of Dajarra has declined slightly (see Table 1). Health, education and employment, as well as social factors, draw Dajarra people to Mt Isa (Memmott et al. 2006).

Table 1: Population change in Dajarra, 1981–2006

	1981	1986	1991	1996	2001	2006
Aboriginal population	250	146	154	171	163	151
Total population	300	180	190	204	190	178
Aboriginal proportion	83.4%	81.1%	81.5%	84.2%	85.8%	84.4%

Source: Memmott et al. (2006) and ABS (2009)

Table 2: Populations of settlements in North West Queensland and eastern Northern Territory, 2006

Place	Aboriginal pop.	Total pop.	Proportion Aboriginal	Settlement type
Dajarra	151	178	84.4%	Town
Boulia	75	205	36.6%	Town
Urandangi/Marmanya	20	25	80.0%	Town/outstation
Mount Isa	3,089	18,857	16.4%	Regional city
Camooweal	131	312	42.0%	Town
Alpurrurulam (Lake Nash)	322	343	93.9%	Discrete settlement
Cloncurry	1,149	2,384	21.9%	Town
Burketown	53	173	30.6%	Town
Doomadgee (locality)	979	1,052	93.1%	Discrete settlement

Source: Table by Long (2005:69) and figures based on ABS (2009) except Urandangi from Long (2005)

Aboriginal population trends for Dajarra appear to be fairly stable into the near future. Under these conditions (compared with remote Aboriginal settlements), service priorities of Aboriginal residents in Dajarra were concerned more with the quality of services provided rather than an expressed need for increased levels of supply (Long 2007), particularly as three new houses completed in 2009 eased the demand for housing.

From the mid-1990s, Long (2005: 155) observed the cultural composition and social interactions in Dajarra over a decade:

> The Dajarra population is comprised of a number of family groups that form a core group of long-term Dajarra residents, yet the population of Dajarra is also characterised by regional mobility with members of these core families migrating between Dajarra and other regional centres, particularly Mt Isa. Some Dajarra people have migrated to Mt Isa and are long term residents there yet continue to identify strongly with Dajarra. At times distinctions are made between Dajarra people and these Mt Isa-Dajarra people. In contrast to Mt Isa, Dajarra is a town that is entirely dominated by Aboriginal behaviour patterns and social relations. It is a town where relatives and friends can maintain close and intense social relations.

The relative social stability at Dajarra, particularly when compared with the discrete Aboriginal communities in the Gulf and Cape York Peninsula, perhaps contributes to Dajarra's marginal position in State policy development and allocation of resources. As one senior bureaucrat from the Department of Aboriginal and Torres Strait Islander Policy (DATSIP) commented in 2008, Dajarra was 'off the radar'

for the State Government because of its relatively benign social situation. At this time the State was focused on improving the statistics as they related to (i) alcohol abuse, (ii) child safety, (iii) health, and (iv) education, in that order of priority. Under these policy conditions, problems with water and housing in this country town with a high Aboriginal population were not about to attract administrative or fiscal attention, despite the persistence of the problem, nor despite the relatively modest corrective measures needed to improve the supply of rainwater to the State houses.

3.2 Climate

Dajarra is located in a region characterised by a hot, dry climate, consisting of low annual rainfall and very high evaporation rates. Most rainfall occurs in the hottest period of the year from October through to March, with the highest rainfall typically falling between December and March. Rainfall is highly variable and generally low during the cooler months (BOM 2009). Climatic data for Dajarra are not published by the Australian Bureau of Meteorology, but a guide to the climate profile is discernible from the data supplied on the surrounding towns, and from local rainfall records kept for the Bureau at the old Post Office in Dajarra.

Table 3: Mean daily maximum and minimum temperatures for selected locations in the region

	deg C	J	F	M	A	M	J	J	A	S	O	N	D
Urandangi	Max	38	37	36	32	27	24	24	27	31	35	37	39
	Min	24	23	21	17	12	8	7	9	13	18	21	23
Mt Isa	Max	38	37	35	33	27	25	25	27	31	35	37	38
	Min	24	24	22	20	14	11	10	11	15	20	22	23
Boulia	Max	38	37	35	31	27	23	23	26	30	34	37	39
	Min	25	24	22	17	12	9	8	9	13	18	21	22

Source: BOM 2009

Table 4: Mean rainfall (in mm) for selected locations in the study region

	J	F	M	A	M	J	J	A	S	O	N	D	Annual	Summer (Oct-Mar) % of total
Mt Isa	79	84	58	16	20	17	6	3	6	19	22	56	389.5	82%
Dajarra	75	89	56	16	20	9	10	7	7	16	17	52	360.9	84%
Urandangi	62	64	41	13	12	9	9	4	6	14	21	39	296.1	81%
Boulia	47	51	35	14	13	10	9	6	7	15	21	31	261.1	77%

Source: BOM 2009 and unpublished Dajarra rainfall records to 1996

The local records show the extreme inter-annual variability in rainfall, with only 102.1 mm recorded in 1963, and 976.4 mm in 1974. A drought through the years 2007 and 2008 reduced the supply of drinking water from rainwater tanks, resulting in the use of a tanker truck to cart water from a variety of locations around Dajarra (this coincided with a period of high fuel costs). Evaporation rates reduce the efficacy of open water storage options, although a dam has been proposed as one solution to the supply problem.

Sustainable architectural design principles and solutions for hot, arid climates vary considerably from appropriate designs for the temperate and tropical climates of Australia. Despite the differences in climate, housing solutions in arid regions, such as the Georgina basin, invariably reproduce (often poorly designed) house types used in coastal regions (cf. Seemann et al. 2008). The result is an over-reliance on mechanical airconditioning systems that add to the cost burden of living in a remote community (see Rounsefell 2009; Duell et al. 2006).

As climate change projections for this part of Australia are developed, data from the climate models will need to be factored into infrastructure planning for Dajarra and other settlements in the Georgina basin and North West Queensland. Climate change will affect rainwater harvesting, currently the major source of drinking water in Dajarra. During periods of high rainfall, flooding in Dajarra regularly affects housing located on the western edge of town. The occupation of these low-set houses would need to be considered if the climate shifts toward wet seasons with a greater frequency of high rainfall events. The planning for infrastructure and housing will also need to mitigate the adverse effects of climate change on the health of the residents (see Campbell et al. 2008).

3.3 Local government

The township of Dajarra lies in the boundaries of the Cloncurry Shire, which is administered by the Cloncurry Shire Council. Given the historical changes to shire boundaries in North West Queensland, the placement of Dajarra in the Cloncurry Shire could be described a geographic anomaly. The main sealed road from Cloncurry to Dajarra is via Mount Isa, which, since the 1960s, has become the major service centre in the North West region, and headquarters of the Mt Isa Town Council.[4] The Boulia Shire, located to the south of Dajarra, is responsible for maintenance and upgrades to the Diamantina Developmental Road, which passes through Dajarra to Mt Isa. Thus, for a road trip to their Shire offices, Dajarra residents travel on a road maintained by a second local authority, passing through a regional centre under the control of a third local authority.

Regional shire councils deliver and manage water services to towns under a Regional Water Supply Strategy, developed by the Department of Environment and Natural Resources (DERM – previously the Department of Natural Resources and Water). This process is regulated under the Queensland *Water Act 2000*, which requires a water resource plan for each catchment relating to both surface and groundwater. Water service providers are required to be consistent with this plan, which is monitored over a ten-year period before renewal.

During the last decade, the Cloncurry Shire Council faced severe water shortages for the town of Cloncurry, which has a growing population (2384 in the 2006 Census) as a regional service centre for mines. During the severe drought in 2008, the town supply for Cloncurry ran so low as to become undrinkable. Much of the population was forced to purchase bottled water and drinking water was trucked to the town.

During 2008, the Mayor of Cloncurry had made the Cloncurry water supply his main priority in office. This involved lobbying the State Government to fund the Shire's preferred solution, a pipeline that connected Lake Julius on the Leichhardt River to Cloncurry's storage dam, Chinaman Creek Dam. After stalled negotiations between the Council and the State Government, the Mayor, Andrew Daniels, contacted the media, which attracted national coverage. Well aware of Dajarra's water problem, the Mayor (elected in early 2008) stated that he also wished to fix the Dajarra town supply while in office. In 2009, a 38 km pipeline was under construction from Lake Julius to Cloncurry to alleviate the supply problem. The Queensland government-owned corporation SunWater was managing the $42 million project.

There is one full-time employee of the Cloncurry Shire residing in Dajarra, responsible for a range of council services including rubbish collection, operation and monitoring of the water supply and sewage system. The residents of Dajarra have consistently requested increased local employment by the Shire Council, without result. In 2009, at least two Dajarra residents were employed by the neighbouring Boulia Shire Council and commuted weekly to that shire to execute their work.

4 The 2009 State Budget announced funding of $4 million to seal the Cloncurry to Dajarra road.

3.4 Services at Dajarra

Dajarra residents use a number of mainstream services typical of a small, remote country town (Table 5). In addition to mainstream services, a range of specific Aboriginal services are provided in Dajarra. Dajarra residents also travel regularly, usually to Mt Isa, to access services that are not available in Dajarra or to increase service options (Long & Memmott 2007; Long 2007). The State Government health clinic at Dajarra is staffed by a full-time nurse and visited by the Royal Flying Doctor Service, with Mt Isa (the regional centre for Queensland Health) and Townsville providing specialist health services.

Dajarra has a primary school attended by 43 students in 2009. According to the headmaster, attendance is high and the students are well adjusted and relatively diligent. Since the 1970s, gradual population decline in Dajarra has led to a fall in school numbers with the consequent loss of teaching staff. Secondary school students either attend boarding school or high school (where they live with relatives) in Mt Isa/ Families have moved from Dajarra to Mt Isa to coincide with children attending secondary school.

Table 5: Organisations and agencies providing services in Dajarra, identified by the residents

Jimberella Cooperative (including caravan park)	Queensland Health (clinic)
Jimberella Store	Allied Health
Cloncurry Shire Council	Aboriginal Health
Dajarra State School	Women's and Men's Health
Parent & Community organisation	Royal Flying Doctor Service
Dajarra Sports Committee	Home and Community Care (HACC)
Roadhouse (and mail centre)	Catholic Church
Centrelink	Protestant Church
Community Development Employment Program	Aboriginal and Islander Catholic Council (AICC)
Legal Aid	LDS Church (Church of the Latter-day Saints)
Power	State Emergency Service
Telstra/CDMA phone network	Dajarra Hotel
Queensland police	

Source: Long 2007: 33

The police station is staffed by at least two police officers who reside in the town: there are three detached houses for police with one being completed in 2009. The town also hosts an employment agency and CDEP, aged care service, a women's centre and a range of government, NGO and private services (see Table 5).

The Jimberella store operated as a community-run shop until it was leased to Outback Stores in 2008. This arrangement with Jimberella Cooperative only lasted until 2009. The new lease was being negotiated in September 2009. As well as providing meals and accommodation, a general store at the Dajarra Roadhouse was the only local source of groceries after the closure of the Jimberella store. Many of the residents shop regularly at the supermarkets in Mt Isa, up to two to three times a month depending on transport options. The Dajarra Hotel was the only licensed premise in Dajarra, and also offered accommodation. A camping ground with ablution block provides a small income to Jimberella Cooperative during the winter tourist season.

In 2009, there were five registered foster families in Dajarra that cared for children from across the Gulf of Carpentaria and Georgina regions. This provided some income for the carers and the children increased the enrolment at the primary school by ten students out of 43. This service provided by Dajarra families is indicative of the social stability of the community in the township.

3.5 Employment and CDEP

In 2009, Aboriginal people of working age were under-employed in Dajarra, including CDEP workers. The Aboriginal unemployment rate was 25% in 2006 with only 30% of the total population in full-time work (ABS 2009). Cloncurry Shire Council provides for one full-time local council worker, although a significant number of Dajarra residents feel this is inadequate for a number of reasons (Long 2007). In 2009, two Dajarra residents were working full-time for the Boulia Shire Council, residing in Urandangi during the week. At least three Dajarra residents were employed at the Phosphate Hill mine, owned by Incitec Pivot.

The tasks allocated to CDEP were insufficient to fully engage about 12 registered employees, even on a part-time basis. Despite the underemployment of CDEP workers, State Housing had employed contractors from Mt Isa for all repairs, maintenance and gardening work on their properties. However, only basic technical skills are required to repair many of the problems associated with the effects of the bore water on building and infrastructure. Older Aboriginal residents have some of the skills for general house maintenance and repairs, although these workers tend to find employment that takes them away from the town.

3.6 Aboriginal housing and buildings at Dajarra

Long (2007) has described the housing stock in Dajarra. In an extended period of intermittent fieldwork, he was also able to experience the socio-spatial use of a significant number of the houses in Dajarra and the adaptation of the dwellings to accommodate Aboriginal lifestyles (Long 2005). Memmott (2007) has recorded and observed changes to the built environment in Dajarra since the early 1970s.

The Aboriginal housing stock is managed and delivered by two separate entities: the State Government, through Housing and Homelessness Services (previously the Department of Housing), and the Australian Government–funded Aboriginal housing organisation, the Jimberella Housing Cooperative. The State managed the tenancy of 18 houses in Dajarra:

> In September 2008, rents for these Dajarra houses were around $80 per week, with a five-bedroom house over $100. As is the usual practice in Department of Housing rental properties, there was a sliding scale for rent based on the combined household income. An upper threshold limit, if exceeded, renders tenants ineligible for public housing. In 2008, three Department of Housing properties in Dajarra were vacant. (Flatau et al. 2009)

In 2009, Jimberella managed 26 houses, including one dwelling in Mt Isa that was rented to the general public through a real estate agent. The Jimberella Housing Cooperative was established in 1974, initially to provide affordable housing for Aboriginal people in Dajarra. Prior to becoming a housing organisation, Jimberella grew from a decision by a few local Dajarra people to start a community grocery run to Mt Isa. Frustrated by the high prices at the local, privately run store, the Cooperative offered an improved service to the Aboriginal residents of Dajarra. The early success of the Cooperative led to Jimberella purchasing the store. Since formation, Jimberella has provided a range of services to the community, including community transport, education and skills training. Jimberella also represents the community in land and heritage negotiations (Long 2005: 150), and provides a range of informal services, such as the use of phones, faxes and computers as well as being a source of information and advice.

The Cooperative owns the Jimberella Hall and the attached offices. Completed in 2005, the office extension to the Hall provides administration rooms for the Cooperative, community facilities and rooms that are rented to service providers. The ample verandahs of the hall and offices are a focal point for social interaction for the Aboriginal residents of Dajarra. The Jimberella Hall and office complex also serve as a central location for service providers and consultants visiting Dajarra and as a venue for formal and informal meetings.

As well as its social function, the hall is used to accommodate groups of visitors to Dajarra, and has been used for temporary accommodation for locals when flood-prone houses are inundated during the wet season. This occurred in January 2009, when 300–400 mm of floodwater passed through seven State houses, prone to flooding when Carbine Creek exceeds its banks.

Three new Jimberella houses were completed in 2009. These were funded under the National Aboriginal Health Strategy – Environmental Health Program (NAHS-EHP) and had been commissioned in 2003. The three houses took four years to build and involved the unsuccessful use of CDEP labour during one phase of the construction.

In Dajarra, long-term Aboriginal tenants develop an attachment to some of the public houses. For example, although living in a small four-bedroom house with between 12 and 15 occupants, one family preferred not to move into one of the new, larger four-bedroom houses completed in 2009. The attachment to the houses is reflected in the attention to gardens and self-constructed additions to the rental housing.

As of September 2009, all of the Jimberella houses in Dajarra were rented, including the three houses completed in June 2009. From 2007 to 2009, two to three of the State houses were unoccupied (see Flatau et al. 2009: 90–91).[5] Jimberella and Queensland Housing had different styles of managing the tenancies, with the Cooperative being more lenient on lapses of rental payment. Jimberella aimed to maintain occupancy, and attempted to arrange a financial plan for repayment with tenants to make up for rent in arrears. This management approach was based on the experience that a vacant house would add to the burden on an occupied house. However, this approach had led to cases of serial underpayment of rent that affected the Cooperative's operating budget.[6]

3.7 Energy

The Mica Creek Power Station in Mt Isa supplies electricity to Dajarra and most of the North West region, through the Ergon Energy–owned distribution network. In 2009, the Queensland Government-owned, gas-fired power station at Mica Creek was not connected to the national grid. A proposal to connect Mt Isa to the grid was discussed by the State Government in 2008, and the Australian Government in 2009. Additional sources of renewable electricity generation were discussed in the context of this proposal that is directed toward meeting the electricity demand from the mining industries in North West Queensland.

The domestic use of electricity in Dajarra is relatively high, and is related to the use of airconditioners, hot water systems and refrigeration. Energy costs place a financial burden on Aboriginal residents, particularly pensioners and the unemployed or under-employed (see Pearce et al. 2008 on utility stress). Rounsefell (2009) recorded energy bills of $800 per quarter for a pensioner in a two-bedroom State house, and $1500 per quarter in a Jimberella house occupied by 12 to 15 people. Reducing domestic energy consumption is hindered by the poor water quality, as discussed below.

3.8 Service demand in Dajarra

Long (2007) described survey participants' relatively modest list of suggested improvements to service delivery in Dajarra. The issue of water quality consistently topped the list of residents' concerns. Long's survey suggests that Dajarra residents (and those in Urandangi and Wunara) lower their expectations

5 Jimberella rents were slightly less than those for the State houses, and Community Housing tenants were eligible for to apply for Commonwealth Rent Assistance, not available to Queensland Housing tenants (Flatau et al. 2009: 91).

6 Financial problems have been used as a reason to disband IHOs (PricewaterhouseCoopers 2007). In 2001, in an inter-government workshop in Dajarra, Jimberella board members had raised as a priority the need for assistance with the management of their tenancies.

of service delivery, because of their geographic location. The survey identified a desire for increased participation in service delivery, or increased levels of interaction with the service provider. This finding included the water supply.

Long's survey demonstrated the importance of the Jimberella Housing Cooperative to the Aboriginal community in Dajarra, both as a multi-service provider, a broker for service delivery and a culturally appropriate setting for service interactions. The Cooperative was not without its local critics, and several survey respondents voiced concerns about the centralisation of service interactions and service-related information through Jimberella and its hall and offices. This concern was related to the perceived lack of information about the timing and content of meetings (Long 2007: 33–34). At the same time, general observations and the survey data indicate the importance of key members of the community (most often associated with the Jimberella Board) in both the distribution and interpretation of information related to services.

4. Dajarra's problem water and water problems

The water supply for the township of Dajarra is owned and operated by Cloncurry Shire Council. Water is pumped from a number of subartesian bores to a high level reservoir and then reticulated to about 200 consumers through 62 connections. Four bores are used for the main town water supply, with several additional bores reserved as emergency back-up sources. The system is remotely controlled and monitored by operators at the Cloncurry Shire Council, who have 24-hour on-call access to any fault that occurs in Dajarra. The response time to faults is affected by the travel time from Cloncurry to Dajarra (181 km on a predominantly unsealed road via Duchess).

Cloncurry Shire Council upgraded the Dajarra water supply during 2007 with funding assistance from an Australian Government grant (Small Communities Assistance Plan). The upgrade involved the reconstruction of the supply reservoir sited on Dajarra Hill, construction of a low-level reservoir and installation of pumps that lift water into the elevated supply reservoir. A new delivery main was also constructed to convey water from the supply reservoir to the town reticulation system. The upgrade also installed chlorination equipment to ensure the town supply meets microbiological water quality requirements.

This 2007 upgrade to the water supply improved the pressure at the connections in the township, which had previously been a source of complaint from the residents (see Long 2007). However, occasional faults in the system, coupled with relatively high demand for water, resulted in short periods of low volumes in the supply reservoir and low pressure in households.[7] The electricity supply to Dajarra is limited to single phase, which restricts the capacity of the pumps. The yield from the various bores that supply the reservoir is also unreliable (Maunsell Australia 2001).

4.1 History of the town supply

Throughout the early- and mid-twentieth century, Aboriginal people in Dajarra used soaks in Carbine Creek to obtain drinking water, with each family maintaining its own soak. Water was carted to camps and houses in drums or tins. Over the years, 'good' bores replaced soaks, although during the 1950s and 1960s, Aboriginal people in Dajarra had to purchase drums of water from the railway bore.

The Cloncurry Shire Council has struggled to provide an adequate supply of town water since at least the 1940s. Long (2005: 155) summarises the history of the Cloncurry Shire Council's difficulty in providing a reliable source of town water:

7 I experienced the loss of water pressure over two days in July 2009. The town reservoir ran low because of a pumping fault. The fault was fixed on the second day; however, transient lack of supply affected bathing and washing across the town and was cause for local complaint, recorded on video.

> In 1935 the railway put down a bore for stock at Dajarra. In 1945 Cloncurry Shire Council put down a bore for the town, but the supply was insufficient. In 1950 and 1953 the Department of Irrigation and Water Supply drilled two bores at Dajarra but they were failures. In 1954 the Cloncurry Shire Council asked Queensland Railway whether water from the railway bore could be supplied to residents.

Since the establishment of Dajarra, 'a considerable number of bores have been drilled in the vicinity of the town in search of a reliable supply. As discussed in previous planning reports, and confirmed by the recent investigation by PPK, the prospect of a reliable quality groundwater source in Dajarra is extremely limited' (Maunsell Australia 2001: 18).

The two bores, including the Windmill Bore, located on an alluvial aquifer associated with Carbine Creek, were the only source of ground water suitable for drinking. Historically, Windmill Bore, operated by the Stanbroke Pastoral Company in 2001, supplied the stockyards and the railway during its operation:

> People refer to this as the good supply. The first Aboriginal housing in Dajarra was connected to the 'good' supply, however all dwellings are now connected to the town supply. Occasionally rainwater tanks in town are empty (especially in the case of large households), at such times people have to use the town supply or transport water from the 'good' supply on Carbine Creek. (Long 2005)

Windmill Bore was operational in the early 2000s and supplied a tank used for drinking water for Dajarra residents. Testing of the supply identified microbial contamination in 2001 (Maunsell Australia 2001: 19). This may have been from contamination of the tank at the time of sample, rather than from microbes present in the aquifer; however, filtration and treatment were recommended if the supply was to be used for drinking. There is inadequate volume from this bore for the town supply and a risk of upstream contamination of the aquifer (see below).

During a water supply crisis in 2001, the community, desperate for immediate action and critical of Cloncurry Shire's inaction, issued a press release to draw attention to the ongoing health issues and other implications they faced as a result of the failed water supply. One Dajarra woman observed: 'I remember collecting water from the Carbine River when I was a kid – and guess what? I am well in my fifties and still heading to the river, collecting water today. What a bloody joke' (in Long 2005: 154–155).

A whole-of-government 'strategic planning workshop' was held in Dajarra in October 2001. Eight Dajarra residents were joined by representatives from ATSIC, 16 State departments and agencies, Cloncurry Shire Council and Western Mining Corporation (WMC), which operated the Phosphate Hill Mine in 2001. The Dajarra town water supply was the first issue raised in relation to essential services and infrastructure. At the time of the workshop, two engineering and hydrological consultancies were preparing reports on the water supply, engaged by the Cloncurry Shire Council and funded by WMC. The report by Maunsell Australia confirmed local knowledge:

> Dajarra's water supply is generally substandard with a number of deficiencies being identified. The most critical components of the town's water supply system relate to the availability of a water supply (adequate bore yields) and the quality of the water. (Maunsell Australia 2001: 35)

This report was used as the basis for improvements to the water supply distribution system, completed in early 2007. These improvements to yield and reticulation, while welcomed by the community, did not address the critical component of the quality of the water. Given the duration and persistence of the problem, and widespread knowledge of the problem across different levels of government, and continued advocacy by the Jimberella Cooperative, it is understandable that Dajarra residents are frustrated in their quest for a reliable drinking water supply.

4.2 Water use

Council records and observations indicate a high per capita water usage in Dajarra, which is consistent with towns in arid regions (Maunsell Australia 2001). There were no residential water meters in Dajarra[8], although the Council monitored overall consumption from the reservoir. The Cloncurry Shire Council has a water restriction policy that was implemented in Dajarra in 2007 and 2008. General observations during fieldwork indicated that many of the town's residents largely ignored these restrictions.

The corrosion of pipes and fittings results in the loss of water from the system, but the high per capita rate of town water use is also related to a demand that is excessive when compared to urban centres on the coast (Brisbane, for example). The use of water for lawns and dust reduction – potentially improving environmental health – is understandable in the arid climate experienced in Dajarra. Evaporative airconditioners use large quantities of water (GHD 2003), particularly when using hard, saline groundwater (Duell et al. 2006).

4.3 The consequences of the Dajarra water supply

Recent samples show that the town water supply in Dajarra fails to meet the Australian Drinking Water Guidelines (NHMRC 2004) because of the high mineral and salt content of the water.

> As can be seen [see Table 6], not only do the parameters listed exceed the guideline limits, but they exceed them by significantly large amounts and not only provide the town water with an unsatisfactory taste for residents but also will lead to excessive fouling, scaling and corrosion of metal fittings regularly exposed to the water. (Rounsefell 2009)

Chlorination, installed in 2007, ensures the town water supply meets microbial standards but the bore water is not treated for its aesthetic qualities. In general, the residents of Dajarra do not drink the town water but it is typically used for certain types of cooking (by the majority of the residents surveyed), household cleaning, washing of people and clothes. It is also regularly used on lawns and gardens, for dust abatement, different types of evaporative cooling, and in wading pools for children and associated water play (Long 2008: 4–5).

Sources of potable water for Dajarra residents include household rainwater tanks, bottled water, water from the railway bore on Carbine Creek and water collected from waterholes. The Cloncurry Shire Council has arranged for rainwater tanks to be filled with water carted from proximate, potable sources that included good local bores (e.g. Pearce's Bore and the bore at Phosphate Hill mine) and the Mt Isa town supply. In 2008, one delivery of water (of uncertain origin) by tanker truck was rejected and the rainwater tanks emptied because of the foul odour of the carted water.

8 Generally, the cost of installing meters, which allows for direct charges for water, would fail public benefit tests in small, remote settlements.

Table 6: Example data for routine water quality monitoring of Dajarra town water (17 April 2007)

Parameter	Dajarra town water result[1] (West End result)[2]	Guideline limit[3] (aesthetic)	(health)	Notes
Total hardness (mg/L as CaCO3)	1080 (1510)	200	--	60-200 mg/L good quality >500 mg/L severe scaling problems
Temporary hardness (mg/L as CaCO3)	318 (258)	--	--	>200 mg/L leads to excessive scaling of pipes and fittings --
Chloride (mg/L)	689 (1210)	250	--	--
Sodium (mg/L)	204 (387)	180	--	Taste threshold High concentrations of sodium may be a health risk to people with hypertension and congestive heart failure.
Total dissolved solids (mg/L)	1680 (2630)	500	--	<500 mg/L good taste >1000 mg/L excessive scaling, corrosion and unsatisfactory taste
Sulphate (mg/L)	183 (328)	250	500	> 500 mg/L can have purgative effects

1 Queensland Government water analysis report for bore-reservoir town water at Dajarra School sampling point (17 April 2007)

2 Queensland Government water analysis report for bore-reservoir town water at West End sampling point (17 April 2007)

3 Australian Drinking Water Guidelines (NHMRC 2004)

Source: Rounsefell 2009

4.4 Potential effect on community health

Some Dajarra residents have claimed that drinking the town water has caused diarrhoea. Residents have avoided drinking the water because of its taste, but also because of the potential effect on health. According to the nurse working at Dajarra in 2008, children visited the health clinic to request drinking water. There is anecdotal evidence that the scarcity of drinking water increases the consumption of soft drinks, which may have long-term consequences for health (Bailie et al. 2004). The cost of bottled water and soft drinks adds to grocery bills and reduces potential expenditure on food.

4.4.1 Bathing and cleaning

Long (2007) recorded the bathing and cleaning problems associated with the hardness of the town water. Town water causes scale and staining of bathroom fixtures, shower trays, baths, sinks and toilet pans. The bore water affects the longevity of both washing machines and clothes that are washed in the water, with much higher concentrations of detergents required. In her audit of water use in Dajarra, Rounsefell (2009: 3) found that:

> Washing machines were always run for the longest available wash time setting by residents as the hard water meant that clothes did not clean very well and surplus chemicals needed to be used to try and create a lather. If the washing machines were used for a hot or warm wash cycle, they tended to last a shorter time before breaking down. This is suspected to be due to the temporary hardness in the water precipitating out when heated and reducing efficiency/causing erosion.

4.4.2 Corrosion of water infrastructure

Metal supply pipes, junctions, valves, taps and appliances are corroded by the high salt content in the bore water. Corrosion results in leaks that increase the demand on the reservoir supply and the pumping equipment. The very high water consumption recorded in 2001 was partly attributed to excessive leakage of water from the distribution system (Maunsell Australia 2001).

In hot water systems, the high mineral content of the town water results in rapid and excessive scaling of heating elements, corrosion of the tanks and leaking fittings. This combination of effects contributes to the high electricity consumption in Aboriginal households in Dajarra. The poor water quality has led to a reliance on electrical hot water systems after the failure of solar hot water systems installed in the 1980s (see Lloyd et al. 2000).

In Dajarra, there is widespread use of town water in sprinklers to water the lawns and gardens surrounding houses and public buildings. Lawns are preferred for children's play, aesthetic appearances and to reduce dust (see Long 2008). The use of hoses and sprinklers on gardens results in the aggressive corrosion of structural steel columns, stair stringers on housing and steel fences.

Figure 2: Examples of the corrosive effect of Dajarra bore water on structural steel and the scale that affects plumbing fixtures

Photographs by Tim O'Rourke

4.5 Evaporative airconditioners

In arid regions, with hot dry climates, evaporative cooling is generally more efficient and effective than refrigeration-type airconditioners. A comparison of evaporative and refrigerative airconditioners in Longreach, western Queensland, demonstrated the difference in running costs between these two systems. The evaporative airconditioners used 21% of the electricity consumption costs of running a refrigerative system ($481 compared with $2 288 per year). Adding the cost of water to the evaporative system increased its running cost to 28% of the refrigerative system; however, maintenance was not included in the case study costing. (GHD 2003: 8–9.)

Evaporative airconditioners were retrofitted to the State housing stock in the early 2000s. Installed on the roof, on one side of the ridge capping, all of the units were located on the same roof plane that was used to collect rainwater to fill the household rainwater tank. As well as contamination of rainwater, the bleed from the evaporative airconditioners has resulted in the corrosion of gutters, roofs and metal downpipes. Several residents reported the tendency of the rooftop evaporative coolers to leak though the ceiling, although the cause of this problem was not identified. The poor water quality increases the frequency of maintenance of evaporative airconditioners, imposing an additional cost to Queensland Housing.

Evaporative airconditioners are effective in cooling houses in Dajarra and have the benefit of introducing large volumes of fresh air. Houses with evaporative airconditioners also had significantly lower electricity bills than the Jimberella houses fitted with refrigerative units, with airconditioning generally accounting for a large proportion of domestic power consumption (Rounsefell 2009; GHD 2003).

Figure 3: Roof-mounted evaporative airconditioners on the State housing

Photographs by Tim O'Rourke

4.5.1 Repairs and maintenance

Regular plumbing maintenance in Dajarra was impeded by the relatively high cost of bringing tradespeople from Mt Isa. Residents in State houses reported that problems could take months to be repaired after report of such defects (see Long 2007; Rounsefell 2009). Both housing agencies would wait until a number of faults were ready to be repaired before engaging a plumbing contractor. Jimberella, however, was able to respond promptly to minor faults, such as leaking taps, through the supply of fittings and hardware, particularly where the tenant had the skills to repair the fault.

Across Dajarra a number of residents[9] have regularly carried out repairs on their rental houses and those of their relatives, replacing tap washers and fixing cisterns and minor plumbing and drainage faults. Several residents had adjusted their rainwater collection system to capture more water or block the contamination from evaporative airconditioners. Long (2005) documented the self-constructed alterations and additions to the rental housing in Dajarra, which demonstrated a set of building skills present in the community.

4.6 Rainwater supply

Household rainwater tanks are the main source of drinking water for the majority of Dajarra residents. Storage capacity and contamination of the rainwater in tanks are problems identified in the study preceding this report (Long 2007). Three problems were identified with rainwater tanks: (1) the limited capacity of the tanks to both harvest and store water, (2) contamination of the tank by town water and/or leaves and debris, and (3) problems with tank stands.

In 2009, rooftop evaporative airconditioners on all of the State houses resulted in contamination of rainwater tanks attached to all but one of these houses. The town bore water from the evaporative cooler seeps onto roofs and flows into the rainwater tanks. During operation, the evaporative coolers produce a low but constant outflow of water from the bleed hose, a setting that is adjusted for water supplies with high mineral salts: the operation of the evaporative coolers concentrates the salt content of the bleed water. With use, salts also accumulate on the filter pads, resulting in water dripping from the pads. In

9 This number is difficult to quantify but at least six or more residents made repairs on their own houses. Anecdotally, this tended to occur more in Jimberella houses, partly perhaps because of the stability of the tenancy as well as the supply of hardware by the Cooperative (Stephen Long, pers. comm. December 2009)

addition to contaminating the rainwater tanks, the 'bleed' corrodes the metal roof sheeting, gutters and gutter brackets. The contamination of rainwater tanks affected 18 of the total of 43 houses occupied by Aboriginal tenants in Dajarra.

On houses with both gable roofs and pyramidal roofs the evaporative cooler was placed on the same plane as the rainwater collection system – half of the roof area for the gables and only one quarter of the roof area of the pyramidal roofs. The two duplexes, under one gable roof, had a cooler on each side of the ridge. In July 2009, at least one resident of a State house had blocked and diverted the section of gutter that collected the bleed from the evaporative cooler, but this reduced the capacity to collect rainwater to one quarter of the roof area. Many of the houses had disconnected the downpipes into the rainwater tanks to prevent contamination of water supplied by truck (as occurred in 2007 and 2008).

In early 2009, the badly corroded guttering on one State house, tenanted by a pensioner, was replaced and the new downpipe reconnected into the rainwater tank, contaminating the tank used to store carted water. The constant cycle of maintenance on State houses, predominantly by subcontractors from Mt Isa, ignores or is ignorant of the systemic problems arising from the quality of the town bore water.

> When household rainwater runs out people are forced to 'look elsewhere for water' and cart it from rainwater tanks on community buildings, from rainwater tanks on other houses, from good bores on neighbouring cattle stations and from creeks, dams and in some instances gilgais. People meet their demands for drinking water by travelling to alternative supplies. Carting drinking water is not an easy task for the aged or for those without a vehicle and in Dajarra some people are forced to cart water by foot either carrying water containers by hand or on prams. (Long 2008)

One Dajarra resident, discussing the problem of contamination of the rainwater tanks with Long (2008) commented:

> When I raised the issue of the contaminated rainwater tanks with [Queensland] Housing it goes backwards and forwards, [Queensland] Housing says it is a [Cloncurry Shire] Council problem and Council says it is a Housing problem.

Long (2008: 74) reported that in a meeting about contamination of rainwater tanks, Queensland Housing, the representative of the State, referred to the water quality as the cause of the problem, and argued therefore that the responsibility for the problem lay with the Cloncurry Shire Council.

Figure 4: The plastic drums on the three corners of this house in Dajarra are used to collect rainwater for drinking

The gutter (or barge roll), which drains to a rainwater tank on the fourth corner of this style of house, is ineffective during heavy rain. Bore water was being used in sprinklers on the grass in an effort to minimise dust.

Photographs by Tim O'Rourke

4.7 Proposals to improve the Dajarra water supply

Reports by engineering consultants (Maunsell Australia 2001; PPK 2001; Rounsefell 2009) outlined possible solutions to the water quality problem in Dajarra.[10] Dajarra residents have also expressed their opinions on options that might secure a source of potable water. The remainder of this chapter reviews the various options that have been considered to date and summarises a recent project to improve the supply of drinking water to the town.

4.7.1 Treatment of existing bore water supply

A reverse osmosis plant could be used to treat the existing bore water (from the granite aquifer) that currently flows from the town reservoir, and two reports have raised this option (PPK 2001; Maunsell Australia 2001). The capital, maintenance and operational costs of this type of treatment plant make this option expensive. The relatively large amounts of electricity used to operate a reverse osmosis system could be supplied by solar power, but this would add considerably to the capital cost of the system. Given the high rates of water use in Dajarra, a dual reticulation delivery system would minimise the volume needed to be treated, but raise the capital cost of the reverse osmosis option. A dual reticulation system would impose responsibilities on the consumers for demand management; however, such a system would be likely to increase the need for pricing to recover capital expenditure and/or fund maintenance costs (Pearce et al. 2008).

A reverse osmosis treatment system would require State or direct Australian Government funding, or contributions from both levels of government. Under the current arrangement, Cloncurry Shire Council would be responsible for the supply of, or sub-contracting of the maintenance of this type of treatment system, in addition to funding operating costs. In this situation, the treatment of the current Dajarra water supply to achieve potable quality could affect the budget for other municipal services without recurrent State or Australian Government funds. In settlements of similar scale to Dajarra faced with similar choices, the cost of this option can prove too expensive for the community (Pearce et al. 2008: 130).

Advances in water treatment technology, such as lower cost and more effective membranes for desalination and treatment of recycled water, should eventually lead to more cost effective treatment systems (CSIRO 2007: 32). Similarly, the introduction of new solar power generation technologies could reduce the operational costs of energy intensive water treatment systems.

4.7.2 Alternative groundwater supplies

In Dajarra, spending on water infrastructure has continued to develop bores that extract groundwater from the granite aquifer beneath the township, despite the low quality of the groundwater (Maunsell Australia 2001). In a survey of alternative groundwater sources, a hydrological report (PPK 2001) describes a geological formation about seven kilometres to the north of Dajarra that shows the possibility of a better quality bore water supply. Residents suggested locations for potential bore sites close to Dajarra based on historical knowledge, with this knowledge coinciding with the suggested location in the report:

> The area suggested for exploration (option C) lies approximately 7 km to the north of the township within the Haslingden Group and aerial photo interpretation suggests strong fracturing and faulting exists in this area. The aim of the project would be to target these fracture sets as they are most likely to yield the best quality and highest volume water. These units are sedimentary in origin, thus reducing the fluoride and potentially the EC (salinity) problem, and are upstream of any potential contaminants originating from anthropogenic activity. (PPK 2001: 5)

10 Two reports by McIntyre & Associates, in 1984 and 1986, were prepared on the town water supply in Dajarra. The reports are summarised by the Maunsell Australia report (2001: 10), but were unsighted by this author, despite attempts to obtain them.

Maunsell Australia (2001: 24) recommended the exploration of this new bore field site based on the findings of the PPK report and the relatively low capital cost of the infrastructure (estimated at $850 000 in 2001) required to connect to the existing town reservoir. In 2008, the Mayor of Cloncurry was aware of the potential new bore field and favoured this option as a solution to the drinking water problem. At that time, Cloncurry Shire Council had a small amount of money allocated to drill for this groundwater source, but apparently required a more precise location to warrant the expenditure ($25 000). To proceed on this option, Cloncurry Shire Council would need to prepare a planning report for submission to DERM and approach the relevant State and Australian Government departments for funding consideration.

The alluvial aquifer related to Carbine Creek was the source of good quality drinking water historically, via the Windmill Bore and Bore 12. In 2001, a hydrological report warned against the use of this supply for the local water supply, because of potential contamination from the town cemetery, refuse along the creek, and septic tanks (PPK 2001). Even if extracted upstream of these potential contaminants, this aquifer would be unlikely to supply the needs of the town, given the relatively high water consumption and flow variability of this type of aquifer (CSIRO 2009). Maunsell Australia (2001: 25), however, did recommend filtration and chlorination of the Windmill Bore supply as an option for one supply of water that met NHMRC guidelines.

The bore at the Phosphate Hill Mine, 60 km from Dajarra by road, has an abundant supply of good quality water. The cost of piping and pumping over this distance reduces the viability of this option. During 2007 and 2008, the Phosphate Hill bore water was trucked to Dajarra to fill the rainwater tanks.

Any new source of town water of improved quality will need to consider a dual reticulation system, which could use the lower quality bores to provide a supply for toilet flushing and gardening. The separate system would need a reservoir and pumps, small diameter reticulation system, storage located at each premise and the re-plumbing at each house to accommodate the changes. Given the available solutions, a dual reticulation system of potable and non-potable supplies should be considered in all future developments and also as an option to retrofit existing buildings.

4.7.3 Surface water storage option

Members of the Cloncurry Shire Council and representatives from Dajarra discussed the possibility of a dam on a local creek to the north-west of the township (approximately 4.5 km). The Mayor of the Cloncurry Shire expressed a preference for this option based on the improvement to water quality and cost (ABC 2009). The viability of surface storage in the region is compromised by low annual rainfall, the high variability of the rainfall, and very high evaporation rates. The proximity of the proposed dam catchment to the local rubbish dump could result in potential contamination problems. With the added benefit as a recreation resource, a dam had support from some community members. The report by Maunsell Australia did not investigate the feasibility of this option as a water supply, but it recommended further investigation of a dam as a possible option to improve water quality (Maunsell Australia 2001: 24–25, 38).

4.7.4 Greywater use

A reduction in demand on the town supply could be achieved with the use of treated greywater on gardens and lawns. Surveys of Dajarra residents by Long (2007) indicated that local people were familiar with greywater systems and considered them to be a method of conserving water. Potential health risks associated with domestic greywater use and treatment systems need to be carefully considered.

4.7.5 Rainwater collection

In 2009, there was a pressing need to improve rainwater collection on the Aboriginal residential buildings in Dajarra. Housing for the teachers and police were fitted with rainwater tanks that were not affected by evaporative airconditioners. The Dajarra Roadhouse relied on two 4000 L tanks (connected to a large roof area) to supply drinking water for the staff and guests, and these proved adequate during drought years. Of the public buildings, the primary school was relatively well supplied with rainwater tanks and an effective rainwater harvesting system, used to supply drinking water for the students and the kitchen. The large roof area of the Jimberella Hall and its offices was only connected to one 3500 L tank until 2008, when the Cloncurry Council arranged for three additional tanks to be installed. The provision of these tanks is discussed below.

4.7.6 Water tank case study

The mining-fertiliser company Incitec Pivot was involved in two community meetings at Dajarra, held in 2007 and 2008, which identified and prioritised infrastructure problems in the community. Incitec Pivot operates the Phosphate Hill Mine, 60 km by road to the east of Dajarra. In more recent times, mining companies have adopted various forms of community service obligation, ranging from specific employment schemes, sponsorships, and grants to local communities. Represented by Julia Shadlow-Bath, the community liaison officer for the Mt Isa region, Incitec Pivot engaged with Dajarra people through the Jimberella Cooperative. Given the proximity of the Phosphate Hill mine to Dajarra, the town was an obvious location for Incitec Pivot to deliver on its stated community responsibility. The previous owner of Phosphate Hill mine, Western Mining Corporation (WMC), had commissioned technical reports on Dajarra water supplies (PPK 2001) and funded drilling for new bores.

In the public meetings at Dajarra, involving Incitec Pivot and Cloncurry Shire and the ICC, drinking water was identified as a major problem. Incitec Pivot gave a grant of about $30 000 to the Cloncurry Shire Council to install rainwater tanks in Dajarra that would be available for public use. The following points outline the sequence of events during the installation of the tanks:

- Four 20 000 litre rainwater tanks were delivered to Dajarra in November 2008 and installed on open steel frames on concrete footings.
- Three of the tanks were located at the back of the Jimberella offices, collecting water from the long skillion roof.
- The fourth tank was placed adjacent to a school building in the school grounds. The offer to the school was accepted by the Principal without her knowledge of the purpose of the tanks: for use by Dajarra residents.
- For the three tanks installed at the offices, the height of the gutter relative to the top of the tank required the rainwater downpipe to be cut into the side of the tank wall (with silicon caulking), bypassing the (removable and cleanable) mesh filter entry point, and reducing the storage capacity of the tank.
- The tanks were installed without first-flush devices or other types of filter systems.
- Substantial rain in late December caused the base of the tank to deflect between the sparsely framed steel support structure.
- The tanks were emptied and additional steel members were site-welded to reduce the spacing.
- Further rain in January filled the tanks but caused the renovated steel structure to deflect with some of the welded joints appearing to crack.
- At the school, the Principal considered the renovated stand dangerous and disconnected the tank from the downpipe.
- At Jimberella, the tanks were emptied, the steel frame cut from the footings and concrete slabs were poured for the three tanks. The tanks were reconnected, using the same inlet, a legacy of the tank stand.
- The height of the tap and the lower inlet combine to reduce the storage capacity to around 70% of the 20 000 litre capacity.

- Despite being a source of drinking water, the installation of the tanks did not appear to follow Australian Standard guidelines.
- The large roof area of the Jimberella Hall is only connected to one 4500 L tank, with the majority of the roof catchment flowing to the ground.
- In March 2009, after an unusually good wet season, the new tanks were empty.
- The Dajarra School Principal requested the Cloncurry Shire Council to remove the steel tank stand and replace it with a concrete slab, as per the solution at the Jimberella Cooperative building. The Principal was told that it was the school's responsibility to remedy the problem of the tank stand.
- Given the lack of general public access to the school grounds (without permission), the Principal would not have accepted the tank if the general purpose of the added rainwater collection had been made clear prior to installation.

Two community meetings held at Jimberella Hall, organised by the Incitec Pivot community liaison advisor, identified the drinking water problem as a funding priority: the other priority was to install lights for the local airstrip, required for night landing by the Flying Doctor Service. From her position as a community liaison advisor, Shadlow-Bath observed that local government tended to expect support from mining companies for the supply of municipal services.

The water tank case study demonstrates a number of problems arising from the delivery of a relatively simple service. The optimal installation of rainwater tanks in Dajarra could have been achieved with a low level of planning and design skills, and a site visit to survey the public buildings used to harvest the rainwater. This type of project needs to be administered by either a shire engineer or a consultant civil engineer, or a building inspector or project manager with relevant technical background. As sources of community drinking water, the installation and maintenance of the rainwater tanks should comply with the guidelines of the *Rainwater Tank Design and Installation Handbook* HB 230-2008.

Although the intentions of the project were clearly supported by the community, once the modest grant was received there appeared to be little attempt to engage with the building owners about the location of the tanks. In case studies of water management in remote Aboriginal communities, Grey-Gardner found that 'communities have been engaged and willing to take on the responsibilities associated with water management activities' (2008a: 19). Responsibility for the management increased when systems were explained to community members.

Figure 5: Rainwater tanks installed at the rear of the Jimberella offices, in November 2008
Photographs by Tim O'Rourke

Figure 6: Rainwater tanks installed at the rear of the Jimberella offices, in March 2009
The small tank on the left of the photograph is the only tank that harvests rainwater form the sizable Jimberella Hall roof
Photographs by Tim O'Rourke

5. Desert Services that Work: Demand Responsive Services to Desert Settlements

Using the case study data, this section responds to the five research questions asked by Core Project Five.

Research question 1

What are characteristics of the interplay between demand and supply of services, according to the perceptions of consumers and service providers engaged at the local interface?

Dajarra people feel marginalised and ignored, with some residents angered by the failure to secure a potable water supply. Having endured the problems with water for decades, and after workshops, petitions and press releases, Dajarra people hold the Shire Council responsible for the lack of action (see Long 2007).

Consumers acknowledge that improvements have been made to the supply system, and that extensive work to the storage and reticulation system improved water pressure to Dajarra. Despite improvement to the water storage and distribution system, faults in the bores and pumps resulted in periods of very low pressure in the town. The service response to these faults must first travel by road from Cloncurry, with the system monitored from Cloncurry. Partly for this reason, interviewees expressed unease with the absence of any local control, or local capability to repair the system (see Long 2008: 9).

There is widespread discontent in the Aboriginal population of Dajarra at the general level of service provided by Cloncurry Shire Council. Dajarra residents considered that one local full-time employee on the Council staff was inadequate for the town's needs. Early survey work for this report recorded local opinions on the Council and levels of municipal service:

> Interactions between Dajarra and Cloncurry Shire Council would be improved through the establishment of a Dajarra-based CSC workforce that is drawn from the Dajarra population. Elsewhere in the region there are significant examples of the capacity of Indigenous people to contribute to local government services and main roads construction and maintenance (e.g. Boulia, Bedourie and Camooweal). There are strong feelings in Dajarra that CSC should employ more Dajarra people as workers in order to improve the council's work in Dajarra (such as improving the amenity of the town). Furthermore, it was stated that CSC should employ people on full wages to do these things instead of the current situation whereby CDEP crews are doing work that is the responsibility of local government. (Long 2008:10)

A new mayor was elected to the Cloncurry Shire Council at the local government elections in 2008. After his election, the Mayor visited Dajarra to meet with residents in the Jimberella hall to discuss local concerns. Dajarra residents saw this as a positive start to his term, given the absence of visits by the previous mayor (over two terms).

At the time of interview in 2008, the Mayor was preoccupied with negotiating with the State Government to secure a town water supply for the township of Cloncurry. Associated with a large pastoral property close to Dajarra, the new Mayor was familiar with Dajarra's water problems. He discussed a range of solutions to the drinking water problem, with a new bore field approximately seven kilometres to the north of the town being his preferred solution. He stated his intention to remedy the water quality problem in Dajarra, but at the time his priority was the Cloncurry supply, and the Council funding for Dajarra was limited at the time to $25 000 for exploratory drilling.

The inability of the Council to retrieve a consultant's report on groundwater at Dajarra (PPK 2001) suggested capacity constraints for a municipal administration in a shire of this scale and population – 3158 people in the 2006 census (ABS 2009). Staff turnover at the municipal level would also result in loss of 'corporate memory' of shire services. Skilled technical positions, such as a shire engineer, were difficult to retain given the distance from the coast and capital cities, municipal budgets and a relatively long period of high demand for engineering and construction professions (driven by mining and construction). The capacity to attract and retain skilled staff is a problem affecting remote settlements in regional Queensland, and leading to unpredictability in desert regions (Stafford Smith 2008: 9). This turnover of staff, combined with the relatively short political cycle, appears to have affected the resolution of the Dajarra water problem.

Research question 2

What are the conditions that permit successful practice to develop between consumers and service providers?

In Dajarra, the Jimberella Housing Cooperative operates as both a local, multifaceted service provider, and as an intermediary between the Aboriginal community and a variety of government and non-government service providers. Jimberella provides a point of contact between the Aboriginal community in Dajarra and service providers, and operates as a de facto representative body for the people of Dajarra. Jimberella staff and board members have the capabilities, backed by limited resources, to engage with external organisations, service providers and industry; for example, the Cloncurry Shire Council and the mining companies. Community leaders in Dajarra, particularly members of the Jimberella Board, have used the news media to advocate for improved water supply (for examples see *North West Star* 2008; ABC 2009).

At the Jimberella Hall and offices, service interactions occur in a setting that is owned and controlled by the Aboriginal people of Dajarra. This well-designed office building attached to the Jimberella Hall is a focal point for agencies, contractors and consultants seeking to make contact with Dajarra people. The Dajarra case study suggests that an appropriate setting, controlled by the consumer, encourages

successful service interactions. Physical settings can be designed to accommodate culturally specific behaviours, but often ownership, personalisation and patterns of use determine the success of a place for interactions with outsiders.

Records kept at Jimberella Cooperative offices by the staff serve as a history of service interactions. Both Cloncurry Shire Council and the Mt Isa office of the ICC (FaHCSIA) were unable to find reports on the Dajarra water supply, which were quickly retrieved from the Jimberella archive. At the time of the request, the ICC was undergoing another reorganisation and name change. Local organisations, which both represent the consumer and retain records of service delivery and the history of interactions, can influence successful practice. Without this historical data, attempts to improve the service delivery, or manage demand, can be repetitive and inefficient.

Local administration, record keeping, research and advocacy skills could be improved with support and training. There is also a requirement for consistent and ongoing supply of knowledge and independent advice related to services, preferably delivered in person to the Jimberella Board and administrators. The proposed changes to the function and funding of Jimberella in 2008 provides one example of the need for this type of support. A four-page pamphlet, and limited consultation from the State Government, outlined four choices that the Jimberella Housing Cooperative and Dajarra residents could make regarding their future. The choices ranged from transferring all housing assets to the State, to amalgamating with other rural housing organisations to form a regional housing service provider. This was a decision of great importance for the people of Dajarra that involved considerable complexity.

Research question 3

At what scales of governance should different service delivery functions be assigned to optimise both demand- and supply-based criteria?

The requirement to sustainably manage water on the scale of drainage basins, catchments and larger regions by necessity involves the State as the primary regulator of water supply and water service providers. In Queensland, management of water resources at the scale of catchment and drainage basin gives limited opportunities for the representation of Aboriginal organisations in developing water resources plans and involvement in natural resource management.

In regional Queensland, local government provides drinking water services – in the case of Dajarra, both owning and managing the water distribution system. In south-east Queensland, water assets have been removed from local governments to create the state-owned SEQ Water Grid, managed by new State statutory authorities. The Queensland Government is now directly accountable for water supply security and drinking water safety. Councils still own the distribution infrastructure and will be responsible for the delivery and sale of water to consumers.[11] This major shift in ownership of water aims to develop consistent service standards for an urbanised and relatively densely settled region. Larger regional centres have adopted this reform but it is likely that the smaller, regional shires will continue to manage both treatment and distribution of drinking water supply.

Remoteness, small populations and tight budgets can limit the capacity of shires to retain engineering and technical staff. This deficit in technical capacity at the municipal level will frequently mean that expertise is supplied by the State government, either directly or through funding programs. The Queensland State Government has been open in their view on the service expectations of people living in remote settlements. Responding to press reports on the conditions for the Aboriginal population of Urandangi (to the east of Dajarra), Premier Bligh commented:

11 The distribution/retail entities are to be made of council groups, scheduled to begin operation in 2010 (see Queensland Water Reform Commission 2009).

> Many people choose to live in these very remote places because of other lifestyle reasons, and understand, I think, that not every service is going to be available to them ... Having said that, I think there is significant opportunity for us to work with small towns in Queensland to develop alternative sources of power such as solar thermal. (ABC 2008)

Notwithstanding that there is State and local government responsibility for water service delivery, studies across remote Aboriginal settlements argue for greater community participation in the management of water supply (Beard 2006: 9; Grey-Gardner 2008b; FRDC 1994: 169). In a community such as Dajarra, the key to effective participation would be through integrating community involvement with a local government administration that has a long history as the water service provider. This method of water management contrasts with discrete Aboriginal settlements that have greater autonomy than Dajarra, such as Doomadgee and Gununa.

Reducing demand through changes to behaviour requires support and funding from municipal and state governments, as has been the case in south-east Queensland where an extended media campaign, in addition to regulation, was successfully used to reduce water use.[12] Likewise, subsidies from both state and local government have been used for household fixtures and water tanks across much of urbanised Australia. The remoteness should not preclude towns like Dajarra from sharing in these services.

The suite of problems caused by the quality of water at Dajarra provides insight into the administration and delivery of houses by service providers operating from two levels of government. In Dajarra, State control of housing can be compared to a Commonwealth-funded housing organisation, over a period of almost 40 years. In the Dajarra case study, the Aboriginal Housing Organisation, Jimberella Cooperative, appears to have been more successful in providing housing, based on tenancy and the maintenance of housing (Long 2007). Jimberella is more successful at maintaining occupancy of its housing stock than Queensland Housing. The State is regarded by tenants as a less flexible manager of housing. Anecdotally, they are slow to respond to requests for repairs and maintenance, and these requests need to be phoned through to Mt Isa, usually through Jimberella offices as few State housing tenants have a phone.

Three new Jimberella houses, delivered by the National Aboriginal Health Strategy, represent a major improvement to the design of houses in Dajarra. Despite cost overruns and delivery problems (including the failure to maintain the local labour component), the Commonwealth program embraced an architectural service that consulted with the community and adhered to the National Indigenous Housing Guide.

Contractors from Mt Isa are used for the repairs and maintenance of State Housing: this includes gardening, for which Dajarra CDEP works are equipped but lack sufficient tasks. The location of low-set houses in a flood-prone area of Dajarra demonstrates a pattern of poor settlement planning and housing design; seven State houses were flooded in January 2009 (as well as many previous years). Recent repairs and maintenance of the State housing stock demonstrates a history of poor decision making, and an ignorance of lifecycle costing.

Research question 4

What are the service type and delivery style priorities of consumers within a specified budget framework, and what is their capacity to participate and willingness to contribute to services?

Aboriginal responses to a survey in Dajarra and Urandangi were modest in their desire for types of services (Long 2008: 81). The main services priorities were water, power, shelter and access (connection) to country. For several decades, the quality of the drinking water in Dajarra has been placed at the top of residents' service delivery priorities for the town. The town water supply service affects Dajarra residents in two ways: firstly, through a lack of drinking water, and secondly, the

12 Water supply authorities generally are required to implement demand reduction programs to demonstrate reduced consumption.

effects of hard, saline groundwater on housing, energy consumption and household items. In attempting to answer this research question, we can ask what is the relationship of Dajarra people to potential improvements to the quality of the water service, and, secondly, what contribution can the residents make to ameliorate the consequences of living with the current bore water supply.

Dajarra residents expect that the water supplied to their houses should be of drinking quality. Older members of the community remember a direct connection of a group of houses to the railway bore, which provided water suitable for drinking. Community leaders can clearly articulate the problem, the highest on their wish list of service improvements, and they have used different methods to advocate for change and are capable of constructively engaging in the discussion of service options. Participants in a survey expressed desire to engage with the Cloncurry Shire Council, though possible engagement options ranged from scheduled council meetings in Dajarra to the establishment of a representative position for a Dajarra resident, whose function would be to attend meetings in Cloncurry to advocate for Dajarra (Long 2008: 10). Long (2007) also recorded a desire for greater participation on the council workforce, in preference to CDEP employment.

The dependence on rainwater for drinking, sourced from sub-optimal collection systems, demonstrates the resilience of the Dajarra people. This resilience and a history of building self-constructed camps and extensions to houses indicate the capacity to participate in the management of household water supplies. Participation in design, planning and installation of rainwater systems is necessary to the ongoing maintenance and safety of this form of potable supply:

> Achieving safe and secure drinking water supplies in remote communities involves a mix of policy and technical investment. Of which, rainwater harvesting techniques should be considered as a simple system that can be maintained by community members. Our work has shown that rainwater harvesting when properly managed can be an effective and sustainable supply of drinking water in remote areas (including arid regions). (Grey-Gardner et al. 2004: 15)

A number of the more technically competent residents perform maintenance jobs for other householders in Dajarra.[13] There was evidence of minor adjustments to rainwater collection systems to increase the yield and prevent contamination from the evaporative airconditioners, although the latter practice was not commonplace – this may be a result of passive use of rented housing in combination with a poor relationship with the service provider. In the survey by Long (2008), some tenants indicated that responsibility for all housing maintenance and repairs lay with the housing provider.

Town water in Dajarra is unmetered at the connection to households. Water restrictions were in place during the fieldwork but they were rarely observed, with the regular use of sprinklers or hoses on lawns throughout the day. It is difficult to gauge the reaction of the Aboriginal resident to the introduction of water rates, but over time this seems inevitable given the direction of Australian water policy and legislative reform. For the majority of Aboriginal residents in Dajarra, a charge for water would most likely result in an unwanted financial burden and 'utility stress' (Pearce et al. 2008).

Improvements to the sustainability of the water-energy-housing nexus involve changes in demand behaviour and, depending on the extent of systemic changes, household responsibility for managing residential equipment. Rounsefell (2009) recommended a range of residential measures to gauge water and energy consumption, and use of the data to educate consumers to engage in conservation and cut their expenditure on these utilities.

13 These members of the community tend to be men aged in their late 50s and older, who have had a varied and active work history, many employed in maintenance jobs on pastoral stations.

Research question 5

What are the critical issues and strategies to improve the service system, including the strengths and weaknesses of different technology and governance options?

The service system in Dajarra is affected by the town's remoteness, low population size, and the absence of a proximal, high-value industry. These reasons partly explain the contrast between recent spending on water quality and security in the capital cities compared to hundreds of small remote settlements across Australia:

> It is not possible to improve all drinking water supplies in the short term and governments and water authorities, in association with their customers, need to make practical decisions on the most appropriate course of action. This requires a balanced consideration of the health risks, the cost of treatment and public desire for improved water quality. (FRDC 1994: 38)

A general perception that lower service standards are acceptable in remote communities may partly explain government complacency in dealing with problems in outback towns, even with essential services such as drinking water (see ABC 2008).

Dajarra, along with other regional towns with high Aboriginal populations, is on the periphery of the Queensland Government's recent Aboriginal policy priorities. Discrete Aboriginal communities in the Gulf and on Cape York Peninsula and Palm Island were the focus of the policy, funding and administration. Senior State bureaucrats acknowledged that, in 2008, policy was directed toward results that could provide positive responses to media criticism. This combination of politics, policy and the press is further compromised by, with few exceptions, the media's shallow analysis of complex issues.

An analysis of the various options to either fix or ameliorate the Dajarra water problem reinforces the need for a prompt exploration of the potential new bore field, suggested in the PPK report in 2001. This initiative is the responsibility of the Cloncurry Shire Council. However, in 2009 large infrastructure spending on the water supply to Cloncurry was preceded by national press coverage orchestrated by the Mayor of the Shire. A key strategy to improve service systems is the effective use of the media to draw attention to critical local issues, and continued local advocacy to lobby State and Federal Parliamentarians. The skills required to advocate and lobby for a cause can be developed, but are helped by articulate spokespeople, speaking on behalf of the general community. Experience in administration and governance (Indigenous Housing Organisations, boards, representative bodies, committees, etc) helps to equip people with these skills. The advocacy also requires effective use of good quality data and advice on service-related problems.

In Dajarra, advanced technical solutions to the water problem, available to larger scale settlements of unquestioned viability, are generally considered to be costly to install and maintain. By way of comparison, a study of small settlements in South Australia also found this to be the case:

> The outlay for reverse osmosis maintenance appears unsustainable. The costs are presently covered by the municipal services grant, although the excessive water costs means a lower proportion of the funds are available for other environmental health services. In future, monies collected from householders for water will need to be 'amassed' for future capital and maintenance expenditure. (Pearce et al. 2008: 3)

In Dajarra, rainwater harvesting is sub-standard and well below optimal capacity. This situation would benefit from an increased responsibility of the householder (through education programs), and greater community participation in the installation and maintenance of systems, which requires the development of local technical skills. Although a level of technical capability exists in the older generations in Dajarra, the transfer of skill to the younger workers, many on CDEP, is less evident. Deficits of locally based technical expertise are common across remote settlements (Seemann et al. 2008: 14–16).

It is doubtful that the volume of housing stock in Dajarra is enough to sustain more specialised trades and specific vocational training (Seemann et al. 2008: 17). There is potential to explore a regional repair and maintenance service based on identification of culturally motivated mobility patterns (Memmott et al. 2006). In the Georgina region, this 'beat' could include Boulia, Duchess and Urandangi. Dajarra people have strong cultural ties to the Myuma Aboriginal vocational training facility run by Colin Saltmere at Camooweal. Plans to expand the range of training courses at Myuma, to include domestic building and repairs and maintenance, could help to create and maintain this capacity (see Memmott 2010).

This case study and findings from co-researchers demonstrate the importance of the distribution of service-related information that is comprehensive in its explication, and communicated through appropriate media and content. For many services and members of the community, face-to-face interactions and explanations remain the best form of information delivery. There continues an ongoing requirement for the exposure of people in remote towns and settlements to information related to choice, demand management, and innovations in service delivery. Comprehensive data, often requiring research, experimentation and evaluation, is sometime necessary to help with improvement to service delivery and the resolution of problems – fixing the drinking water problem in Dajarra, for example.

Particularly because of the remoteness of places like Dajarra, the community should be encouraged to use digital technologies to gain information about service-related issues, and to use the medium as a means of advocacy. Digital communication technologies require ongoing training and technical support (particularly given the rate of change in these technologies). In Dajarra, the local production of videos on history and Aboriginal culture, supported through Feral Arts, demonstrates the capabilities of Dajarra residents to use digital technologies. Locally produced video, which also involves interaction with the community, could be used as a medium to distribute information on water and energy conservation and use. Approaches to service delivery need to encourage information sharing and distribution both within the community (Long 2007: 35) and between communities in the region.

This report and earlier studies (Long 2007, 2008) found that the Jimberella Housing Cooperative was integral to the service interactions between the Aboriginal community in Dajarrra and both mainstream and specific service providers. The Cooperative provides both the setting and agency that enables a level of 'community control in the effective provision of services' (FRDC 1994: 169). A common theme running through recent (and earlier) literature on water and housing in remote settlements is the importance of community participation in the planning and maintenance of water services. This literature and this report suggest that strategies are needed that build on the existing capacity of Jimberella, as a local organisation, service provider, and service broker to the community. Yet criticism of Indigenous Housing Organisations (relevant to Dajarra with respect to rent arrears and other economic indicators of function) has resulted in moves to mainstream housing, now under the guidance of the Queensland Government. Policy makers need to be wary that the short-term economic benefits of reducing or removing Jimberella could be 'offset by long-term damage to the community at large'.[14]

Conclusion

In 2009, the prospects for Dajarra as a viable, small remote town remain promising. Dajarra's location, the existing physical infrastructure and social capacity combine to create economic opportunities for the township derived from mining, tourism and the pastoral industry. On the edge of the North West mining province, Dajarra has been used as a base for mining exploration on leases that show potential for future development (exploration activity based in Dajarra increased in 2007 through to 2009). A range of service opportunities could arise from the establishment of a mine to the south-west of the town, accompanied by greater prospects for local employment.

14 This partial quote is from Tony Judt's (2009) discussion of public transport policy and social democracy.

Although distinctly seasonal, the increase in domestic outback tourism also creates opportunities for Dajarra service providers, as increasing numbers travel the Mt Isa–Boulia–Winton road across the winter months. With the closure of the railway line, Dajarra ceased to be a major transport hub for the pastoral industry; however, the town remains a service centre for the local cattle stations. One Aboriginal family living in Dajarra provides mustering and transport services to pastoralists in the region, and local residents continue to work on the stations in the area. In desert settlements such as Dajarra, these actual and potential sources of employment can be 'variable, unpredictable and outside local control' (Stafford Smith et al. 2008: 125). However, the strong connection between the Aboriginal residents of Dajarra and the place, and their demonstrated resilience, contribute to the viability of this settlement.

The water problem in Dajarra consists of two interrelated parts: the municipal supply of town water and the use of rainwater as the primary source of drinking water. The Dajarra water supply is drawn from an aquifer located beneath the town. The hard, saline groundwater does not meet Australian Drinking Water Guidelines, and the chemical characteristics adversely affect housing and lead to the high residential use of electricity.

This report indicates that the town supply of quality water has remained a problem because of the perceived cost of producing potable water, combined with a limited financial, technical and administrative capacity at the municipal level, and a history of political inaction. To their credit, the Cloncurry Shire Council acted on problems with the water supply in the 2000s; however, the infrastructure spending only improved the storage, treatment and distribution system of the non-potable groundwater.

The drinking water problem is one of geography and standards. Political will to fix the problem is affected by a general acceptance of lower service standards in remote settlements:

> The availability of adequate volumes of water of good quality within reasonable distance cannot always be guaranteed for communities in remote locations. If the water quality standards are stringently applied in these circumstances the cost of providing high quality drinking water will be prohibitive. (FRDC 1994: 36)

The Premier of Queensland expressed a view that people in remote settlements accept lower service standards, when commenting on the reported condition of housing, water and energy in Urandangi in 2008 (ABC 2008). This view poses the question: compared to urban centres, how low should service standards be allowed to fall?

In 2001, a report on the water supply identified a potential new bore field, seven kilometres to the north of Dajarra, that could possibly be the source of better quality water. Historical knowledge in the community of previous bores, now capped, reinforced the potential of this option. Although this option is known to members of Jimberella Cooperative and the Cloncurry Shire Council, it remains to be seen whether, after eight years, investigative drilling could proceed to confirm its viability.

Without a new bore field, technical solutions (reverse osmosis) can solve the Dajarra water problem, but this would require a relatively large capital expenditure and recurring costs. The solution requires a degree of creativity, considerable technical expertise and community participation. The solution to the town water problem must quantify the water/energy nexus in Dajarra, for both the service provider and the service user. A move to metered supply by the Council, to recover both fixed and variable costs, will require State or Federal subsidies given the 'utilities stress' that exists among Aboriginal tenants due to their high electricity bills.

As the primary source of drinking water, rainwater harvesting in Dajarra is poorly planned and substantially below the collection capacities of all but the three new houses, completed in 2009. Approximately 40% of Aboriginal housing in Dajarra has no supply of potable water because of the contamination of rainwater tanks by the roof-mounted evaporative airconditioners. The inadequate

supply of rainwater for drinking in Aboriginal households is largely the responsibility of the housing providers, Queensland State Housing and Jimberella Housing Cooperative, established and funded through the Australian Government. The Cloncurry Shire Council, most likely through the State Government, could provide subsidies and technical advice for the installation of residential rainwater tanks. The project to install rainwater tanks to public buildings in 2008 demonstrates a need to build and maintain the technical capacity of the Cloncurry Shire Council. Alternatively, an organisation such as the Centre for Appropriate Technology could be directly contracted through Jimberella Cooperative.

Potable water supply and security would be improved by the installation of optimal rainwater collection systems to all houses, and the removal of the roof-mounted evaporative airconditioners and their replacement with wall-mounted units. Simple adjustments to the collection system would prevent contamination of the rainwater tanks; however, the area collected would only be 25% of total roof surface. Limited technical expertise is needed to improve the rainwater collection and, in contrast to costly solutions to the reticulated groundwater supply, this option could be implemented relatively quickly.

This case study and other research that examines water and Aboriginal settlements (Grey-Gardner 2008a; Beard 2009; Pearce et al. 2008; FRDC 1994: 169) argue for the participation of the community in planning and implementation of improvements to the water supply. There is a role for the Jimberella Housing Cooperative in managing, training, maintenance and monitoring of residential rainwater harvesting systems. This role would build on Jimberella's capacity as an information provider to the community and as a local archive of service data. However, for such a role to be successful there is a need for local and state governments to formally recognise and support such a role. At the residential level, there is a need to increase the responsibility of tenants for the maintenance and use of rainwater tanks for drinking water supply.

Residential surveys in Dajarra describe a desire from the Aboriginal community for increased levels of engagement with the Cloncurry Shire Council. This is both in the interaction between the community and the Council, and an increase in the participation of Dajarra workforce in local government services, if only on a small scale.

Despite a long history of using mainstream services in an outback town, the Aboriginal people of Dajarra retain a distinct identity as the 'Dajarra mob' and maintain distinctive Aboriginal lifestyles (Long 2005). The Jimberella Housing Cooperative operates as an intercultural service broker in an array of service areas, both formally and informally. In 2008, Indigenous Housing Organisations in Queensland were asked by the State Government to choose one of four options that would decide their future. The option to remove Jimberella (hand over all housing assets and maintenance to the State), or to reduce its role in the community, would result in the mainstreaming of housing services, though State Housing. The loss to the community would be the loss of an opportunity to build on the already extant capacity for community leadership, advocacy, education and the retention of 'corporate knowledge' of a long history of a diverse range of service supply and service demand.

Poor quality town water has implications for the health of Dajarra residents and it is untenable in 2009 that up to 40% of Aboriginal houses have no supply of potable water. Poor quality water increases the use of energy and the general cost of living in Dajarra, and affects the sustainability of the town. Future development requires an integrated approach to the provision of utilities, infrastructure and housing that recognises the interconnectedness of water, energy and housing and the influence of climate change.

Recommendations

The following section attempts to set out recommendations that will result in practical benefits to the residents of Dajarra, some of whom express a degree of 'survey fatigue'. One long-term Dajarra resident, when asked to be interviewed for a video documentary, refused our request on the grounds that she was sick of giving her views (on water and housing and tenancies) to different researchers with little to see in the way of improvements. She stated her intention to move to Mt Isa, as she was frustrated with the water quality and supply in Dajarra (we asked for an interview on a day when a pump failure resulted in very low household water pressure).

The recommendations range from relatively simple remedial building work to proposals for the exploration, and future implementation, of costly capital works. Drawing on the findings from the study, and the responses to the DKCRC Core Project 5 research questions (including the contributions of other CP5 researchers), the recommendations identify methods to improve service delivery to the people of Dajarra.

The evaporative airconditioners on all the State Government housing need to be removed from their rooftop location. Although evaporative airconditioners are suited to arid climates, their use with hard, saline groundwater can potentially make them less cost effective than refrigerative type units (Duell et al. 2006: 77). This comparison of the residential use of the two systems should include a lifecycle analysis that includes provision for a program of local maintenance. The choice between airconditioning systems needs to consider long-term plans to improve water quality in Dajarra.

Both State and Jimberella housing need to be fitted with optimised rainwater harvesting systems. The design and installation of the rainwater collection needs to comply with current standards (HB 320-2008 *Rainwater Tank Design and Installation Handbook*) and with a regime of maintenance and testing (see Grey-Gardner et al. 2004). This work could be organised through Jimberella and involve the training of local residents in the installation and maintenance of rainwater tanks for residential, community and public buildings. Previous research in arid regions argues for local participation in the design and implementation of a rainwater drinking supply (Grey-Gardner 2008a). With training, support and minimal equipment, it would seem well within the capabilities of Dajarra people to install and maintain rainwater systems across the town.

Jimberella should be supported to retain ownership and management of the Cooperative's current housing stock and community buildings. This support from the State Government needs to include ongoing financial and training assistance to improve the capacity of Jimberella as a multi-purpose service provider in the region.

Jimberella has maintained a repository of files and corporate memory on the history of service interactions between Dajarra residents and the Australian and State Government departments and agencies, Cloncurry Shire Council, non-government organisations, and private providers of services. It is essential to maintain and increase this capacity to help prevent waste and repetition of poor practice in service delivery.

The Jimberella Housing Cooperative should explore various options to expand the type and amount of services that they currently provide. One option would be to explore the management of the existing State houses. This would increase the viability of local employment in housing and infrastructure services in the town. It could also permit greater coordination and planning for housing and utilities. Given Aboriginal mobility patterns in the Georgina region, Jimberella has the potential to offer services to communities that have cultural and historical ties to Dajarra: Urandangi is one example of a settlement with a chronically poor record of essential service delivery. Increasing the capacity of Jimberella and the scale of its customer base could lead to the delivery of mainstream services.

Cloncurry Shire Council, with funding support, needs to explore the options for a better quality groundwater source, as indicated in a report (PPK 2001). This was the primary recommendation of a report on the Dajarra water supply in 2001 (Maunsell Australia 2001: 35). A desktop study of geological reports could possibly reduce exploratory drilling costs.

The consumption of town water in Dajarra needs to be reduced through programs that change water use behaviour and improve and maintain the distribution system. At the residential scale, continued use of the current groundwater requires optimal plumbing hardware in association with a regular, local maintenance regime. The Jimberella Cooperative is well placed to implement significant parts of such a program. This recommendation could be informed by a cost–benefit analysis of an intensive maintenance regime, with local training and employment, compared with the current pattern of high water/energy use and frequent replacement of fittings and fixtures.

New buildings for Dajarra require a delivery method that integrates infrastructure and settlement planning with design solutions and technologies that reduce the consumption of energy and make optimal use of groundwater. All new buildings, and renovations to existing stock, need to include a dual reticulation system, for future potable water supply. Community and client/user participation in the design process is an integral part of this delivery method. Research is required into more appropriate architectural forms, materials and technologies for arid regions that currently rely far too heavily on housing types and material supplied from the east coast of Australia.

Advances in water treatment technology (CSIRO 2007: 32) and the potential of the region to develop sustainable energy generation may increase the future viability of the treatment of the groundwater sources from the aquifer below Dajarra. Reverse osmosis treatment of the bore water is unlikely to be a viable solution for the town under present conditions; however, if other sources of drinking water prove unfeasible then this option should be revisited periodically to explore the advances in technology and efficacy of water treatment systems.

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