Centre for Appropriate
Technology

THE AUSTRALIAN
NATIONAL UNIVERSITY

CRC for Water Quality
and Treatment

Swimming pools in remote Indigenous communities

Some basic information for planning a pool

Health Related Issues

Carmen Audera

Recreational Water Use in Remote Indigenous Communities

Andrew Peart and Cassandra Szoeke

The Investigation of Technical Issues Associated with the Construction and Management of Public Swimming Pools in Remote Aboriginal Communities

Jonathan Duddles

Assessing the Feasibility of Monitoring Chemical and Microbiological Hazards in Bodies of Water Used for Recreation in Remote Aboriginal Communities

Nigel Vivian

Copies of this report are available from the NCEPH website, http://www.nceph.anu.edu.au and the CRC website, http://www.waterquality.crc.org.au. Hard copy can be obtained from CAT by contacting Robyn Grey-Gardner on catcrl@ozemail.com.au.

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FOREWORD

These four reports on various aspects of swimming pools in remote Indigenous communities result from a collaboration between the National Centre for Epidemiology and Population Health at the Australian National University, which is a member of the Co-operative Research Centre for Water Quality and Treatment, and the Centre for Appropriate Technology Inc.

The Centre for Appropriate Technology has a long-standing interest in the provision of water and sanitation in Indigenous communities. The CAT researched and wrote the 1994 Water Report for the Human Rights and Equal Opportunity Commission and has convened three national workshops over the past decade to develop strategies that meet the needs and aspirations of communities of Indigenous people for water and water related activity in their communities.

The National Centre for Epidemiology and Population Health has spear-headed the Co-operative Research Centre for Water Quality and Treatment's involvement in this area. In 1997, NCEPH's Director, Professor Bob Douglas, and Adjunct Professor Tony Adams reviewed the Western Water Study, a collaborative project between the Central Land Council, the Northern Territory Department of Lands, Planning and Environment, and the Australian Geological Survey Organisation. One of their conclusions was for the further examination of the possibility of using community developed, owned and operated swimming pools as a way of improving health and as a focus for improved technical training in the control and maintenance of water resources.

The four reports included here provide the basic information any community considering building a pool should have at its fingertips.

In the first report, epidemiologist and medical practitioner, Dr Carmen Audera reviews the potential health benefits and risks of providing swimming pools in remote communities.

A CRC-funded summer student project allowed Andrew Peart and Cassandra Szoeke to systematically gather information from Indigenous communities with pools about the benefits, risks, logistics and costs of installing and maintaining a swimming pool. They also gathered information from communities without pools about where people swim, how this is managed and whether there are associated risks.

Centre for Appropriate Technology staff member and engineer, Jonathan Duddles, compiled the necessary information about construction and maintenance options and finally another CRC-funded summer student, Nigel Vivian, worked with CAT engineer, Bob Lloyd, to examine the feasibility of monitoring pool water for chemical and microbiological hazards.

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Bruce Walker, Director, CAT

THE AUSTRALIAN
NATIONAL UNIVERSITY

SWIMMING POOLS IN ABORIGINAL COMMUNITIES:

HEALTH RELATED ISSUES

July 1999

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CONTENTS

INTRODUCTION

Building healthy Aboriginal and Torres Strait Islander communities is one of the greatest public health challenges that Australia faces. Communities will be considered to be healthier only when the physical wellbeing of the individual and the social, emotional, and cultural wellbeing of the whole community has been improved.
Over the past decade several remote Aboriginal Communities have expressed a desire to construct swimming pools in their communities[i, ii]. Independently of other health programs that need to take place, the request for the construction of swimming pools by remote Aboriginal communities should be seriously considered.
Swimming pools could potentially be beneficial to the health, in its broadest sense, of the community. However, communities should carefully examine important issues such as health related hazards, technical aspects, costs and maintenance, before proceeding in their efforts to fulfil their wishes.

Health-related issues, both potential hazards and potential beneficial effects, are considered in detail in the remainder of this report.

HEALTH RELATED ISSUES

1. HEALTH RELATED HAZARDS OF SWIMMING POOLS

A. *Transmission of infectious diseases*.

A great number of micro-organisms have been isolated from water of inadequately maintained swimming pools. Some of these have originated disease outbreaks when affecting several people using that swimming facility.

An international literature review using Medline -1966-1998 and the key words “Outbreak* and swimming pool*” and “Infection* and swimming pool*” yielded 28 reports describing infectious disease outbreaks in which a swimming pool was identified as the source of infection (see Table 1). Fifteen of theses outbreaks occurred in the United States of America, six in England, four in Canada one in Scotland, one in Australia, one in Japan, and one in Greece with a total of 1197 people affected. In twenty-one out of the twenty-eight outbreaks described, a possible contributing factor could be identified. In seventeen cases deficiencies in the disinfecting equipment (ie defects in pool filtration system, plumbing defects, inadequate chlorination, etc) were found. In the other 4 cases either vomiting or faecal accidents had occurred. The swimming pools where these outbreaks occurred covered the range of possible conditions: open air, covered, paddling pools, hotel pools, recreation centres etc. Whirlpools have not been included in this search since they differ substantially from recreational pools. The characteristics of whirlpools facilitate the growth of micro-organisms: they use high temperature water and the volume of water per user is small. Although in normal circumstances these physical conditions would not apply to recreational pools, they should be kept in mind since high atmospheric temperatures and overcrowding can mimic them.

Responsible Agents:

- **Bacteria:** Pseudomona aeruginosa was a frequent cause of swimming pool related outbreaks (6/28 with a total of 205 documented cases), causing 1 outbreak of dermatitis, 3 outbreaks of folliculitis and two outbreaks of otitis externa. E. coli was also responsible for 2 outbreaks resulting in three cases of haemolytic uremic syndrome.
- **Protozoa:** Cryptosporidium was responsible for 8 outbreaks of gastroenteritis with a total of 254 reported cases and Giardia lamblia for 3 outbreaks of gastroenteritis affecting 108 persons.

- **Virus:** Adenovirus type 3, 4, and 7 were each responsible for four outbreaks of pharyngitis or pharyngo-conjunctivitis with a total of 334 people involved. There was one outbreak of each of the following: hepatitis A, Echovirus infection and diarrhoea due to Norwalk virus.
- **Fungi:** Dermatophytes caused two swimming pool related outbreaks of Tinea pedis

Apart from these micro-organisms which are responsible for the reported outbreaks, other pathogens such as coxsackievirus B3 and B4, Poliovirus, Papillomavirus, Hepatitis B virus, Molluscum contagiosum virus, Staphiloccocus aureus, thrichomona, amoebas such as Naeglaeria fowleri, amongst others have been isolated from swimming pool water. It is not clearly demonstrated in all cases that swimming pool water is a way of transmission of these diseases.

Preventive control measures: There are three types of preventive control measures that need to be put into effect in order to limit the spread of waterborne diseases in swimming pools: Hygiene measures, design measures and behaviour measures.

- Hygiene measures include appropriate levels of disinfectant in the water, cleaning and disinfection of changing rooms and showers and cleaning and disinfection of pool walkways.
- Design measures include that floors and walkways should be graded and drained, pool water inlets should be positioned in such a way as to ensure good water circulation, and wall and floor intersection of changing rooms should be covered for easy cleaning.
- Finally, behaviour measures such as showering before entering the pool, avoidance of nose blowing and spitting in the pool, and avoidance of entering the pool with infected wounds or other contagious diseases.

B) Drowning

Drowning and near drowning remain a common cause of childhood death and disability. An international literature review was carried out using Medline -1966-1998 and the key words “drowning and swimming pools”. Figures found in the international medical literature include the following:

- Among Californian preschoolers in 1993 pool immersion incidents were the leading cause of injury death and the eighth leading cause of injuries leading to hospitalization[iii].

- In Dade County, Florida for instance, in 1977 drowning accounted for 32% of all paediatric accidental deaths[iv].
- In Los Angeles drowning is the fourth leading cause of unintentional injury death in all age groups[v].
- In Australia drowning is an important cause of mortality in childhood, accounting for more than 30% of deaths due to injury in the 0 to 4-year-old age group in 1992-1993[vi,vii].

Drowning and near drowning can occur in different places (rivers, dams, swimming pools, sea, etc) and the proportion of deaths that they account for will differ from one place to another. A study done in 1996 on drowning in children under 15 from 1981 to 1993 in Tasmania reported that only 9% of drowning deaths occurred in swimming pools, 32% occurred in dams and ponds, and 21% occurred in a river[viii]. In Florida in 1977, 38% of drownings occurred in swimming pools 27% in canals, 13% in lakes ponds and rockpits, and 11% in the ocean.

Many studies from different countries including Australia report that the majority of drownings that take place in swimming pools are domestic or private apartment pools were there is no adequate supervision or fencing. Thus a study carried out in Harris County, Texas USA from 1983 1989 found that the majority of the 196 unintentional drownings occurred in swimming pools. Of these 50% occurred in apartment swimming pools and 33% in private home pools[ix]. In Los Angeles Count, where drowning is the fourth leading cause of unintentional injury death, there were 1587drownings (1130 males and 457 females) from 1976 through 1984. During this nine-year period the largest proportion of drownings (44.5%) for both sexes, and in almost every age group, occurred in private swimming pools[iv]. In a study conducted at Mater Misericordiae Children's Hospital, South Brisbane, QLD of the 139 children suffering from an immersion injury resulting in presentation at a hospital in the catchment area of The Mater Children's Hospital 100 had occurred in domestic pools[x]. A study of 60 consecutive cases of accidental drowning of children in the Auckland coronial district reveals that 41 of the fatalities occurred around the home and that the unfenced or inadequately fenced domestic swimming pool was the most common hazard[xi]. Another report from New Zealand claims that preschool drownings are common cause of death and that nearly all occur with the childs' everyday environment. Domestic swimming pools were the single most common hazard (39%). Sixty-three percent of these pools had no safety features[xii].

Drowning of Indigenous Australian children.

Total accidental-death rates in Indigenous children in Australia are higher than in non Indigenous children. However the proportion of deaths due to drowning out of the total number of deaths due to injury was always lower in Indigenous children when compared to non Indigenous children[xiii,xiv,xv]. In a study carried out in Western Australia[15] from 1983 to 1992, it was found that although the mortality rate from injury in non Aboriginal children between 0-14 was 4 times less than in Aboriginal children (10.9 compared to 40.6/100 000), 25.5% of the deaths due to injury in non-Aboriginal children aged 0-14 were due to drowning. In Aboriginal children 14.5% of the deaths due to injury were due to drowning. Another study carried out in the Northern Territory[14] states that, again, mortality rates from injury in non–Aboriginal children are half the rate in Aboriginal (29.7 compared to 64.2/100 000). Thirty eight percent of injury deaths in non-Aboriginal children are due to drowning compared to 15.5% in Aboriginal children. Fifty six percent of deaths due to drowning in these children occurred in private home swimming pools and forty four percent of the deaths occurred in other than a private pool (ocean, creeks, waterholes and tanks). A pool was involved in only 5% of deaths due to drowning in Aborigines.

No deaths due to drowning have occurred in any of the13 remote Aboriginal or Torres Strait Islander Communities that have a swimming pool. Deaths, however, have been reported, in other remote communities that do not have swimming pools when children swam in other places such as the river, waterholes and dam[2].

Drowning in adults are usually related to alcohol[xvi] or other drug consumption or pre-existing health problems.

Preventive control measures. Legislation regarding safety aspects of domestic swimming pools such as fencing has been introduced in different countries including Australia.

Public swimming pools should guarantee appropriate supervision of children who have permission to be at the pool and pool fencing must be used to protect unsupervised children, especially toddlers.

C) *Other Accidents*.

Accidents of different kinds are prone to happen in swimming pools if the appropriate design, behaviour and supervision measures are not well observed. The most common factors in fatalities and serious injury have been: prior health problems (heart trouble), alcohol or food before swimming, youth and inexperience, weak swimmers straying out of their depth, unauthorised access to a pool intended to be out of use, diving into insufficient depth of water, and unruly behaviour or misuse of equipment.

Preventive control measures. Premises should be designed in such a way as to reduce to a minimum the likelihood of accidents. Walkways, pool tank flooring and pool edge, access to pool etc. should be constructed following published guidelines[xvii] Swimming pool users should be encouraged not to perform activities which present inherent risks. Children should be closely supervised and hazardous behaviour forbidden. Signs should be posted alerting people to these potential hazards.

2) HEALTH RELATED BENEFITS OF SWIMMING POOLS

A) Beneficial effects of swimming pools on physical health.

i) Infectious diseases. Personal hygiene is one of the most important preventive measures for many infections. Swimming pools may contribute to improved personal hygiene and this could potentially reduce the incidence and prevalence of the following infectious diseases.

- **Skin infection** due to group A streptococci is an endemic disease in Aboriginal children. Apart from morbidity due to pyoderma (or skin infection) itself, these group A streptococcal infections may cause endemic and epidemic post-streptococcal glomerulonephritis which may have a role in the high incidence of end-stage renal disease seen in Aboriginal people[xviii] [xix]. The association between scabies, streptococcal skin infections and outbreaks of acute post-streptococcal glomerulonephritis has been well documented[xx, xxi]. It has been documented that Aboriginal schoolchildren aged less than 9, in whom pyoderma is most prevalent, have a significant reduction in the prevalence of pyoderma when they swim more than once a week in a chlorinated swimming pool[xxii].

- **Otitis media** with effusion is a very common condition in Aboriginal children and is the primary cause of deafness amongst Indigenous Australians. There is still controversy on the best treatment protocol but ear washing is still considered beneficial. The presence of swimming facilities in rural Australian Aboriginal Communities has been associated with a reduced prevalence of Otitis media in children[xxiii]. Health workers from remote Aboriginal and Torres Strait Islander Communities reported that the prevalence of chronic Otitis media with effusion decreased during the time that the swimming pool was open and children swam regularly[ii]. There is also a belief amongst many clinicians in the north of Australia that recreational use of swimming pools by children with perforated eardrums reduces the degree of otorrhoea. The irrigation of the nose and face may help clear away heavily infected and purulent material. The benefits obtained would out weight the possible risk of introducing a small water-based bacterial load[xxiv]. A review of rates of otorrhoea after swimming in children with grommets has shown that rates of otorrhoea were consistently higher in children who did not swim. Some studies reported that otorrhoea rates decreased even further as the frequency of swimming increased[xxv].

  A recent 5-year prospective controlled study of 533 children reported that unprotected swimming, regardless of depth or type of water was not associated with an increased rate of otorrhoea. The lowest otorrhoea rate was reported in children who swam, with no significant difference between those who swam and were given antibiotics and those were not given antibiotics?[xxvi]

- **Trachoma**. The prevalence of trachoma, a disease caused by repeated infection of the eye with *Chlamydia trachomatis*, is very high in Australian Aboriginal communities and is still the primary cause of blindness. The single most effective preventive measure for trachoma is face washing, which could be enhanced by swimming in a chlorinated swimming pool.

Although there is little documented evidence, health workers in communities which have a swimming pool, when consulted, claim that they have observed a reduction in the overall incidence of infections, specially skin, ear and eye infections coinciding with the periods that the swimming pool is open[ii].

- **Exercise promotion**. Swimming pools provide the possibility of performing exercise. Life expectancy of Aboriginal Australians is an average of 20 years lower than for non-Aboriginal Australian. A primary contributor is premature adult death due mainly to a very high incidence of cardiovascular diseases. Aborigines' lifestyle has been modified in such a way that, apart from very serious social and emotional distress (which by itself is an important health determinant), it has had a very negative effect on their diet, and physical activity. An inadequate diet, high levels of saturated fat intake, lack of exercise and obesity are important risk factors for cardiovascular diseases.

The World Health Organisation claims that [xxvii]: "regular physical activity is associated with lower mortality rates. Appropriate physical activity may be a valuable tool in therapeutic regimens for the control and amelioration (rehabilitation) of cardiovascular disease, coronary artery disease, hypertension, congenital heart disease, peripheral vascular disease, obesity, chronic obstructive pulmonary disease, diabetes mellitus, musculoskeletal disorders, end-stage renal disease, stress, anxiety and depression, etc. Regular physical activity, independent of other factors, reduces the probability of coronary artery disease and early death. Participation in vigorous sports activities, such as jogging, swimming, tennis, etc., helps to protect against the development of hypertension, even when other predisposing factors are present. Physical exercise also contributes to the control of body weight. Consideration of the metabolic abnormalities in patients with type II (adult onset) diabetes indicates that they would make excellent candidates for an exercise program. Osteoporosis is an important health problem for the elderly. The best treatment available at present is prevention, and a high level of physical activity throughout life can result in a larger skeletal mass during old age".

Sport facilities in Aboriginal communities are scarce or absent. Swimming is an adequate sport for all ages and is most appropriate for hot climates.

B) Beneficial effect of swimming pools on social health.

The major causes of adolescent Aboriginal morbidity and mortality are preventable: they have to do with ways of living, with the social, cultural and physical environments that surround adolescents. Alcohol, smoking and the use of dependence-producing drugs, including the sniffing of petrol, glue and other volatile substances, is cause for serious concern for the future health and well-being of Aboriginal youth and their families. Petrol sniffing in particular, is an increasing problem in remote Aboriginal Communities in the Northern Territory, and the habit primarily affects adolescents and young adults[xxviii], a vulnerable and powerless group in both Aboriginal and non-Aboriginal culture. Strategies have been suggested to attempt to improve the social, cultural and physical environments and ameliorate the problem. A primary intervention should include, apart from education, involvement in cultural and recreational activities. Swimming pools could cover the recreational aspect and could also be a way of providing skills to youngsters by engaging them in tasks useful to the community such as supervising and teaching younger swimmers, acting as life-savers, organising competitions etc. Furthermore young people need gathering places, places where they can meet and communicate with other members of the community in a "healthy" atmosphere.

CONCLUSIONS

Swimming pools can provide the possibility of improving the health status of Aboriginal communities. There is evidence that the incidence and prevalence of infectious diseases in children that have access to swimming in clean water is lower than in those that don't swim regularly. Swimming pools could potentially improve social well being of community members, especially of children and adolescents. However, it is essential that certain prerequisites are fulfilled to ensure safety of swimming pool use by community members. These include construction, maintenance and supervision issues. There are a number of useful local government guidelines[xxix,xxx,xxxi]The characteristics of the community with regard to its geography, climate, customs, beliefs, intended use and so forth should always be kept in mind when choosing the most appropriate design, materials, technology and products.

There a number of different options to chose from for swimming pool maintenance. Although it is relatively simple with modern equipment and chemicals to maintain swimming pool water in a clean and safe state, a close supervision of the system is essential. In the majority of the documented swimming pool infectious disease outbreaks, a fault in the disinfection system or a misuse of chemicals was detected.

Drowning is serious health hazard, especially for children and particularly in conditions where there is inadequate fencing and/or adult supervision.

Communities considering building swimming pools must also consider their commitment and ability to maintain and supervise the pool.

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Appendix 1 – Table 1. Summary of search on swimming pool related infectious disease outbreaks from 1966 to March 1998

Year	Country	Type of pool	No cases	Microorganism	Disease	Identified possible contributing factor	Reference
1975	Minnesota USA	Whirlpool	32	Pseudomona aeruginosa	Dermatitis	Deficiencies in disinfecting equipment	JAMA 1976; 235(20) 2205-7
1977	Georgia USA	Private recreation centre	105	Adenovirus type 3	Sore throat, fever, headache, and anorexia	Defect in pool filtration system	Am J Epidemiolo 1980;111(2):229-37
1977	Georgia USA	Private recreational facility	72	Adenovirus type4	Pharyngoconjunctival	Inadequate amounts of chlorine	J Infect Dis. 1979;140 (1):42-7
1978	USA	Swimming pool	4	Pseudomona aeruginosa	Otitis externa		Health Lab Sci 1978;15(1):50-7
1978	USA	Health spa whirlpool	20	Pseudomona aeruginosa	Dermatitis		JAMA 1978; 239(22) 2362-5
1978	West Yellowstone, USA	Motels indoor swimming pool	14	Pseudomona aeruginosa	Pustular dermatitis	Inadequate disinfection procedures	Public Health Rep 1981 ;96(3):246-9
1980	Tennessee, USA	Health spa swimming pool	37	Pseudomona aeruginosa	Folliculitis	Equipment malfunction and pool had not been chlorinated for two days	Rev Infect Dis 1983; 59(1): 1-8
1981	London England	Public swimming pool	18	Pseudomona aeruginosa	Otitis externa	Chlorination inadequate	J Hyg Lond 1981; 86(3): 357-62
1982	Ohio	Public swimming pool	103	Norwalk virus	Diarrhoea	Pool chlorinator unconnected	Am J Epidemiolo 1982;116(5):834-9
1983	Vermont USA	Whirlpool	16	Pseudomona aeruginosa	Dermatitis		Am J Epidemiol 1985;122(5):915-7
1984	USA	Swim class	69	Giardia lamblia	Giardiasis	Poorly maintained	Am J Public Health 1984 74(2): 155-6\
1984	USA	Indoor swimming pool	117	Pseudomona aeruginosa	Folliculitis	Inadequate desinfection	Arch Dermatol 1984;120(10):1304-7
1985	New Jersey, USA	Indoor pool	9	Giardia lamblia	Giardiasis	Not sufficient chlorine levels	Am J Public Health 1988 78(6): 659-62
1986	Canada	Swimming pool in physiotherapy unit.	15	Pseudomona aeruginosa	Folliculitis	Structure repairs were needed	CMAJ 1986;134(8):909-13
1986	Canada	Hotel swimming pool	26	Pseudomona aeruginosa	Folliculitis	`	J Clin Microbiol 1986 23(3): 655-9
1988	Los Angeles	Outdoor swimming pool	44	Cryptosporidium	Cryptosporidiosis	Resistance of Cryptosporidium to chlorine and inadequately	Am J Public Health 1992;82(5):742-4

						maintained pool filtration system	
1988	USA	Hotel water slide pool	30	Giardia lamblia	Giardiasis	Emptying of adjacent toddlers wading pool into water slide pool	Pedriatr Infect Dis J 1988; 7(2):91-4
1988	London England	Sports centre	67	Cryptosporidium	Cryptosporidiosis	Plumbing defects	Epidemiol Infect. 1991;107(3):497-508
1990	British Columbia Canada	Public swimming pool		Cryptosporidium	Cryptosporidiosis	Frequent faecal accidents	Can J Public Health 1993;8495) 334-7
1991	Puerto Rico	University swimming pool	27	Dermatophytes	Tinea pedis		Bol Asoc Med P R 1991;83(5) 181-4
1992	Scotland	Children's paddling pool	6	E.coli 0157	Haemolytic uremic syndrome		Epidemiol Infect. 1994 ;112(3):441-7
1992	Gloucestershire. England	Swimming pool	12	Cryptosporidium	Cryptosporidiosis	Faecal accident	Commun Dis Rep CDR Rev 1994;4(2):R20-2
1992	Louisiana, USA	Campground swimming pool	20	Hepatitis A	Hepatitis A	Connection swage line and pool water	J Infect Dis. 1992; 165(4):613-8
1993	Milwaukee	Resort swimming pool	51	Cryptosporidium	Cryptosporidiosis		Epidemiol Infect. 1995 ;115(3):545-53
1994	England	Outdoor swimming	46	Echovirus	Echovirus infection	Vomiting into the pool	J Public Health med. 1994; 16(2):145-8
1995	Sydney, Australia	Indoor swimming pool	17	Cryptosporidium	Cryptosporidiosis		Med J Aust 1996 16;165(11-12):613-6
1996	London England	Paddling pool	6	E coli O157	Haemolytic uraemic syndrome	Inadequate disinfection procedures	Commun Dis Rep CDR Rev 1996; 6(2): 33-6
1996	Andover-England	Open air	8	Cryptosporidium	Cryptosporidiosis		Commun Dis Rep CDR Rev 1997 7(12) 190-2
1997	Japan	Swimming pool class	88	Dermatophytes	Tinea pedis	Dermatophytes isolated from floors and public baths	Public Health 1997 ;111(4):249-53
1997	Okalahoma, USA	Community swimming pool	77	Adenovirus type 7	Pharyngitis	Malfunction of pool chlorinator	South Med J 1987;80(60:712-5

CRC for Water Quality
and Treatment

Co-operative Research Centre for Water Quality and Treatment

Recreational Water Use in Remote Indigenous Communities

**by Andrew Peart and
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August 1998

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Sharon Ingram was also instrumental in establishing this study and she and Michele Moloney collected and collated feedback from the communities on an earlier draft of this document.

Executive Summary

This is the first systematic gathering of information about the advantages and hazards associated with recreational water use in remote Indigenous communities. For 13 communities detailed information was gathered about swimming pools with an examination of the benefits, risks, and logistics of installing and maintaining a swimming pool. For 26 other communities, information was gathered about where people swim, how this is managed and whether there are associated risks.

Our results show that those communities with pools have been able to manage them successfully and that there is considerable anecdotal evidence of health and social benefits. The main health benefits are a reduction in skin sores and eye and ear infections. In communities without pools, children will find a way to play in water during the summer. In some cases this can be hazardous, as the water is stagnant, from contaminated sources or contains potentially dangerous objects, and there are associated risks to health and safety.

This report aims to be a useful resource for communities which are considering building a pool as well as for those which already have one and for potential funding agencies.

This report also provides the groundwork for a more systematic study of the health issues associated with recreational water use in communities. There are two ways in which such a systematic study could be conducted. One would be to compare health and well-being in communities with and without pools. The second would be a study of one community with data collection before and after pool establishment.

CONTENTS

INTRODUCTION

Swimming is a favourite pastime amongst children in many Indigenous communities throughout Australia. As well as this important social role, swimming may be an important contributor to hygiene.

While there are many stories about the benefits and risks of swimming in each individual community, there has been no systematic gathering of information across communities. Thus, this study was an audit of remote communities in Australia to collate basic information about recreational water use. For those communities which have them, detailed information was gathered about swimming pools with an examination of the benefits, risks, and logistics of installing and maintaining a swimming pool. For the rest of the communities - the majority - information was gathered about where people swim, how this is managed and whether there are associated risks.

Limited availability of swimming areas containing clean water could have a serious impact on health as there is an increased risk of the areas harbouring bacteria or viral agents. Swimming in an uncontrolled environment also carries the risk of hazards such as submerged branches or barbed wire.

Individual communities have reported that swimming in a chlorinated swimming pool reduces the incidence of infections, including eye, ear, and, especially, skin infections. However, the construction and maintenance of a swimming pool can be complicated and problematic, and if pool maintenance and/or supervision are inadequate, the pool itself can become a health risk for the community.

AIM

The aim of this study was to compile existing knowledge about recreational water use in remote Indigenous communities in order to provide a resource document for those interested in improving the safety of recreational water use, including the building of swimming pools in remote communities.

METHODS AND STUDY POPULATION

Indigenous communities were identified from information obtained from ATSIC regional offices. We excluded communities which were not primarily Indigenous settlements, ie those which were part of a non-Indigenous town. Communities were contacted if they were:

- likely to have more than 50 people and be located within a radius of five hundred km of Alice Springs (the desert region was our area of particular interest)
- likely to have more than 400 people and be located outside a radius of five hundred km from Alice Springs, but excluding those located adjacent to the sea.

Communities were faxed a copy of the questionnaire. There were different questionnaires for communities with and without swimming pools. A community contact was then interviewed by telephone. The interviews were conducted during January and early February 1998.

Forty-five communities without a swimming pool were identified: 17 could not be contacted despite numerous attempts and two had no-one available to respond to the questionnaire during the data collection phase. Information was therefore collected from 26 (58%) communities. Both the communities which responded and those which did not were widely dispersed geographically, but otherwise it is not possible to ascertain how representative the communities which responded are.

Fifteen communities with swimming pools were identified, of which two declined participation, giving a response rate of 87%. Three chose to respond to the questions by mail rather than by phone.

A draft report was sent to all participating communities and comments were collected between May and August 1998. We note that circumstances can change rapidly in these communities, so that specific details may have altered since this information was collected.

RESULTS AND DISCUSSION

Communities without swimming pools

The information collected is tabulated in Appendix 1.

Community characteristics

The majority of the communities (18/26) were in the Northern Territory, with another three in Western Australia, two each in New South Wales and Queensland and one in South Australia. The communities ranged in size from 60 to 1,600 people. Most, but not all, had schools and health clinics. Those without these services tended to be the smaller communities (Appendix 1, Table 1a).

Swimming area and water characteristics

In all of the communities contacted, swimming in a natural or artificial water source was reported (Appendix 1, Table 2a). The water source was usually a few kilometers from the community, but could be up to 80 km away. Swimming most commonly occurred in creeks or rivers or associated water holes. Less common sites included sewerage ponds, a stock tank, excavations associated with roadworks and dams.

In many communities swimming was only possible after rain (Appendix 1, Table 2b) and the water was reported to become stagnant fairly quickly.

Comments on water quality varied widely (Appendix 1, Table 2b). In just under half the communities the water was generally considered to be clean, in the rest it was not and in these it was often reported to be muddy or green.

A variety of animals were reported to frequent the swimming sites (Appendix 1; Table 2c).

Illness, hazards and accidents

Risks to health and safety associated with these swimming areas were reported by a number of communities (Appendix 1, Table 2c). Just over one-third of the communities reported that infectious outbreaks could be associated with these swimming areas; five reported drownings (although some occurred years ago) and a few reported minor accidents.

A number of communities which reported no illness or accidents added “but its only a matter of time, I’m sure” or “you’d think there would be though”. Reports such as “the dam is in a disused mine” and “the water hole near town is cleared of rubbish once a year” indicate the reasons for their concern. Another community was more specific indicating that: “lots of drums and junk is thrown into the dam, especially in the middle where it is deep, but the water level is always changing”. A different community reported “the river can be very dangerous as *anything* can be in it and the children dive in. Also the cattle wade in and there is farm run off in it so it can’t be healthy.”

Ill health and accidents were associated with most types of swimming areas, but rivers could be particularly hazardous. Although no accidents had been reported at Tjuwampa, that community reported “When it rains the river flows very rapidly and is very dangerous. Everyone knows not to swim there at this time”. In contrast, the community of Kalkaringi reported “hundreds” of deaths in the river until they built a bridge across it. These mainly occurred when people had been drinking in the main town and then walked through the river to get home. Now there are a two or three deaths each year. This is a large number considering the population of the community is only 600 and the river only runs from October to November! Three children drowned in one day last year when they jumped off the bridge into the water. Two drowned as they were swept away, the third jumped off the bridge up-river (not usual) and was swept under it, caught in debris and drowned. It is worth noting that young and drunk people are cited as those who most commonly drown.

In Nyrripi it was also reported that, from time to time, children fill the wheelie bins with water from taps. This is a problem because water is scarce and also because there is a strong risk of drowning if a child dips in head first. It does, however, illustrate that children will find anywhere to swim.

Supervision

In many communities swimming is probably unsupervised or only supervised sometimes (Appendix 1, Table 2c). Where the swimming place was some distance from the town, it was assumed that an older person would generally have taken the children there and would have then supervised them. Supervisors would generally have been parents, other adults or older children (adolescents). Although there seems to be no relationship between supervision and accidents, the swimming areas are often “in the middle of nowhere” and thus there is little or no assistance around. Another concern is that dangerous areas, like sewage ponds, are often “out of bounds” to children and thus they are likely to go there unsupervised and possibly not report any accidents occurring there.

Views about swimming pools

Table 3 in Appendix 1 lists whether or not the communities were thinking about getting a swimming pool and their knowledge of other communities with pools. The pool at Santa Teresa is best known, but many communities thinking of getting a pool do not know of communities which have one.

Not all communities stated health benefits when they were asked about the benefits and risks of having a pool. Fifty-two percent of communities stated cost/funding as the main barrier. For example, Laramba specified although they could afford to get a pool, it was the maintenance costs that they were unable to fund. Twenty-six percent of communities quoted the workload as a concern for establishing a pool; with statements such as “no-one wants the responsibility of maintenance...”. Fifteen percent of communities stated lack of expertise within the community as a difficulty in maintaining a pool and 7.4% of communities expressed a concern for adequate safety of a pool. Only 7.4% of communities expressed lack of water as a problem for keeping a pool. One community (3.7%) did not believe they had enough people to warrant having a pool. The population of that community (Irrungadji) was 200.

Communities with Swimming Pools

The information gathered from these communities is tabulated at Appendix 2.

Community Information

Eleven of the thirteen communities have a population between 140 and 1,200 people. The other two communities have populations of 2100 and 3,800 people. The communities interviewed are spread throughout a variety of locations, both desert and tropical, in WA, NT, and Qld (Appendix 2, Table 4a).

All have schools offering at least primary education, with the majority teaching up to year 10. Two of the communities have TAFE colleges.

All communities interviewed have a health clinic with full time nursing sisters and health workers. Three have at least one full time doctor (Appendix 2, Table 4a). Of the representatives of the community interviewed, all but one had been in the community for longer than one year (Appendix 2, Table 4b).

Pool Characteristics

The first pool was built in Santa Teresa in 1972. Eight of the pools were constructed within the period 1983-1989. Four were constructed within the period 1993-1997.

Two of the pools are indoors (inside a large shed). The others are outdoors. Style, size, and number of pools varies (see Appendix 2, Tables 5a-c).

In five cases the pool belongs to the community. Six belong to the council, one to the local school and one to the town. In all but one case, the pool was built under the initiative of the group which now owns it. The exception is Santa Teresa where the construction of the swimming pool was done by the Catholic Mission, but it is now belongs to the Council.

One of the pools is built solely out of fibre-glass. One is built of fibre-glass and concrete, and the others are built solely out of concrete.

All pools have change rooms and toilets. All except one have showers available. Five have open air showers.

All the outdoor pools have a fence, the majority being cyclone fencing topped with barbed wire. The majority of the outdoor pools have some sort of shadecloth erected as shelter. In one community all these shade coverings have been destroyed by vandals and not replaced.

In most cases school swimming carnivals are the only scheduled activity for children. At four of the pools toys are available, and at one pool toys were available in the past but have all been destroyed and not replaced.

Four of the pools have a shop on the premises.

Pool Use

Daily opening hours vary greatly between communities. Some pools are open all year and some for only part of the year (Appendix 2, see Tables 6a).

The number of people using the pool each day varies greatly both within and between communities. It is mainly Aboriginal children who use the pool, though adults and non-Aboriginal children and adults do use the pool at times.

Pool Maintenance

In most cases there is at least one full-time caretaker responsible for maintenance. This person often has one or more people to assist them.

In 77% of cases the water source for the pool is bore water. In all cases sand filter systems are used. Chlorine is used in all the pools. The type of chlorine used varies however, including gas, liquid, and granulated chlorine. Other chemicals are used to varying degrees at different pools, including HCl, soda ash, cyanuric acid and alum (Appendix 2, Tables 7a-c). At one pool the chemicals in the water are not tested, but are kept at a level where they don't hurt the children's eyes. At all the other pools the chemicals are monitored at least once daily. In nearly all cases the pool water is changed only when the pool requires maintenance. Water loss due to evaporation and filter cleaning varies greatly between communities, depending on location and time of year (Appendix 2, see Tables 7a-c).

The main contaminants mentioned were dust, dirt, leaves, stones and insects. Brushes, nets, and vacuums are used at all the pools. Types of vacuums vary from small manual to large automatic models. Maintenance of pool and premises at the smallest pool takes one person about two hours per week. Time per day spent in maintenance of pool and premises at the other pools varied between one hour and twenty hours per day.

Most communities report that repairs are necessary to pumps and filter at intervals ranging from 2-3 times per year to every 4 years. In most cases all but the most major repairs can be carried out at the community.

All the pools have been closed for short periods (up to a week) in the past for reasons such as poor water quality, broken parts, disciplinary measures, and cleaning. Four of the pools have been closed for much longer periods (months or years) due to prolonged lack of appropriate maintenance.

Health Related Issues

In all but two of the communities swimmers are required to shower before entering the pool. Of the two communities which don't require swimmers to shower, one has no showers but requires swimmers to hose themselves down before swimming.

At the pools in WA communities, people may swim in bathers or shorts only (and T-shirts if they wish). At the other communities people may swim fully clothed.

At half of the pools, people may not be allowed to swim if they have a health condition such as open sores, an infection or are wearing a cast or bandage. At the other pools they have not found this to be an issue. At no pool is it necessary to have a medical check-up or certificate in order to swim.

Drinking, petrol sniffing, and illegal drugs are prohibited at all the pools. At all but one of the pools they have not had a problem with any of these. At the pool in the largest community there have been incidences of people drinking and sniffing at the pool. Supervisors there have found this difficult to stop.

Animals are not allowed on the premises of all but two of the pools. At those two pools the dogs may not enter the water.

Bacteriological testing is performed at six of the thirteen pools.

Six of the communities reported that no disease or outbreak had occurred which was attributed to the pool. One community did not know. Conditions reported by the other six communities as being possibly attributable to the pool included ear infections, hepatitis A, rotavirus, and sore eyes.

Eight of the communities reported that there had been no significant accidents at the pool in the last year. One community did not know. Accidents reported by the other four communities included children slipping on concrete surrounding the pool and requiring stitches; gravel rash from similar falls; a couple of broken arms from children misjudging jumps into the pool; a child swallowing and inhaling water and needing hospitalisation.

Aside from those listed , no negative health effects were reported to have been caused by the pool. Positive health effects noted included reduced incidence of skin, eye, and ear infections (anecdotal evidence only), higher standards of personal hygiene, and psychological and social benefits (Appendix 2, Tables 8 a and b).

Supervision

All the communities have one or more people who act as pool supervisor. All of these people have training in first aid, and at five of the pools they also have lifesaving qualifications.

Nine of the pools are covered by public liability insurance. Three communities were unsure as to whether they had insurance at their pool. One community had no insurance at the pool.

At one of the pools there are two men living on the premises who act as a nightwatch. All the other communities rely on locked gates and doors for night-time security. Four of the communities reported significant problems in the past with break-ins and vandalism. Break-ins may occur because people simply want to swim out of hours, or they may wish to rob the premises (eg stealing petrol from maintenance machinery). More than once the importance of a good fence was stressed. It is interesting to note that the indoor pool at Warakurna is one of the only buildings in the community not to have been broken into (Appendix 2, Table 9).

Finance

Overall costs for construction of pool and premises varied between $80,000 and $600,050 (Appendix 2, Tables 10 a and b).

Funding for the pools came from a variety of sources including: store money, grants, donations from community members, and special funds set up within the community.

Three of the pools charge an entrance fee. This ranges from 50c to $2.00. An average yearly maintenance cost is approximately $10,000-$15,000, though this can vary greatly depending on the size of the pool and premises. Funding for maintenance comes from a variety of sources.

Swimming in Other Places

At 11 of the thirteen communities, people regularly swam in other places before the pool was built (Appendix 2, Tables 11 a-d). At ten of these communities people still swim at those places, but three of these report much less swimming there since the pool was opened. The types of places (excluding the pool) where people are swimming include waterholes, creeks, rivers, dams, beaches, lagoons, billabongs, and a sewage treatment pond.

Seven of the communities reported that the water at their swimming place looked clean. In the others, contaminants such as sewage, discarded chemical drums, and blue-green algae were cited. All of the communities reported a variety of animals in the proximity of their swimming place.

Children swimming at these locations were generally unsupervised except when they had been driven there in which case they may be supervised by adults or older children.

Most of the communities reported no accidents at their swimming place in the last year. One of the communities reported a number of cut feet (cut on broken glass and coral) and two communities reported drownings (within the last fifteen years).

Most communities reported that it was unknown as to whether any diseases or outbreaks had occurred which could be attributed to the swimming place. One community reported several bouts of gonorrhea, eye infections, and infected sores that have been attributed to the swimming place. One community reported that coral spawn at the local beach has been known to cause severe infection if it comes into contact with an open wound.

Final Points

A number of issues were mentioned as being important to keep in mind when considering the construction of a community pool. These included security, supervision, costs, maintenance, and location (Appendix 2, Table 9).

Issues of supervision were raised many times throughout the course of the interviews. One of the main problems regarding supervision of swimmers is that very few people in the community are willing to act as supervisor. This can be due to a number of reasons, including: the need for appropriate qualifications; time commitments; pressure from family and friends to open the pool out of hours; and the possibility of expulsion from the community should there be a death while on duty. In many cases it was reported that the supervisor holds other positions of responsibility in the community and has taken on the job of pool supervisor on top of their other duties.

Another problem faced by a number of communities is lack of access to bacteriological testing. These communities are unable to get their water sample to appropriate facilities within the 24 hors or so that it remains a viable sample.

It should also be noted that the shop at the Ngkurr pool completely funds the maintenance costs.

CONCLUSIONS

Our results show that in communities with pools, swimming at other areas was reduced. In communities without pools, it was clear that children will find a way to play in water when it is hot. Perhaps the controlled environment of a pool will assist with monitoring this behaviour. Many communities from both survey groups stressed the social benefit a pool would have and such benefits have been documented (Golds et al. 1997). The health benefits of pools were mentioned with a reduction in skin sores and ear infections reported which has also been documented in a few studies (Carapetis et al. 1995; Hudson & Rockett. 1984). The health benefit of a simple increase in hygiene should also be noted.

We hope that this report will be a useful resource to communities which are considering building a pool as well as for those which already have one and for potential funding agencies.

This report also provides the groundwork for a more systematic study of the health issues associated with recreational water use in communities. There are two ways in which such a systematic study could be conducted. One would be to compare health and well-being in communities with and without pools. The second would be a study of one community with data collection before and after pool establishment.

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Appendix 1

Profiles of communities which do not have a swimming pool

Table 1a: Community information

Community	**Size of community**	**Aboriginal population (number and %)**	**Location**	**Distance to nearest large town**	**School**	**Health Centre**
NT:						
Ali Curung	450 people	430 (96%)	160km S of Tennant Creek	160km to Tennant Creek, NT	Years 1-7	Health Clinic; 2 registered nurses, 3 Aboriginal health workers.
Amoonguna	223 people	220 (99%)	15km E of Alice Springs	15km to Alice Springs, NT	Years 1-4	Currently in process of setting up.
Aputula	250 people	230 (92%)	420km SE of Alice Springs	420k, to Alice Springs, NT	Primary School	Community controlled Health Centre.
Areyonga	235 people	230 (98%)	240km W of Alice Springs	240km to Alice Springs, NT	Primary School	
Atitjere	180-200 people (varies)	180-200 (96%)	Approx. 200km NE of Alice Springs	Approx. 200km to Alice Springs, NT	Years 1-10	Health Centre with f/t nursing sister.
Elliot	403 people in town, 200 on outstations	400 (99%)	Half way between Alice Springs and Darwin	250km to Tennant Creek, NT	Years 1-11, high school by correspondence	1 sister, 1 nurse, 3 Aboriginal health workers, doctor visits once a fortnight.
Kalkaringi	330 people	280 (85%)	SW of Katherine	580km to Katherine, NT	Pre-school to year 7, high school for approx. 200	Health Centre; 2 sisters, 4 Aboriginal health worker trainees.
Kilminggan	183 people	180 (98%)	140km S of Katherine	40km to Mataranka, NT	Primary school, secondary may be done by correspondence	Aboriginal health worker, For medical care, 40km to Mataranka Health Clinic.
Kintore	Approx. 420 people	420 (95%)	600km W of Alice Springs	600km to Alice Springs, NT	School	3 Ngangkaris (traditional healers), 5 Aboriginal health workers, 2 p/t aged care community based workers, a resident Medical Officer, 2 registered nurses (1 a midwife), 2 administrators.
Laramba	300 people	300 (100%)	219km NW of Alice Springs	219km to Alice Springs, NT	Primary school	Health Clinic with f/t nursing sister.
Ntaria	600 people	575 (96%)	130km W of Alice Springs	130km to Alice Springs, NT	Primary school up to Grade 6	Health Clinic; 3 nurses, 4 Aboriginal health workers, doctor visits from Alice Springs two days per week.
Nturiya	160-180 people	156-176 (97%)	220km N of Alice Springs	17km to Tea Tree NT	No school, travel to Tea Tree for years 7-9	Health Clinic; sister comes once a week from Tea Tree, doctor comes once every few weeks.
Nyrripi	305 people	300 (98%)	450km NW of Alice Springs	450km to Alice Springs, NT	Primary to year 7	Health Centre; 1 male nurse, doctor comes once a month.
Ortippa Thura	60 people	60 (100%)	400km E of Alice Springs	400km to Alice Springs, NT	Ungraded primary school	Health Clinic attended once a month by a nurse and sometimes by doctor 7-8 times a year. Not attended in January.
Papunya	280 people	259 (93%)	250km W of Alice Springs	250km to Alice Springs, NT	Primary school. Secondary school by correspondence	
Tjuwanpa	815 people	800 (98%)				
Wallace Rockhole	142 people	140 (99%)	120km SW of Alice Springs	120km to Alice Springs, NT	Years 1-6	Health Clinic; 2 p/t trainee Aboriginal health workers. Hermannsburg Health Centre sister comes once a week, doctor comes once every 6 weeks.

Table 1a: Community information (Cont)

Community	Size of community	Aboriginal population (number and %)	Location	Distance to nearest large town	School	Health Centre
Willowra	470 people	460 (98%)	340km NW of Alice Springs	340km to Alice Springs, NT	Primary school	Health Centre with f/t nursing sister.
WA:						
Irrungadji	200 people	195 (98%)	On edge of Nullagynein, Western Desert, approx. 300km SE of Port Hedland	200km to Newman, WA	Primary and secondary schools in town of Nullagyne	Health Clinic in the town.
Lamboo Gunian	100 people	100 (100%)	Approx. 700km E of Broome	20km to Halls Creek, WA	No school, children travel to Halls Creek	Doctor visits community once a week. Hospital at Halls Creek.
Turkey Creek	400 people (dry season) 600 (wet season)	Depending on season (always >95%)	Half way between Halls Creek and Kununurra	Approx. 200km to Kununurra, WA	Primary and secondary schools	
SA:						
Pipalyatjara	270 people	256 (95%)	Far NW of South Australia, Pitjantjatjara Lands	Approx. 800km to Alice Springs, NT	Primary and secondary	
NSW:						
Toomelah	505 people	500 (99%)	Northern border of NSW	72 miles to Moree, NSW	Kindergarten-year 6. Years 7-12 go to Boggabilla (9 miles away)	
Walhallow	170-200 people	170-200 (98%)	30km from Quirindi	30km to Quirindi, NSW	Kindergarten-year 6	Health Centre; Aboriginal Education Officer organises visits by doctor once a week. Close to Quirindi hospital.
QLD:						
Hopevale	1200 people	Approx. 1180 (98%)	46km NE of Cooktown	Approx. 400km to Cairns, QLD	Years 1-7	Health Centre.
Normanton	1600 people	Approx. 1300 (80%)	Approx. 600km W of Cairns	Approx. 600km to Cairns, QLD	Primary school	Aboriginal Health Centre and hospital.

Table 1b: Information about the person answering the questionnaire

Community	Person answering questionnaire	Position in community	Time in community
NT:			
Ali Curung	Mr Bruce McCrae	Council Clerk	3 months
Amoonguna	Mr Barry Byerley	Council Clerk	22 months
Aputula	Ms Rosemary Matasia	Office worker	7 years
Areyonga	Ms Perina Oliver	Administrator	2 years
Atitjere	Mr John Hayes	Council Clerk	7 months
Elliot	Mr Dennis Ramsey	General Manager for Garunga Council	Since October 1997
Kalkaringi	Mr Billy Bunter	Liaison Officer	Over 20 years
Kilminggan	Ms Melonie Brown	Secretary for Kilminggan Council	3 years
Kintore	Dr Bill Williams	Medical Director, PHHS	
Laramba	Ms Pam Lynch	Town Clerk	10 years
Ntaria	Ms Dot Robinson	Administrator	6 years
Nturiya	Mr Des Kelly	Store Manager and Central Tenterlink Agent DSS	3..5 years
Nyrripi	Mr Nevil Reid	Essential Services Officer	18 months
Ortippa Thura	Ms Joan Johannsen	Health worker, Store Keeper and Secretary/Accountant for the Community	27 years
Papunya	Ms Alison Anderson	Council Clerk	16 years
Tjuwanpa	Ms Jacinta Edwards	Accountant for the Resource Centre	2.5 years
Wallace Rockhole	Mr Ken Porter	Council Clerk	15 years
Willowra	Mr Peter Bastable	CDEP Manager	9 months
WA:			
Irrungadji	Mr Daniel Archer	Community Co-ordinator	
Lamboo Gunian	Mr Mark Gordon	Community Chairman; Station Manager	12 years
Turkey Creek	Mr Rick Chapman	CDEP Officer	4 years
SA:			
Pipalyatjara	Mr Michael Davis	Municipal Services Officer	1 month
NSW:			
Toomelah	Ms Linda Whitton	Health worker trainee	38 years
Walhallow	Mr Shaun Allen	Community Co-ordinator	24 years
QLD:			
Hopevale	Mr Lloyd Bambi	Council Deputy Chair	29 years
Normanton	Ms Liz Callope	Local justice co-ordinator	3 years

Table 2a: Swimming in the community

Do members of the community swim anywhere in the proximity of the community and how far is the swimming area?

Community	Do members of the community swim anywhere near the community	Distance to swimming area from community
NT:		
Ali Curung	Yes, unfortunately they swim in the sewage ponds. They also swim in water holes which are out of town.	Creek: 15km Sewage ponds: 1km
Amoonguna	Yes, in a gorge.	Approx. 3km
Aputula	Yes, it is a dam on one of the nearby properties.	About 80km
Areyonga	Yes, waterhole near town, also waterholes in the surrounding hills.	Waterhole near town - 10mins. walk. Waterholes in hills - 5mins walk.
Atitjere	Yes, when it rains (usually Jan. - Mar/April) in waterholes within the river system.	About 15km
Elliot	Yes, at the Longreach Waterhole.	14km
Kalkaringi	Yes, in the Victoria river.	Half a kilometre
Kilminggan	Yes, in the river.	Approx. 100m
Kintore	Yes, in a creek and excavation associated with road works.	Creek: Approx. 500m. Excavation: 10km.
Laramba	Yes, in waterholes.	About 20km
Ntaria	Yes, when it rains people swim in the river or waterhole (just off the river).	In the community.
Nturiya	Yes, in rock waterholes in the river bed.	1 hour drive.
Nyrripi	Yes, in a waterhole.	15km.
Ortippa Thura	Yes, in a big steel stock tank and waterholes in the creek.	Stock tank: 2.5km. Creek: in the community.
Papunya	Yes, in 3 waterholes within an area of 2 square km.	20km.
Tjuwanpa	Yes, in the river, and waterholes left behind after the rains. Also, recently (since a few months ago) roadworks close by which the workers dug a large hole to keep water in for construction use.	1km.
Wallace Rockhole	Yes, in waterholes.	Approx. 40-80km.
Willowra	Yes, a number of waterholes in the vacinity.	Not sure, but not walking distance.
WA:		
Irrungadji	Yes, a dam in a disused mine and a river.	River next to community. Dam approx. 2-3km.
Lamboo Gunian	Yes, a dam on the station and a river during the wet season.	Dam: about 7km. River: about 150km
Turkey Creek	Yes, in the Bow River during wet season.	About 35km
SA:		
Pipalyatjara	Yes, in a waterhole.	Approx. 10km
NSW:		
Toomelah	Yes, in the river.	In the community.
Walhallow	Yes, in the river.	
QLD:		
Hopevale	Yes, in a creek.	2-3km.
Normanton	Yes, in waterholes. Some swim in pool at local caravan park (privately owned).	Waterholes about 5km.

Table 2b: Characteristics of the swimming water

Community	Water source	Amount and availability of water	Running or stagnant water	Water quality
NT:				
Ali Curung	Sewage ponds: effluent water,. Each house has a septic tank, any overflow from this is pumped into the septic ponds. Waterholes: rain run off.	3 sewage ponds 20m x 60m x 1m deep. Waterholes vary according to rain.	Stagnant. The waterholes in the creek bed flow 2-3 times per year.	Creek: Not bad, it has a sandy bottom although after it sits for a while the water does go green.
Amoonguna	Rain.	At peak, the equivalent of four Olympic pools.	Stagnant.	Following rain water looks clean but quickly turns green.
Aputula	Bore and rain.	Dam has a diameter of about 10m and depth of about 2m.	Stagnant.	Water does not look clean. Usually green or brown in colour.
Areyonga	Waterhole near town - bore Waterholes in hills - spring	Waterhole near town – about 30m across, 2m deep in middle. Waterholes in hills - vary from about 3m across to about 15m across.	Stagnant.	Waterhole near town is cleared of rubbish once a year. Water pretty filthy most of the time. Waterholes in hills are green. many people refuse to swim there.
Atitjere	Rain	When waterholes are full they are about 20m across.	Running. By the time they become stagnant it is very difficult to get to them (have to walk through a lot of mud).	Water looks brown.
Elliot	River	Waterhole when cut off in the dry season is 100m long and quite deep. In the wet it is 60km long	Wet season the water can be running. Dry season water is stagnant.	Base is white clay so the water looks milky. The water has never been tested however, there does not seem to be any pollution.
Kalkaringi	Rain. The river runs in the wet season from Oct-Nov	Depends on the rain	Flowing in wet season, otherwise stagnant.	Looks clean however, for about 4 years now there has been some problem with regard to the sewage tanks overflowing into the river. This was originally a problem in the wet season, but now also in the dry season.
Kilminggan	River water from springs	Quite deep and 100m wide, even wider in some places	Running.	Clean. It is clear mineral/lime.
Kintore	Rain. Water trucks at excavation sire (dam)	Creek - about 1m deep and about 10x6m across. Excavation - 1m deep and 3x3 square	Stagnant.	Creek very muddy.
Laramba	Rain.	When full approx. 25m across, but only lasts a few days	Stagnant.	During first few weeks after rain the water is clean and clear, then bullocks come and the water becomes a dirty brownie-green colour.
Ntaria	Rain.	Unknown. Deep or shallow depending on rainfall and evaporation. Water stays longer in the waterhole than the river as it is deeper and has better shade.	Stagnant.	Very dirty looking, it is stirred up from the muddy river bed.
Nturiya	Rain and run off.	Full it can be 5km long and 50m wide, also smaller deep (up to 6ft) waterholes.	Running when creek runs (very rarely and briefly) then stagnant.	Waterhole looks fine when fresh, can get a bit muddy. After a while stagnant water can smell
Nyrripi	Rain, in a creek bed.	Depends on rainfall.	Mostly stagnant.	Quite clean until stirred up.
Ortippa Thura	Stock tank: bore water. Creek: rainwater.	Stocktank: 10,000 gallons, 6ft tall, 10ft across. Creek: depends on rain.	Stocktank is filled by a pump run by a windmill.	Looks clean. Some debris in the water and the odd dead bird but in general is described as 'OK'.

Table 2b: Characteristics of water (Cont)

Community	Water source	Amount and availability of water	Running or stagnant water	Water quality
Papunya	Creeks.	Depends on rain. Prior to the last couple of months there was no water as there had been no rain for a while. There is a swimming area of about 100 sq/m at the largest hole and slightly less at the others.	Running when new. Currently stagnant.	Looks clean when new. Often does not look clean.
Tjuwanpa	Rain water in river and waterholes. Water trucks keep road works dam filled.	About 50m squared in the road works dam. Waterholes and river depending on rainfall and evaporation.	Stagnant.	The roadworks dam water is muddy. There also seems to be an outbreak of lice, breeding in the dam.
Wallace Rockhole	Rain.	Can be very deep. Especially the waterholes in rock gorges.	Stagnant.	Looks clean. The waterholes in river beds get muddy when people stir up the water.
Willowra	Bore.	Unknown.	Stagnant.	Not sure but probably not clean.
WA:				
Irrungadji	Rain.	Varies with rain. River at peak approx. 150m across. Dam approx. 700-800m across.	River - running. Dam - stagnant.	River clean when flowing. Dam warm in hot weather and brown in colour.
Lamboo Gunian	Rain.	Unknown.	Dam - stagnant. River - running.	Looks clean in both areas except directly after rain.
Turkey Creek	Rain.	Varies depending on rain. Usually water for about four months after a good rainfall. At its peak river is 100m across.	Running.	Dirty for the first month or so after the rain. Therefore water is clean for about three of the four months.
SA:				
Pipalyatjara	Spring.	Unsure.	Not running, but not strictly stagnant as the spring continually feeds the waterhole.	Clean.
NSW:				
Toomelah	Rain and run off.	River is 20ft wide in some places.	Running.	Not clean. The water is muddy and milky in colour.
Walhallow	Rain.	Depends on rainfall.	Running for about 3-4 months of the year. Stagnant for the rest.	Dirty. Cattle wade in it and drink from it, also farm run-off is in it.
QLD:				
Hopevale	Rain.	Varies with rain.	Running.	Looks clean.
Normanton	Waterholes - rain. Pool - bore.	During wet season there are many waterholes, large and small.	Waterholes - running. Pool - stagnant.	Waterholes look clean. Pool generally green and pretty filthy looking.

Table 2c: Health and safety aspects

Community	Diseases or outbreaks attributed to swimming area	Animals in proximity of swimming area	Accidents occurred at swimming area	Supervision
NT:				
Ali Curung	There is a very large problem with scabies in the community. Swimming in the sewage ponds is thought to exacerbate any sore and is thought to have caused a number of middle ear infections.	Creek: Kangaroo, bush turkey, dog, donkey. Sewage pond: only birds.	No.	Sewage pond: None! It is totally illegal to swim there. Creek: May have some supervision because an older person has to drive them there.
Amoonguna	There have been a number of streptococcal infections that could possibly be attributable to the swimming area.	Cattle, dingos, camp dogs, kangaroos.	None.	Sometimes.
Aputula	No.	Bullocks, horses, donkeys, dingos, emus, sometimes kangaroos.	No.	The dam is quite far from the community. Young children need an older person to drive them.
Areyonga	Suspected repeated ear infections.	Camels, donkeys, horses, mangy dogs.	None.	None.
Atitjere	No.	Cattle, horses, goats, kangaroos.	A few bumps and scrapes, nothing major.	No adult supervision.
Elliot	None attributed to swimming area, but recently they had an outbreak of boils. No one knows what caused this.	Cattle, birds, horses and other wildlife.	A drowning 1970's. Boy almost drowned a month ago. Cuts from broken glass.	Some parental supervision.
Kalkaringi	Could cause serious health problems. Health inspectors have taken samples but no response as yet.	Kangaroo, bush turkey, crocodiles, snakes.	2-3 drownings per year, usually alcohol related, but not always.	No.
Kilminggan	No.	Crocodiles, cattle, dogs, wildlife.	Minor accidents.	No.
Kintore	Possible increase in skin sores and ear infections after rain.	Camp dogs, and other wildlife.	None known of.	Some parents may supervise their children.
Laramba	None known of.	Cattle, kangaroos, wallabies, and other wildlife.	None.	Almost always.
Ntaria	Ear infections attributed to the river.	Dogs, horses and other wildlife.	None.	No.
Nturiya	Unknown.	Cattle, horses, dogs, kangaroos, emus, bush turkey, other wildlife.	No.	Parents usually supervise.
Nyrripi	No.	Camels, kangaroos, cattle, other wildlife.	No.	Yes, parents supervise.
Ortippa Thura	Increase in sore ears when creek runs.	Cattle, dingos, kangaroos, emus, bush turkey, other wildlife.	Girl slipped on narrow edge and broke her arm.	Adults always supervise.
Papunya	Unsure.	Cattle, horses.	None.	None.
Tjuwanpa	Unknown.	Cattle, horses, dingos, emus, camels, other wildlife.	None known of.	None.
Wallace Rockhole	Sometimes minor ear infections after swimming at waterholes.	Cattle, horses, kangaroos, wallabies, dingos, other wildlife.	Tourist drowned at the gorge in one of the waterholes.	Yes.
Willowra	No.	Cattle, horses, donkeys, dingos, other wildlife.	No.	Supervised by older children or adults.

Table 2c: Health and safety aspects (Cont)

Community	**Diseases or outbreaks attributed to swimming area**	**Animals in proximity of swimming area**	**Have any accidents occurred at the swimming areas**	**Supervision**
WA:				
Irrungadji	No.	Cattle, kangaroos, emus, turkeys, other wildlife.	Cuts from broken glass in both river and dam.	Sometimes.
Lamboo Gunian	More ear infections when children swim in dirty water.	Cattle, horses, kangaroos.	None.	Always.
Turkey Creek	No.	Cattle, other wildlife.	None.	Unknown, however, given the distance to river from community, young children would need to be driven there presumably by an adult.
SA:				
Pipalyatjara	No.	Camels, dingos, kangaroos, other wildlife.	No.	Usually not.
NSW:				
Toomelah	No.	Kangaroos, horses, cattle, other wildlife.	A few years ago a young girl drowned.	Yes, adults take their own children.
Walhallow	No.	Cattle, sheep, other wildlife.	Cuts from broken glass in river.	No.
QLD:				
Hopevale	One outbreak of ear infections.	Horses, feral pigs.	None.	Parents supervise young children. Older children generally not supervised.
Normanton	None attributed to waterholes. Pool considered to have been the source of a number of ear infections. Also suspected to be the cause of an outbreak of meningitis last year.	Cattle, horses, crocodiles, other wildlife.	Some accidents at waterholes, eg. fish hooks.	Usually supervision.

Table 3: Communities thinking of getting a pool and knowledge of communities with a pool

Community	**Are they thinking of getting a Pool**	**Do they know of communities with a Pool**	**Which Community**
Aputula	**no**	no	
Atitjere	**no**	no	
Kalkaringi	**no**	no	
Orrtipa Thurra	**no**	no	
Turkey Creek	**no**	no	
Elliot	**no**	no	
Kilminggan	**no**	yes	NguKurr
Willowra	**yes**	no	
Hopevale	**yes**	no	
Irrungadji	**yes**	no	
Lamboo Gunian	**yes**	no	
Normanton	**yes**	no	
Nyrripi	**yes**	no	
Tjuwanpa	**yes**	no	
Walhallow	**yes**	no	
Nturiya	**yes**	rumours	
Pipalyatjara	**yes**	rumours	
AliCurung	**yes**	yes	Ngukurr
Areyonga	**yes**	yes	Daly River
Kintore	**yes**	yes	Warburton, Santa Teresa
Laramba	**yes**	yes	Santa Teresa
Ntaria	**yes**	yes	Santa Teresa
Papunya	**yes**	yes	Santa Teresa
Toomela	**yes**	yes	Goondiwindi
Amoonguna	**yes**	yes	Santa Teresa
Wallace Rockhole	**yes**	yes	Santa Teresa

Appendix 2 - Communities with pools

Table 4a : Community information

Community	Size of community	Aboriginal population (number and %)	Location	Distance to nearest large town	School	Health Centre
NT:						
Nauiyu Nambiyu	wet - 500 people dry - 300 people	300-500 (93-96%)	Northern NT	200km S of Darwin	Catholic school years pre-school-10	Health Centre with 3 registered nurses and a health worker
Ngkurr	1000 people	(99%)	Northern NT	About 300km east of Katherine.	Years 1-10	Community Health Centre with two full-time nursing sisters plus two trainees.
Pularumpi	283 people	(>95%)	Melville Island (NT)	80km N of Darwin	Years 1-7	Community Health Centre
Santa Teresa	400-700 depending on the month	Majority	Alice Springs NT	80km SE of Alice Springs	Years 1-?	Health Centre with two registered nurses and one male and three female health workers (two part-time)
Yuendumu	800 people	720 (90%)	Central Australia (NT)	300km NW of Alice Springs	Years 1-10	Health Clinic with four full-time nurses. Doctor present 2 days per week
WA:						
Papulankutja (Blackstone)	170 people	160 (94%)	Eastern WA (Warburton region)	800km SW of Alice Springs	Years 1-10	Health Clinic with full-time nursing sister.
Warakurna	350 people	335 (96%)	Eastern WA (Warburton region)	700km W of Alice Springs	Years 1-10	Community Health Centre
Warburton	517 people	470 (91%)	Eastern WA (Warburton region)	1000km SW of Alice Springs	Years 1-8 TAFE College	Day Clinic with three nursing sisters
QLD:						
Cherbourg	2100					
Kowanyama	1200 people	?	Western coast of Cape York Peninsula (Qld)	About 600km W-NW of Cairns	Years 1-10	Health Centre with 4 full-time nurses plus Aboriginal health workers.
Laura Town	140 people	100 (71%)	Cape York, Qld	About 300km N of Cairns	Yes.	Yes, Health Centre.
Thursday Island	3,800 people	(>95%)	North of Cape York, far north Qld	About 800km N-NW of Cairns.	Years 1-12; TAFE College.	Hospital and Health Centre with six or seven full-time doctors. Numerous nurses and health workers.
Woorabinda	950 people	(95%)	Central Qld	160km SW of Rockhampton	Years 1-10	Health Centre with one doctor and four nurses.

Table 4b: Person answering the questionnaire

Community	Person interviewed	Time in community	Position in community
NT:			
Nauiyu Nambiyu	Mr August Stevens	3 years	Sport and Recreation Officer
Ngkurr	Mr Ian Tosh	2 1/2 years	Sport & Recreation officer.
Pularumpi	Mr Lawrence Costa	16 months	Community Development Employment Projects (CDEP) Co-ordinator
Santa Teresa	Mr Jack Wallace	6 years	Essential Services Officer
Yuendumu	Mr Andrew Stojanoski	4 1/2 years	Youth Services Manager
WA:			
Papulankutja (Blackstone)	Mr Jim Hare	4 years	Community Adviser (Shire Clerk)
Warakurna	Mr Brian Rogers	3 weeks (position is 6 weeks total)	Relief Projects Officer
Warburton	Mr Damien Maclean	14 years	Development Officer (Shire Clerk)
QLD:			
Cherbourg	Mr Chris Gymore	5 years	Environmental Health Worker
Kowanyama	Mr Murray Wilson	5 years	Plumber / Water officer
Laura Town	Committee	N/A	N/A
Thursday Island	Ms Michelle Hodgetts	9 years.	Pool Caretaker (and local business owner)
Woorabinda	Mr Bob Effeney	15 years	Council Plumber

Table 5a: Pool characteristics

Community	When was the pool built?	Number, type and size of pool.	To whom does the pool belong?	Under whose initiative was the pool built?	Construction material.
NT:					
Nauiyu Nambiyu	1987	Open air pool 40m x 20m with a shade covering one end.	Council.	Council.	Concrete.
Ngkurr	December 1996.	Four open air pools: a) 25m x 15m x 1-1.8m deep. b) 9m x 4m x 1-1.8m deep. c) 9m x 4m x 1m deep. d) 5m x 6m x 35cm deep.	Community.	Town Clerk (Lyn Mott).	Fibre-glass.
Pularumpi	November 1995	One open air pool, 50m in length.	Community.	Council and community.	Concrete.
Santa Teresa	1972	Two open air pools, one is 25m and the other is a small wading pool. Main pool is 10'deep at diving end and 3' at shallow end. Wading pool ranges from 9" to 2' deep.	Council.	The mission.	Concrete.
Yuendumu	1985	One small open air `pool, 6-7m x 3m.	School.	School council.	Predominantly fibreglass (and some concrete).
WA:					
Papulankutja (Blackstone)	1988	One indoor pool 25m x 10m. Wading pool at one end separated by a short brick wall.	Community.	Previous community adviser.	Concrete.
Warakurna	1993	One indoor pool divided into two: a) 50m x 15m (and 1 - 1 1/2m deep) b) 5m x 15m (and 40cm deep)	Community.	Community.	Concrete.
Warburton	1989	One open air pool, 25m x 10m.	Community.	Community.	Concrete.
QLD:					
Cherbourg	1983	Two open air pools.	Council.	Cherbourg council.	Concrete.
Kowanyama	1986	Two open air pools. One 25m x 20m x 1.5m deep. One wading pool.	Council.	Council.	Concrete.
Laura Town	1997	One open air pool.	Town.	Ang-Gwarra Corporation.	Concrete.
Thursday Island	1987	Three open air pools. One is a full size olympic pool. One is about 2m x 4m x 30cm deep. One is about 8m x 8m x 1m deep.	Council.	Council.	Concrete.
Woorabinda	1988	Two open air pools. One is a six lane olympic size pool and the other a small wading pool.	Council.	Council.	Concrete.

Table 5b: Pool characteristics

Community	Toilet and shower details	Surrounds	Fence
NT:			
Nauiyu Nambiyu	Two toilet cubicles attached to both change rooms plus a urinal in the mens. Four shared open air showers.	Pool surrounded by 1/2m concrete edging. surrounding this is grass and coconut palms.	Cyclone fencing with barbed wire at the top. Approximately 2 - 3m in height.
Ngkurr	Four toilet cubicles and four showers in each of the change rooms plus four individual urinals in the mens. No open showers.	Pool surrounded by a concrete apron around which is a large area of lawn and a few trees.	1.8m high cyclone fence topped with barbed wire.
Pularumpi	Two toilet cubicles and two showers in each change room. Two open air showers	Surroundings landscaped with trees and lawn. Also a BBQ area.	6m cyclone fence surrounding premises.
Santa Teresa	Two toilet cubicles and five showers in each change room. One urinal in mens.	Pool surrounded by a strip of concrete, then grass and there is a small off one side covered with shade cloth.	Surrounded by a 6'high wire fence with barbed wire across the top.
Yuendumu	Toilets at school are used as change rooms. No showers, swimmers hose themselves before entering pool.	Very small area, (10 x 15metres) all concrete.	Surrounded by high concrete wall and also a sliding, lockable roof.
WA:			
Papulankutja (Blackstone)	Two toilet cubicles in each change room. Four open air showers	Inside shed, pool surrounded by concrete floor and seats along walls. Games room on mezzanine floor above change room.	As the pool is in a shed there is no need for heavy fencing around the compound.
Warakurna	Two toilet cubicles attached to each change room plus a urinal in the mens. Four open air showers	Inside shed, pool surrounded by concrete floor.	Fence between change rooms and pool.
Warburton	Two toilet cubicles in each change room plus a urinal in the mens. Four showers in each. No open air showers.	Pool surrounded by concrete apron about 2m wide. A further 2m of grass surrounds concrete apron.	Perimeter fence is a cement block 1/2m high. On top of this is cyclone fencing.
QLD:			
Cherbourg	Two toilets in each change room, no showers. No open air shower.	Grass, trees, landscaped.	Yes.
Kowanyama	Three toilet cubicles in womens. Two toilet cubicles plus a urinal in the mens. One shower in each. No open air showers.	Pool is in a fairly large complex surrounded by 6 foot fence. Pool is surrounded by a concrete concourse. Outside fence is grass and trees.	2m high cyclone fence topped by barbed wire.
Laura Town	Three showers and toilet cubicles in each change room. One open air shower.	Grass and trees.	Yes.
Thursday Island	Male change room has six showers, plus three toilet cubicles and a urinal. Female change room has four showers plus six toilet cubicles. No open air showers.	The pool is surrounded by a concrete apron around which is a large area of grass and palm trees. A beach volleyball court is under construction.	2m high cyclone fence topped with barbed wire.
Woorabinda	Two toilet cubicles plus a urinal in the mens; Three toilet cubicles in the womens. Four showers in each. No open air showers.	Pool surrounded by concrete apron 4m wide. Around this is grass and trees. (trees to be removed because of leaf litter).	6 ft high chain wire fence with three strands of barbed wire on top.

Table 5c: Pool characteristics

Community	**Shelters**	**Children's games and activities**	**Shop**
NT:			
Nauiyu Nambiyu	No shelter.	Equipment for pool volleyball and basketball is available.	Community shop 200m away.
Ngkurr	There are 3 shade cloths each of about 6 m^2. One is over the wading pool. The others are over parts of the lawned area. Under each of these are four sets of table and chairs.	Sometimes activities are planned during school time. A mini-trampoline is to be installed at the deep-end for children to jump off into the pool.	There is a shop at the pool.
Pularumpi	A shadecloth covers the BBQ area and half the pool.	During school months there are swimming sports days. During holidays other games such as waterpolo are organised.	Shop 5 mins from pool.
Santa Teresa	One small area off one side which has a shade cloth.	School organises swimming lessons and a swimming carnival.	Community store across the road from swimming pool.
Yuendumu	There is an area of shadecloth with a seating capacity of four people.	No scheduled activities - pool too small.	Nearest shop 200m away.
WA:			
Papulankutja (Blackstone)	The shed in which the pool is located is corrugated iron with a steel frame.	School organises games when using pool. Otherwise no specific scheduled games or activities.	General store 200m away.
Warakurna	Indoors.	School organises swimming sports days. Also a couple of tyre tubes and basketballs for use at the pool.	Nearest shop 500m away.
Warburton	Currently no shelters, but soon to have sails hoisted over pool for shade.	Balls etc. available but no specific scheduled activities.	General store 40 yds from pool
QLD:			
Cherbourg	Yes.	Not known	Yes.
Kowanyama	Metal roofed shelter at the deep end of the pool. May be removed as children jump off it. Shadecloth over entire pool.	No scheduled activities.	Shop about 700m away.
Laura Town	Shaded area to sit under.	School organises activities when using pool. Otherwise no scheduled games or activities.	No.
Thursday Island	There is a shadecloth over the toddler pool.	No scheduled activities, although there is a stadium with scheduled games.	There is a kiosk.
Woorabinda	There were shade coverings but destroyed by people walking on them and burning them with cigarettes.	No scheduled activities. There were pool toys but all have been destroyed.	There is a pool kiosk.

Table 6: Pool use

Community	Opening Hours	Number of entries per day.	Who uses the pool?
NT:			
Nauiyu Nambiyu	Open all year. 1-2 hrs per day to general public and 24hrs per day to keyholders (who must sign a form stating they will respect pool rules and be liable for any damage they cause).	5-20 per day.	Pool used almost solely by children (including non-Aboriginal children)
Ngkurr	During school time it is open 2pm - 5:30pm every day. At other times opening hours depend on the weather and demand	At the moment (wet season), <15 per day. Normally (before wet), 80-100.	Mainly children use the pool. Non-Aboriginal people use the pool.
Pularumpi	Open 7 days, 3-6pm all year round, (earlier on weekend).	30-40 children per day.	Mainly children. Both Aboriginal and non-Aboriginal people use the pool.
Santa Teresa	August-March. Usually opened about 2.30-5pm for children. Adults after 5pm.	?	Both adults and children.
Yuendumu	Open five days per week from Sep to Apr. During school term about 2 hrs per day (plus swimming classes). During school holidays open to general community 12pm-4pm.	When open to school only: 30 When open to general community: 70 (which is very full).	Mostly Aboriginal children use the pool. Very few adults and very few non-Aboriginal children use it.
WA:			
Papulankutja (Blackstone)	Open Nov. - Mar. 11-12pm, 3-5pm, and 7-8pm if very hot	About 30 people.	Mainly children. Both Aboriginal and non-Aboriginal people use the pool.
Warakurna	Currently open at least one hour per day.	5-50 depending on population at the time.	All people in the community use the pool.
Warburton	Open Nov. - Easter, 2-4pm each day. Open in evenings every 2-3 weeks for a pool party	50-70 each day. 120-150 if very hot. Up to 100 at parties.	All people in the community use the pool.
QLD:			
Cherbourg	Depending if operator is available, pool is open 7 days per week during summer from 3.00 - 5.00 pm.	50 -100.	Both adults and children. Some non-Aboriginal people use the pool.
Kowanyama	Usual opening hours are 2:30-5:30pm every day.	More than 30 every day Can be up to 60 or 70.	Pool used mainly by children (including non-Aboriginal children)
Laura Town	Open most days between 8.00 am and 5.00 pm. Closed during wet season.	About 22 people.	Adults and children, both Aboriginal and non-Aboriginal use the pool.
Thursday Island	Open six days a week (closed Mondays for maintenance). 11am-7pm Mon-Wed, Fri & Sat; 9am-9pm Thurs; 1pm-9pm Sun. After 6.30 for lappers Tues and Fri.	Weekdays 5-10 people. Weekends upwards of 40 people (up to 150 or more).	Children and adults, both Aboriginal and non-Aboriginal use the pool.
Woorabinda	Open from Sep. 1 until May 1. During school holidays 11am-6pm daily. During school term 3pm-7pm.	On a quiet day 50-100 people. On a busy day 300-400 people.	Adults and children (both Aboriginal and non-Aboriginal) use the pool.

Table 7a: Pool maintenance

Community	Who is responsible for maintenance?	Water source.	Water treatment system.	Chemicals used.	Monitoring of chemicals
NT:					
Nauiyu Nambiyu	Sport & Recreation Office.	Bore water (town supply).	Sand filter.	Liquid chlorine, 5,000L per year. Acid. Stabiliser	Chemicals monitored each morning.
Ngkurr	Mr Tosh (Sport & Rec.) is responsible for maintenance. He has a crew of up to ten other people who help (all on the CDEP programme).	Bore water (lots of calcium).	Sand filter.	8 x 70kg chlorine gas bottles per year. 16 x 40kg bags granulated chlorine per year. 10 x 25L drums HCl per year. 10 x 20 kg bags soda ash per year.	Large pool, automated chemical monitoring checked numerous times daily. Other pools monitored manually daily.
Pularumpi	Full-time pool caretaker/ supervisor.	Spring water.	Sand-filter.	120kg chlorine/year 1000kg salt/year 5L polyguard and polysheen/year.	Water checked once daily.
Santa Teresa	Jack Wallace and a team of 6 men (2 Apprentices	Bore water (town supply).	Skimmer box for solids. 2-3 sand filters. Backwash used to clean dirt in filters every day.	48x5 litre bottles of hydrochloric acid per week (depends on climate), Algatac 6 bottles per week.	Manual cleaning with a test kit occurs every morning for chlorine and acidity.
Yuendumu	School term: school (vice president). Holidays: council (recreation officer)	Bore water (town supply).	Had a salt-water treatment system which "died". Now sand filters are used.	Chlorine, one pool tablet per day.	Testing kit lost. Chlorine levels kept at a point where they don't hurt the children's eyes.
WA:					
Papulankutja (Blackstone)	Full-time pool caretaker/ supervisor	Bore water.	Sand-filter system.	100L HCl per year. 6 chlorine tablets every few days.	Water checked once daily.
Warakurna	Community	Bore water.	Sand-filter system. Water also goes through treatment plant at community.	¼Lliquid chlorine per day. Additional 2kg once per week.	Water checked morning and night.
Warburton	Full-time pool caretaker/ supervisor.	Bore water.	Sand-filter system.	Approx. 200kg chlorine/year.	Water checked three times per day during open season.
QLD:					
Cherbourg	Council.	Barambah and creek (town water supply).	Filtration system.	Hydrochloric acid, sodium hydrochlorite. 200l per day.	Chemicals checked daily.
Kowanyama	2 full-time staff responsible for pool & premesis. Another person maintains lawns and surrounds	Bore water (town supply).	Sand filter.	About 200L of 10% sodium hypochlorite per week 20L of acid per week. Small amounts of alum and soda ash.	Chemicals monitored daily.
Laura Town	Pool park supervisor.	Bore.	Filters.	Required by law.	Chemicals monitored daily.
Thursday Island	The council is responsible for maintenance. The full-time caretaker does the maintenance.	A large local dam which is supplied by water pumped from elsewhere (didn't know where).	Sand filters.	Chlorine gas: 1 x 70kg bottle per month. Alum: 1kg per week. Soda ash: 4 x 25kg bags per week. Cyanuric acid: unknown.	Chemicals monitored three times daily.
Woorabinda	The engineering dept. of the council.	Artesian bore (town supply).	Three rapid sand filters.	Liquid chlorine, 80L per day in open season, 25L when closed. Granulated chlorine, 200-300kg per year. Cyanuric acid, 250kg per year HCl, 800L per year Alum, 8kg at every backwash (2/wk).	Manual monitoring every morning, plus readings taken from automated chlorination unit 2-3 times per day in open season.

Table 7b: Pool maintenance

Community	Is the water changed	Amount of water required	Water loss due to evaporation and filter cleaning	Main contaminants
NT:				
Nauiyu Nambiyu	Water not changed.	50,000 gallons (litres?).	Wet season: no loss (in fact water must be drained from the pool due to rain). Dry season: 1000L+ per week lost.	Dirt, leaves, rocks (thrown in), chip bags, lolly wrappers.
Ngkurr	Only in wading pool, water is effectively changed every four days. This pool is also completely drained and cleaned once per year.	Wading pool: 10,000 L.	Each of the smaller pools is topped up 100mm every day. The larger pool is topped up 50-60mm every three days	Dust in the dry season, sand, leaves, frogs.
Pularumpi	Water not changed. Use of polyguard and polysheen stops algae formation.	Unknown.	Very little water lost ..... about 100L/year.	Leaves; Rocks thrown in; Frogs.
Santa Teresa	Wading pool is changed in winter.	Unknown.		Dust, lights attract bugs.
Yuendumu	Water not changed.	250,000 litres.	Backwash (which is done once every 4-7 days) loses 100L.	Dirt and dust.
WA:		.		
Papulankutja (Blackstone)	Water is not changed.	Unknown (probably same as Warburton as the pools are the same design).	5% per week	Mainly dust.
Warakurna	Water changed only when pool needs maintenance.	Unknown (probably same as Warburton as the pools are the same design).	100-200L per week. (probably more than average as filters have been cleaned a lot recently)	Dust; Insects; Small amount of leaf matter and seed capsules.
Warburton	Water dumped once every 2-3 years to allow maintenance.	200,000L.	Never measured. No difficulty with community water supply	Mainly dust.
QLD:				
Cherbourg	Only if contaminated.	2.5ML large pool. 10,500L small pool.	Not known.	Leave, stones.
Kowanyama	Water changed only when maintenance needed.	Unknown.	Unknown.	Leaves.
Laura Town	Yes. How often?	Unknown.	5cm.	Dust.
Thursday Island	Water not changed, but backwashes every three days	Unknown	Not a significant amount of water lost.	Dust, bird droppings.
Woorabinda	Water changed only for maintenance. Last time 2 yrs ago.	1.5 mega-litres.	Backwash (which is done twice/week) loses 100,000 litres.	Leaves, clothing (eg hats and t-shirts), dust, food wrappers, grass cuttings.

Table 7c: Pool maintenance

Community	Cleaning equipment used	Time per day spent in maintenance of pool and premises	Repairs	Has the pool been closed for any reason?
NT:				
Nauiyu Nambiyu	Manual pool vacuum; net; sometimes hand scrubbed.	One person spends about one to one and a half hours per day.	In the last year there has been a breakdown of both the pool pump and chlorinator, and a damaged shade. Repairs are usually carried out locally, otherwise sent to Darwin.	Closed about half a dozen times in the last year due to deterioration of water quality when the caretaker goes away.
Ngkurr	Automatic vacuum in the large pool. Hand vacuum in other pools. Skimmer nets.	Four people 3-5hrs each per day.	Pumps must be rebuilt every 10 months - 1 yr. This can be done at the community.	Closed over a year ago because of poor water quality. Also closed periodically when there is a funeral or for disciplinary reasons (eg if rocks are thrown over the fence at night).
Pularumpi	Vacuum, Net.	One person spends 2-3 hours per day.	Repairs carried out by local tradesmen when necessary.	Closed last year for three days because of high levels of algae. Necessary chemicals were unavailable.
Santa Teresa				Dec. '97 closed for five days, a pipe was broken by vandals.
Yuendumu	Pump filter box. Pool vacuum which runs through filter system.	One person spends about two hours per week.	Every year $700 is spent fixing filter and about another $100 in odd repairs.	Closed when filter breaks (for three months) or pool needs cleaning (for one week). Closed throughout '90 and '91 as new school staff didn't know how to run it..
WA:				
Papulankutja (Blackstone)	Scoop net, Pool vacuum cleaner.	One person spends one hour per day.	Pump or filter needs repair 2-3 times per year.	Closed over winter. Also closed for one day 2-3 times per year as disciplinary measure after break-ins.
Warakurna	Portable vacuum, brush, net.	One person spends one hour per day on weekdays and two hours per day on weekends.	Repairs carried out by pool caretaker. No tradesmen in community.	Closed for long periods due to lack of maintenance.
Warburton	Vacuum which sucks dirt into mobile carriage alongside pool..	One person spends three hours per day during open season.	Filtering system cleaned annually.	Closed last year for 12 days when water temp exceeded 30'C and an amoebic meningitis outbreak was feared.

Table 7c: Pool maintenance (contd)

QLD:				
Cherbourg	Vacuum, brooms, hoses, chemical products.	One hour per day by pool operator.	As required.	Pool usually closed when operator not available. In past had problems which were sorted out by employing a trained person (not specified if pool closed).
Kowanyama	Onga vacuum; nets.	Two staff spend about three hours each per day.	There has not been much need for repairs in the past. Major repairs are sent elsewhere.	Closed for about twelve months when staff left and new staff couldn't maintain pool properly.
Laura Town	Vacuum.	Four hours per day.		
Thursday Island	Automatic vacuum, nets, brushes.	One person spends an average of five hours per day.	The council has the option (and has done so in the past) to close the pool for four weeks each year to carry out repairs.	Closed on a few occasions in the past for a day or two due to lack of appropriate chemicals and problems with the filters.
Woorabinda	2 dolphin vacuum cleaners; 2 manual vacuum cleaners; hose, broom, brushes.	One person spends about one to two hours per day.	Suggestion is to allocate $60,000 per year for repairs. Repairs include filter adjustment (every 4 years), repainting amenities (every 2 years), and removing graffiti every year.	Closed throughout '95 and '96 as there was no money to run it. Closed at other times for repairs (often waiting for a part.)

Table 8a: Health related issues

Community	Must people shower before swimming?	Swimming gear.	Are swimmers not allowed in the pool for any health condition?	Is a medical check-up or certificate required?	Are sniffers or drinkers allowed in the pool?
NT:					
Nauiyu Nambiyu	Swimmers must shower before entering pool (though often it's no more than a quick spray)..	Nearly all swimmers swim fully clothed.	Supervisor tries to keep children with infections and sores out of the pool. Not always effective.	No.	No problem with sniffing in this community. The pub is about 5km away so there is no problem with drinkers (they swim in the river).
Ngkurr	Swimmers must (and do) shower before entering the pool.	Usually swim fully clothed (no shoes).	No.	No.	Despite a problem with sniffing and drinking in the community, there is not a problem with this at the pool.
Pularumpi	All swimmers must (and generally do) shower prior to entering pool.	No restriction on swimming gear so long as they've showered.	If someone has an open sore they may not swim.	No.	No alcohol or other drugs are allowed at the pool. Anyone obviously intoxicated is asked to leave.
Santa Teresa	Yes.	Shorts and t-shirts.			Not allowed.
Yuendumu	They hose themselves down.	Shorts and top. No long trousers or shoes.	Open sores, sore ears, cast or bandage.	No.	No.
WA:					
Papulankutja (Blackstone)	Swimmers shower in clothes they wear to swim prior to entering pool.	Males wear shorts. Females wear shorts and a T-shirt.	If anyone is bandaged up they are not allowed in the pool.	No.	Community is an alcohol free area. Sniffing in pool premises is prohibited so sniffers partake elsewhere.
Warakurna	All swimmers must (and generally do) shower prior to entering pool.	All must wear bathers or shorts. Women can wear T-shirts.	No.	No.	Sniffing and drinking are prohibited. Any sign of sniffing or drinking and the person is asked to leave.
Warburton	Swimmers shower in swimming gear prior to entering pool.	All must wear bathers or shorts. Women can wear T-shirts.	This has not been an issue.	No.	Community is an alcohol free area. Sniffing in pool premises is prohibited so sniffers partake elsewhere.
QLD:					
Cherbourg	Most respect the rules.	Swimming costume.	If someone has an open sore they may not swim.	Operator may suggest check-up first.	No.
Kowanyama	Swimmers must shower before entering pool.	Generally swim in clothes.	Has not been an issue.	No.	Not much of a problem with sniffing in the community. Drinking is not allowed in the pool premises.
Laura Town	Swimmers shower before entering pool.	Swimming costume.	Yes.	No.	No, sign enforced by law.
Thursday Island	Swimmers are required to shower before they enter the pool. They do not always obey this rule.	Many swimmers swim in clothes.	Yes.	No.	There have been no big problems with sniffers or drinkers at the pool. Both are banned from the premises.
Woorabinda	No. Chlorine levels are kept at >3ppm.	Must wear something, although children under four skinny-dip (usually boys). Swimmers usually wear whatever they have on into the pool.	Attempts are made to stop anyone with "something obvious" from swimming	No.	Though the whole area is supposed to be dry there are incidences of people drinking at the pool. Supervisors try to stop this but it can be difficult. There is a similar situation with sniffing.

Table 8b: Health related issues

Community	Are animals allowed in the premises?	Bacteriological testing.	Have there been any diseases or outbreaks attributed to the pool?	Have any accidents taken place in the last year?
NT:				
Nauiyu Nambiyu	No.	A sample is sent to Darwin once per month.	Some outbreaks of ear infection which could be attributed to the pool though this is not definite.	None in the last year.
Ngkurr	No. Some dogs find their way in but are chased out.	Not done.	A person recently recovered from Hepatitis A. It is believed that it might have contacted from the pool.	The first couple of months of pool being opened there were three split heads from children running and slipping on wet concrete. Last month a child swallowed a large amount of water (some in the lungs), was sent to Darwin hospital for observation.
Pularumpi	No.	Once per month a water sample is sent to Darwin for testing.	No.	No.
Santa Teresa	No.	Sample is sent to Alice Springs.	Nil.	None.
Yuendumu	Dogs come in but don't swim. If a dog bites someone it is thrown out.	None.	No.	About twice per year children slip on concrete around pool and require stitches.
WA:				
Papulankutja (Blackstone)	No.	None.	No.	No.
Warakurna	No.	No access to appropriate facilities so testing is not done.	One outbreak of otitis media has been attributed to the pool (due to poor pool maintenance). Pool was closed.	No.
Warburton	No.	Tests conducted every two weeks.	No.	The odd 'slip-over' but nothing significant.
QLD:				
Cherbourg	No.	None.	Not known.	Not known.
Kowanyama	Yes but not in the pool itself.	The plumber tests the water once per month when he tests the town water.	Every time there is an outbreak of rotavirus it is attributed to the pool. This is unverified.	A couple of broken arms in the last two years because of children misjudging jumps into the pool from a height.
Laura Town	No.	None.	No.	No.
Thursday Island	No.	None.	There was a scare about 14 months ago when it was thought that there was hepatitis in the pool. This was unproven.	None.
Woorabinda	They try to stop animals entering, but the occasional dog wanders into the grounds.	Once per month a sample is sent to Brisbane.	Hospital staff have attributed a number of cases of sore eyes to high chlorine levels.	A few falls on the concrete which need stitches. Also gravel rash from similar falls.

Table 9: Supervision and insurance

Community	Are swimmers supervised? Supervisors qualifications	Supervision and security of premises at night.	Insurance for accidents.
NT:			
Nauiyu Nambiyu	One of the sport & recreation officers supervises. They all have first aid skills but no life-saving qualifications. At other times parents supervise their own children.	No nightwatch. Doors are locked.	No insurance.
Ngkurr	Two supervisors with have first aid skills. Their authority is respected.	Occasional problems with security at night especially when the local problem with petrol sniffing is bad. There are now two local men who live permanently at the pool premises in a donga.	Community Liability insurance.
Pularumpi	Caretaker acts as lifeguard. He has done an appropriate certificate course. There are three others in the community with similar qualifications who also act as lifeguard at different times.	The premises has three gates all of which are locked at night. There are also movement triggered flood-lights.	Unsure but assumed so.
Santa Teresa	One lady. Two other ladies were funded by CDEP but has been cut back. Older children look after the younger ones.	Nil.	Council.
Yuendumu	School term: a teacher or teachers aid supervise. School hols: The recreation officer (who has first aid skills) supervises	No nightwatch.	Both school and council have insurance.
WA:			
Papulankutja (Blackstone)	Pool Supervisor has Senior First Aid Certificate. His authority is respected.	None.	General community insurance.
Warakurna	Current pool caretaker supervises. He has appropriate training in first aid and life saving and his authority is generally respected. Mothers supervise small children in smaller pool.	Premises has double gate and double doors, both locked at night. It is one of the few buildings in the community that has never been broken into.	Unsure.
Warburton	Pool caretaker is main supervisor. She has first aid certificate and life-saving skills. She often has 2-3 community people assisting her. These people are unqualified.	No patrol of pool at night. Pool is broken into about twice per year requiring mending of fencing. Members of the community help keep an eye on the pool at night.	Council has Public Liability Insurance which is sufficient as there is no entry fee..
QLD:			
Cherbourg	Pool operator is main supervisor.	Pool not open at night.	Yes, Cherbourg Council.
Kowanyama	One full-time supervisor who has first aid skills but no lifesaving qualifications. Two or three others in the community who help out with supervision.	In the past there has been a problem with break-ins and vandalism. In recent times there has been less of this which may be attributed to the fact that the current supervisor lives directly across the road from the pool.	Unsure.
Laura Town	15	Nil.	Yes.
Thursday Island	Caretaker is main supervisor. Helped on busy days by a couple of local men. All have bronze medallion in life-saving and first aid skills.	The premises is surrounded by floodlights.	Public liability insurance.
Woorabinda	Pool manager and assistant supervisor. Both have bronze medallion in life-saving and first aid skills. There is a high turn-over of managers every season due to stresses placed on them by family and community. The respect and authority they have depends on who holds the position at the time.	The Aboriginal police drive past once an hour, throughout the night (used to be four times per hour). Break-ins still occur with upward of 200 people entering the pool illegally each week in summer. Vandalism is also a problem.	The council has public liability insurance.

Table 10a: Finance

Community	Construction costs (including a breakdown where avail.)	How was the construction financed?	Entrance fee
NT:			
Nauiyu Nambiyu	Total: $80,000	Not sure but presumably through grants.	None.
Ngkurr	Overall about $270,000. The cost of just pool installation was $190,000	All people involved in the CDEP programme (about 350 people) gave $2 from their weekly pay for a period of two years. Other money came from grants (eg from local government).	$2 per person.
Pularumpi	Total $144,885 -Earthworks: $6,700 -Topsoiling: $480 -Supply & installation of pool (including fibre-glass & concreting): $66,020 -Design & construction of pump cubicle:$5270 -Toilet block: $40,000 -Shade construction: $7,200. -Block paving: $7,425 -Outdoor showers: $590. -Fencing and gates: $11,200.	A grant from ATSIC.	50c per person.
Santa Teresa	Unknown, records lost.	Unknown.	None.
Yuendumu	Unknown.	Unknown.	None.
WA:			
Papulankutja (Blackstone)	Total: $300,000. Unsure of breakdown of costs.	A grant of $100,000 from Aboriginal Youth Affairs. The community store profits and community funds covered the rest.	None.
Warakurna	Total:$350,000. Unsure of breakdown of costs.	Majority funded by community and store. Small amount from ATSIC.	None.
Warburton	Total:$300,000. Unsure of breakdown of costs.	$150,000 was given by community store. $70,000 from a government grant. community raised the rest over the years.	None.
QLD:			
Cherbourg	Unknown, records lost.	Unknown.	Not known.
Kowanyama	Unsure of any costs.	Unsure.	None.
Laura Town	N/A	N/A	N/A
Thursday Island	Unsure of any costs.	Unsure.	Children 50c; Adults $2
Woorabinda	Total: $600,050. -Toilets, showers, and change rooms: $130,000.	A 20% surcharge was placed on all alcohol sold at the local licensed premises. This gave a deposit after 2 years and within 4 years the pool was paid off. The Dept. of Aboriginal Affairs gave $130,000 at the completion of the pool for the amenities block.	None.

Table 10b: Finance

Community	**Maintenance costs (including a breakdown where available)**	**How are the maintenance costs financed?**
NT:		
Nauiyu Nambiyu	-Chemicals and cleaning products: $7660/year. -Repairs (in the last year):$2,200. -Personnel costs: about $4,000/year.	Costs covered by a "Social Development Fund" which comes from the store and the club (where people can drink for one hour each day).
Ngkurr	-Chemicals and cleaning products: $6,000 - $7000 per year. -Water treatment and cleaning equip.: $1,500 per year. -Personnel costs: $40,000 per year.	All maintenance costs are funded by the shop.
Pularumpi	Total of $10,000- $15,000/year. On top of that is a full-timecaretaker position with salary of $28,000/year.	ATSIC, CDEP, and the council, (CDEP covers caretaker salary).
Santa Teresa		
Yuendumu	-Chemicals and cleaning products: $25/week. -Water treatment and cleaning equip.:$800/year. -Personnel costs: included in the salaries of the pool caretakers (ie school vice president and sport & rec. officer).	Council pays with funds raised from the youth programme which is mainly from selling hamburgers and soft drinks at the disco.
WA:		
Papulankutja (Blackstone)	-Chemicals and cleaning products: $2,000/year. -Water treatment and cleaning equip.: $1,000/year. -Cleaning and maint. of premises: $300/year. -Personnel costs: $8,000-$9,000/year.	A grant from the local shire of $7,000/year. Personnel costs are paid by 'Youth Development' within Ngaanyatjara Council.
Warakurna	Overall maintenance budget of $8,000/year.	Unsure.
Warburton	-Chemicals and cleaning products: $4,000-$5,000/year. -Water testing: $250/year -Water treatment and cleaning equip.: $2500/year (depends on sporadic repairs). -Cleaning and maint. of premises: $3,000/year. -Personnel costs: $25,000/year. -Major maint. (eg. re-painting pool): $10,000.	An essential service contribution has been established in the community. This generates $20,000 per year. In addition the local shire contributes $6,000 towards pool maint. each year
QLD:		
Cherbourg	Unknown.	Unknown.
Kowanyama	Overall maintenance costs <$10,000/year.	Council.
Laura Town	N/A	N/A
Thursday Island	Unsure of maintenance costs.	Council supplies chemicals and covers maintenance costs.
Woorabinda	-Chemicals and cleaning products: $45,000/year. (Water testing: $5,000/year. Water treatment and cleaning equipment: $40,000/year.) -Cleaning and maint. of premises: $20,000/year. - Personnel costs: $47,500/year. -Also cost of power to run pumps (unknown).	Council.

Table 11a: Swimming in other places

Community	Did people swim in other places before pool was built?	Do they still swim there now?	Water source
NT:			
Nauiyu Nambiyu	Yes, Daley River Crossing during the dry season, and a creek (also billabongs and waterfalls) during the wet season.	Yes.	Rain.
Ngkurr	Yes, in lagoons and billabongs (those without crocodiles).	Yes.	Rainwater.
Pularumpi	Yes, at the beach (very close to community) and at two waterholes..	Yes, but less now that the pool is open.	Waterholes-a spring.
Santa Teresa	Unknown.	Unknown.	Unknown.
Yuendumu	Yes, a dam on the edge of the community and an outlying dam.	Yes, the school pool is too small to hold a swimming carnival so this is held in the outlying dam (the cleaner of the two).	Rain water run-off.
WA:			
Papulankutja (Blackstone)	No, there isn't any water. There are summer storms once every few years.	They still swim in puddles after a summer storm.	Rain water.
Warakurna	Yes, a gorge nearby which has two main swimming areas.	Yes.	Rain water.
Warburton	Yes, people used to swim in sewage treatment pond. Also in a dam and in creeks when running (very rare).	No, people now realise that these are very dangerous places to swim.	Sewage and effluent water (treatment plant). Bore water (dam). Rain water (creek).
QLD:			
Cherbourg	Yes.	Yes.	
Kowanyama	Yes, in the local creek.	Yes, but less than before the pool was opened.	Rain.
Laura Town	Yes.	Yes.	
Thursday Island	Yes, at the local beaches.	Yes.	Ocean.
Woorabinda	Yes, the major creek, which used to be the town water supply.	A few people do. They can take their dog or ride their horses in.	Rain water run-off.

Table 11b: Swimming in other places

Community	Amount of water	Running or stagnant	Does water look clean?
NT:			
Nauiyu Nambiyu	Daley River Crossing (during dry season): about 200m wide and 1m deep. Creek (during wet season): about 1m wide and 1/2m deep (although it can be a lot wider and deeper).	Running.	Water looks crystal clear.
Ngkurr	Varies depending on location.	Usually stagnant.	Usually looks very clean.
Pularumpi	Each about 5m x 5m (don't know how deep).	Not stagnant as they're supplied by a spring.	Very clean.
Santa Teresa	Unknown.	Nil.	Yes.
Yuendumu	Sometimes the dams aren't full. Even the bigger (nearby) dam is sometimes dry.	Stagnant.	Very dirty. If you put your hand in it you can't see it. The bigger (nearby) dam has 44 gallon drums at the bottom and the children have a rainbow tinge when they come out because of the chemicals. The outlying (cleaner) dam has pigs and cattle wallowing in it.
WA:			
Papulankutja (Blackstone)	Puddles.	Stagnant.	Muddy.
Warakurna	One area about 10m x 10m and about 4m deep, the other a little smaller.	Depends on time of year. Rain comes in Dec. and water is running. By April water is stagnant. Sometimes there are more rains in April in which case water will be running again.	Clean if running, not if stagnant.
Warburton	About 100,000 litres in both the dam and the treatment plant.	Stagnant.	Treatment plant water is green. Dam has brown, muddy water.
QLD:			
Cherbourg	Unknown.	Running.	
Kowanyama	Varies with rain. At its peak it may be 100m across.	Running during wet. Does become stagnant and people sometimes still swim.	The water looks clean. It is tested every two months and has had high levels of faecal coliforms in the past.
Laura Town	Unknown.	Running.	Yes.
Thursday Island	N/A	N/A	The water looks clean.
Woorabinda	Creek has not had a decent run for three years.	Usually stagnant.	No. It has had blue-green algae in it.

Table 11c: Swimming in other places

Community	Distance to community	Supervision	Amount of time water is available
NT:			
Nauiyu Nambiyu	Daley River Crossing right next to community. Creek about 10km away.	Only if parents accompany children.	Depends on season (see above).
Ngkurr	Many within 10-20km.	Supervision within the family group who choose to swim there.	Depends on location. Some all year round, some dry up
Pularumpi	10-15 mins walk.	None.	Waterholes: all year. Beach generally only used during dry season due to danger of crocs.
Santa Teresa	7k	Unknown.	Water available at all times.
Yuendumu	Big dam: 300m. Other dam: 10km.	None at the closer dam, but at the outlying dam children are supervised by the people that drive them there.	Dams can be all year round depending on the rain. When the drainage channels in town flood (very rare) they swim there too.
WA:			
Papulankutja (Blackstone)	The low point of the land, about 500m from the town centre.	None.	About two days after the rain once every few years.
Warakurna	About 11km by track.	Presumably young children are supervised by whoever drives them there.	December until April. Longer if there are more rains in April.
Warburton	3km to both the dam and the treatment ponds.	None.	The creeks only appear once every few years and usually last only a few days.
QLD:			
Cherbourg	300m	Mostly, if adults present.	All year round.
Kowanyama	Right next to town (20m).	None.	Always water.
Laura Town	1km	Yes.	
Thursday Island	Walking distance from the community.	Occasionally.	Always water.
Woorabinda	30m.	None.	People can usually swim there for three weeks of the year. The creek has running water for about 21 days per year.

Table 11d: Swimming in other places

Community	Animals in the proximity	Accidents in the last year	Have any diseases or outbreaks occurred which can be attributed to the swimming place?
NT:			
Nauiyu Nambiyu	Dogs, crocodiles.	None.	Unknown.
Ngkurr	Buffalo, crocodiles, cattle, horses, dingos, kangaroos, goannas.	None.	No.
Pularumpi	Many wild animals in the proximity.	None in the last year. Child bitten by a box jelly-fish eight years ago..	Unknown.
Santa Teresa	Nil.	Nil.	Unknown.
Yuendumu	Mainly cattle.	Someone drowned once at a smaller dam and now no-one goes there.	Unknown but probably.
WA:			
Papulankutja (Blackstone)	Dogs.	None.	Unknown.
Warakurna	Many wild animals in the proximity.	None.	Unknown.
Warburton	There were cattle but they were culled in 1988 There are birds and ducks but not significant numbers of other animals.	None.	Not known for sure but probably.
QLD:			
Cherbourg	Cattle, horses, wildlife.	None known of.	No.
Kowanyama	Cattle, horses, dogs, birds, wallabies.	None.	Unknown.
Laura Town	Yes.	No.	No.
Thursday Island	Dogs, crocodiles, crabs.	A number of cut feet (cut on broken glass and coral). Nothing serious.	Coral spawn has been known to cause severe infection if it comes into contact with an open wound.
Woorabinda	Dogs, cattle, birds, kangaroos, rats, wallabies, snakes, fish, turtles, ducks.	Two drownings have occurred in the river in the last fifteen years.	Several bouts of gonnorreah, eye infections, and infected sores have all been attributed to this swimming place.

Table 12: Final points

Community	What are the most important things to keep in mind when considering construction of a comm. pool?	Any health effects (+ve or -ve) that have been due to the installation of the pool.
NT:		
Nauiyu Nambiyu	Made particular mention of the importance of a good fence. Theirs is becoming a little dilapidated and as a result there have been a number of break-ins.	Despite a few incidences of "tropical ear" which may be attributed to the pool, overall there has been less incidence of skin, eye and ear infections.
Ngkurr	Community involvement is important; Make sure site is well chosen (ie suits local terrain); Look at water quality before deciding which chemicals should be used (eg gas is good here because of hard water).	There is an obvious improvement in the amount and severity of scabies in the community. Also improvements in body odour and general cleanliness.
Pularumpi	Can be problems due to availability of materials (waited three months for the construction of a fence), but no major problems encountered here.	Less sores. Children happier. Socially beneficial, especially for children.
Santa Teresa	High sloping ground and good foundation.	All positive and good.
Yuendumu	Supervision is extremely important as a drowning could easily result in the closure of the pool. Also the supervisor on duty would be thrown out of the community because that is the way of their Tribal law.	The pool helps with skin diseases and also provides regular exercise. It keeps the children active during the daytime and then they are tired at night so they get into less trouble due to boredom. The community is more social and happy.
WA:		
Papulankutja (Blackstone)	Supervision. The pool must be strictly supervised and maintained which places a greater burden on staff who take on these duties on top of what they're already doing.	No negative effects have been encountered. There are fewer cases of scabies when the pool is open in summer.
Warakurna	In this case one of the hardest things about the construction of the pool was that all the concrete had to be hand mixed.	Psychological and social benefits.
Warburton	Whether or not the pool is under cover is a crucial consideration. Security is better if the pool is in a shed but the "social guard" where the community keeps an eye on the pool is not present. Also an open pool in the middle of the community is convenient, and more visually pleasing. A design for easy maintenance should be considered and the pool is best constructed out of direct sunlight.	The fact that people are no longer swimming in the sewage treatment ponds and the dam mean that the negative health effects caused by the water in these areas are no longer a factor. Community spirit & interaction is high and there is less incidence of skin lesions &sores.
QLD:		
Cherbourg		No.
Kowanyama	It is very important that there is someone qualified (or willing to become qualified) and INTERESTED in looking after the pool.	There is anecdotal evidence of less skin, eye, and ear infections since the installation of the pool.
Laura Town	To ensure regular tests are carried out. To ensure that health regulations are met. Employ a responsible person.	None noted.
Thursday Island	Safety is a key issue. Very important that the pool surrounds are constructed with safety in mind. Adequate pool maintenance and supervision are essential.	While no +ve or -ve health effects have been documented, it is generally considered that the pool helps to improve the standard of hygiene in the community.
Woorabinda	Running cost is $120,000 per year. Buy simple equipment that can be fixed easily and quickly. Try to keep pool open as much as possible to minimise vandalism.	

DRAFT REPORT

ON

THE INVESTIGATION OF TECHNICAL ISSUES ASSOCIATED WITH THE CONSTRUCTION AND MANAGEMENT OF PUBLIC SWIMMING POOLS IN REMOTE ABORIGINAL COMMUNITIES

FOR

CENTRE FOR APPROPRIATE TECHNOLOGY INC

REPORT BY

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APRIL 1998

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EXECUTIVE SUMMARY

This report covers the technical issues associated with the construction and management of swimming pools in remote Aboriginal communities. A brief summary follows.

Selecting an appropriate size swimming pool is an important first step for communities considering a swimming pool. An overcrowded pool may result in accidents, may overload the filter and disinfection system and may reduce the water quality. A pool should be designed to cope with the anticipated number of users now and into the future.

Remote communities with potentially limited water supply may be concerned about the quantity of water required to operate a public swimming pool. For example a 25m swimming pool can use up to 4,000,000 litres of water per year through evaporation, backwashing filters, splashing, and emptying for maintenance. While for some communities, this may represent only a fraction of their normal water use, it is essential that communities check their water supply capacity.

There are several types of swimming pool construction; above ground/below ground, concrete/fibreglass, with each having advantages and disadvantages. Typically public swimming pools in both remote and urban communities across Australia are underground, concrete structures. Concrete pools are durable and offer the advantage of scum gutters which enables the most effective water circulation. Other types of construction may also be appropriate however depending upon the availability of skills and resources in remote communities, and the ground conditions.

Continuous 24 hour water circulation is essential in a public swimming pool to ensure adequate water quality, with the water being turned over every 4 hours. However the rate of pollution removal from pool water is also dependent on the efficiency of the circulation system. Domestic backyard swimming pools tend to have side inlets and skimmer box outlets. For larger public pools, bottom inlets are more efficient at reaching all areas of the pool, and scum gutters are more efficient at removing surface pollution. Scum gutters are not easily incorporated into fibreglass pools; a reason why public pools are usually made from concrete.

Pumps and filters are a major maintenance issue for most community swimming pools. This is often because domestic systems have been installed rather than the more expensive commercial grade pumps and filters. Domestic pumps and filters are not designed to be running 24 hours per day, usually have plastic components which do not survive the harsh environmental conditions in remote communities, and are usually undersized. As a result they require replacing or rebuilding at regular intervals.

While there are several types of pool filter, the most common and most appropriate for use in large swimming pools are high rate sand filters. Sand filters are able to remove suspended solids and some small pathogenic organisms.

Disinfection is the process of destroying bacteria, viruses, algae and other pathogens which are not removed through filtration. There are several methods of disinfection which are discussed in this report. The most effective disinfection systems are typically the most hazardous, requiring a higher skill level to manage effectively. For example a gas chlorinator is the most effective disinfection system yet potentially the most hazardous if strict safety measures are not followed. A salt water chlorinator is the least hazardous yet this the effectiveness of this type of technology is untested in public swimming pools, particularly in remote communities. Salt water chlorinators do not cope well with fluctuating bather loads and require regular cleaning or replacement of salt cells in hard water conditions. There are a range of other options which fall somewhere between these two in terms of effectiveness, safety risk and ongoing maintenance. The effectiveness of the different systems depends upon many factors including whether the pool is indoor or outdoor, the quality of water source, if regular maintenance is carried out, the fluctuation of users, water temperature, and community acceptance of the system. The ongoing maintenance costs of the different systems depend greatly upon the remoteness of the community, the level of skill within the community, quality of water source, and the number of users.

There are many jobs created once a pool is installed in a community, such as pool management, cleaning and maintenance, pool attendants, and security. These jobs may be filled by people within the community or by skilled people from outside. There are several courses on swimming pool operation

and maintenance available which local people could enrol in. Appendix 3 has brief details about some available courses.

Most states and territories have guidelines, codes of practice or regulations covering the operation and maintenance of public swimming pools. These guidelines are included in Appendix 1. There are also several relevant Australian Standards which provide useful information; a summary of these being included in the report.

Appendix 2 highlights some pump, filter and disinfection technologies which are designed for use in public swimming pools. While a product review has not been carried out for this report, these brochures are included as an example of some available technology which may be appropriate for use in remote communities.

RECOMMENDATIONS

These recommendations should be read in conjunction with the findings of research carried out by the National Centre for Epidemiology and Population Health, the Centre for Appropriate Technology Inc, and the Pintupi Homelands Health Service, on health issues associated with swimming pools.

The following recommendations cover some of the technical issues which need to be addressed by communities considering a swimming pool.

1. The community should estimate the number of people likely to use a swimming pool. If known, the rate of population growth should be taken into consideration. As a general guide, allow 4 square metres per bather when calculating pool size.
2. The community should check the available water supply to make sure it has capacity for the expected pool water usage.
3. An engineer or project manager experienced in swimming pool design and construction should be appointed by the community to prepare a design and specification for construction, invite and receive tenders, supervise the construction and ensure quality control.
4. The project manager should prepare a detailed cost estimate prior to a financial commitment being made by the community. As a guide only, a 25m indoor concrete pool for an Aboriginal community in Central Australia has recently been costed at around $600,000. Costs will vary considerably from community to community depending upon remoteness, skills available in the community and soil conditions.
5. The cost estimate should include the anticipated ongoing maintenance costs. This enables the community to investigate how it will effectively budget for ongoing operation and maintenance.
6. A below ground pool is preferable unless there are difficult ground conditions such as high water table, steep site or hard rock.
7. A concrete pool is preferable to fibreglass for the following reasons: concrete enables the installation of scum gutters which provide efficient water circulation; concrete potentially offers more opportunities for local involvement in construction; in high ground water concrete has a greater capacity to resist flotation.
8. Bottom inlets and scum gutters/channels should be installed to allow for more efficient water circulation.
9. Ensure pumps are commercial quality with bronze impellers, stainless steel sleeved shafts, and oversized stainless steel hair and lint strainers. A second pump should be installed to double the turnover rate in emergencies and to act as a backup.
10. Filters should be commercial quality high rate sand filters.
11. The plumbing system should be designed by an engineer to ensure the pumps, filters and pipework are appropriately sized.
12. It is not possible to recommend a disinfection system which would be appropriate for all communities. The engineer should consult closely with the community to select the appropriate system.
13. An indoor pool is preferable for communities where there are high evaporation rates, high winds and dust storms. The structure should have adequate ventilation to dilute volatile air contaminants.
14. Toilet, shower and changeroom facilities should be designed and constructed in accordance with the relevant state guidelines, the Building Code of Australia and the local council guidelines.

INTRODUCTION

It is anticipated that this report will become a chapter in a more general report on swimming pools for remote Aboriginal communities. Other aspects of this bigger picture report will include an audit of swimming pools existing in Aboriginal communities, a detailed study of the swimming pool at Santa Teresa and an analysis of the health issues associated with swimming pools in remote communities.

This report is not a technical manual nor does it replace the guidelines or codes of practice already in place in most states of Australia. The current codes of practice are generic, covering mostly public swimming pools in mainstream urban communities. The purpose of this report is to raise issues which remote Aboriginal communities should consider when investigating and planning swimming pools. It covers the basic operation of a public swimming pool and highlights the advantages/disadvantages of the various technical options available.

Information has been sourced from relevant literature, pool builders, pool equipment suppliers, state guidelines and regulations, Australian Standards, Aboriginal communities which have experience with public swimming pools, and the National Centre for Epidemiology and Population Health audit of community swimming pools.

WATER ISSUES

Quantity of water required for normal operation of a swimming pool

A common question asked, particularly of Central Australian communities who are considering a swimming pool, is "do you have enough water?" Swimming pools consume water through evaporation, periodic refilling, and through regular backwashing of filters.

Rates of evaporation vary considerably throughout Australia. An example of the expected amount of water loss from an exposed swimming pool due to evaporation is provided here for a Central Australian community several hundred kilometres west of Alice Springs. The closest and most relevant meteorological station is at Giles just inside the WA border. The mean daily evaporation rate at Giles Meteorological Station is 9.5mm which is an average of 3,467mm per year. At this rate, a 1.5m deep swimming pool would require refilling 2 to 3 times per year. A 25m outdoor, unprotected pool in Central Australia may therefore lose between 900,000 - 1,350,000 litres of water per year through evaporation.

Pools are usually only emptied and refilled when there is substantial maintenance required such as repainting walls etc. A 25m pool may therefore require around 450,000 litres for refilling every 4-5 years.

The major use of water is for backwashing filters. This is required on a regular basis to ensure the filters operating efficiently. The water flow is reversed through the filters to wash away any sediment which has accumulated in the filter. The quantity of backwash waste water depends on the type of filter, the filter condition, and the size of the pool.

Using high rate sand filters the time for backwashing could be up to 4 minutes every day. For a 25m pool this could amount to 7500 litres of wastewater per day. Up to 2,700,000 litres per year could be used in backwashing filters.

Some water is also lost through splashing of bathers.

The total amount of water used for an exposed outdoor 25m pool could therefore be in the order of 4,000,000 litres of water per year. For a community of say 500 people this water use represents 22 litres/person/day which is a fraction of normal daily water usage. Nevertheless communities should check that they have the capacity in their water supply systems for this extra water demand.

The water loss could be significantly reduced if the pool is sheltered from the sun and wind. The obvious saving would be evaporation losses if the pool was covered. Water for backwashing pumps may also be reduced if the quantity of dust entering the pool is reduced. Pool enclosures are discussed later.

Disposing of wastewater discharge from swimming pools

Backwash wastewater can carry harmful protozoa and helminths which have been trapped in the filter system but have survived chlorination. This water therefore needs to be disposed of in a safe way.

A Cryptosporidia outbreak in NSW which is currently being investigated by the NSW Department of Health is believed to be associated with swimming pool backwash waters (Burgess 1998 pers. comm.).

Backwash water should not be discharged into rivers, dams or lakes, nor be discharged onto the ground surface. Backwash water should be discharged to the community sewerage system, common effluent drainage or stormwater drainage system if they are available. This will mean gaining permission from the relevant authority to discharge into the system.

The South Australian Code of Practice specifies that under no circumstances can backwash water be discharged into a septic tank. This requirement should be observed by remote communities in other states as well. Where communities do not have a common effluent drain, deep sewer, or piped stormwater drainage system, the backwash waters can be safely discharged to a specially constructed absorption or evaporation trench.

Pretreatment is usually not required for backwash waters from sand filters before being discharged into the community sewer. Backwash water from filters using diatomaceous earth as the filter medium however does require pretreatment in the form of a settling tank to prevent blocking of the sewer system (Gabrielsen 1987). Types of filters are discussed later.

Water quality

The effect of calcification

In arid communities bore water is often rich in calcium which can cause scale to form on plumbing and filters. Where a saltwater chlorinator is used scale will build up on the salt cell reducing its effectiveness to chlorinate the pool. The life of a salt cell may be reduced to 1-2 years in these conditions.

The amount of scale build up or cloudy water is dependent on a number of factors;
- water temperature,
- dissolved solids in the water,
- amount of calcium hardness
- total alkalinity
- pH

The easiest of these to control is total alkalinity and pH. If the pH is maintained between 7.2 - 7.6 and total alkalinity is maintained between 60 - 200ppm scale build up will be reduced.

POOL STRUCTURE

Pool size

It is important to ensure that a community pool is the correct size to avoid overcrowding. Overcrowding can;

- result in accidents,
- make it difficult for supervisors to see if anyone is in danger,
- can overload the filter and disinfection system,
- and can reduce water quality.

When planning for a swimming pool the community first needs to assess how many people will use the pool. The pool should then be designed to cater for the peak bathing load - the highest number of people likely to use the pool at any one time. Growing communities should design their pool to cater for a potential increase in users in years to come.

There is very little information on what is an appropriate size for swimming pools in small remote communities. Table 1 below shows the maximum safe pool capacity in terms of square metre per bather used for designing mainstream urban pools.

	Indoor	**Outdoor**
Shallow water (less than 1.5m)		
Recreational swimming		
beginning swimming instruction	3.6m^2	4.0m^2
advanced swimming instruction	1.8m^2	2.2m^2
Deep water (deeper than 1.5m)		
advanced recreational swimming	1.8m^2	2.2m^2
diving, area within 9m of deep end diving wall	15.0m^2	18.0m^2

Table 1: Maximum safe pool capacity for urban pools - Square metre per bather (Gabrielsen 1987:157)

Apart from NSW, the various State guidelines do not have a direct formula for calculating pool size. The NSW guidelines specify a range of 3.0 - 4.5 square metres per bather, depending on the depth of pool. The WA guidelines use a figure of 2.3 square metres per bather when calculating the number of toilet facilities required. These figures are consistent with Table 1.

In remote Aboriginal communities where the users are most likely to be children, a size of 3.6 - 4.0 square metres per bather may be appropriate. As an example, a 25x12m pool should be sufficient for 75 - 83 bathers at any one time.

A summary of the size of swimming pools currently being used in some Aboriginal communities is shown in Table 2 below

Community	Population	Entries per day	Pool Size (metres)
Papulankutja (WA)	170	30	25x10 including wading
Warakurna (WA)	350	5-50	50x15 (1-1.5 deep) including wading 5x15 (0.4 deep)
Warburton (WA)	517	50-150	25x10
Nauiya Nambiyu (NT)	300-500	5-20	40x20
Ngkurr (NT)	1,000	80-100	25x15x1-1.8 9x4x1-1.8 9x4x1 5x6x0.35
Pularumpi (NT)	283	30-40	50m
Santa Teresa (NT)	400-700	30-50	25x10x1-2.5 wading pool
Yuendumu (NT)	800	30-70	6-7x3
Kowanyama (Qld)	1,200	30-70	25x20x1.5 wading pool
Thursday Island (Qld)	3,800	5-150	3 pools 1 olympic size 6x5x0.3
Woorabinda (Qld)	13,999	50-400	Olympic size + wading pool

Table 2: Population, number of entries and sizes of swimming pools in a variety of Aboriginal Communities (from draft report of NCEPH swimming pool audit)

Common types of pool construction

There are many types of pool construction to consider when planning a community pool. Swimming pools can be built above ground or below ground, and can be constructed from concrete, concrete block, fibreglass, or vinyl. Each has advantages and disadvantages and the choice depends upon many factors.

It is not possible to provide cost estimates for each type of pool because every community will have different conditions, such as freight distances for materials, availability for using local building materials, availability and skills of local labour, access to construction equipment, soil conditions, climate. Table 3 shows the construction costs for a range of pools constructed in remote Aboriginal communities.

Community	Construction of pool	Pool Size (metres)	Cost	Year constructed
Papulankutja (WA)	concrete	25x10 including wading	$300,000	1988
Warakurna (WA)	concrete	50x15 (1-1.5 deep) including wading 5x15 (0.4 deep)	$350,000	1993
Warburton (WA)	concrete	25x10	$300,000	1989
Nauiya Nambiyu (NT)	concrete	40x20	$80,000	1987
Ngkurr (NT)	fibreglass	25x15x1-1.8 9x4x1-1.8 9x4x1 5x6x0.35	$270,000	1996
Pularumpi (NT)	concrete	50m	$144,885	1995
Santa Teresa (NT)	concrete	25x10x1-2.5 wading pool	?	1972
Yuendumu (NT)	fibreglass	6-7x3	?	1985
Kowanyama (Qld)	concrete	25x20x1.5 wading pool	?	1986
Thursday Island (Qld)	concrete	3 pools 1 olympic size 6x5x0.3	?	1987
Woorabinda (Qld)	concrete	Olympic size + wading pool	$600,050	1988

Table 3: Types of pools in a selection of Aboriginal communities showing comparative costs (from draft report of NCEPH swimming pool audit)

The construction costs shown in Table 3 above may not be the full cost associated with these swimming pools. For example the cost of local involvement, excavation, landscaping, toilet and shower facilities, buildings and fences may not be included in all of the above costs. As a guide only and for comparison, a 25m indoor, below ground, concrete swimming pool for a community in central Australia has recently been costed at $600,000. It is important to have a detailed cost estimate prepared by the project manager prior to deciding on a design and prior to a financial commitment being made.

Above ground or below ground

Most public swimming pools are built below ground because they are usually more cost effective. With a concrete pool, the outer faces of the walls and floor may not need to be formed if the pool is built below ground. This can be a great cost saving. Pool surrounds are easier to construct for a below ground pool because the pool edge is at a similar level to the surrounding ground.

Precautions need to be taken to prevent below ground pools from floating when the pool is empty if the groundwater table is high or likely to be high during the rainy season. Pressure relief valves can be used however they are prone to seize up and fail to operate when needed. Rather than relying upon pressure relief valves, a concrete pool with thicker walls and floor can be used to give extra weight to the structure, making it less likely to float. An added precaution could be not emptying the pool during the wet season. Slotted subsoil drainage pipes could also be considered to reduce the groundwater table to below the bottom of the pool.

Above ground pools are more suited when hard rock is encountered which is expensive to excavate, for wet sites requiring dewatering during construction, or for steep sites where extensive cut and fill would be required. Above ground pools then require a raised platform surround. One advantage of an above ground pool is easier access to pool plumbing for maintenance.

Table 4 highlights the advantages and disadvantages of the common construction methods.

Concrete

The most common construction material for public swimming pools in Australia is concrete. In the past there have been few other options for large public pools. Concrete pools are durable, long lasting and have the ability to be made into many sizes and shapes, with a variety of pool finishes.

Swimming pools impose unusually heavy loads on their foundations and therefore require higher quality and higher strength concrete than most other small concrete structures. Concrete pools need to be designed by a professional structural engineer. The concrete mix, including methods of placing, compacting and curing all need to be correctly designed to ensure that the required properties of concrete are obtained. The required properties for a concrete pool are;

- impermeability
- durability
- strength

Design and construction should be in accordance with Australian Standard AS1480 Concrete Structures code. Australian Standard AS2160, Contract for the Supply and Construction of a Swimming Pool provides a useful reference when preparing contract documents. Detailed design considerations are not included in this report.

Some of the main issues which need to be carefully considered with concrete pools are;

- the time of year for construction - effectively placing and curing concrete during the hot months in Central Australia would be difficult,
- ground water salinity - if coastal the concrete may need to be designed for saline conditions,
- ground water level - a heavier structure may be required to prevent flotation
- cost of freight for concrete materials.

	Advantages	Disadvantages
Below ground	• usually less expensive than above ground • easier access at ground level • cheaper and easier for landscaping around	• Plumbing can be more difficult to access for maintenance • expensive excavation costs in rocky or wet ground
Above ground	• easier access to pool plumbing • suited to rocky conditions, wet sites and steep sites • suited to restricted sites in urban areas	• usually more expensive more below ground • steps or substantial structure may be required for access to the pool
Concrete using conventional formwork	• a good finish can be achieved • conventional method to ensure a watertight and durable pool • Scum gutter system can be used which allows more effective water circulation • less likely to float (when empty)	• effective curing of concrete not easy on hot days (>32^o) • expense of formwork • expense of concrete
Concrete with concrete block as formwork	• more opportunities for employment and training of local labour • less concrete required • usually cheaper to construct • Scum gutter system can be used which allows more effective water circulation	• may be difficult to achieve a watertight structure • special considerations required for structural stability • effective curing of concrete not easy on hot days (>32^o)
Sprayed concrete	• no requirement for internal formwork • rapid construction • Scum gutter system can be used which allows more effective water circulation	• effective curing of concrete not easy on hot days (>32^o) • specialist skills and equipment required • accurate concrete mixing required • the pool is lighter in weight and therefore more likely to float than a conventional concrete pool (when empty)
Fibreglass (transported in panels)	• Rapid construction • possibly cheaper than concrete • Additional wall and floor finishes unnecessary • 5 year guarantee	• no Australian Standard covering this type of construction • specialist skills required to construct which may preclude local involvement • lightweight pool which is very likely to float in high groundwater conditions (when empty) • limited experience in Australia • unsure of effect of transportation on rough roads • Not suitable for scum-gutter system • Fibreglass fades in the sun

Table 4: Advantages and disadvantages of the common construction methods for public swimming pools

There are several methods of constructing a concrete pool which are described below.

Insitu reinforced concrete using formwork

In this method the walls are formed using steel or wood panels. A high degree of accuracy is required when constructing formwork to ensure that the dimensions are within an acceptable tolerance and to ensure that the finish is compatible with the proposed finishing material. All steel reinforcement must be accurately placed with a minimum cover of 40mm to prevent any corrosion.

Premixed concrete is usually necessary to provide the accuracy of mix. This may be the limitation in remote communities. To avoid segregation of the mix and potentially creating more permeable concrete, the concrete should be placed using a wheelbarrow, placed in layers not exceeding 500mm and then compacted using vibrators.

While this is the conventional method of constructing a durable and watertight concrete swimming pool, it is often the most expensive. Cost will depend largely on location of the community and freight of materials may be the determining factor when deciding which type and method of construction to use.

Concrete using concrete block as formwork

This method is simpler and cheaper than the insitu concrete pool using formwork. Concrete block walls are constructed on a concrete base slab. After the walls have been constructed reinforcement is placed in the hollows and then filled with concrete. Depending on the size and structural design, a thickness of reinforced concrete may be required behind the walls. The blocks can then be rendered before tiling or painting.

There are some concerns about this method however for pools larger than 12.5m (Davies 1981). The following issues may need to be addressed by the designer;

- Concrete blocks are less dense than well compacted concrete and as such are more permeable, particularly to water under pressure. While the filled hollows may be well compacted and impermeable, the ends of the block and the mortar joints are comparatively porous. A waterproof membrane may be necessary to ensure watertightness. If the water table is high the external sides of the walls will also require additional waterproofing.
- Due to the different permeability rates between concrete blocks and insitu concrete, cracking of the wall and membrane may occur if moisture movement or drying shrinkage occurs.
- The crushing strength of concrete blocks is less than that of insitu concrete.
- Steel reinforcement placed through the hollows of the blocks are by necessity positioned in the middle of the wall. This is not in the most suitable placement structurally since the tensile stress is on the inner face of the wall when the pool is full and on the outer face when the pool is empty.
- It may be difficult to achieve a substantially rigid joint at the junction of the wall and floor, particularly over a 25m span.

The advantages of this system are that less concrete is used, less expensive equipment can be used and there may be more opportunity for the employment and training of local labour. If the community already has a local building team, they may already have the necessary experience to complete this work.

Reinforced sprayed concrete or shotcrete

Another method of constructing a concrete pool is with sprayed concrete. This is a very fast method of construction and is usually cheaper than a conventional concrete pool using formwork. Concrete is conveyed through a hose, projected at high velocity onto the surface and is compacted on impact. For this reason internal formwork is not necessary which can be a considerable cost saving.

Additional costs may be incurred in remote communities however due to specialist equipment and skills being required. The quality of the material and of the mix is very important which may be difficult in remote locations. The completed pool is lighter than a conventional concrete pool therefore is it more prone to flotation when empty in high groundwater conditions.

Fibreglass

Fibreglass pools can be premoulded before transporting to the site or can be assembled on site using flat panels. Premoulded fibreglass is used extensively for small private pools. The main limitation with premoulded fibreglass pools is the size which can be transported. The maximum width for normal transportation is 4.5 metres. This precludes premoulded fibreglass from being used for public swimming pools (as they are usually wider than 4.5 metres).

Fibreglass pools constructed using panels of fibreglass which are joined on site can overcome the limitation of transport widths. These pools are relatively quick to build compared with concrete pools, although specialist skills are required. For remote locations this type of construction is likely to be less expensive than concrete due to reduced freight costs. Suitable backfill material may still need to be carted to site as well as concrete for the pool surround.

A major problem with fibreglass pools is that they are likely to float in high groundwater conditions when the pool is empty. This may prevent the pool from being emptied for maintenance.

Vinyl

Vinyl liners are commonly used for above ground private pools. The vinyl only serves as a membrane to provide water tightness; it has no structural strength in itself. Liners can be placed over concrete, steel or fibreglass and may be used to refurbish a pool. They are not widely used for public pools because of their lack of durability and lack of ability to withstand abuse from vandals. Vinyl liners are not considered further in this report.

Wall and floor finishes

There are several types of wall and floor finishes available such as ceramic tiles, exposed aggregate, paint or cement render. The choice will depend upon the following factors;

- initial cost,
- slip resistance,
- glare resistance,
- ease of cleaning,
- stain resistance and
- chemical resistance.

Ceramic tiles are generally the most expensive type of finish but they offer the best qualities in terms of glare resistance, ease of cleaning, stain and chemical resistance. While slip resistance is generally better with other types of finish such as exposed aggregate surfaces, paint or render, ceramic types can be chosen which are sufficiently slip resistant.

Rendered and painted surfaces can be adequate if a hardener is used, at a substantially reduced initial cost. Exposed aggregate surfaces provide excellent slip and glare resistance, but are generally more difficult to clean.

WATER CIRCULATION AND FILTRATION

The maintenance of high quality water in the pool at all times is important to ensure safe conditions for the users of the pool. The necessary water quality in the pool is achieved using pumps to circulate the water through a filter system to remove any suspended solids and to improve the clarity of the water. The water is then disinfected by a chemical process to kill any pathogenic organisms, before entering the pool again. This process, shown in figure 1 below, is usually continuous, 24 hours per day.

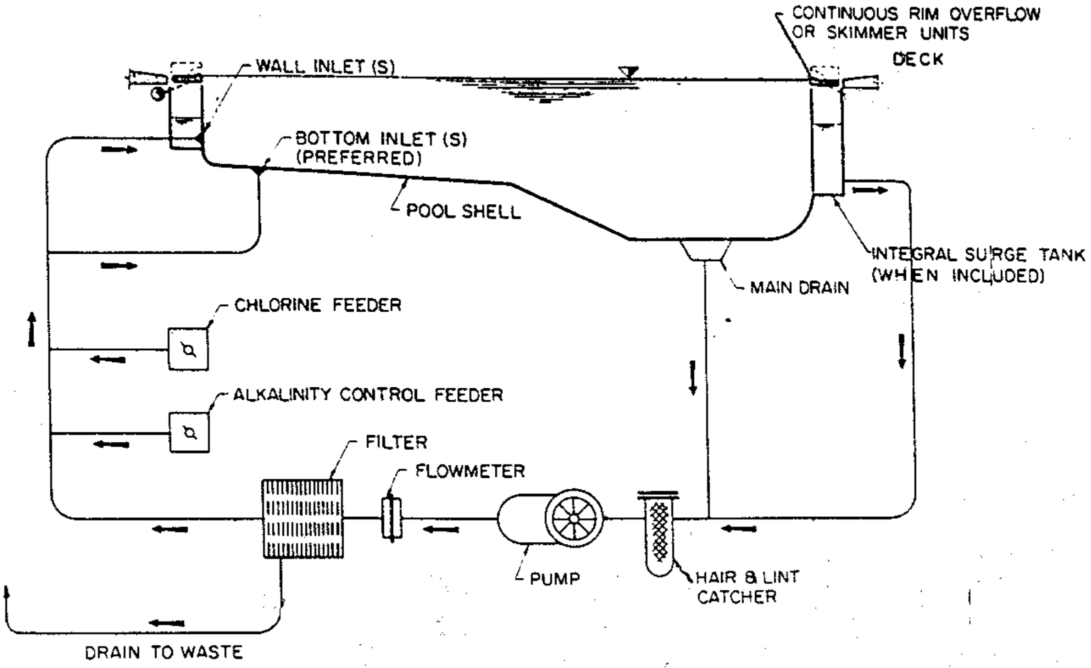

Figure 1: Process of water circulation, filtration and chemical treatment (Gabrielsen 1987:193)

The hydraulic system should be designed by a professional engineer to ensure the appropriate pump and filter combination, and correct pipe sizes are selected. This is critical for the efficient operation of the circulation system. It is essential in a community pool that good quality, commercial size pumps and filters are installed, rather than installing cheaper systems designed for domestic use. Domestic pumps and filters are usually only designed to run 4-6 hours per day rather than 24 hours per day which is necessary for a larger community swimming pool.

Turnover

The time taken for the full volume of water in the pool to pass through the filtration and disinfection system and back into the pool again is referred to as the turnover rate. The required rate of turnover depends on a number of factors such as;

- the number of users
- the circulation efficiency - the design of inlet and outlet positions
- filter performance
- pool size especially depth
- temperature, pH, chemical treatment
- personal hygiene standards of the users
- length of time pool is closed to users

Pool water must be continually recirculated to maintain necessary sanitary levels, free from harmful organisms and turbidity. The dilution of filtered and treated water into the pool must occur continuously. Shutting down filtration and treatment systems during the closed periods will decrease the system's effectiveness. In fact it is during the closed periods when it is possible to remove 100% of the pollution in the pool.

The effect of different inlets and outlets on turnover

The effectiveness of each turnover to reduce pollution levels depends largely on both the location of the water inlets, and the type of skimming system. Bottom inlets continually pushing water upwards have been found to be more effective than wall inlets in large pools. Wall inlets can have difficulty reaching the central areas in large pools.

The outlet system comprises skimmer boxes or scum gutters/channels at the surface combined with an outlet in the pool floor. Continuous surface skimming around the perimeter of the pool using scum gutters/channels are more effective than individual skimmer boxes located intermittently around the pool. Most large public pools (greater than 10m) use scum gutters/channels. Skimmers and scum gutters are covered in more detail later in the report.

Figure 2 shows the comparative effect of turnover on removing pollution levels, with both bottom inlets and wall inlets, during the after bathing period (AB period). The top graph shows a pool with wall inlets where some "clean" water and some of the remaining "polluted" water is removed from the pool and progressively filtered "clean" with each turnover. Depending upon the efficiency of the outlet system, one turnover of the pool water may only remove about 58% of the pollution (Gabrielsen 1987). With each subsequent turnover more pollution is removed, until after about 4 turnovers less than 2% of the pollution remains. During pool opening hours users continually introduce pollution and their activities help mix the water. If the pool was open for 8 hours per day, these 4 turnovers may have to occur during the 16 hours when the pool is closed.

The lower diagram in Figure 2 refers to a pool with bottom inlets. The bottom inlet system minimises the mixing of clean treated water with the untreated water. The clean water is segregated and is used to push the polluted water up and into the scum channels. Figure 2 shows 100% of the pollution being removed after only one turnover.

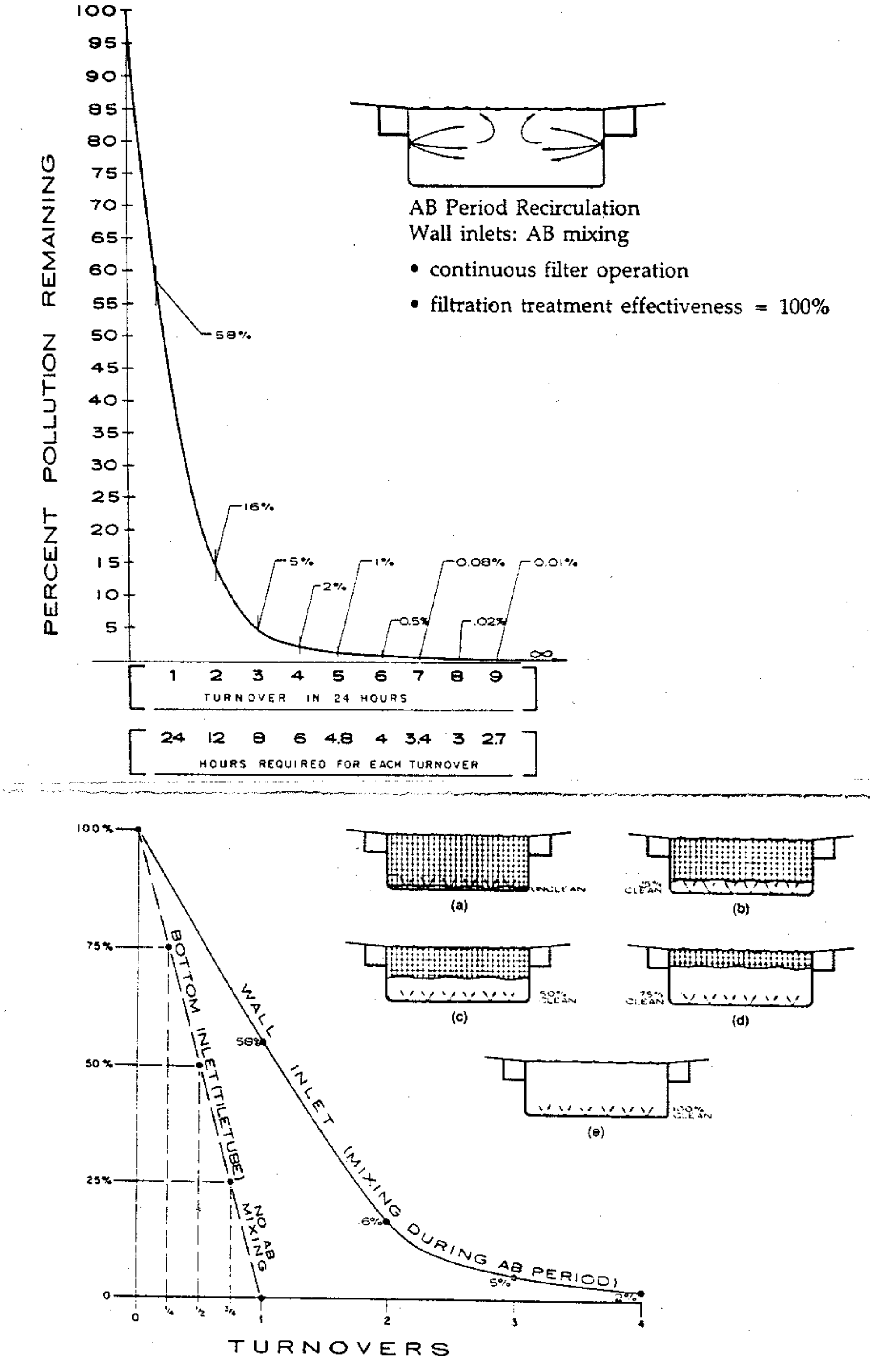

Figure 2: Comparative effect of turnover rate on removing pollution levels using wall inlets and bottom inlets (AB refers to the after bathing period- ie when there are no swimmers)(Gabrielsen 1987:197,198)

Common turnover rates

The turnover rate as required by each State or Territory is shown below in Table 5. The guidelines however do not specify the type of circulation system required.

	WA	NT	QLD	NSW	VIC	SA	TAS	ACT
Swimming pools	8hrs	-	-	2hrs	-	6hrs	-	-
Wading pools	-	-	-	0.5hrs	-	2hrs	-	-

Table 5: Turnover rates specified by the state guidelines

Common best practice is to have a 4 hour turnover rate for swimming pools and a 1 hour turnover rate for wading pools.

Effect of dust storms or other extreme events

In order to cope with dust storms or other extreme events in remote communities it may be preferable to increase the turnover rate after the storm to clear the water faster. It would be advisable to have two pumps. One pump could be operated to achieve a 4 hour turnover during normal operation. When necessary both pumps could run to achieve a turnover of only 2 hours.

Pumps

There are many types and sizes of pumps available with varying costs and maintenance requirements. Pumps typically are a major maintenance issue in remote community swimming pools. In some communities they are being rebuilt 2-3 times per year. This is likely due to inadequate quality and undersized pumps being installed in the first place.

One of the problems at Santa Teresa for example is that the pumps have plastic impellers. Under the heavy dust load they do not last very long at all. In other communities, pools have 5 domestic quality pumps, rather than one high quality purpose built commercial pump. Pumps for domestic swimming pools are not designed to be running 24 hours per day.

A hair and lint strainer is also required to protect the pump from damage. Hair, lint, leaves and other undesirable items are collected in a basket which can be checked and emptied daily. An audit of a variety of swimming pools in remote Aboriginal communities found that the system also needs to cope with rocks, clothes (nappies, T shirts, hats), and food wrappings. Most of these things would sink and can be picked up off the bottom of the pool. Floating items would be trapped in the scum channel or skimmer basket or in the hair and lint strainer. Commercial types of strainers are available with cast iron body and cover, and stainless steel perforated basket. The hair and lint strainer is usually bolted onto the pump.

Pumps installed in remote community public swimming pools should be commercial quality pumps with the following features;

- cast iron body
- enclosed bronze impellers
- stainless steel sleeved shaft
- self priming
- oversized hair and lint strainer with stainless steel basket
- easy access panels for servicing normal wearing parts without having to disconnect pipework
- appropriately sized for optimum efficiency
- specifically designed for public swimming pools

For pools up to 25m long, one appropriately sized pump should be adequate to deliver a 4 hour turnover rate. A second pump is advisable to double the pump rate and reduce the turnover to 2 hours for emergency situations. The second pump can also be used for backup purposes. This is preferable to having 4-5 undersized pumps.

A typical commercial pump used for a 25m swimming pool might be rated at 10HP, 7.5kW and require 3 phase power. Communities need to check their available power output so that the appropriate pump can be selected. The lack of a 24hour power supply may be a limiting factor is some small communities. Appendix 2 includes specification sheets for pumps which are designed for commercial swimming pools.

Filtration

A filtration system is required to remove suspended solids and some small pathogenic organisms from the water before it is returned to the pool. Water enters a filter tank through the top and is forced under pressure through the filter media and exits as clean water through the bottom. The small particles are trapped in the filter media where they remain, and the clear water is returned to the pool via some additional chemical treatment. The filters are cleaned out regularly by backwashing, the water and suspended solids being discharged into a sewer or drainage system.

Filters do not however remove bacteria, viruses, algae or fungi. The chemical treatment is required for this purpose. This is discussed in greater detail later in the report. It is necessary to note that pool clarity is not achieved through filtration alone; filtration and chemical treatment work together to produce clear, safe water.

The filtration system has to contend with;
- particulate matter (suspended and colloidal)
- debris and dirt
- soil, dust
- hair
- traces of faecal material and urine
- scaly skin
- sweat, saliva and mucus
- potions from bodies
- grease and oil
- air pollutants

Water clarity

Water clarity refers to the lack of cloudiness in the water and the simplest measurement of this would be to ask ‘can you see the bottom?’ The clarity of water is important for a number of reasons;
- suspended particles in the water can harbour small pathogenic organisms such as some protozoa and helminths, which survive chemical treatment
- clear water enables swimmers to judge distances and depth under water
- clear water enables pool attendants to see if anybody is in danger under the water
- a clean sparkling pool is visually pleasing and more inviting to users

The Western Australian and South Australian guidelines use a simple visual test to determine the acceptable clarity of water. A 150mm diameter matt black disc placed at the deepest part of the pool must be clearly visible when viewed from out of the water.

There are other more scientific methods of determining the clarity of the water such as passing a beam of light through the water and measuring the weakening of the light. This is measured in Jackson Turbidity Units (JTUs)(Dawes 1979).

Types of filters

There are several types of filters available for swimming pools including sand filters, diatomaceous earth, and cartridge filters. Table 6 highlights the advantages and disadvantages of the different filters.

Sand Filters

This is the most common type of filter system used for public swimming pools. Sand filters are efficient and are very easy to operate and maintain. One of the main features of sand filters is that the sand can be continually reused over a period of about 7 years before it needs replacing. They can filter material down to a size of 10 micron which is adequate for a public swimming pool. To clean the filter, water is reversed through the sand to dislodge the accumulated dirt. The sand being heavier remains in the filter tank while the dirt is washed out to a safe disposal point. Backwash times are relatively short compared to other filters; around 2-3 minutes, reducing water wastage.

High rate sand filters can achieve a filtration rate of between 50-100 kilolitres per square metre of filter per hour. A 25m pool may require 2 appropriately sized high rate sand filters. Appendix 2 includes specification sheets for high rate sand filters which are designed for use in public swimming pools.

Diatomaceous earth (DE) filters

DE is a fine material which is the fossilised skeletal remains of marine life. These filters have the ability to screen finer particles as small as 1 to 5 micron and are therefore able to produce very clear water under normal operation. Unfortunately they are relatively maintenance high and expensive to operate. The DE must be replaced when the filter is cleaned about once per week. A protective mask must be worn when handling DE to prevent inhalation as it is known to be a lung irritant. Another drawback is that the old DE cannot be disposed of into the sewer system, because it is liable to set hard and block the system. It therefore needs to be carefully bagged and disposed of at the community rubbish dump.

These systems are rarely used in urban public swimming pools and are also not recommended for use in Aboriginal community swimming pools.

Cartridge filters

Cartridge filters are made of a synthetic fabric or high compact paper which traps particles down to a size of 10-25micron. Some cartridges are disposable and expensive, others are cleaned by hand. These systems are designed for spas or small swimming pools and not generally suitable for large swimming pools.

	Advantages	Disadvantages
High rate sand filter	• easy and economical to maintain • sand reusable for 7 years • high rate of filtration 50-100m^3/m^2/hr • 10 micron filtration • 2-3 minute backwash time	
Diatomaceous earth	• high quality filtration 1-5micron	• filtration rate only 5-10m^3/m^2/hr • more expensive to operate • not commonly used for public pools • DE needs to replaced regularly • cannot discharge backwash waters into sewer - need a special settlement tank
Cartridge		• filtration rate only 1-2.5m^3/m^2/hr • not appropriate for public pools

Table 6: Advantages and disadvantages of different filtration systems

Skimmers or scum gutters/channels

Most swimming pool contaminants enter the pool on the surface and a skimming action is required to remove this debris from the surface before it sinks to the bottom. The two main systems used are skimmer boxes and scum gutters. Table 7 provides a brief summary of the advantages and disadvantages of each.

Domestic or small swimming pools typically use skimmer boxes which consist of an opening in the wall with a hinged weir and a perforated basket or strainer. The hinged weir automatically adjusts to suit the water level in the pool. Usually one skimmer is required for every 20-30 square metres of surface area. Skimmers are particular suited to small pools where the bathing load is low, to pools of irregular shape, or to fibreglass pools. They are cheaper to install than scum gutters.

Skimmers in the past have been associated with suction drain injury which can result if small children sit on an uncapped suction drain. The dimensions of the chamber can be designed to minimise this risk along with the installation of secure lids which can only be removed with a special tool. Australian Standard *AS 1926.3-1993 Swimming Pool Safety - Water recirculation and filtration systems* specifies the design of skimmer boxes to reduce the incidence of suction drain injury.

Most larger swimming pools use scum gutters. Scum gutters provide a continuous trough around the surface of the pool and provide far superior surface skimming action. Scum gutters are recommended for community swimming pools where there is a heavy peak bathing load. There are various shapes and sizes of scum gutters available (see figure 3). Since the majority of pollution is likely to be in the surface layers of water the scum gutter/channel should be designed to take not less than 60% of the outflow from the pool (Perkins 1988).

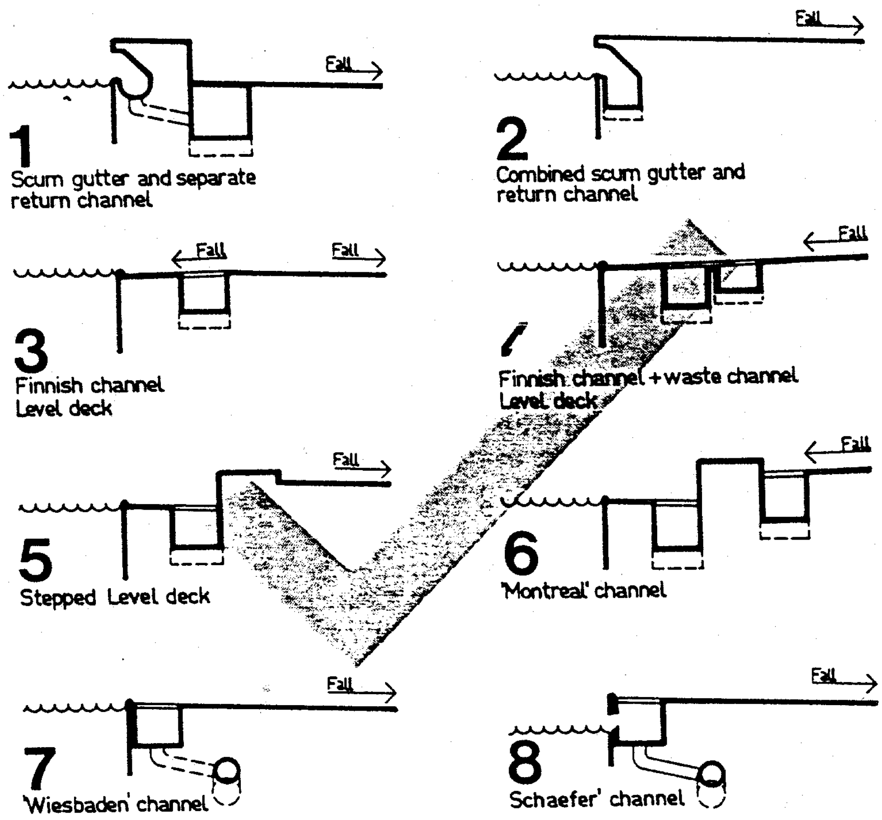

Figure 3: Some of the different types of scum gutter/channel systems available (Davies 1981:41)

Scum gutters/channels provide additional benefits in that they are effective at controlling waves, are easy to clean and maintain, provide a hand grip for swimmers, and are easy to construct in a concrete pool.

A major design consideration with scum gutters/channels is the surge tank. Because the gutter level is fixed there must be some method of controlling variations in water level. When the pool is in use, swimmers displace water which overflows into the channel. When swimmers get out of the pool they will take some water with them, and the water level may drop. Surge tanks can be integrated into the channels to enable the recirculation system to absorb and replace surge water rapidly. A typical surge volume design is around 50 litres per square metre of pool surface area plus a 20% allowance for controls and piping (Gabrielsen 1987).

	Advantages	Disadvantages
scum gutters/ channels	• superior surface skimming action • easy to construct in concrete pools • provides hand grip • effective wave control • easy cleaning and maintenance	• not usually suited to fibreglass pools • requires a surge tank • must be accurately constructed to ensure it is perfectly level
skimmer box	• cheap to install • suitable for fibreglass pools • automatic weir adjustment with water level variations	• not recommended for public pools with a heavy swimming load • potential for suction drain injury

Table 7: Advantages and disadvantages of surface skimming systems

CHEMICAL TREATMENT

Disinfection

Disinfection is the process of destroying bacteria, viruses, algae, and other pathogens which are not removed through filtration. This is required to prevent transmission of diseases through the pool water. Many of the common disinfectants oxidise the water simultaneously which refers to the breaking down of organic debris.

There are several methods of disinfection and all have their advantages and disadvantages. The factors which might affect which method to chose include;

- cost of installing treatment systems
- ongoing cost of purchasing chemicals
- storage and handling of chemicals
- cost of freight for chemicals
- shelf life of chemicals
- disinfection effectiveness including residual
- ease of use (staff training requirements)
- safety requirements
- user comfort

The main options include liquid chlorine, granular chlorine, gas chlorine, salt water chlorination, bromine, and ultraviolet light with hydrogen peroxide. Table 7 highlights the advantages and disadvantage of the various disinfection systems available.

Chlorine

Chlorine has been used successfully for treating drinking water and swimming pool water for many years. One of the main advantages of using chlorine for swimming pool water treatment is that it disinfects and oxidises simultaneously. The drawback with chlorine though is that if the levels are not maintained within the required range skin and eye irritation can occur.

It is important to understand the terms free chlorine, combined chlorine, and total chlorine. Free chlorine is the amount of chlorine available for disinfection; that is the chlorine available to kill bacteria and other organic pollutants. Combined chlorine is the chlorine which has reacted with the organic matter introduced by bathers, such as urine and perspiration, to form chloramines. It is an excess of chloramines which cause foul chlorine odours. The total chlorine is the sum of the combined plus available chlorine.

Free chlorine is unstable and dissipates in the sun. For outdoor pools free chlorine can be stabilised using cyanuric acid. While the cyanuric acid stabilises chlorine extending the period of disinfection, it also ties up some of the chlorine, meaning extra chlorine has to be added. The correct amount of cyanuric acid and chlorine is critical to its effectiveness. Too much cyanuric acid has been associated with liver and kidney damage (Griffiths 1995).

Chlorine is available in three basic forms; liquid, granular and gas.

Liquid chlorine - Sodium Hypochlorite (NaOCl)

Sodium hypochlorite used for swimming pools is a stronger concentration of household bleach with a 12-16%NaOCl aqueous solution. Liquid chlorine is the easiest to use and is the safest of the three types of chlorine. It is virtually sediment free and can be added to the pool direct through an auto dosing chlorinator.

One of the main disadvantages however, particularly for use in remote communities, is the short shelf life; 60-90 days. Sodium hypochlorite deteriorates rapidly especially if stored in warm, humid conditions or if exposed to sunlight. While it is manufactured at 16% solution, it rarely reaches the pool operator above 15% and may be as weak as 10%. For remote communities the solution may already be at this low level before it leaves the store in town. Transport out to the community may be unreliable and chlorine may be transported in the back of a ute in the sun further reducing the solution.

Further investigation may be required for some of the existing swimming pools to determine the quality of the product in the major centres in the NT, and then measure the deterioration rate once out in the community.

Liquid chlorine has the effect of raising the pH which eliminates the need for adding soda ash, but may increase the requirement for sodium bisulphate or muriatic acid (hydrochloric acid).

Granular chlorine - Calcium Hypochlorite ($CA[OCl]_2$)

Calcium hypochlorite is a mixture of chlorine (50%), calcium (28%) and oxygen (22%) and is available in granular or table form. One of the main advantages of Calcium hypochlorite for use in remote communities is that it has a relatively long shelf life; up to 1 year. While it deteriorates in the sun it can be stabilised with cyanuric acid to extend its life.

From an operators point of view however it requires more preparation than liquid chlorine before use. The granular type should be mixed with water in a container and allowed to stand while the calcium hydroxide and insoluble materials settle out. Above the sediment, the green liquid can be siphoned off to another container for use in the pool.

While most of the calcium hydroxide and other insolubles are settled out some remain in suspension, which can cause a gradual build up of scale in the pool equipment. For this reason calcium hypochlorite should not be used as a backup in a saltwater system for extended periods of time otherwise calcium deposits will build up on the salt cell.

While Calcium hypochlorite is safer than gas it does still have some dangers. A strong oxidiser, calcium hypochlorite may explode if not kept dry, or if it comes in contact with organic materials such as petroleum products, algacides, cleaning fluids, detergents, and paper products.

Gas chlorine (Cl_2)

Of the three types of chlorine, gas is the most effective disinfectant and oxidiser. Gas chlorine is prepared commercially by the electrolysis of salt and is supplied as a liquid under pressure in a metal cylinder. The liquid returns to a gas form as it is emitted from the cylinder. A major advantage of gas is that there are no shelf life problems.

A disadvantage is that gas is extremely toxic, and strict safety precautions must be observed. A separate ventilated storage shed is required to house the gas cylinder, and must contain breathing apparatus for changing the cylinder and emergencies. The operator needs to be trained in the use of self contained breathing apparatus. It is unlikely that this type of system would be acceptable to people in remote Aboriginal communities.

Salt water chlorinator

Salt water chlorinators eliminate the need to add chlorine. Course refined rock salt is added to the water which is passed through the chlorinator. The chlorinator converts the salt into sodium hypochlorite via a process called electrolysis. The sodium hypochlorite disinfects the water and converts back to salt. The salt water chlorinator is only effective when the pumps are running so the system must run 24 hours per day. As with pumps and filters it is essential to ensure that commercial systems are installed which are designed for 24 hour usage. A public pool would typically require 2 to 3 appropriately sized chlorinators.

The saline water in the pool is at a concentration of around 5,500ppm compared to seawater which has a salt concentration of around 37,000ppm. This low level of salinity is unlikely to cause problems to concrete or equipment. The advantage is that the water should be more comfortable to swim in, with less likelihood of eye irritations.

Once the initial salt level is achieved, the salinity can be maintained by adding bags of rock salt on a regular basis. The amount of regular salt addition depends upon how much water is lost through backwashing filters and water splashing out. Salt is not lost through evaporation. Typically for a 25m pool, 4-5 x 25kg bags of salt are added each week at a cost of around $7 per bag.

From a maintenance point of view the salt cells require cleaning regularly to remove the build up of scale. This is usually carried out weekly by washing the cells with a hose or in a light acid solution. In very hard water, as found in many central Australian communities, the salt cells may need replacing every few years which can be quite expensive.

While salt water chlorinators are widely used in domestic pools, their use in large public swimming pools around Australia is limited with even less usage in Aboriginal communities. One of the main limitations with salt water chlorinators is the ability to cope with fluctuating bathing loads.

Chlorine can used as a backup if required, with liquid chlorine being the most appropriate form. Again the problem arises of the short shelf life of liquid chlorine, especially if it is stored for use in an emergency. Granular chlorine can be used for a manual backup dosing, although Calcium hypochlorite will increase the build up of scale on the salt cell.

Aboriginal communities should be made aware of the above limitations if they are to install a salt water chlorinator. This type of technology is untested in both mainstream and remote community public swimming pools.

Bromine ($C_4H_4O_2N_2BrCl$)

Bromine has excellent disinfection and oxidisation properties. Bromine is sold in sticks and is dissolved slowly in water in a bromine dissolving tank. The main advantage of bromine is that the combined bromine does not irritate the senses as the combined chlorine does. A disadvantage is that organic bromine is flammable and explosive. It is also expensive, cannot be stabilised, and dissipates rapidly in outdoor pools. Its major use is in hot tubs or spa pools. It would not be appropriate for use in remote community swimming pools.

Ultraviolet (UV) light plus hydrogen peroxide

UV treatment is a safe and easy method of treating water and is acceptable under the South Australian guidelines for indoor swimming pools up to 500,000 litres capacity. This would include most indoor 25m pools.

Water is disinfected as it passes through ultraviolet light at a certain intensity. Because no residual disinfectant is produced, hydrogen peroxide is added as an oxidiser. Organic matter introduced from bathers is oxidised and micro-organism growth is inhibited. The system must operate 24 hours per day to be effective. This type of treatment must be combined with an efficient circulation and filtration system, because turbidity can reduce the UV light transmission and bacteria may be shielded in the suspended solids.

Type of chemical treatment	**Advantages**	**Disadvantages**
salt chlorinator	• easy and cheap to operate • safe storage and handling of rock salt • less eye irritation	• little experience in large public pools • only effective when pump is running • expensive installation • salt cells require weekly cleaning and replacement every few years • chlorine backup may be required
liquid chlorine Sodium Hypochlorite (NaOCl)	• ease of use, no mixing required • low danger in storage and use • keeps pH levels up • can be used in autodosing units • can be stabilised with cyanuric acid to extend its life in the sun (for outdoor pools only)	• very short shelf life (2-3 months) • unstable - dissipates quickly at high temperatures and in sunlight • more expensive than granular chlorine • increases sodium levels in poor water • causes scaling if pH not balanced
granular chlorine Calcium Hypochlorite (CA[OCl]$_2$)	• 1 year shelf life, easy to store • less expensive than other forms of chlorine (except gas) • keeps pH levels up • can be used for disinfecting decks and change room floors • kills algae • can be stabilised with cyanuric acid to extend its life in the sun (for outdoor pools only)	• must be prepared beforehand • can be explosive - extreme care must be taken • may increase calcium hardness • pH must be lowered with acid
gas chlorine (CL$_2$)	• no shelf life problem • excellent oxidiser and bactericide	• the risk may not be acceptable by remote Aboriginal communities • strict safety requirements • system installation expensive due to safety requirements • training in the use of breathing apparatus necessary • regular servicing of chlorinator every 6-12 months to maintain safety
organic bromine ($C_4H_4O_2N_2BrCl$)	• effective oxidiser and disinfectant • effective algacide • less eye irritation • more suited to spas and hot tubs	• cannot be stabilised - can dissipate quickly in outdoor pools • organic stick form combustible • expensive compared to chlorine • emits a strong odour and can stain pool walls if used in excess • not usually used for public pools
ultraviolet light with hydrogen peroxide	• reduced dependency on pool chemicals • safe and easy to use • less eye irritation • approved for use in indoor pools up to 500,000 litres (in SA)	• no residual disinfectant • hydrogen peroxide required which lowers pH • colour, turbidity and chemical composition can interfere with UV transmission • expensive installation of equipment • uncommon method of treatment for swimming pools

Table 7: Advantages and disadvantages of various disinfection methods

Water balance

The correct chemical balance in the water is essential to ensure that disinfectants are effective, and to ensure that the pool water is comfortable for the users. The major components of water balance are pH, total alkalinity and total hardness.

pH

In simple terms pH is the measure of acidity or alkalinity measured on a scale of 1-14. For swimming pool water the pH should be in the range 7.2-7.6. If the pH is too high (alkaline) chlorine effectiveness is reduced. The water may also become cloudy and scale can form on the walls, filters and pipes. If the pH is too low (acid) eyes can be irritated, and metal fittings and pipes may corrode.

The type of disinfectant used can have an effect on pH; gas chlorine lowers pH, liquid and granular chlorine raises pH. If the pH is low it can be raised by adding soda ash, and if pH is high it can lowered by adding sodium bisulphate or muriatic acid (hydrochloric acid). It is essential however to check the total alkalinity before attempting to adjust pH.

Total alkalinity

Total alkalinity is the measure of dissolved mineral salts in the water and indicates the extent to which the water is buffered to respond to pH adjustment. This is measured in mg/l or ppm. The higher the total alkalinity the more difficult it is to change pH. The lower the alkalinity the more likely the pH will change even due to changes in bathing load or weather. The total alkalinity can be raised by adding sodium bicarbonate or soda ash. Total alkalinity should be in the range of 60-200mg/l unless gas chlorine is used when the range should be 150-200mg/l.

Total hardness

Hardness is a measure of the amount of calcium and magnesium ions found in water. Hardness can cause scaling and clogging of plumbing and filters. In remote communities water hardness may be a major issue.

The use of granular chlorine can increase water hardness. Maintaining the pH within the range mentioned above can help control water hardness. However if the total hardness level reaches 500-600ppm the pool should be emptied and refilled.

Monitoring - testing and recording requirements.

Regular monitoring of the pool water is essential to minimise the risk of diseases being spread rapidly through the community. Each state or territory has guidelines on the water parameters to be tested and the frequency of testing required. The test results should be recorded and maintained for future reference.

As a suggested minimum for remote communities, the water should be tested prior to the pool being opened each day for the following chemical parameters;

- free chlorine
- combined chlorine
- pH
- water balance

During periods of high usage it may be necessary to test for the above parameters more frequently; say every 2-3 hours and make chemical adjustments accordingly. It would also be useful to record the bathing load at this time.

Other testing which may be carried out weekly or fortnightly include;

- total dissolved solids
- water clarity
- Isocyanuric acid
- bacteriological sampling

Research is currently being carried out at Santa Teresa on pool water quality which will hopefully recommend an appropriate testing regime for swimming pools in remote Aboriginal communities.

Automatic monitoring and dosing

The South Australian Public and Environmental Health Regulations require that all public pools have automatic dosing and control equipment for disinfectants and pH.

Probing systems can measure the chemical qualities of the water at regular intervals, typically every two hours, and provide a print out for recording purposes. To get the most out of an automatic probing system, the controller can be connected to a chlorine pump or acid feed for automatic injection of chemicals at the required rate. The effectiveness of actually improving water quality however depends largely on the turnover rate of the pool because this will determine the lag time between testing the water and the chemicals having an effect. An automatic controller can be useful for saltwater chlorinators fitted with a liquid chlorine backup system.

Automated dosing and control equipment can assist a swimming pool operator in consistently achieving the required level of water quality. However in remote communities, such technology must not be considered as a surrogate for an experienced and skilled operator. It is difficult to make any firm recommendations about this type of technology as it is relatively new and untested in remote communities. As with most pool technologies the systems which are designed for domestic use would not be appropriate for use in remote community public pools.

Chemical handling and storage

Each state and territory has regulations relating to storage and handling of chemicals. The designer of a community pool should ensure that the storage and handling facilities for the different chemicals meets with the appropriate Act for that state.

The following chemical storage and handling issues should be addressed for remote communities.

- chemicals should be stored in a cool, dry, locked place, out of the sun, and out of the reach of unauthorised people
- chemical storage shed should be well ventilated
- the shed should be bunded to withhold spills
- a dousing shower should be available in case of emergency
- appropriate signs should be clearly visible, indicating type of chemical, emergency procedures and that smoking is not permitted
- chemicals should be stored in their original containers
- pool chemicals should not be stored in the same room as petrol, oils or pesticides.
- operators should be trained in the safe use of pool chemicals
- appropriate safety equipment should be worn when handling chemicals
- fire extinguishers should be readily accessible.
- the instructions on the label should be adhered to when handling and mixing chemicals, and disposing of containers

POOL SURROUNDS

Fencing

For security and safety reasons the pool must be fully enclosed either within a fence or a building which can be closed to the public out of hours.

Australian Standard AS1926.1-1993 specifies that mesh fences with apertures between 13-100mm (such as chain mesh), must have a minimum height of 2.4 metres. The top 450mm should be angled toward the outside at 90-135 degrees. A strainer wire should be fitted at the top and bottom of the fence. This type of fence is typically used in remote communities to secure other structures, and would be appropriate for the security of a swimming pool. Regular maintenance may be required to ensure the enclosure is secure.

Fences can also be used to provide a windbreak, either with shade cloth or vegetation. For outdoor pools this would be beneficial to reduce dust from entering the pool.

Shade structures are recommended for outdoor pools to reduce evaporation, chlorine dissipation and water temperature. Shade structures should be designed in to ensure it is not possible for children to climb on top and jump into the pool.

Enclosure

It may be appropriate in some communities to have the pool fully enclosed in a structure. This would offer the following advantages;

- added security,
- safety,
- protection for the users from the sun and wind,
- reduced dust entering the pool,
- reduced evaporation,
- reduce chlorine loss, and
- cooler water temperature.

The main issue which needs to be considered with indoor pools is ventilation. There must be adequate fresh air make up to dilute volatile air contaminants.

Landscaping

The site should be landscaped to make it a pleasant place to be, as well as to reduce bare soil which potentially will enter the pool. Non slip, free draining surfaces should be constructed around the pool for safety of the users. Facilities should be available for rubbish disposal.

Amenities

Change rooms, toilet and shower facilities should be installed in accordance with the Building Code of Australia, and any local council regulations. Apart from WA, the various state swimming pool guidelines or regulations do not specify the number of toilet and shower cubicles required.

The WA regulations specify the following which may be appropriate as a minimum for remote communities;

- one water closet for every 40 female swimmers,
- one water closet plus one urinal for every 60 male swimmers,
- one shower for every 40 swimmers, and
- one handbasin for every 60 swimmers.

It is important to note that the above WA requirements are calculated by allowing 2.3 square metres of pool area per swimmer. Facilities should be allocated on a 50:50 male female ratio.

The amenities block should be designed to ensure all users pass by the showers on their way through to the pool area to encourage pre-showering.

These facilities should be cleaned daily with shower floors being disinfected to prevent the transmission of infectious skin diseases

MANAGEMENT

Many of the technical issues associated with the management of a public swimming pool are covered in the relevant sections earlier in the report. Non-technical community and health management issues are not covered in great detail here. It is anticipated that the research being carried out by the National Centre for Epidemiology and Population Health including an audit of existing swimming pools in remote communities will highlight other management issues.

Ongoing cost

Communities will need to ensure they have adequate funds available for the ongoing maintenance of a swimming pool. Table 8 shows the swimming pool maintenance costs experienced by a variety of Aboriginal communities.

Community	**Pool Size (metres)**	**Maintenance cost (per year)**
Papulankutja (WA)	25x10 including wading	$3,300 plus staff $8,000
Warakurna (WA)	50x15 (1-1.5 deep) including wading 5x15 (0.4 deep)	$8,000
Warburton (WA)	25x10	$10,750 plus staff $25,000
Nauiya Nambiyu (NT)	40x20	$13,860
Ngkurr (NT)	25x15x1-1.8 9x4x1-1.8 9x4x1 5x6x0.35	$8,500 plus staff $40,000
Pularumpi (NT)	50m	$10-15,000 plus staff $28,000
Santa Teresa (NT)	25x10x1-2.5 wading pool	?
Yuendumu (NT)	6-7x3	$2,100 plus staff
Kowanyama (Qld)	25x20x1.5 wading pool	$10,000
Thursday Island (Qld)	3 pools 1 olympic size 6x5x0.3	?
Woorabinda (Qld)	Olympic size + wading pool	$110,000 plus staff $47,500

Table 8: Annual maintenance costs of swimming pools in a variety of Aboriginal Communities (from draft report of NCEPH swimming pool audit)

As can be seen in Table 8 there is a great variety in the running costs of swimming pools in different communities. While each community has a different number and size of pools the differences are also due to such issues as;

- age of pool,
- type of equipment installed,
- quality of equipment installed,
- skills within the community,
- number of local people employed,
- extent of external services required,
- remoteness of community,
- climatic factors,
- geographic factors,

- maintenance regime,
- number of users,
- number of months open,
- indoor or outdoor, and
- security.

For this reason it is not possible to provide a general estimate of maintenance costs for all communities. At the time of investigation and design of a specific pool, the project manager should be able to prepare an estimate of expected maintenance costs.

Staff requirements

For the effective operation and maintenance of a swimming pool several staff will be required to carry out the following essential duties;

- pool management for safe water quality assurance, water testing, chemical dosing, reporting, financial administration and accountability, problem solving, managing staff,
- pool equipment cleaning and maintenance,
- pool attendants with life saving and first aid skills,
- shower, toilet and change room cleaners,
- yard cleaner, gardener, rubbish disposal,
- security both when the pool is open and closed, and
- medical checkup of users to reduce the risk of infectious diseases being spread.

The various positions may be filled by people within the community who already have the required skills, by local people who are trained up, by experienced people from outside the community, or by a combination of the above. Where experienced people are required from outside the community, additional costs of accommodation need to be considered. Appendix 3 includes details of some TAFE courses in swimming pool operation and maintenance.

REGULATION COMPLIANCE

Each state has guidelines, codes of practice, or legislation covering the design, construction, operation and maintenance of public swimming pools. A brief review of these guidelines follows. The state guidelines are included in Appendix 1 (hard copy only).

Northern Territory

Territory Health Services (1996) *Water Quality and Hygiene Standard for Swimming, Diving, Water Slides, and Paddling Pools.*

Territory Health Services (1996) *Guidelines for the Safe Operation and Maintenance of Children's Wading Pools.*

South Australia

South Australian Health Commission (1992) *Code of Practice - Standard for the Inspection and Maintenance of Swimming Pools and Spa Pools in South Australia.*

South Australian Health Commission (1991) *Code of Practice - Standard for the Operation of Swimming Pools and Spa Pools in South Australia.*

Queensland

There are currently no guidelines for commercial swimming pools in Queensland. The Queensland Dept of Health are beginning the process to work out some guidelines. They currently use the NH&MRC *Australian Guidelines for Disinfecting Private Swimming Pools*.

Western Australia

Health Department of Western Australia (1997) *Guidelines for the construction, opening, alteration or extension to swimming pools.*

Health Act (Swimming Pools) Regulations 1964.

New South Wales

Department of Health NSW (1996) *Public swimming pool and spa pool guidelines.*

Australian Capital Territory

There are apparently no such regulations in the ACT.

Victoria

Health Department Victoria (1990) *Health (Infectious Diseases) Regulations 1990 Water Purification standards for public swimming pools and spa pools.*

Tasmania

Tasmania uses the Places of Assembly Regulation 1974, which refers to swimming pools in a general way only, and the NH&MRC *Australian Guidelines for Disinfecting Private Swimming Pools*. The Department of Community and Health Services are currently rewriting the Guidelines for Places of Assembly which will more specifically address the requirements for public pools.

Commonwealth

National Health and Medical Research Council (1990), *Australian Guidelines for Recreational Use of Water,* Australian Government Publishing Service, Canberra.

National Health and Medical Research Council (1989), *Australian Guidelines for Disinfecting Private Swimming Pools,* Australian Government Publishing Service, Canberra.

There are currently no NH&MRC guidelines for public swimming pools.

Australian Standards

There are several Australian Standards which may be useful and appropriate for public swimming pools in remote communities.

AS1926.1-1993 Swimming pool safety - Fencing for swimming pools.
Includes details on minimum height of fences and appropriate fencing construction for security.

AS1926.2-1995 Swimming pool safety - Location of fencing for private pools.
Refers only to private pools.

AS1926.3-1993 Swimming pool safety - Water recirculation and filtration systems.
Includes details on the design of skimmer boxes to avoid suction drain injury. Also includes details on min/max water velocities for inlet and outlets.

AS2818-1986,1993 Guide to swimming pool safety.
Covers such issues as legal liability, underwater dimensions, diving pools, fencing, warning devices and alarms, above ground pools, skimmer boxes, suction points, instructions, safety features, safety in pool maintenance, electrical safety, safety in pool use.

AS2160-1984 Contract for the supply and construction of a swimming pool.
Can be used for both fibreglass and concrete pools and provides a useful contract guide.

AS2927-1987 The storage and handling of liquefied chlorine gas.
Covers the safe storage and handling practices for chlorine gas.

Building Code of Australia

The building code provides details on the structural and safety requirements of the public amenities, including details on the number of toilets and showers required. All works should conform to the requirements of the Building Code of Australia.

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Pool Design 1993. 'Look before you leap.' *Pool Design* Autumn/Winter.

APPENDIX 1

STATE GUIDELINES, REGULATIONS OR CODES OF PRACTICE

Copies are available from CAT
and for updated information ring the Health Department in your state or territory

APPENDIX 2

EXAMPLE OF PUMP, FILTER AND DISINFECTION TECHNOLOGIES DESIGNED FOR PUBLIC SWIMMING POOLS

It was not the intended purpose of this report to carry out a product review. The attached brochures show some of the available systems which are specifically designed for public swimming pools. While these systems are largely untested in remote Aboriginal communities, they are more likely to be suitable than systems designed for domestic use.

Copies are available from CAT

APPENDIX 3

TAFE COURSES AVAILABLE FOR SWIMMING POOL OPERATORS

Copies are available from CAT

CRC for Water Quality
and Treatment

Cooperative Research Centre For Water Quality and Treatment

Summary Research Scholarship:

Assessing the Feasibility of Monitoring Chemical and Microbiological Hazards in Bodies of Water used for Recreation in Remote Aboriginal Communities

Nigel Vivian

April 1998

Supervisors:

Bob Lloyd
Centre for Appropriate Technology
Alice Springs

Gabriele Bammer
National Centre for Epidemiology and Population Health
The Australian National University
Canberra

Contents

1. INTRODUCTION

The purpose of this study was to begin to investigate the feasibility of maintaining safe swimming pools in remote Aboriginal communities. Anecdotal evidence indicates that the presence of pools may reduce the incidence of eye, ear and skin infections in such communities, particularly among children. Placing pools in remote communities, however, may place a large burden on the community in terms of maintenance. Thus there is a need to see if the basic maintenance in terms of chemical and microbiological monitoring of the pool can be carried out at sites remote from main centres. For logistical reasons, it was not possible to undertake this study at a very remote community, but it was possible to examine the difficulties involved in monitoring chemical and microbiological levels at a pool at Ltyentyre-Apurte (Santa Teresa), an Aboriginal community eighty kilometres east of Alice Springs. Comparisons are made between this pool, pools in Alice Springs, and natural swimming holes.

2. BACKGROUND

The main tasks in pool water management involve keeping the water clean and at the correct pH and chlorine levels. Chlorine addition is the main method of keeping the pool free from pathogens. Generally it is assumed that if these factors are properly managed, the pool is safe to swim in. The chlorine will also attack nitrogenous compounds in sweat and urine which act as nutrients for algae. However if there is a large bathing load in the pool, or faecal contamination, higher doses of chlorine (super-chlorination) may be required.

In poorly chlorinated pools pathogenic microorganisms may be sustained. Pathogenic bacteria such as *Staphylococcus, Streptococcus, Pseudomona aeruginosa, Mycobacterium marinum, Klebsiella, Yersinia* and *Legionella* can all be found. Adenoviruses associated with conjunctivitis, pharyngitis and fever and enteroviruses such as polio, coxsackie and hepatitis A may also be present. In addition there is growing concern about chlorine-resistant and potentially lethal bacteria and parasites, such as *Cryptosporidium.* The latter organismforced the temporary closure of several pools in Australia last summer. Harmful protozoa such as *Giardia* may survive in recommended operating levels of chlorine. Consequently, it is not always sufficient to assume that a pool is safe based purely on compliance with chlorine guidelines. Microbiological testing of swimming pool waters may give a better indication of how safe it is to swim. Comparisons with natural water bodies will give an indication of the value of swimming pools as a community health asset.

Even in main centres comprehensive testing of pools for specific organisms can be difficult and expensive. In remote communities it is made more difficult by the distances and times involved for sample transfer. In Alice Springs a laboratory is available to test for *Eschericia coli (E- coli)*, the biological indicator of faecal contamination, as well as total coliforms (TC) and total bacterial plate count (TPC). Samples should preferably be tested for coliforms within 6 hours of collection, but may still be tested within 24 hours (AS2031.2, 1987). Remote communities with swimming pools then have access to microbiological tests, as long as the sample can get to a laboratory within 24 hours. This service is generally possible for most of the larger communities as the drinking water is usually regularly tested for bacterial content. In most cases mail or flying doctor air services transport the samples. Alternatively presence/absence tests for *E. coli* or coliforms may be performed on site with only an incubator and minimal expertise required. The presence of protozoa or other specific non-bacterial pathogens can usually be identified only by health centre admissions.

In this study the results of chemical and microbiological tests are compared to the guidelines for swimming pools developed by Territory Health Services and the Australian Water Quality Guidelines for recreation water.

This study has been completed in conjunction with a separate audit of remote communities with and without swimming pools undertaken by medical students Andrew Peart and Cassandra Szoeke (1998). The study is also intended to be a companion to a report on the technical issues associated with the construction and maintenance of public swimming pools by Jonathon Duddles (1998).

3. STUDY METHOD

The following water quality parameters were tested on site at Alice Springs Swimming Centre and the Ltyentyre-Apurte Swimming Pool:

Parameter	**Testing method**
temperature	electronic thermometer (accuracy ±0.20 ^{o}C)
pH	pH meter (accuracy ±0.1 pH units)
free chlorine	Hach DPD colorimetric kit (accuracy ±10%)
total chlorine	Hach DPD colorimetric kit (accuracy ± 10%)
salinity	conductivity meter (accuracy ± 10%)
coliforms	Millipore “Colisure” presence/absence test kits

On site tests for temperature, pH, free and total chlorine and salinity were taken at a frequency of every hour between 12pm and 6pm at Alice Springs and every one to three hours from 6am to 6pm at Ltyentyre-Apurte. This enabled daily patterns to be identified for before and after chlorination, and before and after pool opening. A pool supply and maintenance company in Alice Springs also conducted independent chemical testing (Marriott Agencies).

Water samples for bacterial testing were taken by standard methods at three-hour intervals in most cases. The samples were delivered to the Northern Territory Department of Lands Planning and Environment laboratory in Alice Springs for analysis. Tests were done for total coliforms, faecal coliforms and total plate counts by membrane filtration. In addition some bacterial tests were done on site using the Millipore presence/sense test kit.

The ambient air temperature was measured on site, as well as the presence or absence of clouds and wind, since these factors affect chlorine levels. The number of swimmers (bathing load) was recorded to indicate the significance of possible contamination sources. The tap water used for filling the pool was also tested to indicate the starting condition of the pool water.

Interviews were conducted with the caretakers of the Alice Springs and Ltyentyre-Apurte pools to determine how the pools were managed. Conversations with many members of the Ltyentyre-Apurte community were also conducted to determine the community’s reaction to the pool, and any concerns they may have. Additional information was also obtained from with representatives of the Santa Teresa Catholic Church, Spirituality Centre, health clinic and the school.

Natural water holes in the Alice Springs region were tested for temperature, pH, conductivity, and bacterial counts. The location of the water holes tested were the popular swimming centres: Ormiston Gorge, Glen Helen, Ellery Creek Big Hole and the Alice Springs Telegraph Station water hole.

4. RESULTS AND DISCUSSION

4.1 Alice Springs Swimming Centre

4.1.1 Pool characteristics and conditions at testing

The Alice Springs Swimming Centre consists of an Olympic size swimming pool, as well as toddler and babies pools, giving a total area of 1614 m^2 and a total volume of 2.8 ML. The pool was opened in 1974 and serves a population of approximately 25,000. The pool is open every day of the week during summer, from 9 to 13 hours per day and has between 250 and 800 visitors daily. There were 381 visitors of all ages on the day of testing.

Testing was conducted on March 15 from 12pm to 6pm. The maximum air temperature in Alice Springs that day was 34.9 degrees, and maximum wind speed was 19 knots (Source: Bureau of Meteorology, - data available on request). These conditions were fairly typical for March which has an average maximum temperature of 34.7 degrees and average maximum wind speed of 23 knots. The day was cloudy in the afternoon with a total of 6.8hours of sunshine for the day, compared to an average of 9.5 hours per day for March.

4.1.2 Test results

Free chlorine levels were measured at between 1.5-1.8 mg/L. These levels are under half the 1996 Northern Territory guideline of 4.0 mg/L. (Note measurements before 3pm lacked accuracy due to the use of the wrong scale on the colorimeter). The pH, alkalinity and salinity were shown to be slightly above the relevant guidelines, while the concentration of stabiliser was quite low. Temperature, hardness, combined chlorine and bather loads were within the guidelines (see Tables 2.1 and 2.2. for physical and chemical test results).

All microbiological samples taken from the pool were well within the Northern Territory guidelines with no coliforms detected (see Appendix A for microbiological results).

Generally the pool was clear and found to be in good condition, although on the day of testing some of the chemical levels required some adjustment. The free residual chlorine levels were maintained at a fairly stable level of around 1.5 mg/L, by the use of automatic chlorination equipment. The value was maintained even with large swimmer numbers over a long period (see Appendix A). The reason for the lower level of chlorine was because the pool manager was working to the level specified on the pool test kit used. This kit specified 1.5 mg/L as the safe operating condition. This chlorine concentration, however, is considerably lower than the relevant Northern Territory guideline concentration ie 4.0 mg/L, (where the temperature was above 26 degrees and stabiliser is used in the pool). The particular test kit used could not be used to maintain the NT recommended levels as the maximum concentration it can detect is only 3.0 mg/L. The Australian Guidelines for Disinfecting Private Swimming Pools (National Health and Medical Research Council, 1989) state that a free chlorine concentration of 3.0 mg/L is sufficient for pools using stabiliser and at a temperature greater than 26 degrees. Despite lower chlorine concentrations, the microbiological analyses were all well within the Northern Territory guidelines.

Testing by Marriott Agencies indicate that greater amounts of stabiliser could be used to reduce the chlorine requirement. The pH levels were a little high. High levels tend to reduce the effectiveness of the chlorine as a disinfectant. In addition high pH levels may cause some problems with maintenance of pumps and filters. High salinity levels were also evident, which could also contribute to maintenance problems.

The salinity of the pool was over four times that of the Alice Springs water supply (Table 1), indicating that after being initially filled, nearly three times the pool volume was lost by evaporation over the summer. It might be noted that the chemicals added to the pool do not have a significant effect on the salinity, since they are at relatively low concentrations. The manager estimated that the amount of water lost from the pool is close to its total volume. The actual figures for the topping up water were difficult to obtain since water passing through the meter also supplies a domestic residence. To manage the salinity problem in the long term the pool is emptied and refilled with fresh supply water before it is opened each season.

4.1.3 Pool maintenance

The pool manager, Ian O'Leary, tests pH and the free and total chlorine levels daily. The water quality testing equipment used by the manager is a standard 'Aquality' pool test kit, which was less accurate than the equipment used in this study, yet fine enough for effective management. Other less important factors such as alkalinity were tested less frequently. Occasional samples were sent to Marriott Agencies for independent testing and advice. Microbiological samples are not taken at the Alice Springs pool. Although both the manager and the Environmental Health Officer from the Alice Springs Town Council would like to see microbiological testing done regularly due to the expense it has yet to be organised. There is no legislation regarding mandatory microbiological testing of swimming pools in the Northern Territory, although the Territory Health Services guidelines recommend a periodic bacteriological analysis.

For the Alice Springs pool, the manager typically adds 25 kg of soda ash and 12 to 18 kg of gaseous chlorine per day to a total pool volume of 2.8 ML. Small amounts of stabiliser are added when required. The water from all the pools is re-circulated continuously, 24 hours per day, through a high rate sand filter. Water re-circulation time was estimated at 6.5 hours. In addition the babies' pool was emptied once per week and cleaned out as a separate exercise. The filters were back-washed each afternoon. The manager noted that some algal problems have occurred in the past. Management of such problems has been by chlorination and vacuuming as the manager prefers not to use algicides.

Water used to top up the pool is from the town water supply which has a relatively high salinity and hardness (Table 1). The level of hardness could be reduced by fine filtration at the supply tap.

Table 1: **Analysis of Alice Springs tap water.**

Conductivity mS/cm	Salinity mg/L	Hardness (mg/L as $CaCO_3$)	PH	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)
0.747	448	194	7.22	0.10	0.16

Solar heating is used at the beginning and end of the season to maintain comfortable water temperatures. The water passing through the solar heating system could reach high enough temperatures to effectively sterilise it. However it may take several days to sterilise the entire volume of the pool.

4.2 Other Public Pools in Alice Springs

The Alice Springs Town Council conducted a random sample of 25 pools at various motels and other accommodations during the 1997/98 season (see Appendix B for full results. Of these 40% did not meet the minimum Northern Territory guidelines for a free residual chlorine concentration of greater than 1.0 mg/L and a combined residual chlorine concentration of less than 1.0 mg/L (see Appendix B). Over 60% of the pools tested had free residual chlorine levels of less than 4.0 mg/L, which is the relevant standard if the pool temperature is greater than 26 degrees and stabiliser is used. Considering that most of the pools were outdoors stabiliser is most probably used, and the temperatures would normally be above 26 degrees during the summer.

4.3 Ltyentyre-Apurte Swimming Pool

4.3.1 Pool characteristics

Ltyentyre-Apurte is a community of approximately 500 to 700 Aboriginal people and a small population of people of European descent.

The pool at Ltyentyre-Apurte is open for six months of the year from the start of October until late March. The main pool measures 33m x 17m, with a diving area of 10m x 8m, a wading pool of 12m x 6m and a toddlers' pool of 5m x 5m. The total surface area is 738 m^2 and the total volume of water is 550 cubic metres, or 0.55 ML.

The Ltyentyre-Apurte Pool was opened in 1980. This was a greatly welcomed development in the town, where temperatures often exceed 40 degrees in the summer, and there are no permanent water holes nearby. Primarily children from 2 to 12 years old use the pool. According to information obtained from the Ltyentyre-Apurte School the number of children in this age bracket in the community is around 120. During the peak of the season approximately 50 to 60 children use the pool each weekday afternoon between 3pm and 5pm and sometimes on weekends. Adult Aboriginal women and men rarely use the pool, since it is not considered appropriate. It was, however, found that a few older Aboriginal women used the pool during the study period. In addition, teenagers of either sex rarely used the pool since they were too modest to wear shorts. Some of the Europeans working in the community also used the pool, usually at night or early in the morning.

The community sees the pool as an important asset, since it gives the children a means of healthy recreation. The pool is seen as partly responsible for the fact that there is no petrol sniffing in the community. The children are noticeably more happy and outgoing when the pool is open. On the days when the pool was open the children seemed to be less likely to indulge in destructive behavior such as throwing stones. When children from other communities visit they are generally impressed with the pool.

The main pool and wading pool water are treated and re-circulated separately. Four pumps, rated at 2 horsepower each (3kW), are used on the main pool and one pump, of the same size is used on the wading pool. Each pump is connected to a sand filter with a filtration rate of 76 litres per minute. The turnover rate for the main pool is around 28 hours. This rate is considerably lower that the turnover rate of 4 hours suggested by Duddles (1998). The wading pool has a turnover rate of about 6 hours, which also falls short of the guidelines for the Northern Territory (two hours). The two hour turnover rate recommended for wading pools is because small children are very susceptible to infection (Territory Health Services, 1996). An upgrade of the pumping system for the pool then would be needed to meet Northern Territory Guidelines.

During the survey some children mentioned that the pool was not big enough for them although the amount of space for each child during peak season was well within the guidelines of 4 m^2 per swimmer (Duddles, 1998).

The Ltyentyre-Apurte pool is an outdoor, concrete lined pool. The caretaker mentioned that he preferred an outdoor pool since he wouldn't have to worry about vandalism of lights or fittings. Many of the outdoor lights at the pool had already been vandalized, so are no longer used. Another reason given for not using the lights was because they attract a large number of insects, which cause additional filtering problems, when they end up in the pool. One advantage of an outdoor pool is that incident sunlight contains UV light that kills bacteria in the pool. The disadvantage is that sunlight also causes greater losses of chlorine and high evaporation rates. Also an outdoor pool may be more difficult to secure against unauthorized usage. The Ltyentyre-Apurte pool has a 2.4m fence with barbed wire on the top. Children break through the fence at times, so holes need to be fixed as soon as they are identified.

The pool at Ltyentyre-Apurte is open for just five months since the cold dry desert nights causes the water temperature to drop too low for comfort outside this season. As for the Alice Springs pool solar heating could be used to extend the season to enable greater utilisation of the pool. However, the caretaker was very reluctant to have heating installed since it may become a possible target of vandalism and require extra maintenance. Solar heating would only be appropriate if it was well secured and had a fully automatic thermostat. Maintenance requirements would also have to be minimal. The expense of the solar heating unit would have to be shown to be worthwhile, with the children taking advantage of a considerably longer swimming season. The Alice Springs pool extends its season by only a few weeks using solar heating

4.3.2 Pool Maintenance

The present pool caretaker, the Essential Services Officer (ESO) Jack Wallace, has been working in the community for six years. During the summer season he tests the water daily at around 8am for chlorine and pH with a standard pool test kit. Liquid chlorine (Sodium hypochlorite with 125g/L of chlorine) and 32% w/w hydrochloric acid are added according to how much is required. On an average day 40 L of sodium hypochlorite (or 5kg of chlorine) is required. The chlorine and pH levels are rechecked after an hour to see if more chemicals are required. Extra acid is used on weekends, to improve the disinfecting ability of the chlorine. Stabiliser is added less frequently, and 1-1.5 litres of algicide is used per week to keep algae levels down. The algicide was applied at a rate of about four times that specified by the supplier (ie 1- 1.5 litres per week instead of per month). Since the algicide contains copper sulfate, which is potentially poisonous at high levels, tests for copper were taken.

Top-up water from the bore is required on most days. The caretaker stated that the daily water requirement on hot days (around 45 degrees) to account for backwashing, evaporation, splashing was 1,500 L. However for an evaporation rate of 2.08m over the 6-month period (as measured at Alice Springs Airport by the Bureau of Meteorology - see Appendix D), the expected evaporation alone should be in the region of 8,400 L per day. The increase in salinity levels of a factor of four in a season indicates that the evaporation rate is closer to the mark. Thus the top up water use estimated by the ESO is probably a low figure. The analysis of the bore water is shown in Table 3:

Table 3: Analysis of Ltyentyre-Apurte supply water.

Conductivity mS/cm	Salinity mg/L	pH	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Copper (mg/L)
0.517	310	7.49	0.02	0.04	0.25

Although the bore water is not chlorinated, there have been no coliforms detected in the monthly tap water samples sent for analysis by the ESO in the last five years.

The amount of chlorine used in the Ltyentyre-Apurte pool was less than the amount used in the Alice Springs pool, but was high relative to the number of pool users, and pool volume. This is partly because much of the chlorine is lost in manual dosing, but possibly also due to a higher organic loading. The liquid chlorine used at Ltyentyre-Apurte is purchased in 200 L containers which require a front end loader to be moved. Chlorine may, however, be purchased in smaller containers if a front-end loader is not available. Depending on storage temperatures, the concentration of chlorine in the liquid form is estimated to decay at a rate such that it may be less than a third of the specified concentration by the end of the season, (information from Adelaide Pool Resources). Consequently the chlorine used at Ltyentyre-Apurte is probably not at the concentration which is specified on the container. The distributor recommended that chlorine be used as quickly as possible and stored in an open shaded area so that available breezes can cool it. Presently chemicals are stored in a locked shed with good shade and ventilation. Buckets used to hold and transfer chemicals are rinsed after use to minimize the possibility of a poisoning occurring.

The filters operate continuously, on a total volume of 550 cubic metres (0.55ML) and are back-washed each day from Monday to Friday, at 9am. Treatment is normally finished by 10am so that the pool has stabilised by 3pm when it normally opens.

4.3.3 Results

Pool temperature, salinity, combined chlorine levels, hardness, copper concentration and bather loads were all found to be within the NT guidelines. As for the Alice Springs, pool free chlorine levels of 0-2.9 mg/L, were below the NT guidelines (1996) of 4.0 mg/L. Alkalinity and stabiliser concentrations were slightly below recommended levels (see Tables 4.1 and 4.2. for physical and chemical test results).

All but one of the microbiological samples was well within the Northern Territory guidelines. The one that failed, due to a high total plate count, was taken while the pool was closed (Monday, March 23rd 6am). Appendix C gives the complete set of microbiological results.

Generally it was thought that the pool was well maintained and kept. The results of the chemical testing are given in Appendix B. Despite apparently quite warm air and water temperatures, the pool was only opened to the community children on three days over the study period. Less than 20 children swam on these days, which was much lower than observed by the caretaker during the peak of the season. The community children thought the water was too cold even if though it was constantly over 26 degrees during the study period.

Since the swimming load was relatively low and the temperature was also somewhat low the study results may show a best case scenario for the pool. In addition, lower levels of sunlight at this time of year would cause reduced chlorine losses.

Chlorine levels were generally maintained above 1 mg/L, although the concentration dropped significantly on sunny days, especially when the children were swimming. Children swimming in the pool caused the free residual chlorine levels to drop below 1 mg/L while the pool was open on the 19th of March (see Figure 1), even though the levels were well above this in the morning when the manager sampled the pool. The caretaker does not normally monitor the chlorine levels while it is open, so the state of the pool during normal operation is unknown. Because of losses throughout the day, the chlorine levels need to be quite high at the start of the day to ensure safe levels in the afternoon. Again, as for the Alice Springs pool, the caretaker was adding chlorine to the level recommended by the pool test kit used and was unaware of the NT guidelines.

Despite the lower than recommended low chlorine levels, no coliforms were detected in the samples sent to the laboratory. The total plate count was also well below the specified limit of 100 organisms per mL for most samples (Territory Health Services, 1996). These results would suggest that the pool was generally safe to swim in. However, one sample, taken on Monday, March 23rd at 6am, exceeded the guideline for total plate count with 2500 organisms detected in 1mL. This sample was taken when the pool had a very low chlorine level (0.04 mg/L). The pool had not been open since the previous Saturday, almost two days beforehand. Since the pool was not treated on Saturday the chlorine levels that afternoon would have been well below the 1.5 mg/L measurement taken on the Friday afternoon (March 20th). The low chlorine levels at this stage may not have been enough to disinfect the bacterial load from the children on the Saturday. However, by 9am on Monday, March 23rd, after chlorination had taken place, the total plate count dropped back to zero when the free residual chlorine level was 2.4 mg/L. So in this case the chlorine level was apparently sufficient to restore safe swimming conditions in the pool.

None of the tests for bacteria done on site using the “Colisure” presence/absence kits were positive. Combined chlorine levels were high after chlorination, but were maintained less than the Northern Territory guidelines of 1mg/L in all samples.

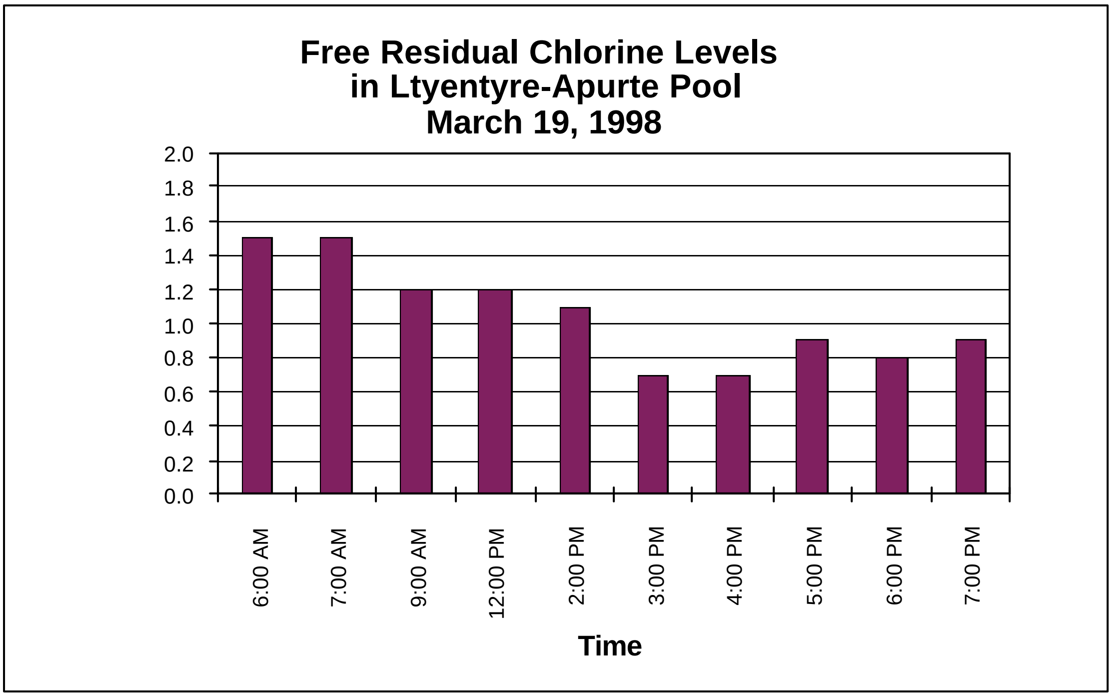

Figure 1.

The copper concentration detected in the pool water at the end of the season was 0.8 mg/L. This value was a bit lower than the expected level due to evaporation of the supply water. With a concentration ratio of 4:1 over the season and an initial water supply concentration of 0.25 mg/l a level of 1.0mg/l might be expected. The value was lower than the Australian Water Quality Guidelines (1992) for drinking water (1.5 mg/l). The addition of the algicide would indicate a higher level than 0.75 mg/l suggesting that most of the extra copper was precipitated out of suspension and removed by filtration and vacuuming.

The salinity of the pool water (1260 mg/L) at the end of the season was about four times the salinity of the water supply (310 mg/L). This indicates that the evaporation rate over the summer was about 3 times the pool volume, giving the same concentration ratio as found for the Alice Springs Pool. This concentration is consistent with an evaporation rate of around 2.0 m per season (i.e. 738m^2 x 2 = 1500 m^3 compared with the volume of the pool of 550 m^3). The caretaker mentioned that the pool is emptied about every 6 months to keep salinity levels manageable. No samples of pool water were sent on a regular basis to Alice Springs for testing.

The pH levels were generally within limits, although a bit low at times. The caretaker had a tendency to keep the pH low in order to improve the effectiveness of the chlorine.

During the study period the pool water temperatures were between 26 and 30 degrees (see Figure 2).

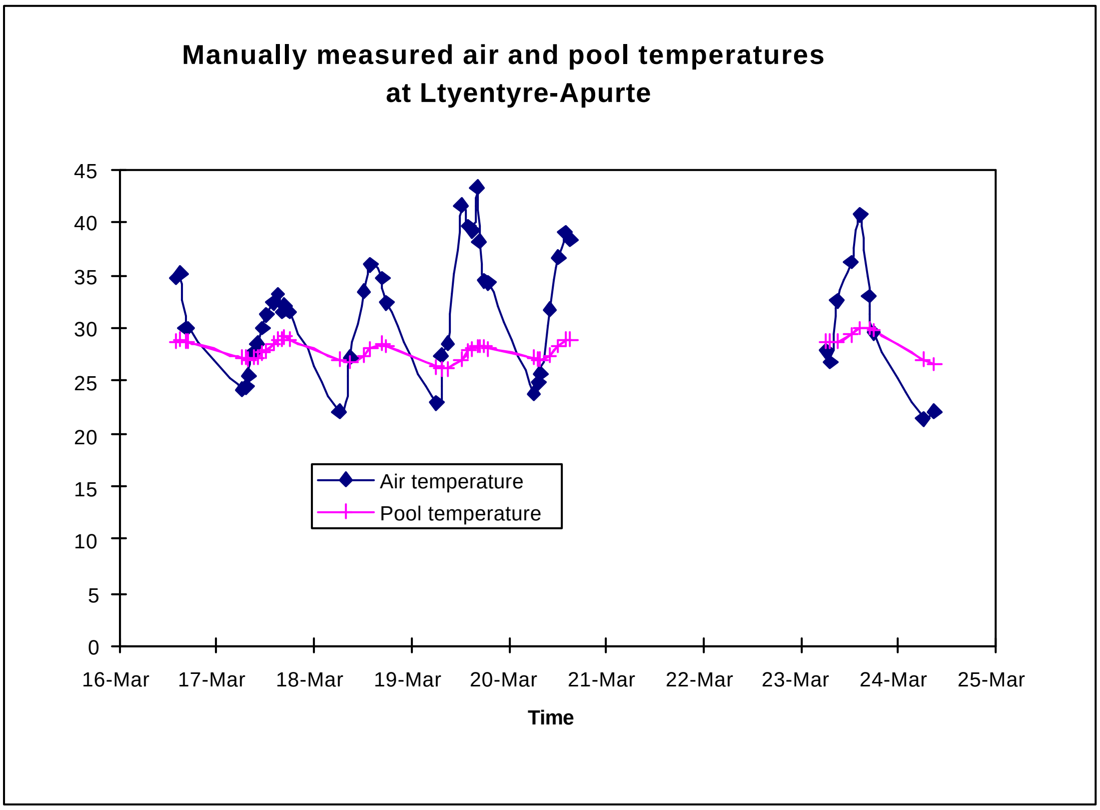

Figure 2.

The results showed that the Ltyentyre-Apurte Pool was in better condition than about 40% of the public pools randomly sampled in Alice Springs. Obviously the health of a pool is more dependent on how it is managed rather than where it is located, or who swims in it. Even though the pool may normally be safe at the low chlorine levels measured, if faecal matter enters the pool and is not identified, several children may become seriously ill. Although faecal matter has often been found in the Lytentyre-Apurte pool, no illnesses have been attributed to the pool as yet. Normally the caretaker checks and cleans all the skimmer boxes daily, and super-chlorinates the pool if faecal matter is found. Maintaining chlorine levels at the NT recommended guidelines will reduce the risk posed by faecal contamination.

4.3.4 Auto-dosers

The responsibilities of the pool caretaker could be lessened by the use of auto-dosing equipment. This device would allow automatic adjustment of the pH and chlorine levels to ensure safe swimming. With this equipment the caretaker would only need to clean the pool, backwash the filters and replace chemicals when they are low. The caretaker would still have to visit daily, but the time spent at the pool would be considerably reduced. Further savings might be expected due to less chemical wastage, since much of the chlorine is currently lost within the first few hours after manual dosing. Another advantage of the auto-dosing equipment is that such a device is prepared to work weekends, whilst the caretaker may not be. The caretaker at Ltyentyre-Apurte has requested that auto-dosing equipment be installed at the pool, so that he is free to take care of his other responsibilities. Reports from managers of public pools, which have installed auto-dosers, indicate that they work well, and that no maintenance of the equipment is required. However, the use of such devices seems to be untested in remote communities. Also this equipment can only be of benefit to water quality at Ltyentyre-Apurte if the pumps and filters are upgraded to improve water turnover rates. At the current turnover rate, the lag time between detecting low chlorine levels and bringing them up to standard is too long to ensure safe swimming conditions.

The only identified problem with auto-dosing equipment is that only liquid chlorine may be used, which has a relatively short shelf life. This would not prevent effective disinfection since the auto-chlorinator will just add more chlorine to keep the concentrations up, but is more expensive than other chlorination methods. Salt water auto-chlorinators are also available, but several salt pool operators have reported problems with salt water pools because of the generally high level of hardness of the supply water in central Australia.

4.3.5 Dust

A major factor in the cleanliness of pools in remote desert locations is the level of dust present in such situations. Like many central Australian communities Ltyentyre-Apurte has regular dust storms which creates a lot of work in maintaining water quality. During the study period the pool had up to 5% of the pool bottom covered in dust, with the toddlers' pool being the worst affected. Some of the dust was obviously wind borne, but a lot was also carried in by the children from the dusty surrounds of the pool area. Pool vacuuming did not occur in the study period, and was apparently not done regularly. The caretaker indicated that vacuuming the entire pool was very labour intensive and normally took about a day to complete. One of the reasons for the long time was because the circulation pump is undersized. One option to reduce the level of imported dust would be to incorporate wind breaks attached to the security fence. An automatic pool cleaner (eg. a "Kreepy Krawly") could be used when the pool is closed to keep the bottom clean with minimal labour. This option would, however, also require the pump to be correctly sized to operate the unit.

4.3.6 Supervision and health effects

Supervision of the swimmers was found to be a very important consideration in operating a pool in a remote Aboriginal community. In the pool under consideration the children were supervised, during opening hours, by a community member (an Aboriginal woman), who enforced the rules of the pool.

The rules were that the children must shower before entering the pool, and wear clean shorts (t-shirts if they wish). It was observed that these rules were mostly obeyed during the study period. The presence of the supervisor is important to ensure the safety of the children, and to give proper regard to hygiene requirements. The social consequences of a death or accident occurring to a child using the pool would be serious and may result in the supervisor being beaten and/or expelled from the community. Permanent closure of the pool could result from such an unfortunate situation. Consequently the availability of adequate local supervision must be allowed for since it may determine the long-term viability of any pool.

Apparently it has been difficult in the past to get Aboriginal people to take the responsibility of looking after the pool at Ltyentyre-Apurte.. Pools can only be of benefit to the community if they are well maintained and supervised. If they are not they can pose a serious health risk to those that use it. According to the health centre staff there have been no illnesses or accidents directly associated with the Ltyentyre-Apurte pool since its opening. The Health Centre staff also commented that there seemed to have been a reduction in the number of ear, eye and skin infections among children in the community during the season when the pool was open.

4.3.7 Other comments

Ltyentyre-Apurte has been a designated alcohol-free community since the pool was first opened in 1980. Drinking still occurs outside the town, and some people enter the community under the influence of alcohol. People who have been drinking are, however, not allowed in the swimming pool area, as this may be a threat to the safety of the children. From conversations with several community members, petrol sniffing is not considered to be a problem in the community.

Poor hygiene habits in the pool that were observed during the study included spitting, profuse nasal discharge, and beverage containers being thrown into the pool. Some vandalism has occurred at the pool involving graffiti, breaking windows, light and sprinkler fittings and throwing stones into the pool and on the roof. Maintenance required on the pool has included fixing pipes, filters and pumps, mowing lawns, and repairing vandalism. Sand and acid in the water causes a great deal of stress on the pumps, so bearings and impellers need to be replaced periodically. The caretaker is responsible for identifying and repairing any such problems.

4.3.8 Summary

Overall the observations of the pool at Ltyentyre-Apurte are consistent with the results of an audit of swimming pools in other remote communities in the Northern Territory, Queensland, South Australia and Western Australia (Peart and Szoeke 1998). The health and social benefits found at Ltyentyre-Apurte were also found in other communities with swimming pools. The pool was found to be well run, under the guidance of an enthusiastic and responsible caretaker. It was found to be quite feasible to do on site testing for the key chemical parameters that affect the pool water quality. In addition bacterial testing at a laboratory 80 km away posed no problems.

There were some aspects of the community at Ltyentyre-Apurte, however, that might not be considered typical for remote Aboriginal communities. The centre has been established for over 45 years as a Catholic Church run mission with considerable influence from the religious order. Ltyentyre-Apurte is designated as a dry community, and sniffing is not considered to be a problem. And lastly, the centre is relatively close to Alice Springs, so supply of chemicals and equipment and maintenance are not major problems.

4.4 Comments regarding a possible swimming pool for Kintore

Kintore is a remote Aboriginal community of approximately 300 people situated some 450 km west of Alice Springs, near the West Australian border. The community has been requesting a swimming pool for some time. The present study shows that the pool could offer considerable benefits to the community if it is properly maintained. Being in a more remote location than Ltyentyre-Apurte, there may be some increase in difficulties with the supply of chemicals, materials, and the maintenance of equipment but none that could not be overcome. Kintore drinking supply water is regularly sampled, with the water analysed in Alice Springs. Thus swimming pool water could be analysed as well.

The key feature would be to ensure the availability of a responsible caretaker. Installing auto-dosing chlorination equipment would reduce the responsibilities and the level of expertise required of the manager.

Presently at Kintore children swim in a nearby creek after sufficient rains, or in a small pond on an excavation site 10 km out of town. These sites do not meet the community's desire for a large, clean, safe pool within the town. The health service at Kintore have noticed an increase in skin sores and maybe ear infections after the first few days of swimming after rain (Peart and Szoeke 1998). Also a set of sewerage ponds are about to be installed at Kintore. Evidence elsewhere suggests that there is a considerable risk that the children will swim in these ponds in hot weather despite warning signs and security fences. Thus the installation of swimming pool may avoid the significant health risk to the children which the appearance of the sewage ponds would provide.

Kintore is known to be quite windy and dusty. A minimum requirement to reduce the amount of sand dropped into the pool might be windbreaks. Even these may not keep the dust out sufficiently to avoid excessive cleaning and the requirement for a high capacity filtration system. The introduction of large amounts of dust can cause the pool to go green with algae. Treatment involves super-chlorination, which is expensive and may require closure of the pool until proper water quality is regained. One method of overcoming such problems would be to consider an indoor pool. To avoid vandalism and maintenance problems, skylights would be more preferable than electric lights. An indoor pool would also have the advantage of reducing the possibility of children breaking into the pool and swimming unsupervised.

If a pool were built at Kintore, it would provide a valuable opportunity to conduct an epidemiological study before and after it is opened to see if improvements in the health of the children can be shown to be statistically significant.

Another significant problem that would affect the viability of a pool at Kintore is the sustainability of the present water supply. The current sustainable yield of the aquifer at Kintore is estimated at 235 m^3/day, (Wischusen, 1995). According to the ESO at Kintore the current demand regularly exceeds this value in the summer months. The installation of the deep sewerage system may increase the present demand for water. The water requirement for a pool of the same size as the one at Ltyentyre-Apurte, is 550 m^3 to be filled over several days, then more than 10 m^3 per day to account for losses from backwashing, evaporation and splashing. An indoor pool would have lower evaporation losses.

4.5 Natural swimming holes

4.5.1 Results

The results for the physical testing of the water holes are shown in Table 5.

Table 5: Test results for natural swimming holes.

Name	Date	Time	Water temp. deg C	pH	Cond. EC	Salinity mg/L	Colour
Glen Helen	5/4/98	14:30	23.4	8.01	2060	1236	grey-green
Ormiston	5/4/98	15:30	22.2	7.45	322	193	grey-green
Ellery Creek	5/4/98	18:00	21.4	7.22	164	98	tea
Telegraph Stn	6/4/98	09:00	18.6	9.10	262	157	brown-green

See Appendix D for the Microbiological test results.

4.5.2 Discussion

Water holes are not managed in any way, so that if they are contaminated with faeces, or dead animals there is a real possibility of transmission of infection. Also, since the children are not supervised whilst swimming in these pools, there is a greater chance of injury, or drowning.

There are no permanent water holes close to Ltyentyre-Apurte where people may swim. However, after large rains when the local creeks fill up, a lot of people of all ages from the community jump in for a swim. Health centre staff at Ltyentyre-Apurte have noticed higher rates of infections after large rains, when the community has been swimming in the creeks. Problems with discharges from septic system have been cited as the possible cause of these infections. Obviously it would be preferable to have the community swimming exclusively in the pool. There is, however, an aversion amongst adult Aboriginal people towards swimming in supervised swimming pools.

Contamination of water holes can also come from animals and stock in the area, from faecal contamination of the water. On the day of testing, cattle stock were noticed grazing beside the water holes at Glen Helen and Ellery Creek. People had also been swimming the same day at Ellery Creek, and possibly at the other holes.

Faecal coliforms were detected in all water holes and plate counts were between 230 and 4500 organisms per 1 mL. The higher level of microorganisms in the water holes relative to the swimming pools tested indicated that there is a greater possibility of infection from swimming in the water holes. However the National Water Quality Guidelines for Recreation Waters (1992), which is the relevant standard for the water holes, is less stringent on microbiological standards for recreational waters. All of the water holes had faecal coliform counts less than the guideline of 150 coliforms per 100 mL, which indicates they are probably safe for primary contact.

The physical conditions measured at each of the water holes were mostly fine for swimming, according to the National Water Quality Guidelines for recreation waters (1992). The water at the Telegraph Station Water Hole had a pH of 9.1, which is just above the guideline of 9.0, however at the time of testing the water was too shallow to allow any more than wading, so the high pH should not be a problem.

4.6 Relevent Water Quality Regulations/Guidelines

4.6.1 Key parameters

The Northern Territory Guidelines for Water Quality and Hygiene Standard for Swimming, Diving, Water Slide and Paddling Pools (1996) are the primary guidelines for swimming pools in the NT. The Australian Guidelines for Disinfecting Private Swimming Pools (NH&MRC, 1989) are stated where they differ from the Territory guidelines. Where the limits are not stated the Australian Water Quality Guidelines (1992) for recreational waters (primary contact) are given. Only the latter set of guidelines is applicable to natural swimming holes.

The guidelines are as follows:

Microbiological**:** The Northern Territory guidelines states that there should be no coliforms, *Pseudomonas aeruginosa* or pathogenic *Naegleria* detectable in 100mL, and the total plate count should be less than 100 per 1 mL. The Australian Water Quality Guidelines suggest that the median bacterial content should not exceed 150 faecal coliform organisms/100mL or 35 enterococci organisms/100mL. Pathogenic free-living protozoans should be absent (only important if temperatures exceed 24^0C).

pH**:** Territory Health Services guidelines (1996) state that pH should be between 7.2 and 7.6 for swimming pools. Low pH values can cause eye irritation. High pH values reduce the effectiveness of chlorine dosage.

Temperature**:** Range of $15\text{-}35^0$C for prolonged exposure. Low temperatures may induce cramps or hypothermia. High temperatures encourage growth of harmful microorganisms.

Chlorine**:** Where the water temperature is above 26 degrees Celsius, the minimum concentration of free residual chlorine should be greater than 2.0 mg/L. If the pool is stabilised with cyanuric acid, the minimum free residual chlorine concentration should be 4.0 mg/L. The combined residual chlorine level should be maintained at less than 1 mg/L. (Territory Health Services Guidelines, 1996).

The Australian Guidelines for Disinfecting Private Swimming Pools (NH&MRC, 1989) specify a lower minimum free residual chlorine concentration of 3.0 mg/L for pools with stabiliser and at greater than 26 degrees. Higher levels may be maintained without detrimental effects, but this is expensive and considered unnecessary.

Stabiliser**:** Should be less than 50 mg/L. Levels greater than this reduce the disinfection efficiency.

Total alkalinity: Should be maintained between 60-200 mg/L, and between 150-200 mg/L in pools using gaseous chlorine disinfection. Levels higher than 200 mg/L will cause scaling of fittings and surfaces, which may cause pump failure.

Salinity: Should be maintained less than 1500 mg/L. Higher levels reduce the efficiency of disinfection.

Water clarity: Should be maintained so that lane markings and other features on the pool bottom at its greatest depth are clearly visible when viewed from the side of the pool.

Toxic chemicals: Should not exceed concentration for untreated drinking water. Chemicals may be ingested or absorbed through the skin. Heavy metals especially copper, may be present in significant concentrations due to treatment for algae.

Oil and petrochemicals: Should not be noticeable as a visual film, or be detectable by odour. The skin may absorb some organics.

Algae: Should not exceed 15,000-20,000 cells/mL depending on algae type. Algal blooms, especially blue-green algae, can cause contact dermatitis, and influenza-like symptoms in swimmers. Ingestion of blue-green algae may induce gastro-intestinal disorders.

4.6.2 Sampling methods

Standard sampling methods should be used.

4.6.3 Preservation of samples

4.6.3.1 Microbiological samples

An ice-brick cooled esky should be used to transport samples. Samples should have sodium thiosulfate added to neutralise all residual chlorine (APHA Method 9060, 1989). Microbiological samples should ideally be analysed within 6 hours. However, in the extreme circumstances of remote community pools, samples may be still valid if tested within 24 hours as long as the elapsed time is recorded. (AS2031.2, 1987).

A chelating agent should be used in bottles receiving water containing copper, zinc or other heavy metals. Bottles should not be filled to the top (an air space of at least 2.5cm should be left).

4.6.3.2 Physical and chemical samples

Temperature, pH, conductivity and chlorine samples should be analysed immediately on site to reduce chance of contamination or deterioration.

Sampling for heavy metals and toxic chemicals can be sent to Darwin for laboratory analysis. Some indication of chemical levels in the pool should be shown by the analysis results for the bore water used to fill the pool. However, the addition of chemicals and evaporation, may tend to increase concentrations. The constituency of all chemicals added to the pool should be identified, and testing should be done for those, which are suspected to be at significant concentrations.

4.6.4 Testing location

Samples sent to Alice Springs, Department of Lands Planning and Environment may be tested for faecal coliforms, total coliforms, and total plate count.

Samples should only be delivered to the laboratory on Mondays, Tuesdays and Wednesdays, before 1.30pm, unless advance notice is given.

Samples sent to the Darwin office of the Power and Water Authority may be tested for all of the indicators measured in Alice Springs, as well as: *Pseudomonas aeruginosa, Enterococci, and* complete chemical analysis.

4.6.5 Cost of testing

4.6.5.1 Alice Springs:

Microbiological tests for faecal coliforms, total coliforms, and total plate count combined: $45 per sample.

Chemical testing can be done at Marriott Agencies in Alice Springs for free. However samples may deteriorate if they must travel considerable distance to Alice Springs.

4.6.5.2 Darwin:

Microbiological tests for faecal coliforms, total coliforms, total plate count and *Pseudomonas aeruginosa* combined: $60 per sample.

Test for *Enterococci,* $20 per sample.

Limited chemical analysis: including pH, conductivity, total hardness, chlorine, total alkalinity, colour and turbidity: $45 per sample.

Flame Atomic Absorption Spectrometry tests for metals eg. Copper: $10 per sample or for low levels by Graphite Furnace Atomic Absorption Spectrometry:$25 per sample.

Other chemical tests may be done for a specified price.

Samples arriving at Darwin on Thursdays, and Fridays, or outside normal working hours attract a levy.

Delivery costs should also be added. Communities reasonably close to a laboratory may send in samples by road, but more remote communities may need to use a mail plane to ensure that samples are processed within 24 hours.

If microbiological samples were sent to Alice Springs once per month over a six month swimming season (October to March inclusive) the total processing cost would be $270. This should be sufficient if the pool is operated correctly, and frequent chemical testing is performed.

Chlorine, pH and alkalinity can be checked on site with a standard pool test kit, which costs $33.

5. CONCLUSIONS

- This study has shown that key physical and chemical water quality parameters for swimming pools in remote communities can be monitored on site.

- Microbiological samples can be sent regularly to the nearest laboratory for analysis to ensure that the disinfection process is effective.

- The pool at Ltyentyre-Apurte shows that with proper maintenance a remote community pool can be made safe for swimming.

- There appears to be a lack of awareness of the relevant safety levels, in the NT, for free chlorine amongst pool caretakers. This lack is partly due to many pool test kits indicating a chlorine level that is lower than the relevant guidelines.

- Swimming pools in remote communities can be a community asset that provide considerable social and health benefits to the children.

- Well-managed swimming pools provide a safe alternative to natural swimming holes.

6. ACKNOWLEDGEMENTS

Thanks to the CRC for Water Quality and Treatment for providing funding for the researcher, the Centre for Appropriate Technology for providing the base for the study and the National Centre for Epidemiology and Population Health at the Australian National University, for coordinating the work. Special thanks to the people of the community of Ltyentyre-Apurte for putting up with yet another study, it is hoped that it will help other Aboriginal communities. Also thanks to Alice Springs Swimming Centre, the Alice Springs Town Council, Territory Health Services, Department of Power and Water, Marriott Agencies and Glen Nuggin.

7. REFERENCES

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Territory Health Services, Environmental Health Program (January 1996), *Water Quality and Hygiene Standard for Swimming, Diving, Water Slide and Paddling Pools.*

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APPENDIX A – 1 TEST RESULTS FROM ALICE SPRINGS SWIMMING CENTRE

BACTERIOLOGICAL ANALYSIS OF WATER

Sample Location: **ALICE SPRINGS SWIMMING CENTRE**

Sampling Date: **15/03/98** **Job No:**

Sample Site	RESULTS		Time Sampled	Temp C	Chlorine mg L		Coliform Per 100 ml	Faecal Coliform Per 100 ml	E. Coli Per 100 ml	Entero-Cocci Per 100 ml	Pseudo-Monas Aeruginosa Per 100 ml	Plate Count Organisms Per 1 ml 37 C	Plate Count Organisms Per 1 ml C
	Pass	Fail			Free Residual	Total Residual							
Mail Pool			12:00	28.3		3.6	0	0				1	
Main Pool			15:00	29.		2.2	0	0				0	
Blank			17:30	28.9			0	0				0	
Main Pool			18:00	28.8		2.0	0	0				0	

APPENDIX A-2

Date 16/3/98	MARRIOTT AGENCIES	
Time 10.27 am	12 SMITH ST	
FILE Page 1	PH 089 521294	
Alice Springs Town Pool	Read labels for safety & mixing detail	
Speed Street	Use a test kit. Filter at least 8 hrs a day.	
Alice Springs	Return a water sample monthly	
	Report for Alice Springs Town Pool	
High TDS	**High TDS**	
Cub.Meter Fully Tiled	2500 Cub.meter Fully Tiled	
TDS2000 mg/1	TDS2000 mg/1	
	The level of total dissolved solids your pool is too high.	
	Dilute the water in your pool with fresh water.	
	Removing water from a pool can place dangerous stresses on the pool. Remove no more than a quarter of the pool contents at a time & refill with fresh water. Repeat the process until the desired reduction is achieved.	
Low Stabilizer	**Low Stabilizer**	
2500 Cub.Meter Fully Tiled	Cub.Meter Fully Tiled	
stabilizer 6 mg/1	Stabilizer 6 mg/1	
	Add	
	Stabilizer	**110.0 kg**
	This chemical is often difficult to dissolve. Place two cups at a time into a mesh bag. Pantyhose is ideal and suspend the bag at the pool return.	
Low Chlorine	**Low Chlorine**	
Cub.Meter Fully Tiled	2500 Cub.Meter Fully Tiled	
Free Ch 0.89 mg/1	Free Ch 0.89 mg/1	
	The chlorine level is too low for safe use.	
	Superchlorinate according to your routine treatment recipe or add	
	Granular Chlorine	**50.0 kg**
Water Balance	**Water Balance**	
Cub.Meter Fully Tiled	2500 Cub.Meter Fully Tiled	
Liquid Chlorine Stabilizer	Liquid Chlorine Stabilized	
Ts 2000.81 0:Ca	Ts 2000:S1 O: 6:P7.9:A185:A175:	
6.P7.9:A165:H175.Tp28	Scale forming Lang.index	0.3
	Adjust pH to	7.7
	Alkalinity to	110 mg/1
	Cal.Hard to	180 mg/1
	Use Liquid Acid	**13.5 Lit**
	Each day for 4 days	
	Wait 4 hrs and add Liquid Acid	
	Mix in water before adding to pool.	

APPENDIX A-3

FILE Page 2
Alice Springs Town Pool
Speed Street
Alice Springs

Target Test Levels
Fully Tiled
Liquid Chlorine Stabilized

Mg/1	Min	Max	Actual

MARRIOTT AGENCIES
12 SMITH ST
PH 089 521294
Read labels for safety & mixing detail
Use a test kit. Filter at least 8 hrs a day.
Return a water sample monthly
Report for Alice Springs Town Pool

Target Test Levels
Fully Tiled
Liquid Chlorine Stabilized

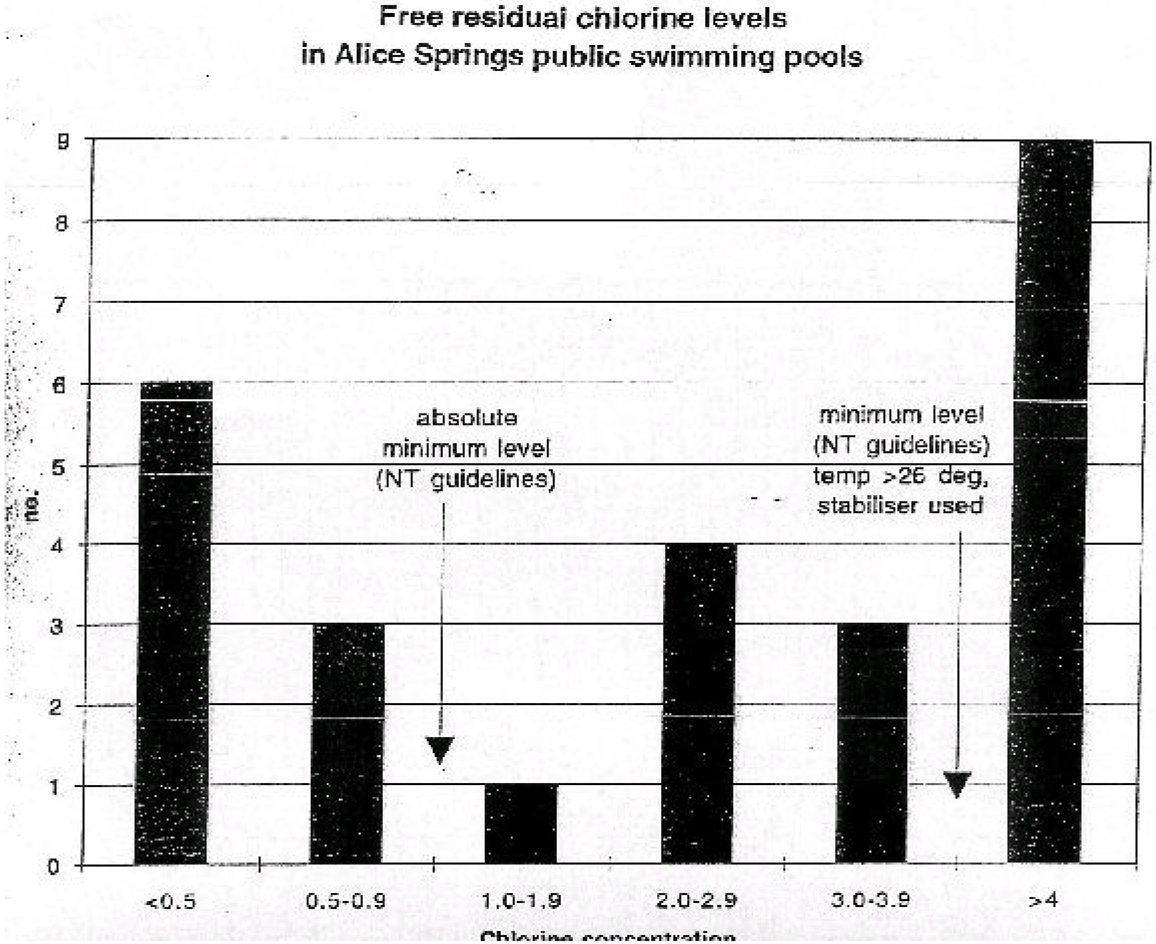
Mg/1	Min	Max	Actual
TDS	0.0	1500.0	2000.0
Stabilizer	80.0	70.0	8.0
Iron	0.0	0.0	0.0
Copper	0.0	2.0	0.0
Free Ch	1.6	5.0	0.8
Total Ch	1.6	6.0	0.0
pH	7.5	7.8	7.9
Alkalinity	80.0	180.0	170.0
Cal.Hard	100.0	350.0	180.0
Lang. Index	-.02	0.2	0.3

APPENDIX B-1 TEST RESULTS FROM PUBLIC POOLS IN ALICE SPRINGS

1997/98 **by Alice Springs Town Council**

Site No.	Free residual chlorine mg/L	Total residual chlorine mg/L	Combined residual chlorine mg/L	pH	Total Alkalinity mg/L	Comply free chlorine >1mg/L?	Comply combined chlorine >1mg/L?	Minimum overall compliance	Comply free chlorine >4 mg/L?
1	0.2	0.2	0.0	7.4	140	No	Yes	No	No
2	0.6			8.4		No	Yes	No	No
3	>4	>4		7.7	100	Yes	?	Yes	Yes
4	3	3	0.0	7.8	100	Yes	Yes	Yes	No
5	>4	>4		7.7	140	Yes	?	Yes	Yes
6	0.1	0.1	0.0	7.6	100	No	Yes	No	No
7	4			7.0	60	Yes	Yes	Yes	Yes
8	2			7.4	100	Yes	Yes	Yes	No
9	>4	>4		7.6	100	Yes	?	Yes	Yes
10	1			7.7	100	Yes	Yes	Yes	No
11	<1					Yes	?	Yes	Yes
12	>4	>4		7.4	60	Yes	?	Yes	Yes
13	0			6.8	60	No	Yes	No	No
14	0.1	0.4	0.3	7.4	140	No	Yes	No	No
15	2.5	3	0.5	7.3	60	Yes	Yes	Yes	No
16	3	4	1.0	7.3		Yes	Yes	Yes	No
17	3.5	4	0.5	7.2		Yes	Yes	Yes	No
18	4	5	1.0	7.3	140	Yes	Yes	Yes	Yes
19	0.2	0.4	0.2	7.6		No	Yes	No	No
20	>4	>4		7.6		Yes	?	Yes	Yes
21	0.2	0.2	0.0	8.0		No	Yes	No	No
22	>4	>4		7.3		Yes	?	Yes	Yes
23	2.7	4	1.3	7.2		Yes	No	No	No
24	0.6	1	0.4	7.4		No	Yes	No	No
25	2.5	4	1.5	7.0		Yes	No	No	No
Min	0	0.1	0.0	6.8	60		Comply	15	9
Max	>4	>4	1.5	8.4	140		Total	25	25
Desired	>1	>1	0-1.0	7.2-7.6	60 to 200		percent	60%	36%
guideline	NT minimum	NT minimum	NT	NT	NT				

APPENDIX B-2


Free residual chlorine levels
in Alice Springs public swimming pools
no.
9
8
7
6
5
4
3
2
1
0
absolute
minimum level
(NT guidelines)
minimum level
(NT guidelines)
temp >26 deg,
stabiliser used
<0.5
0.5-0.9
1.0-1.9
2.0-2.9
3.0-3.9
>4
Chlorine concentration

APPENDIX C-1 TEST RESULTS FROM LTYENTYRE-APURTE SWIMMING POOL

BACTERIOLOGICAL ANALYSIS OF WATER

Sample Location: **SANTA TERESA**

Sampling Date: 17/03/98 **Job No:**

Sample Site	RESULTS		Time Sampled	Temp C	Chlorine mg L		Coliform Per 100 ml	Faecal Coliform Per 100 ml	E. Coli Per 100 ml	Entero-Cocci Per 100 ml	Pseudo-Monas Aeruginosa Per 100 ml	Plate Count Organisms Per 1 ml 37 C	Plate Count Organisms Per 1 ml C
	Pass	Fail			Free Residual	Total Residual							
Pool 17/3/98			12:00	27.9	1.7		0	0				4	
Pool 17/3/98			15:00	28.9	1.4		0	0				1	
Pool 17/3/98			18:00	29.	0.7		0	0				0	
Pool 18/3/98			6:00	26.9	1.1		0	0				0	
Blank			6:00	26.9			0	0				0	
Pool 18/3/98			9:00	26.7	2.5		0	0				0	

APPENDIX C-2

BACTERIOLOGICAL ANALYSIS OF WATER

Sample Location: SANTA TERESA

Sampling Date: 23/03/98 Job No:

Sample Site	RESULTS		Time Sampled	Temp C	Chlorine mg L		Coliform Per 100 ml	Faecal Coliform Per 100 ml	E. Coli Per 100 ml	Entero-Cocci Per 100 ml	Pseudo-Monas Aeruginosa Per 100 ml	Plate Count Organisms Per 1 ml 37 C	Plate Count Organisms Per 1 ml C
	Pass	Fail			Free Residual	Total Residual							
Pool			6:00	28.8		0.04	0	0				2500	
Pool			9:00	28.8		2.4	0	0				0	
Pool			12:00	29.4		2.5	0	0				0	
Blank			14:20				0	0				0	
Pool			15:00	29.9		2.2	0	0				0	
Pool			18:00	29.8		2.2	0	0				0	

APPENDIX C-3

BACTERIOLOGICAL ANALYSIS OF WATER

Sample Location: **SANTA TERESA**

Sampling Date: 24/03/98 **Job No:**

Sample Site	RESULTS		Time Sampled	Temp C	Chlorine mg L		Coliform Per 100 ml	Faecal Coliform Per 100 ml	E. Coli Per 100 ml	Entero-Cocci Per 100 ml	Pseudo-Monas Aeruginosa Per 100 ml	Plate Count Organisms Per 1 ml 37 C	Plate Count Organisms Per 1 ml C
	Pass	Fail			Free Residual	Total Residual							
Pool			6:00	27.0		1.7	0	0				0	
Pool			9:0	26.5		1.7	0	0				0	

APPENDIX C-4

Date 18/3/98
Time 11.17 am
Santa Teresa
via Alice Springs

High TDS
Cub.Meter Paint – Epoxy
TDS 3700 mg/1

Water Balance
Cub.Meter Paint – Epoxy
Liquid Chlorine Stabilized
Ts00:81 0: a 22:/P/ 1:A 25:A230: 28

Target Test Levels
Paint - Epoxy
Liquid Chlorine Stabilized
Mg/1 Min Max Actual

MARRIOTT AGENCIES
12 SMITH ST
PH 089 521294
Read labels for safety & mixing detail
Use a test kit. Filter at least 8 hrs a day.
Return a water sample monthly
Report for Santa Teresa

High TDS
550 Cub.Meter Paint – Epoxy
TDS 3700.mg/1

The level of total dissolved solids in your pool is too high.Dilute the water in your pool with fresh water.
Removing water from a pool can place dangerous stresses on the pool.
Remove no more than a quarter of the pool contents at a time and refill with fresh water. Releat the process until the desired reduction is achieved.

Water Balance
550 Cub.Meter Paint – Epoxy
Liquid Chloring Stabilized
Ts8/00:81 0:8a 22:P/.1:A 25:H230:
Corrosive Lang.index -1.0
Adjust Alkalinity to 120 mg/1
Cal.Hard to 230 mg/1
Use pH Buffer 96.0 kg
Liquid Acid 7.9 lit
Return a new sample next week
******Cloudy water may result ******
Add pH Butter
First. Dissolve in fresh water,........
Than 1 kg. To each bucket.
Wait 4 hrs and add Liquid Acid
Mix in water before adding to pool.

Target Test Levels
Paint – Epoxy
Liquid Chloring Stabilized

Mg/1	Min	Max	Actual
TDS	0.0	1500.0	3700.00
Stabilizer	30.0	70.0	22.0
Iron	0.0	0.0	0.0
Copper	0.0	2.0	0.0
Free Ch	1.5	5.0	2.7
Total Ch	1.5	5.0	2.8
pH	7.2	7.6	7.1
Alkalinity	80.0	150.0	60.0
Cal.Hard	100.0	350.0	230.0
Lang.index	0.	0.2	-1.0

APPENDIX C-5

Date 20/3/98
Time 5.12pm
Santa Teresa
via Alice Springs

Water Balance
Cub.Meter Paint – Epoxy
Liquid Chloring Stabilized
Ts1250.91 0.0a 44:P/.2:A
18:H230: Tp28
CorrosiveLang.index -1.0

Target Test Levels
Paint – Epoxy
Liquid Chlorine Stabilized
Mg/1 Min Max Actual

MARRIOTT AGENCIES
12 SMITH ST
PH 089 521294
Read labels for safety & mixing detail
Use a test kit. Filter at least 8 hrs a day.
Return a water sample monthly
Report for Santa Teresa

Water Balance
Cub.Meter Paint – Epoxy
Liquid Chlorine Stabilized
Ts1250.91 0.0a 44:P/.2:A 18:H230: p28

Corrosive Lang.index -1.0

Adjust	pH to	7.4
	Alkalinity to	100 mg/1
	Cal.Hard to	230 mg/1
Use	**pH Buffer**	**86.0 kg**
	Liquid Acid	**7.9 lit**

Return a new sample next week
*****Cloudy water may result******
Add pH Butter
First. Dissolve in fresh water, .no more than 1 kg to each bucket.
Wait 4 hrs and add Liquid Acid
Mix in water before adding to pool.

Target Test Levels
Paint – Epoxy
Liquid Chlorine Stabilized

Mg/1	Min	Max	Actual
TDS	0.0	1500	1250.0
Stabilizer	30.0	70.0	44.0
Iron	0.0	0.0	0.0
Copper	0.0	2.0	0.0
Free Ch	1.6	5.0	1.8
Total Ch	1.6	5.0	0.0
pH	7.2	7.6	7.2
Alkalinity	80.0	150.0	20.0
Cal.Hard	100.0	350.0	230.0
Lang.index	-0.5	0.2	-1.0

APPENDIX C-6

Date 24/3/98
Time 12.27pm
Santa Teresa
via Alice Springs

Water Balance
550 Cub.Meter Paint – Epoxy
Liquid Chlorine Stabilized
TS1250.S1 0.Ca 39:P7.2:A
45:H220:Tp28
CorrosiveLang.index   -0.6

Target Test Levels
Paint – Epoxy
Liquid Chlorine Stabilized
Mg/1 Min Max Actual

MARRIOTT AGENCIES
12 SMITH ST
PH 089 521294
Read labels for safety & mixing detail
Use a test kit. Filter at least 8 hrs a day.
Return a water sample monthly
Report for Santa Teresa

Water Balance
550 Cub.Meter Paint – Epoxy
Liquid Chlorine Stabilized
TS1250.S1 0.Ca 39:P7.2:A 45:H220:Tp28
Corrosive Lang.index -0.6

Adjust	pH to	7.4
	Alkalinity to	110 mg/1
	Cal.Hard to	220 mg/1
Use	**pH Buffer**	**67.0 kg**
	Liquid Acid	**7.9 lit**

Return a new sample next week
*****Cloudy water may result******
Add pH Buffer
First. Dissolve in fresh water, .no more than 1 kg to each bucket.
Wait 4 hrs and add Liquid Acid
Mix in water before adding to pool.

Target Test Levels
Paint – Epoxy
Liquid Chlorine Stabilized

Mg/1	Min	Max	Actual
TDS	0.0	1500	1250.0
Stabilizer	30.0	70.0	39.0
Iron	0.0	0.0	0.0
Copper	0.0	2.0	0.0
Free Ch	1.5	5.0	2.8
Total Ch	1.5	5.0	0.0
pH	7.2	7.6	7.2
Alkalinity	80.0	150.0	50.0
Cal.Hard	100.0	350.0	220.0
Lang.index	-0.5	0.2	-0.8

APPENDIX D – TEST RESULTS FROM NATURAL SWIMMING HOLE

BACTERIOLOGICAL ANALYSIS OF WATER

Sample Location: **WATERHOLES VARIOUS**

Sampling Date: 5/04/98 **Job No:**

Sample Site	RESULTS		Time Sampled	Temp C	Chlorine mg L		Coliform Per 100 ml	Faecal Coliform Per 100 ml	E. Coli Per 100 ml	Entero-Cocci Per 100 ml	Pseudo-Monas Aeruginosa Per 100 ml	Plate Count Organisms Per 1 ml 37 C	Plate Count Organisms Per 1 ml C
	Pass	Fail			Free Residual	Total Residual							
Glen Helen			14:30	23.4			4	1				230	
Ormiston Waterhole			15:30	22.2			10	3				500	
Ellery Creek Bighole			18:00	21.4			80	30				4500	
Telegraph Stn 6/4/98			9:00	18.6			100	100				620	
Blank			9:30				0	0				1200	