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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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

<u>The effect of calcification</u>

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.

<u>Above ground or below ground</u>

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.

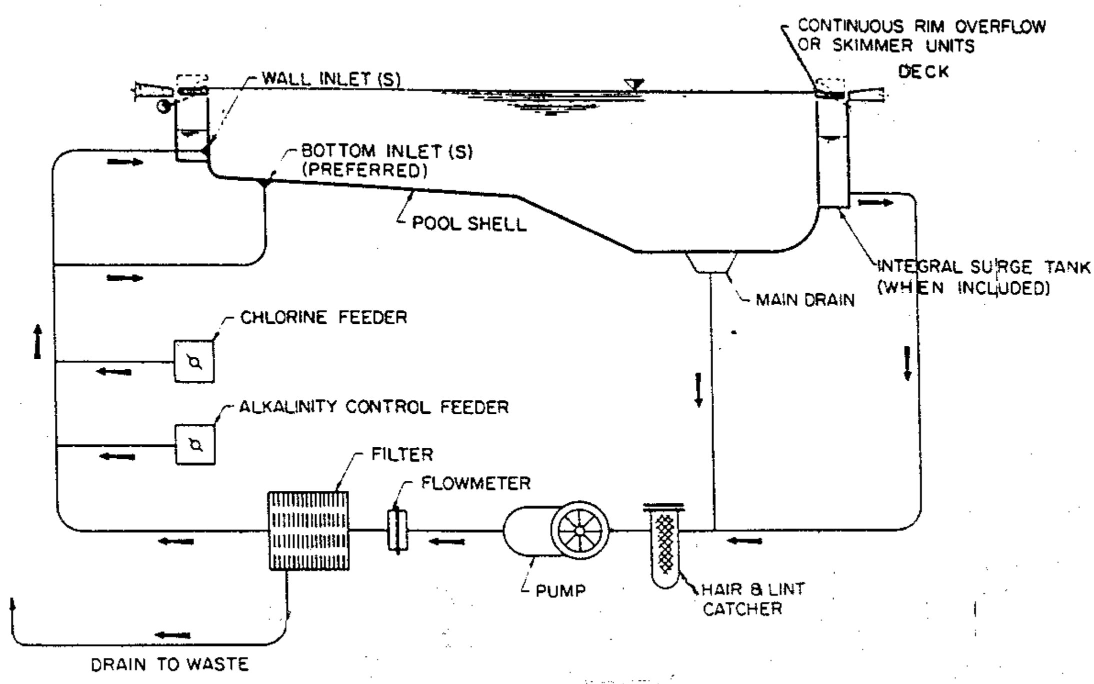

Figure 1: Process of water circulation, filtration and chemical treatment (Gabrielsen 1987:193)

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.

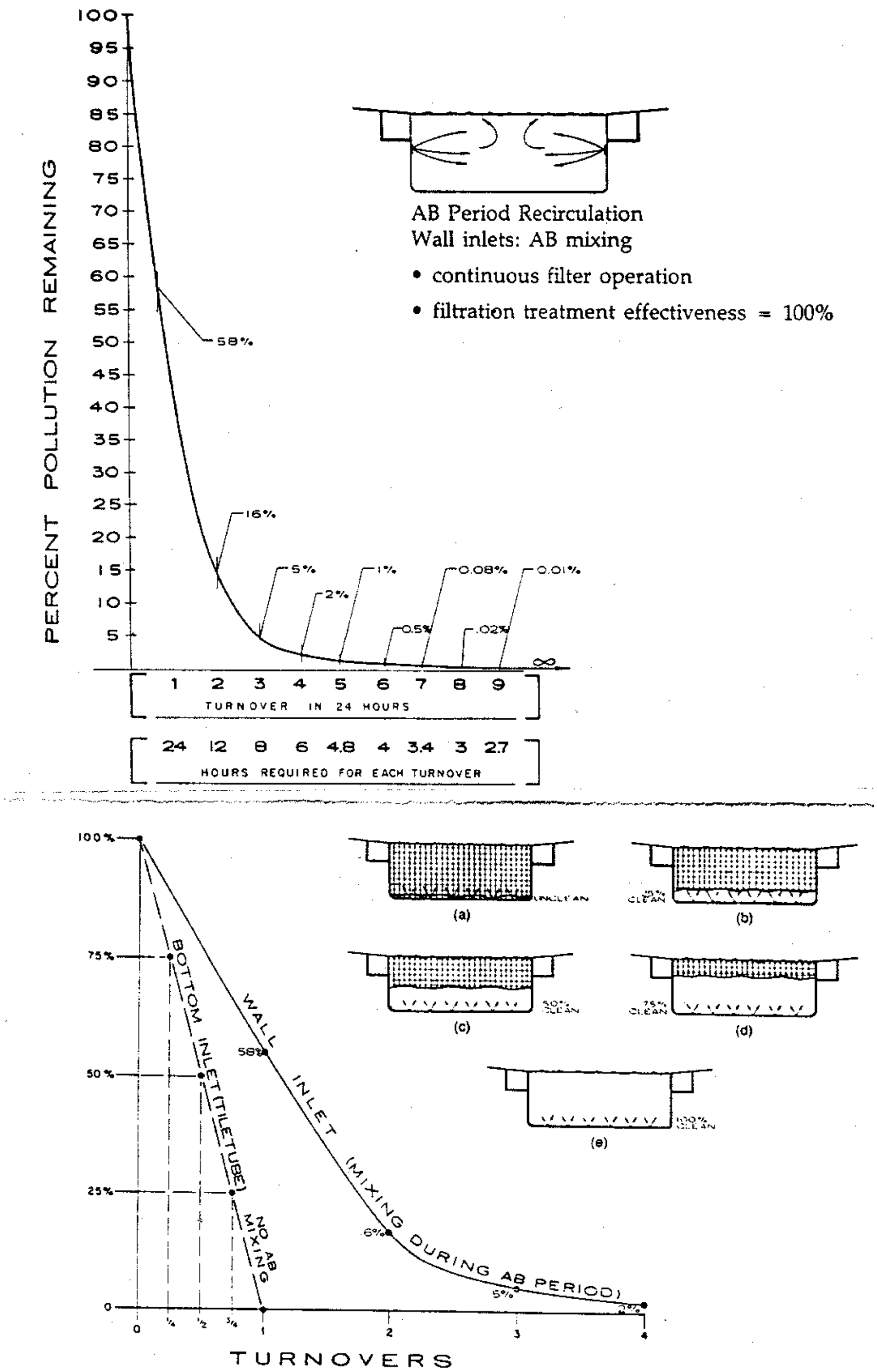

Figure 2: Comparative effect of turnover rate on removing pollution levels using wall inlets and bottom inlets (AB refers to the after bathing period- ie when there are no swimmers)(Gabrielsen 1987:197,198)

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 50-100$m^3/m^2/hr$ • 10 micron filtration • 2-3 minute backwash time	
Diatomaceous earth	• high quality filtration 1-5micron	• filtration rate only 5-10$m^3/m^2/hr$ • 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 1-2.5$m^3/m^2/hr$ • not appropriate for public pools

Table 6: Advantages and disadvantages of different filtration systems

<u>Skimmers or scum gutters/channels</u>

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).

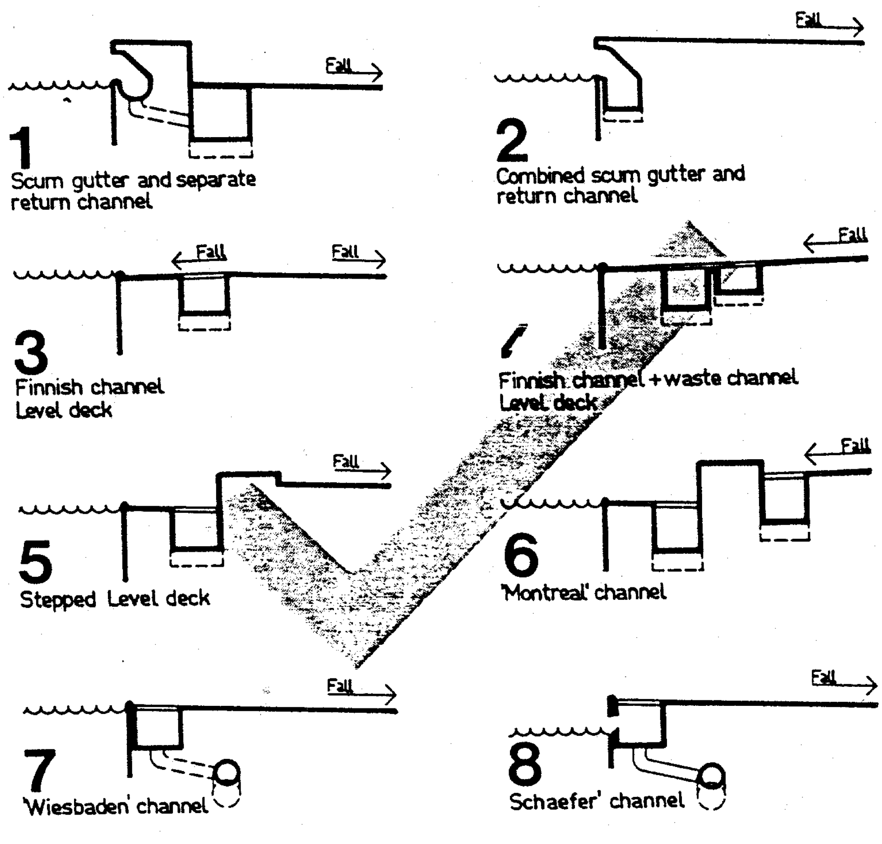

Figure 3: Some of the different types of scum gutter/channel systems available (Davies 1981:41)

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.

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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APPENDIX 1

STATE GUIDELINES, REGULATIONS OR CODES OF PRACTICE

NORTHERN TERRITORY

SOUTH AUSTRALIA

WESTERN AUSTRALIA

NEW SOUTH WALES

VICTORIA

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.

APPENDIX 3

TAFE COURSES AVAILABLE FOR SWIMMING POOL OPERATORS