Asset Management Plan

Aquatic Centres

Maitland City Council

8 June 2022

→ The Power of Commitment

Executive summary

Introduction

Maitland City Council's (MCC) asset portfolio has an estimated financial value of over $1.7 B (in 2022$) across seven asset classes. These asset classes are:

– **Roads and Road Inventory** (all road types, kerb and gutter, paths, signs and traffic equipment).
– **Drainage** (trunk drains, culverts and conduits, floodgates and detention basins).
– **Bridges and Major Structures** (road bridges, pedestrian bridges, retaining walls, lookouts and wharfs).
– **Recreation** (parks, buildings, sporting facilities and open spaces).
– **Buildings** (all MCC owned and operated buildings).
– **Aquatic Centres** (Maitland and East Maitland Aquatic Centres).
– **Plant and Equipment** (plant and equipment used to maintain all MCC asset such as excavators and mowers).

Asset Management Plans (AM Plans) have been developed for each of these asset classes to demonstrate responsible management of assets and associated services, compliance with regulatory requirements, and communicate the level of funding necessary to provide the required levels of service for each asset class.

This AM Plan is for **Aquatic Centre assets** at the Maitland and East Maitland Aquatic Centres**.** The AM Plan outlines requirements to deliver expected services to the community including Levels of Service; Future Demand and Lifecycle Management activities, informing specific asset investment decisions.

This AM Plan builds upon the previous Aquatic Centre plan (completed in 2015) as well as planning work defined in other MCC documents. This plan has been prepared by GHD in close consultation with MCC staff.

What council provides

MCC is expected to provide Aquatic Centre services to the community that are:

– Safe and functional
– Of appropriate quality
– Reliable
– Compliant with relevant legislation
– Delivered in a cost efficient and sustainable manner.

To meet these expectations, the Maitland and East Maitland Aquatic Centres consist of more than 550 individual assets, with a replacement value of **$36.3 M (2022$).** These are summarised as follows.

Table E.1 Asset inventory and replacement costs

Aquatic centre	Asset elements	% Cost total	$ Cost breakdown
Maitland Aquatic Centre	Buildings	26%	$9,545,387
	Picnic Shelters and Tables	<1%	$83,430
	Shade Structures	<1%	$150,000
	Site Services	3%	$1,035,000
	Site Works	2%	$740,000
	Swimming Pools	31%	$11,278,892
	Water Treatment	5%	$1,871,304
	Sub total	**68%**	**$24,704,013**

Aquatic centre	Asset elements	% Cost total	$ Cost breakdown
East Maitland Aquatic Centre	Buildings	5%	$1,696,700
	Picnic Shelters and Tables	<1%	$83,430
	Shade Structures	<1%	$52,530
	Site Services	1%	$447,000
	Site Works	4%	$1,469,500
	Swimming Pools	21%	$7,635,517
	Water Treatment	1%	$256,000
	Sub total	**32%**	**$11,640,677**
	Total	**100%**	**$36,344,690**

MCC measures performance of these assets against technical levels of service targets including, ***Safety*** (zero incidents/accidents); ***Level of Service*** (safe, reliable and affordable operational conditions); and ***Fit for Purpose*** (compliance, condition).

Current asset status

Not every asset is of equal importance or presents the same failure risk. It is therefore important to know which assets are most critical to service delivery. Understanding which assets are critical, and why, helps to focus investment decisions.

Critical assets are those assets that have high **consequences or impacts** if they fail and a high **probability or likelihood** of failing. As an indication of probability of failure asset consumption of aquatic centre assets has been calculated based on condition data available, asset age and opinions of appropriate MCC staff and expert consultants. This confirms which assets are at the end or nearing the end of their life and require replacing or a significant maintenance intervention. For example the data indicates that the East Maitland Aquatic Centre is reaching the end of its useful life with approximately half of the assets (by replacement cost) being 90% consumed.

In summary, **23%** of aquatic centre assets are a "**very high**" business risk, with a further 43**%** of assets being a "**high**" business risk. This equates to a financial replacement estimate (in 2022$) of **~$23.8 M.** This is reflective of:

- The age and condition of the majority of aquatic centre assets, particularly East Maitland Aquatic Centre.
- The high target level of service required of Maitland Aquatic Centre, that is being a "Superior" ranked facility.

These assets should be prioritised in future capital, operations and maintenance planning and delivery. Note that whilst this plan identified these very high-risk assets, it does not necessarily mean a high cost intervention is required.

Future demand

The Maitland Local Government Area is in a period of extraordinary population growth. Most recent population estimates from the Australian Bureau of Statistics for 2020/21 shows the population grew by 3.5%. These accelerated growth rates are predicted to continue for the next five to ten years, with Maitland's population expected to exceed 104,700 by 2041.

Our current growth rate is the fifth highest in NSW and the highest outside of Greater Sydney.

To accommodate this continued growing population, the majority (>90%) are expected to live in new greenfield developments, all of which require new MCC owned and operated assets (such as roads, drainage, paths, recreation etc). New greenfield developments have conservatively been estimated at around 700 new lots per year for the next 10 years.

Whilst this growth directly impacts some asset classes through, for example, the need to construct additional roads and drainage infrastructure, there are no direct capital investment impacts to the Maitland and East Maitland Aquatic Centres. The construction and commissioning of the new 25 m indoor pool at the Maitland Aquatic Centre in 2018 has assisted in providing additional aquatic services to the growing community. It is likely that this growing population will increase patronage and usage of MCC's Aquatic Centre. This increased usage will need to be considered in ongoing operations and maintenance strategies to ensure our Aquatic Assets can sustainably meet demand.

Sustaining the asset portfolio

The estimated cost over time to sustain MCC's Aquatic Centre assets to the target condition and level of service is shown in Figure 5.1 below. As indicated by the horizontal line, the theoretical average annual cost to sustain this asset class (based on long term replacement cycles, asset age/condition and estimated growth) is estimated to be in the order of **$0.9 M** in 2022 dollars. This includes **$0.7 M** for Maitland Aquatic Centre, and **$0.2 M** for East Maitland Aquatic Centre. Most of this reinvestment relates to buildings, pools and water treatment.

This information now provides a target for short term assessments – particularly with regards to priority assets identified and those that have reach the end of their estimated life. The deterioration in the condition of East Maitland Pool presents a future risk that at present is not fully understood until detailed and expert assessment is completed. In general, risk exposure can be further reduced through applying appropriate risk reduction measures or obtaining more accurate condition data that confirms extending asset life is practical.

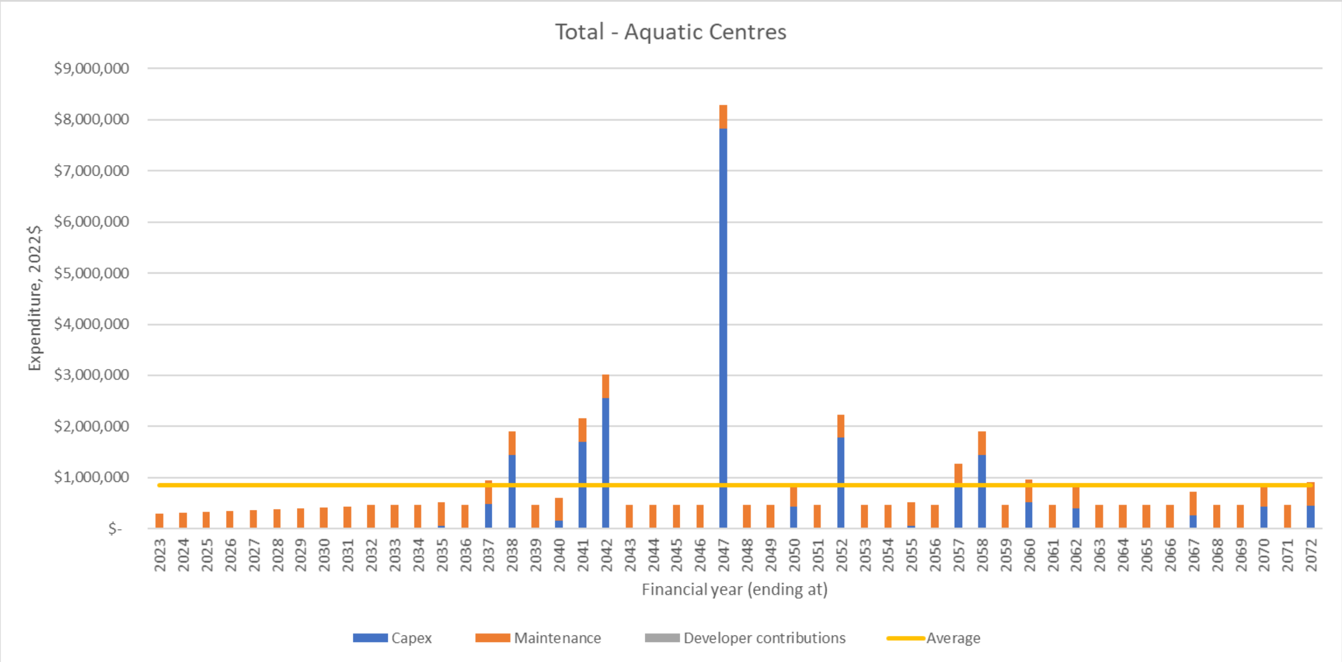

Figure 1.1 Financial projection for asset renewal - total

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1. Introduction

1.1 Asset portfolio

Maitland City Council's (MCC) asset portfolio has an estimated financial value of over $1.7B (in 2022$) across seven asset classes. These asset classes are:

- **Roads and Road Inventory** (all road types, kerb and gutter, paths, signs and traffic equipment).
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Asset Management Plans (AM Plans) have been developed for each of these asset classes to demonstrate responsible management of assets and associated services, compliance with regulatory requirements, and communicate the level of funding necessary to provide the required levels of service for each asset class.

The AM Plans provide a rational framework to enable systematic and repeatable processes to manage costs, risks and levels of service. They attempt to identify expected future costs and assist in predicting future barriers to efficient and effective service delivery.

1.2 Content of this Asset Management Plan

This AM Plan is for MCC's **Aquatic Centre Assets,** being Maitland Aquatic Centre and East Maitland Aquatic Centre.

Each centre is a contained facility consisting of a variety of asset types including outdoor and indoor pools, water treatment plant/equipment, buildings (such as amenities and grandstands) and site works (car parks, landscaping, seating etc).

The AM Plan outlines the general approach and methodology taken in preparing the Plan as well as discussing key outputs. The specific sections included in the AM Plan are as follows:

- ***Levels of service*** – specifies the services and levels of service to be provided by MCC.
- ***Future demand*** – how the growth of the Maitland region will impact on future service delivery and how this growth is to be met.
- ***Lifecycle management*** – how MCC are/will manage its existing and future assets to provide the required services.
- ***Financial summary*** – what funds are required to provide sustainable services.

1.3 Asset management framework

MCC's asset management policy, plans, strategies, tactics, and activities are part of an integrated, overarching *Asset Management Framework*. This framework defines the relationship between key asset management plans and business processes, and how they interact with MCC's broader corporate plans and activities to deliver the Community Strategic Plan and its service outcomes. The key elements of MCC's Asset Management Framework, and their inter-relationships, are shown in Figure 1.1.

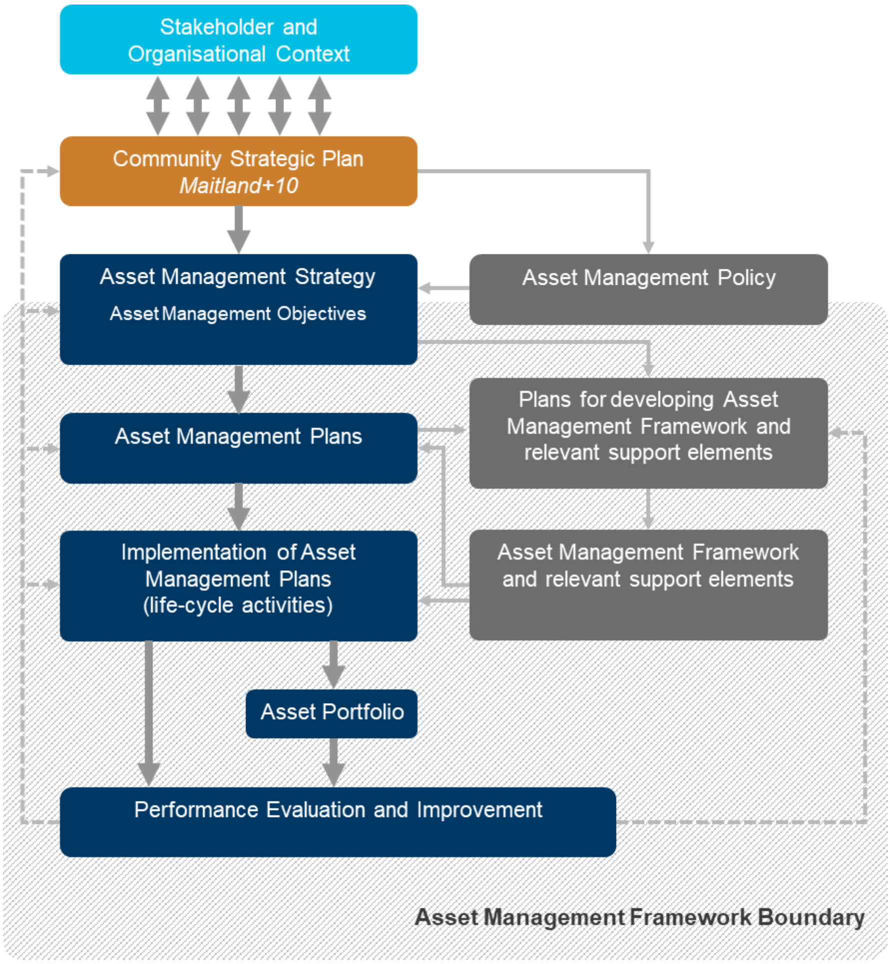

Figure 1.1 Asset management framework

AM Plans are a key element of this framework being a crucial link between city wide strategic asset management goals through to the implementation of tactical service delivery requirements. How the AM Plans relate to other MCC documents and planning outputs is illustrated in the figure below. The AM Plans are a central piece to the Asset Management Framework by consolidating (for each asset class) asset portfolio, master planning and lifecycle information to inform asset status and long term financial reporting.

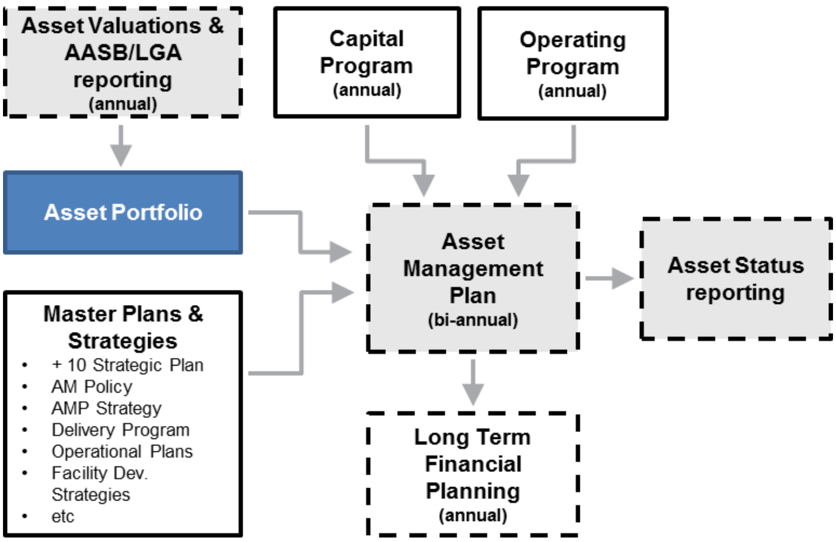

Figure 1.2 AM Plan relationship to other Maitland City Council documents

1.4 Asset management objectives

MCC is responsible for providing services relating to aquatic centres to the community within the broader portfolio of Council assets. To support the inherent goal of meeting levels of service, MCC has adopted key infrastructure Asset Management Objectives and corresponding Tactics, all of which are relevant to this asset class. These objectives are:

– **Objective 1, Health and Safety:** To be a local government leader in how we effectively manage the health and safety risks related to how we use, operate and maintain our assets.
– **Objective 2, Community Focus:** Our asset portfolio supports the Maitland community's growing and changing demand for connectivity, recreational, sporting and community infrastructure and services.
– **Objective 3, Value for Money**: The life cycle management of our assets is sustainable, prioritised and optimised to deliver the right balance of cost, risk and service level outcomes.
– **Objective 4, Empowered and Engaged People**: Our people understand their role in delivering service outcomes and are empowered to consider their decisions and actions from a customer service perspective.
– **Objective 5, Growing Maintenance Maturity:** The maturing knowledge and understanding of our assets supports effective application of our condition and risk-based maintenance approach.
– **Objective 6, Project Delivery:** Our project delivery capability and capacity enable us to consistently meet the expectations and timeframes of our stakeholders.
– **Objective 7, Balanced Growth:** Our city retains its unique balance of heritage, urban, rural, natural character, amenity, lifestyle and physical assets while accommodating growth.
– **Objective 8, Economic Prosperity:** Our infrastructure and asset management practices support and enable the economic prosperity of our City.

1.5 Aquatic centre service delivery program

To meet these objectives, assets are rated in terms of risk and criticality. Criticality assists lifecycle management decision making by defining which assets are most important to the service delivery program. To inform the MCC's service delivery needs, this AM Plan provides:

– Details of the community expectations (where available) and legislative/regulatory requirements
– A discussion on the asset management implications from the growth of the Maitland region
– Lifecycle management strategy recommendations (capital rehabilitation, replacement projects and/or maintenance works) commensurate with asset data available
– Indications of long-term sustainable funding amounts for maintaining adequate services

1.6 Asset management data model

All asset management data reporting in this AM Plan is documented in an excel based Asset Management Planning data model, provided separately to this AM Plan. The logic in this model is based on lifecycle processes, asset condition data and assumptions documented in this AM Plan.

2. Levels of service

2.1 Introduction

One of the basic cornerstones of sound asset management is to provide the level of service that current and future communities want and are prepared to pay for. To achieve this, MCC needs to plan for the provision of desired service levels, for a sustainable cost, over the life span of its assets. Establishing levels of service requires knowledge of customers and stakeholders, and an understanding of their expectations and requirements in terms of aquatic facilities and services.

This section of the AM Plan covers the following:

– Customer research and expectations
– Strategic and corporate goals relevant to levels of service
– Legislative requirements
– Current Levels of Service
– Desired (Target) Levels of Service

2.2 Customer research and expectations

Understanding of customer's expectations is a key input into levels of service and prioritising works across multiple asset types. This understanding will be balanced against legislative requirements and the customers' ability/willingness to pay.

The specific community levels of service expectations are captured in the current Community Strategic Plan. The following table summarises the typical customer expectations that are considered in determining the level of service.

Table 2.1 Typical customer expectations for Aquatic Centre Management

Community LOS	Community expectation
Safety	Facility providers take safety seriously with measures in place to provide safe services.
Quality	Appropriate comfort for patrons within the venue (seating, landscaping, change rooms, clean water, ventilation systems etc) including provision of water quality monitoring and control, water quality testing and treatment.
Quantity	Aquatic facilities are suitable for the functions for which they are required, have sufficient capacity to serve the community and are safe, accessible and aesthetically attractive.
Reliability	Aquatic facilities function as specified and advertised. Any withdrawal of service, aquatic facility closure or shutdown is well communicated. Facility maintenance and repairs are proactively completed to not interrupt service.
Cost Efficiency	Life cycle costs are managed effectively and efficiently to deliver services within known budget constraints.
Legislative Compliance	Compliance with all applicable legislation, particularly water quality.
Sustainability	Long term plans are prepared and implemented to ensure facilities and services are delivered for future generations. Facilities operate in a way that minimises impact to the environment.

2.3 Asset Management Challenges

Within these and other strategic themes of the Community Strategic Plan are a number of challenges that must be confronted in order to achieve the desired community outcomes. These challenges, consistent with the Asset Management Strategy, are summarised as follows and influence outcomes of this AM Plan.

- **Growing and changing demand:** MCC is facing a significant population growth over the coming decades, with an estimated cumulative population growth of 35% over the next 20 years.
- **Aging infrastructure:** Many of MCC's existing assets are approaching the end of the expected lives. As such, their physical condition has deteriorated and will continue to deteriorate at an accelerated pace in the coming years.
- **Legislative Landscape:** The current legislative environment emphasises a need for local government to recognise the equitable recovery of costs from owning and operating infrastructure over the full lifecycle of assets.
- **Heritage Assets:** MCC has a significant number of heritage buildings and infrastructure dating from the early 1800's which present additional challenges and costs for the preservation and maintenance of our unique past.
- **Preserving and restoring natural assets:** The natural environment and unique character of the Hunter River floodplain are an important part of the Maitland's appeal to residents and visitors. In dealing with population growth and urban expansion it is essential that we not only preserve but increase our areas of natural vegetation and green open space.
- **Resilience and sustainability:** While the natural and riverine assets of our city are among its most appealing attributes, they bring with them risks including potential vulnerability to bushfires and floods. Our asset management decision making must be cognizant of these risks and seek to improve the resilience of our flood facilities and infrastructure in a sustainable way.
- **Improving delivery capability:** Across both our capital project and maintenance service delivery processes we have the opportunity to significantly improve our asset information, tools, business processes and skills, and in doing so increase our productivity, efficiency and the value for money of our services.

2.4 Legislative requirements

MCC has to meet many legislative requirements including Australian and State legislation and State regulations in day to day service delivery tasks. For aquatic centres these include:

Table 2.2 Legislative requirements

Legislation	Objective / Intent
NSW Local Government Act	Sets out roles, purpose, responsibilities and powers of local governments including the preparation of a long term financial plans supported by asset management plans for sustainable service delivery
NSW Department of Local Government Water Safety Guidelines	Set outs facility operational standards & equipment, lifesaving practices, law enforcement powers
NSW Public Health Act & Regulations	Stipulates public health risks such as: – Prevention, mitigation and eradication – Closure of public swimming pool requirements – Disinfection, cleanliness, inspection and testing requirements
NSW Health Department Guidelines Public Swimming Pool and Spa Advisory Document	Defines: – Chemical criteria – Chemical testing – Microbiological criteria and sampling
National Occupational Health & Safety Regulations & Guidelines	Stipulates: – OHS skills, training and licensing – Safe usage of plant and equipment, workplace injury and disease prevention, storage and handling of dangerous goods and hazardous substances – Noise management
National Construction Code	Sets the minimum required level for the safety, health, amenity, accessibility and sustainability of certain building types
Disability Discrimination Act 1992	To ensure that the persons with disabilities have the same rights as the rest of the community
Heritage Act 1977	Protection of historic buildings, structures and precincts
Electricity Act 2004	Electricity safety provisions in NSW
Hunter Water Act 1991	Provision of water, sewerage and drainage services in the Hunter region by the Hunter Water Board

2.5 Common levels of services - assets

Aquatic centres consist predominantly of pool, building, water treatment, site services and site work assets. Levels of Service definitions for these assets are defined as follows.

2.5.1 Swimming pools and buildings

Common levels of service have been set at a facility level consistent with the levels of service criteria applied within the Buildings AM Plan. These levels of service are defined in the table below, which in turn set required condition expectations of assets within the facility.

Based on these criteria, MCC have confirmed that the Maitland Aquatic Centre is to be defined as a “**Category A – Superior**” facility and East Maitland Aquatic Centre defined as a “**Category B – Above Average”** facility.

These levels of service expectations will be considered in capital and maintenance priorities/expenditure particularly for assets with the aquatic centre facilities such as buildings, building services, pools, water playgrounds and site assets such as concourses, footpaths and shade structures.

Table 2.3 Facility wide levels of service categories

Category	Description	Service / Condition
A - Superior	– High profile facility with local or regional significance and high public interface/services – Very important to core Council operations – National or State heritage status – Specialist maintenance requirements – Generates revenue	– Building to be in the best possible condition – Minimal deterioration only
B - Above Average	– Very important to core Council operations – Facilities with high public interface/services – Require good public presentation – State heritage status – Generates revenue	– Building to be in a good condition to meet functional/operational requirements
C - Average	– Important to core Council operations/services – Facilities with some public interface/services – Local heritage status	– Building to be in a reasonable condition whilst still meeting service requirements
D - Basic	– Not important to core Council operations/services – Facilities where basic functional performance is acceptable	– Building to meet minimum operation/functional requirements
E - Dispose	– Building is non-operational, dormant or pending disposal/demolition	– Not fit for public or operational use

2.5.2 Water treatment

All water treatment assets such as pumps, tanks, filtration systems, dosing and control equipment must be always compliant with required water quality treatment standards, and/or the standards applicable at the time of construction.

2.5.3 Function-based levels of service

Assets with a relatively simplistic function within this asset class have levels of service defined as either “Functional” or “Not Functional”, meaning the asset in its current state does or does not achieve the original design intent of the asset. Achieving this design intent, or not, is based on one of the core failure modes defined in Section 4.5 of this plan (capacity, condition – including safety, financial efficiency, reliability).

Assets within this asset class where this level of service philosophy applies include:

- Site service supply such as power, water, gas and communications
- Stormwater assets
- External lighting
- Security systems
- Fire systems

2.6 Levels of service - performance

MCC has defined levels of service based on the performance of the facilities in the following ways. These are also articulated in the Aquatic Centres respective operations Manuals.

Table 2.4 Service criteria

Service Criteria	Technical measures may relate to	Performance Target
Safety	Number of injuries or accidents	Zero incidents and accidents
Availability	General opening times	**<u>Sept/Oct and March/April</u>** Mon – Fri: 6:00 am to 6:00 pm Sat: 7:00 am to 4:00 pm Sun: 8:00 am to 4:00 pm **<u>Nov to Feb</u>** Mon – Thu: 6:00 am to 7:00 pm Fri: 6:00 am to 6:00 pm Sat: 7:00 am to 6:00 pm Sun: 8:00 am to 6:00 pm
	Capacity – number of people allowed in the facility/pool to safely deliver services.	As per current Operations Manuals
	Lane availability	As per current Operations Manuals
Water Quality (Frequency and results of tests to meet compliance requirements)	Water quality targets	As per current Operations Manuals
	Water turnover (NSW Health Department Guidelines)	As per current Operations Manuals
	Microbiological criteria: – Heterotrophic plate count (HPC) – Escherichia coli (E. coli) – Pseudomonas aeruginosa	As per current Operations Manuals

Note: The Performance Targets for the current levels of service listed in Table 2.4 will require revision and development in subsequent versions of this AM Plan.

2.7 Target levels of service

To assist in prioritizing asset management activities over the spectrum of MCC's aquatic centre assets, the following target level of services categories have been defined by MCC and applied to the asset hierarchy. Target condition ratings have also been allocated, in accordance with MCC's condition assessment process (with "1" being excellent condition and "5" being unserviceable).

These allocations were defined and agreed with applicable Council staff and managers.

Level 2	Level 3	Level 4	Target Level of Service	Target Condition
Maitland Aquatic Centre	Swimming Pools	Olympic Pool	A - Superior	2 - Minor maintenance
		Learners Program Pool	A – Superior	2 - Minor maintenance
		25 m Indoor Pool	A – Superior	2 - Minor maintenance
		Water Playground	A – Superior	2 - Minor maintenance
	Water Treatment	Pumps, tanks, filtration system, dosing equipment etc.	Compliance / Functional	2 - Minor maintenance

Level 2	Level 3	Level 4	Target Level of Service	Target Condition
	Water Treatment – 25 m Indoor Pool	Pumps, tanks, filtration system, dosing equipment etc.	Compliance / Functional	2 - Minor maintenance
	Buildings	Plant room	A – Superior	3 - Significant maintenance
		Grandstand	A – Superior	3 - Significant maintenance
		Amenities, Office, Kiosk	A – Superior	2 - Minor maintenance
		25 m Indoor Pool Building	A – Superior	2 - Minor maintenance
	Site Services	Supply (power, water, gas, comms)	Compliance / Functional	3 - Significant maintenance
		Stormwater	Compliance / Functional	3 - Significant maintenance
		Lighting (external)	Compliance / Functional	3 - Significant maintenance
		Security	Compliance / Functional	2 - Minor maintenance
		Fire System	Compliance / Functional	2 - Minor maintenance
	Shade Structures		A – Superior	4 - Significant renewal/upgrade
	Picnic Shelters and Tables		A – Superior	3 - Significant maintenance
	Site Works	Concourse and Footpaths	A – Superior	2 - Minor maintenance
		Seating	A – Superior	3 - Significant maintenance
		Bin Enclosures	A – Superior	4 - Significant renewal/upgrade
		Fencing	A – Superior	3 - Significant maintenance
		Landscaping	A – Superior	2 - Minor maintenance
East Maitland Aquatic Centre	Swimming Pools	Olympic Pool	B – Above Average	3 - Significant maintenance
		Toddlers Pool	B – Above Average	3 - Significant maintenance
	Water Treatment - Olympic	Pumps, tanks, filtration system, dosing equipment etc.	Compliance / Functional	2 - Minor maintenance
	Water Treatment - Toddlers	Pumps, tanks, filtration system, dosing equipment etc.	Compliance / Functional	2 - Minor maintenance
	Buildings	Plant Room # 1	B – Above Average	4 - Significant renewal/upgrade
		Plant Room # 2	B – Above Average	4 - Significant renewal/upgrade
		Storage Shed # 1	B – Above Average	4 - Significant renewal/upgrade

Level 2	Level 3	Level 4	Target Level of Service	Target Condition
		Storage Shed #2	B – Above Average	4 - Significant renewal/upgrade
		Grandstand	B – Above Average	4 - Significant renewal/upgrade
		Clubroom, Amenities, Office, Kiosk	B – Above Average	4 - Significant renewal/upgrade
	Site Services	Supply (power, water, gas, comms)	Compliance / Functional	4 - Significant renewal/upgrade
		Stormwater	Compliance / Functional	4 - Significant renewal/upgrade
		Lighting (external)	Compliance / Functional	4 - Significant renewal/upgrade
		Security	Compliance / Functional	2 - Minor maintenance
		Fire System	Compliance / Functional	2 - Minor maintenance
	Shade Structures		B – Above Average	4 - Significant renewal/upgrade
	Picnic Shelters and Tables		B – Above Average	4 - Significant renewal/upgrade
	Site Works	Concourse and Footpaths	B – Above Average	2 - Minor maintenance
		Seating	B – Above Average	3 - Significant maintenance
		Bin Enclosures	B – Above Average	4 - Significant renewal/upgrade
		Fencing	B – Above Average	3 - Significant maintenance
		Landscaping	B – Above Average	4 - Significant renewal/upgrade
		Car Park	B – Above Average	4 - Significant renewal/upgrade

2.8 Asset condition

In understanding levels of service as well as asset performance, MCC use a 1 to 5 condition rating scale (1 = excellent condition, 5 = poor condition) to set target levels of service, manage asset condition against this target as well as inform risk assessments in probability of failure estimates (discussed in section 4.6). These condition targets not only represent expected asset condition, but also the type and level of maintenance strategy to be applied.

Understanding the application of these conditional ratings as defined in this AM Plan can be complex and are primarily for the use of MCC's asset professionals to inform decision making. The following table aims to articulate how asset condition ratings/targeted are interpreted.

Table 2.5 Asset condition explained

Condition Rating	Maintenance Strategy	Maintenance Principles and Intervention level
1	Predictive Maintenance (Proactive)	– Proactive maintenance approach that uses condition monitoring and high frequency inspections during operation to detect possible failures and fixes them before it fails. – Higher cost of maintenance – Low level of failures or defects and complaints expected from the community – High frequency of inspections, condition monitoring and planned preventative maintenance – Only tolerate normal preventative and planned maintenance interventions – Maitland Park, Art Gallery, No.1 Sportsground, Arterial Road
2	Preventative / Planned Maintenance	– Type of proactive maintenance that keeps assets in good working order and reduces the need for major repairs – Aims to limit failures to minor corrective maintenance levels only before intervention – Lower cost than predictive maintenance – Reduces high consequence failures – Frequency of inspections lower than predictive, including monitoring condition and intervening when failures are still minor in nature (eg potholes) – Assets remain safe but we will tolerate a time frame to allow a defect to be repaired – Distributor Roads, Library, Road and Pedestrian bridges
3 and 4	Corrective Maintenance	– Maintenance is carried out following a detection of a failure or defect. This is where we make conscious decisions to allow ‘safe’ failures to occur and the cost for downtime and repair is known to be lower than a preventative or predictive maintenance program – Lower cost than preventative maintenance – Assessment made to let fail then fix within a nominated time frame – Condition rating 3 - tolerate some major corrective maintenance before intervening – Condition rating 4 – intentionally delay intervention to a point where major corrective maintenance needs to occur – Plant and Equipment, Local roads, non critical drainage assets
5	Run to Failure (Breakdown Maintenance)	– Simplest maintenance strategy where assets are allowed to operate until they essential break or fail to operate as designed – Asset receives little to no maintenance until failure or unsafe – Strategy used mostly where asset failure has low safety or financial consequence – Lowest cost intervention – Other than basic maintenance like cleaning and visual inspection, nothing is done until the asset is not functional – Bike racks, streetlights, garbage bins

2.9 Known service deficiencies

Both Maitland and East Maitland Aquatic Centres, whilst functional and in acceptable condition, are aging assets. With the exception of the new 25 m indoor pool (and associated works) constructed in 2018 at the Maitland Aquatic Centre, many of the aquatic centre assets require additional maintenance effort to sustain the facilities at the agreed service level targets. At this point in time, it is recognised by MCC that current maintenance effort is acceptable, however, to mitigate the risk of service deficiencies affecting long term future performance of the Aquatic Centres maintenance effort and expenditure will need to increase.

In addition to this increased maintenance effort, additional capital upgrades will be required to key elements of the centres over the medium term (more than 10 years), such as pool and building structures due to asset age and condition. Water treatment elements will also require upgrades to remain compliant with current water turnover/treatment standards. Whilst water treatment processes comply with the standards they were originally designed and constructed to, these have changed over time and will eventually require upgrading.

Estimates of these capital upgrades (based on age) are included in the long term financial summary of this AM Plan.

3. Future demand

3.1 Introduction

Future demand is a measure of how much customers will consume the services provided by the assets as well as additional (new) assets required to meet predicted population growth. Understanding and predicting demands enable asset managers to plan and identify the best way to meet future conditions.

MCC are currently in a period of extraordinary population growth, with 2020/21 growth rates estimated by the Australian Bureau of Statistics of 3.5% - a rate that is estimated as being maintained for the next five to ten years. This growth will see Maitland's population grow to more than 104,700 by 2041. This growth rate is the fifth highest in NSW and the highest outside of Greater Sydney. To house this continued growing population, the majority (>90%) are expected to live in new greenfield developments, all of which require new MCC owned and operated assets. New greenfield developments have conservatively been estimated at around 700 new lots per year for the next 10 years.

In addition to new assets, this growth will place a greater demand on parts of the existing asset base, potentially requiring additional (or different) maintenance strategies to be applied.

3.2 Demand forecasts

Whilst this growth directly impacts some asset classes through, for example, the need to construct additional roads and drainage infrastructure, there are no direct capital investment impacts to the Maitland and East Maitland Aquatic Centres. The construction and commissioning of the new 25 m indoor pool at the Maitland Aquatic Centre in 2018 has assisted in providing additional aquatic services to the growing community.

It is likely that this growing population will increase patronage and usage of MCC's Aquatic Centres. This increased usage will need to be considered in ongoing operations and maintenance strategies at the facilities to ensure both Aquatic Centres can continue to meet service demand.

3.3 Demand drivers

Factors affecting demand include population change, changes in demographics, consumer preference regional tourism, technology changes, operational efficiency, education initiatives and economics. Multiple interconnected factors will continue to influence demand for assets that support the Aquatic Centres. These drivers (outlined below) are continually monitored by MCC with ongoing maintenance of Aquatic Centres adjusted accordingly.

Table 3.1 Demand drivers

Factor	Discussion
Consumer Preference	Consumer preference is linked to user attitudes and behaviours, which can influence demand. Understanding consumer preference is critical to understanding the potential for which demand management techniques can be used to influence consumers and subsequently control future demand. Consumer preferences are input into the development of services and programs offered at the Aquatic Centres including: – Fitness programs – Learn to swim – Carnivals – Membership options – Entry fees and passes.
Legislation and Policy	Refer to Section 2.4 for the legislative requirements including Australian and State legislation and State regulations applicable to MCC Aquatic Centres. Legislation and policy changes can have far reaching impacts to demand. For example, water treatment and turnover standards have changed over time. Whilst current water treatment processes and assets are compliant to originally design and constructed

Factor	Discussion
	standards, these standards have changed, eventually necessitating a capital upgrade to water treatment assets.
Technology Changes	Technology changes increasing efficiency and sustainability can result in the obsolescence or substitution of some assets. These technology changes will be developed and implemented in alignment with MCC's corporate and asset-specific sustainability programs and targets. The following future technologies are currently under consideration for Aquatic Centres: **Pool heating** More efficient or cheaper heating technology and techniques to replace or augment the existing solar heating systems, potentially enabling year-round centre operation. **Material/repair methods** New materials and methods to deliver cheaper, more efficient and more effective asset repair and renewal solutions. **Water quality management** Fully automated and more accurate chemical treatment and testing technology to facilitate better control of water quality, reduce chemical usage, improve data collection and reduce wear on plant infrastructure and subsequent maintenance costs.
Economics and Competition	MCC aquatic centres are user-pay facilities. The balance of meeting customer preferences at a sustainable cost to the City and the user must drive operational decision making, particularly with the likely increased usage due to population growth. With newer, contemporary facilities becoming available in surrounding LGA's, sustainable revenue streams need to be identified.
Operational Efficiency	Business improvement initiatives such as performance monitoring, risk management and process improvements can be expected to improve effectiveness and efficiency in meeting asset demand.

3.4 Demand management

Consideration of the future growth and impact on services drives the planning and demand management strategies. Strategies to be implemented in this current cycle of asset management planning include resource management and maintenance. Consistent with the tactics included in the Asset Management Strategy, maintenance tactics will be applied as defined in the Lifecycle Management section of this AM Plan.

It is anticipated that resourcing, operations and maintenance requirements will be consistent with historic levels at both Aquatic Centres.

4. Lifecycle Management

4.1 Introduction

This section defines assets owned (including future new assets from growth) and broad plans required to manage and operate the assets at the agreed levels of service (defined in Section 2) while optimising life cycle costs. This section includes:

- Asset Details and Age Profiles
- Maintenance and Renewal Planning
- Asset Lifecycle Activities and Cost Data
- Asset Failure Modes and Consumption Estimates
- Asset Risk Data and Risk Exposure Estimates
- Lifecycle Management Plans

Lifecycle management strategies and tactics, consistent with MCC's AM Strategy are also highlighted throughout this section.

4.2 Background data

4.2.1 Asset hierarchy

Asset information is needed to support decision making. The asset hierarchy provides the framework for segmenting MCC's Aquatic Centres into appropriate classifications to assist with lifecycle planning and management. The asset hierarchy used for this AM Plan is shown below. This hierarchy is "rolled down" to additional levels in supporting data.

Table 4.1 Asset hierarchy

Level 2	Level 3	Level 4	Level 5
Maitland Aquatic Centre	Swimming Pools	50 m	Concrete Shell / Lining / Surround / Finishes / Fittings and Equipment / Services
		Learners/Program Pool	Concrete Shell / Surround / Finishes / Fittings and Equipment / Services
		Waders Pool	Concrete Shell / Surround / Finishes / Fittings and Equipment / Services
		25 m Indoor Pool	Concrete Shell / Surround / Finishes / Fittings and Equipment / Services
		Water Playground	Substructure / Surround / Finishes / Fittings and Equipment
	Water Treatment	Pumps	Circulation Pump / Water Play Equipment Pump / Dosing Pump / Acid Pump / Submersible Pump / Solar Pump
		Tanks	Balance Tank / Holding Tank
		Filters	Filter Beds
		Dosing Equipment	Becks Auto Controller / CO2 feed / Cylinders/Vessels
		Control Equipment	
		Testing Sensors	Ph Probe / Chlorine probe / Solar sensors
		Pipes (cast iron)	
		Solar heating	Solar panels

Level 2	Level 3	Level 4	Level 5
	Water Treatment – 25 m Indoor Pool	Pumps	Circulation Pump / Water Play Equipment Pump / Dosing Pump / Acid Pump / Submersible Pump / Solar Pump
		Tanks	Balance Tank / Holding Tank
		Filters	Filter Beds
		Dosing Equipment	Becks Auto Controller / CO2 feed / Cylinders/Vessels
		Control Equipment	
		Testing Sensors	Ph Probe / Chlorine probe / Solar sensors
		Pipes (cast iron)	
		Solar heating	Solar panels
	Site Services	Supply (power, water, gas, comms)	
		Stormwater	
		Lighting (external)	
		Security	
		Fire System	
	Buildings	Plant Room	Substructure / Superstructure / Finishes / Fittings / Services
		Grandstand	Substructure / Superstructure / Finishes / Fittings / Services
		Amenities, Office and Kiosk	Substructure / Superstructure / Finishes / Fittings / Services
			Main Entry / Change Rooms / Store Rooms / Kitchen / Meeting Rooms and Offices / First Aid Room
		25 m Indoor Pool Building	
	Shade Structures	Shade Structure 1 - 7	
	Picnic Shelters and Tables	Picnic Shelter 1 – 3	
		Picnic Table 1 and 2	
	Site Works	Safety equipment	
		Concourse and footpaths	
		Seating	
		Waste Disposal	
		Lighting	
		Fencing	
		Landscaping	
East Maitland Aquatic Centre	Swimming Pools	50 m 6 lane	Concrete Shell / Surround / Finishes / Fittings and Equipment / Services
		Toddlers Pool	Concrete Shell / Surround / Finishes / Fittings and Equipment / Services
	Water Treatment	Olympic Pool	Pumps
			Tanks
			Filters
			Dosing Equipment
			Control Equipment
			Testing Sensors
			Pipes (cast iron)
			Solar heating

Level 2	Level 3	Level 4	Level 5
		Toddlers Pool	Pumps
			Tanks
			Filters
			Dosing Equipment
			Control Equipment
			Testing Sensors
			Pipes (PVC)
	Site Services	Supply (power, water, gas, comms)	
		Stormwater	
		Lighting (external)	
		Security	
		Fire System	
	Buildings		
		Plant Room #1 Olympic Pool	Substructure / Superstructure / Finishes / Fittings / Services
		Plant Room #2 Toddlers Pool	Substructure / Superstructure / Finishes / Fittings / Services
		Storage Shed #1	Substructure / Superstructure / Finishes / Fittings / Services
		Storage Shed #2	Substructure / Superstructure / Finishes / Fittings / Services
		Grandstand	Substructure / Superstructure / Finishes / Fittings / Services
		Clubroom	Substructure / Superstructure / Finishes / Fittings / Services
		Amenities, Office and Kiosk	Substructure / Superstructure / Finishes / Fittings / Services
			Main Entry / Change Rooms / Storerooms / Kitchen / Meeting Rooms and Offices / First Aid Room
	Shade Structures	Shade Structure 1 - 3	
		Awning 1 and 2	
	Picnic Shelters and Tables	Picnic Shelters 1 - 11	
	Site Works	Safety equipment	
		Concourse and footpaths	
		Waste Disposal	
		Lighting	
		Fencing	
		Landscaping	
		Car Park	Base / Surface / Kerb and Gutter / Signs / Line Marking

4.2.2 Asset information targets

At an appropriate level of the hierarchy, asset information and targets are assigned. This assists in deriving the Maximum Potential Life of an asset and the subsequent Effective Remaining Life. The Maximum Potential Life (MPL) is the time from installation to replacement, with typical maintenance and refurbishment activities taking place during this time frame.

Within the asset hierarchy, the following is allocated in addition to MPL:

- Target level of service (LOS) as defined in Section 2.6.
- Target condition (between "1 and 5" as defined in Section 2.6 and 4.5).
- Consequence of failure (CoF) (between "C1 and C5" as defined in Section 4.6.3 Table 4.12).

MPL, level of service, condition and consequence of failure figures assigned to assets are aligned to industry experience and are agreed/confirmed with MCC staff and managers. Where required, MCC staff have provided judgement (or exception) figures that override these targets. These are summarised in the following table:

Table 4.2 Asset lifecycle information

Level 2	Level 3	Level 4	MPL (years)	Target Level of Service	Target Condition	CoF Rating
Maitland Aquatic Centre	Swimming Pools	50 m 8 lane	50	A - Superior	2 - Minor maintenance	5
		Learners Program Pool	50	A – Superior	2 - Minor maintenance	5
		25 m Indoor Pool	50	A – Superior	2 - Minor maintenance	5
		Water Playground	50	A – Superior	2 - Minor maintenance	2
	Water Treatment	Pumps, tanks, filtration system, dosing equipment etc.	20	Compliance / Functional	2 - Minor maintenance	4
	Water Treatment – 25 m Indoor Pool	Pumps, tanks, filtration system, dosing equipment etc.	20	Compliance / Functional	2 - Minor maintenance	4
	Buildings	Plant room	60	A – Superior	3 - Significant maintenance	4
		Grandstand	60	A – Superior	3 - Significant maintenance	3
		Amenities, Office, Kiosk	60	A – Superior	2 - Minor maintenance	4
		25 m Indoor Pool Building	60	A – Superior	2 - Minor maintenance	4
	Site Services	Supply (power, water, gas, comms)	30	Compliance / Functional	3 - Significant maintenance	4
		Stormwater	50	Compliance / Functional	3 - Significant maintenance	3
		Lighting (external)	20	Compliance / Functional	3 - Significant maintenance	3
		Security	20	Compliance / Functional	2 - Minor maintenance	4
		Fire System	20	Compliance / Functional	2 - Minor maintenance	4
	Shade Structures		20	A – Superior	4 - Significant renewal/upgrade	2

Level 2	Level 3	Level 4	MPL (years)	Target Level of Service	Target Condition	CoF Rating
	Picnic Shelters and Tables		50	A – Superior	3 - Significant maintenance	2
	Site Works	Concourse and Footpaths	30	A – Superior	2 - Minor maintenance	4
		Seating	30	A – Superior	3 - Significant maintenance	2
		Bin Enclosures	30	A – Superior	4 - Significant renewal/upgrade	1
		Fencing	30	A – Superior	3 - Significant maintenance	4
		Landscaping	100	A – Superior	2 - Minor maintenance	2
East Maitland Aquatic Centre	Swimming Pools	50 m 6 lane	50	B – Above Average	3 - Significant maintenance	4
		Toddlers Pool	50	B – Above Average	3 - Significant maintenance	4
	Water Treatment - Olympic	Pumps, tanks, filtration system, dosing equipment etc.	20	Compliance / Functional	2 - Minor maintenance	4
	Water Treatment - Toddlers	Pumps, tanks, filtration system, dosing equipment etc.	20	Compliance / Functional	2 - Minor maintenance	4
	Buildings	Plant Room # 1	60	B – Above Average	4 - Significant renewal/upgrade	4
		Plant Room # 2	60	B – Above Average	4 - Significant renewal/upgrade	3
		Storage Shed # 1	60	B – Above Average	4 - Significant renewal/upgrade	2
		Storage Shed #2	60	B – Above Average	4 - Significant renewal/upgrade	2
		Grandstand	60	B – Above Average	4 - Significant renewal/upgrade	3
		Clubroom, Amenities, Office, Kiosk	60	B – Above Average	4 - Significant renewal/upgrade	3
	Site Services	Supply (power, water, gas, comms)	30	Compliance / Functional	4 - Significant renewal/upgrade	3
		Stormwater	30	Compliance / Functional	4 - Significant renewal/upgrade	3
		Lighting (external)	30	Compliance / Functional	4 - Significant renewal/upgrade	3
		Security	30	Compliance / Functional	2 - Minor maintenance	4
		Fire System	30	Compliance / Functional	2 - Minor maintenance	4
	Shade Structures		20	B – Above Average	4 - Significant renewal/upgrade	2
	Picnic Shelters and Tables		50	B – Above Average	4 - Significant renewal/upgrade	1

Level 2	Level 3	Level 4	MPL (years)	Target Level of Service	Target Condition	CoF Rating
	Site Works	Concourse and Footpaths	30	B – Above Average	2 - Minor maintenance	4
		Seating	30	B – Above Average	3 - Significant maintenance	2
		Bin Enclosures	30	B – Above Average	4 - Significant renewal/upgrade	1
		Fencing	30	B – Above Average	3 - Significant maintenance	4
		Landscaping	100	B – Above Average	4 - Significant renewal/upgrade	2
		Car Park	50	B – Above Average	4 - Significant renewal/upgrade	2

4.2.3 Maximum potential life

A consolidated summary of MPL estimates from MCC staff, as per the above table and consistent with the Buildings AM Plan, is in Table 4.3 below.

Table 4.3 Maximum potential life summary

Asset type	MPL (years)
Concrete shell (pool)	50
Surrounds (pool)	50
Substructure (buildings)	50
Superstructure	50
Finishes	25
Fittings/Equipment	20
Services	30
Internal Walls	50
Internal Floor Coverings	15
Water Treatment	20
Safety equipment	10
Site Works (landscaping)	100
Site works (other)	30

4.3 Asset profiles

4.3.1 Asset inventory and replacement costs

To focus need for investments, it is helpful to understand the number of assets and replacement value of assets against the hierarchy. The Aquatic Centres asset class has an estimated total replacement value (in 2022$) of approximately **$36.3 M** including:

– $24.7 M for Maitland Aquatic Centre

– $11.6 M for East Maitland Aquatic Centre

The breakdown of these replacement costs (in percentage and $) is illustrated in the following table and figures. Note that replacement values included in this AM Plan are based on the valuations completed by MCC in 2022 and other historical cost data (inflated to 2022 dollars).

Table 4.4 Asset inventory and replacement costs

Aquatic centre	Asset elements	% Cost total	$ Cost breakdown
Maitland Aquatic Centre	Buildings	26%	$9,545,387
	Picnic Shelters and Tables	<1%	$83,430
	Shade Structures	<1%	$150,000
	Site Services	3%	$1,035,000
	Site Works	2%	$740,000
	Swimming Pools	31%	$11,278,892
	Water Treatment	5%	$1,871,304
	Sub total	**68%**	**$24,704,013**
East Maitland Aquatic Centre	Buildings	5%	$1,696,700
	Picnic Shelters and Tables	<1%	$83,430
	Shade Structures	<1%	$52,530
	Site Services	1%	$447,000
	Site Works	4%	$1,469,500
	Swimming Pools	21%	$7,635,517
	Water Treatment	1%	$256,000
	Sub total	**32%**	**$11,640,677**
	Total	**100%**	**$36,344,690**

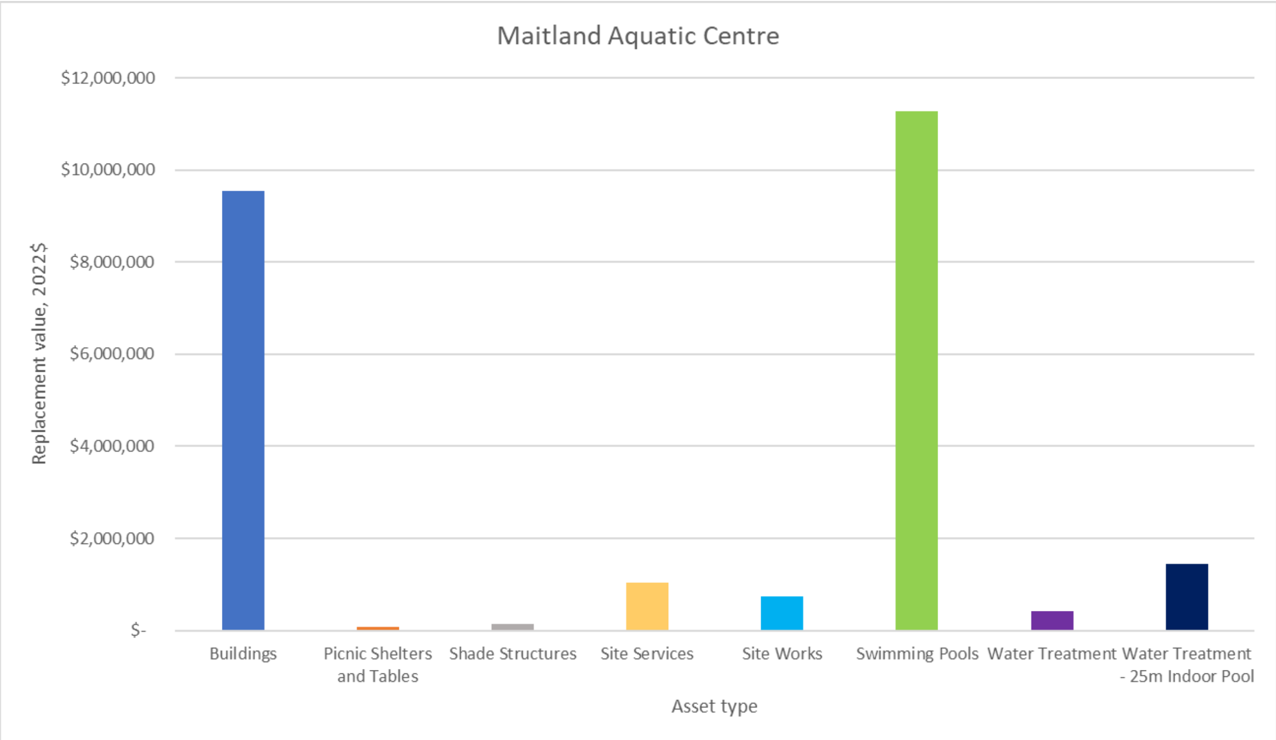

Figure 4.1 Replacement cost by asset type – Maitland Aquatic Centre

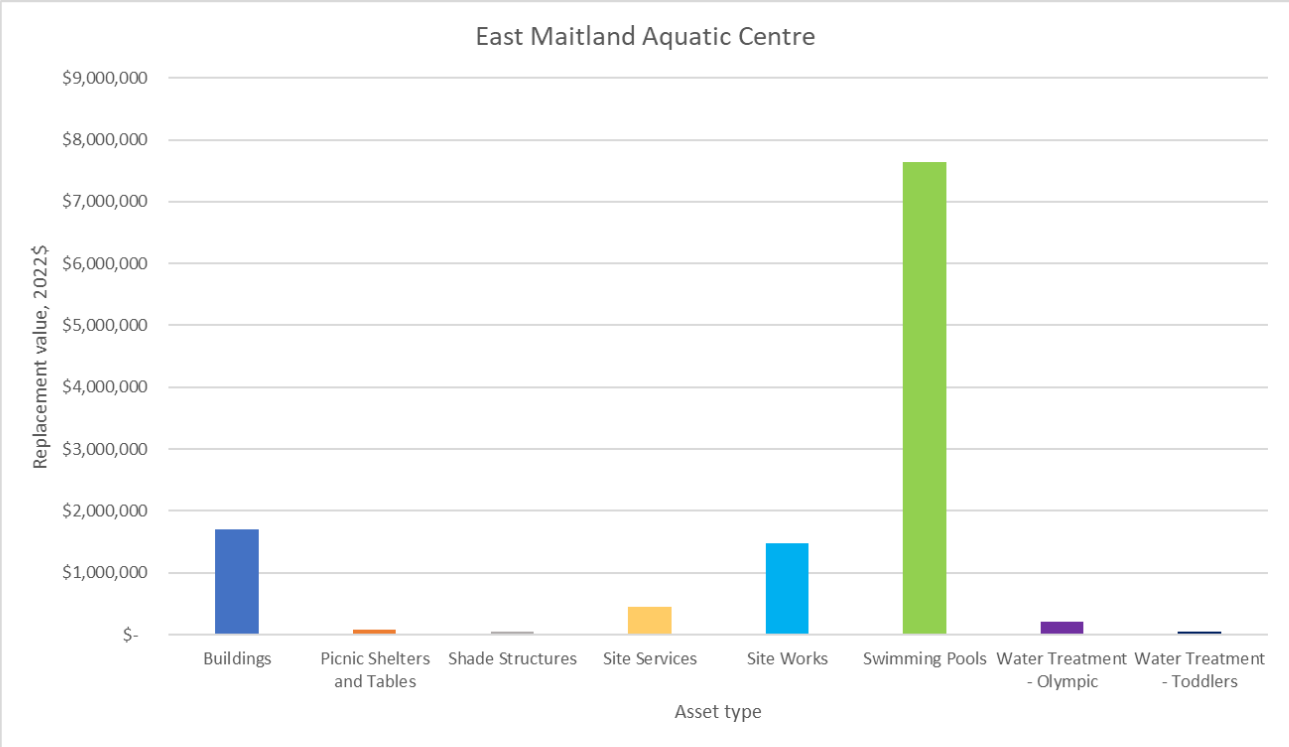

Figure 4.2 Replacement cost by asset type – East Maitland Aquatic Centre

4.3.2 Installation profile of assets

To assist MCC with asset management decision making, including future funding needs analysis, it is helpful to understand the installation profile of the asset portfolio. The following graphs show the replacement value of the assets by year of installation, in 2022 dollar value. This indicates that:

– There is limited data available, resulting in age data being reported at a high level.
– Major capital investments were completed in 1977, 1985 and 2018, with the most recent investment being the new 25 m indoor pool at Maitland Aquatic Centre.

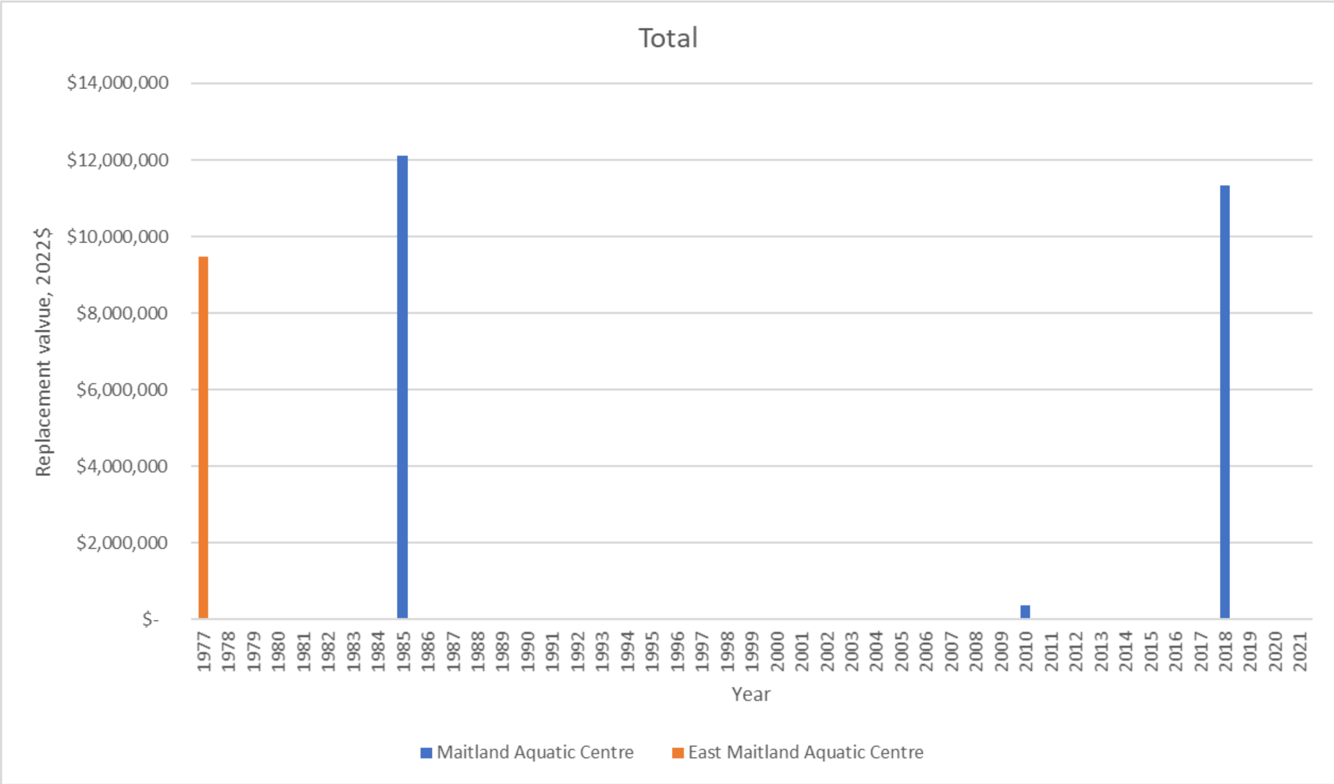

Figure 4.3 *Installation profile – Aquatic centres total*

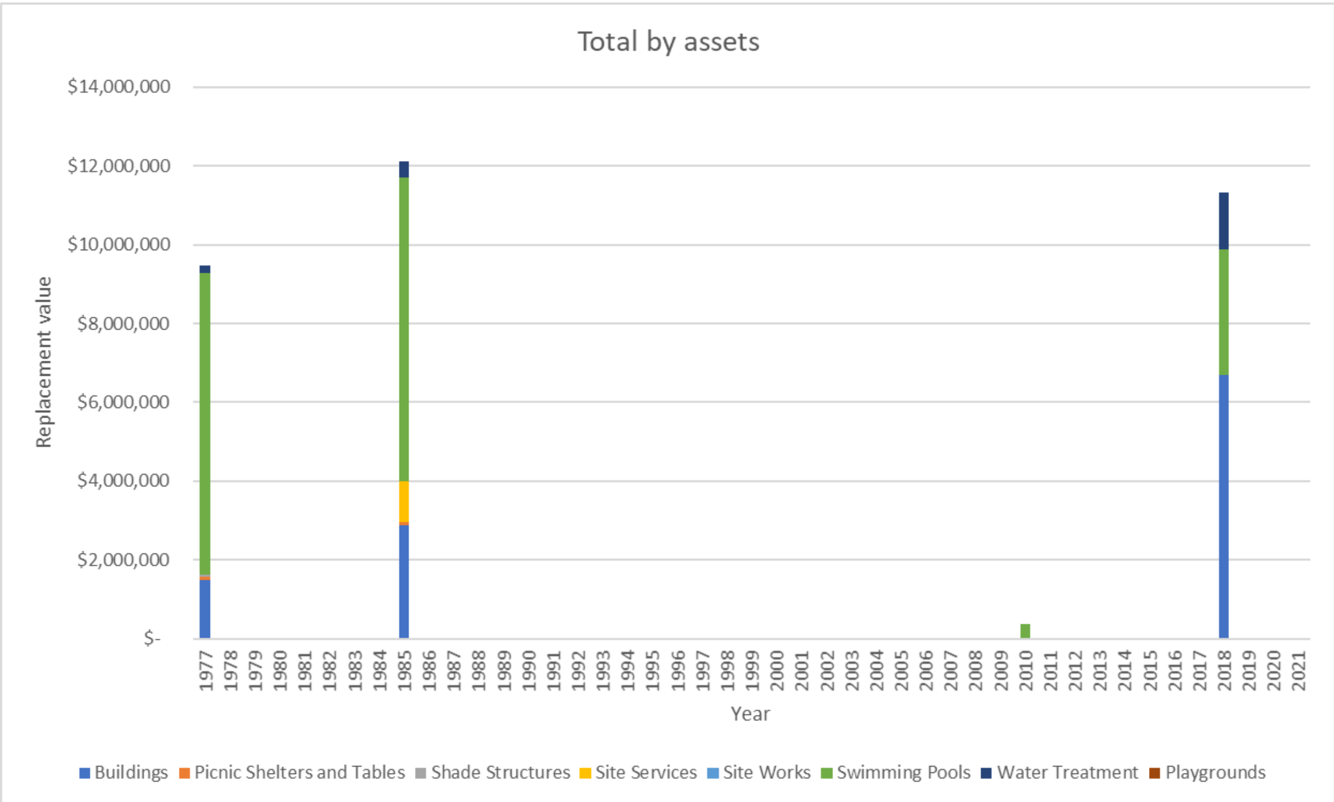

Figure 4.4 *Installation profile – Aquatic centres total by assets*

4.4 Asset lifecycle activities and cost data

Lifecycle activities can be categorized into the following main areas:

– ***Create or Acquire:*** Activities that provide new or donated/gifted assets that increase service potential, performance capability or capacity.
– ***Operate***: The active process of using an asset which may consume resources such as manpower, energy, chemicals, and materials.
– ***Maintain:*** Activities necessary to retain an asset as near as practicable in its original condition but excluding refurbishment / rehabilitation or replacement.
– ***Refurbish or Rehabilitate:*** Activities to sustain the original service potential or substantially extend the life of existing assets by replacing component systems or assemblies without increasing service potential, performance capability or capacity.
– ***Enhance:*** Activities that augment or upgrade existing assets to increase service potential, performance capability or capacity.
– ***Replace:*** Activities that replace existing assets with assets of equivalent service potential, performance capability or capacity.
– ***Dispose:*** Work that permanently removes assets from service.

The lifecycle activities and associated costs for the MCC owned roads and road furniture are further described in the following sections.

4.4.1 Maintenance expenditure/budgets

Estimated maintenance costs at MCC's aquatic centres for future financial years 2022 to 2032 are summarised in Table 4.5. These costs have been estimated by MCC based on historic maintenance expenditure and are consistent with MCC's long term financial plan, inclusive of 5% annual growth. This equates to an average annual maintenance expenditure for existing assets of $399k.

Table 4.5 Estimated future maintenance expenditure budgets

	FY 2022/23	FY 2023/24	FY 2024/25	FY 2025/26	FY 2026/27	FY 2027/28	FY 2028/29	FY 2029/30	FY 2030/31	FY 2031/32	TOTAL
East Maitland Aquatic Centre	$80,465	$84,488	$88,712	$93,148	$97,805	$102,696	$107,830	$113,222	$118,883	$124,827	**$1,088,709**
Maitland Aquatic Centre	$214,234	$224,945	$236,193	$248,002	$260,402	$273,422	$287,094	$301,448	$316,521	$332,347	**$2,898,639**
Total	$294,698	$309,433	$324,905	$341,150	$358,208	$376,118	$394,924	$414,670	$435,404	$457,174	**$3,987,348**

4.4.2 Maintenance and renewal planning

MCC currently carries out maintenance activities that are necessary to keep aquatic facilities and assets operating, including emergency maintenance for instances where portions of the asset may fail and detrimentally affect service and the safety of the facility users. Maintenance includes reactive, planned and cyclic maintenance work activities.

- ***Reactive maintenance*** is unplanned repair work carried out in response to service requests and management/supervisory directions.
- ***Planned maintenance*** activities include inspection, assessing the condition against failure/breakdown experience, prioritising, scheduling, actioning the work and reporting what was done to develop a maintenance history and improve maintenance and service delivery performance.
- ***Cyclic maintenance*** is replacement of higher value components/sub-components of assets that is undertaken on a regular cycle. This work generally falls below the capital/maintenance threshold.

4.4.3 Standards, procedures and specifications

Maintenance work on the Aquatic Centres is carried out in accordance with the following:

- Annual winter maintenance on pool closure (Planned Maintenance Schedules and MCC Aquatics Standard Operating Procedures (SOP's)).
- Emergency and Non- Emergency Repairs (Reactive Maintenance in Accordance with MCC Aquatics SOP's).
- Other cyclic maintenance carried out for refurbishment and repairs.

A summary of the Aquatic Centres Annual Winter Maintenance Activities is as follows.

Table 4.6 Aquatic centres annual winter maintenance task summary

Maintenance policy description	Item no.	Task description	
		Frequency	Tasks
Maitland – all pools	807	12 Monthly	Inspection, cleaning, operational & condition checks of pool equipment including valves, pump motors, tanks, paintwork and auxiliary equipment
		24 Months	Major Overhaul
East Maitland	1105	12 Monthly	Inspection, operational & condition checks of pool equipment including valves, motors, tanks, paintwork and auxiliary equipment
		24 Months	Major Overhaul

A list of MCC's of documented reactive maintenance and operating procedures for Aquatic Centres are included in Appendix B.

MCC's Pool Operation Manuals for the East Maitland and Maitland Aquatic Centres is included as Appendix D and Appendix D respectively.

NSW Health's "Public Swimming Pool and Spa Advisory Document" that defines the public health guidelines for the safe operation and treatment of public pools in NSW is also included for reference in Appendix C. This document provides guidelines on:

- Microbial health risks and transmission
- Microbiological criteria and sampling
- Disinfection criteria, sampling and monitoring
- Managing water quality
- Design, construction and maintenance of pool facilities
- Cryptosporidium risk management
- Operator competencies

– Health risk management planning
– Legislative requirements and enforcement

Additional guidelines on the safe management of public pools are detailed on NSW Health's website:

Public swimming pools and spa pools (nsw.gov.au)

4.4.4 Capital works

New works are those works that create a new asset that did not previously exist or works which upgrade or improve an existing asset beyond its existing capacity. They may result from growth, social or environmental needs.

As noted in Section 3, there are no new major capital works resulting from growth, however capital works to renew/replace aging assets are currently being planned in accordance with MCC's annual capital works program. This includes:

- For Maitland Aquatic Centre, upgrade of the buildings including new club rooms, amenities, change rooms and functional spaces (by 2025)
- For Maitland Aquatic Centre, updated master planning to inform longer term investments

4.5 Asset failure modes and consumption estimates

4.5.1 Failure modes

There are several different ways that an asset can fail to provide its required level of service. These are known as the failure modes of an asset. Each of these failure modes could have a different probability or consequence of failure. Most asset failures can be classified under one of the following four failure modes.

- **Utilisation (capacity):** The demand exceeds the capacity of the existing asset or network of assets, or vice versa in some cases (e.g. usage of a building maybe greater than design capacity due to population increase).
- **Physical (condition):** The condition of the asset (or one of its components) is such that it has reached the end of its effective life (e.g. failure of a pump bearing etc.).
- **Financial Efficiency (cost):** The asset is not being maintained at the lowest lifecycle cost, that is, the cost to execute the current maintenance strategies over time exceed that of the replacement cost.
- **Level of Service:** The asset no longer performs reliably, does not meet the agreed target level of service or does not meet mandatory regulatory requirements (e.g. pool water quality does not meet health targets).

Decisions about the refurbishment and replacement of an asset and the timing of these activities should be based on a sound determination of its predominant or critical failure mode (the failure mode with the highest consequence and probability of occurrence).

4.5.2 Remaining life and asset consumption

For assets within this AM Plan, remaining life and asset consumption was determined at an appropriate level in the hierarchy (based on available data) simply as follows:

- Install year + estimated MPL – current year (2022).
- Applying a ***remaining life factor*** (which is a reduction factor based on the asset condition rating and current level of service). A good condition correlates to a high residual life factor, and a poor condition correlates to a low residual life factor as illustrated below.

If the result of this method did not appear appropriate based on what is inherently known about the asset, a judgement regarding residual life was applied which overrides the above.

These elements are described as follows:

- ***Install Year:*** The year an asset was first installed or replaced.
- ***Estimated MPL:*** As per Section 4.2.3.
- ***Condition Rating:*** A condition rating was applied to each asset based on available condition data or judgment of MCC staff as per Section 2.8

The “remaining life factor” was applied based on combined performance rating of condition and level of service is as follows:

Table 4.7 Remaining life factor

Combined performance	Residual life factor
1	0.99
2	0.90
3	0.66
4	0.325
5	0.075

Based on the remaining life predictions, the consumption of each asset in the hierarchy has been calculated on a least remaining life basis. The Asset Consumption Distribution graphs shown in the following figures illustrate the value of assets that are new (0% consumed) through to assets that have reached their maximum potential life (100% consumed). These graphs provide a good indication of which assets are at the end or nearing the end of their life and require replacing or a significant maintenance intervention.

Level of Service Rating: A target level of service has been allocated for each asset. Historically, actual levels of service for assets have not been consistently or formally documented meaning level of service performance cannot be consistently defined at this stage. This will be addressed in future iterations of this AM Plan.

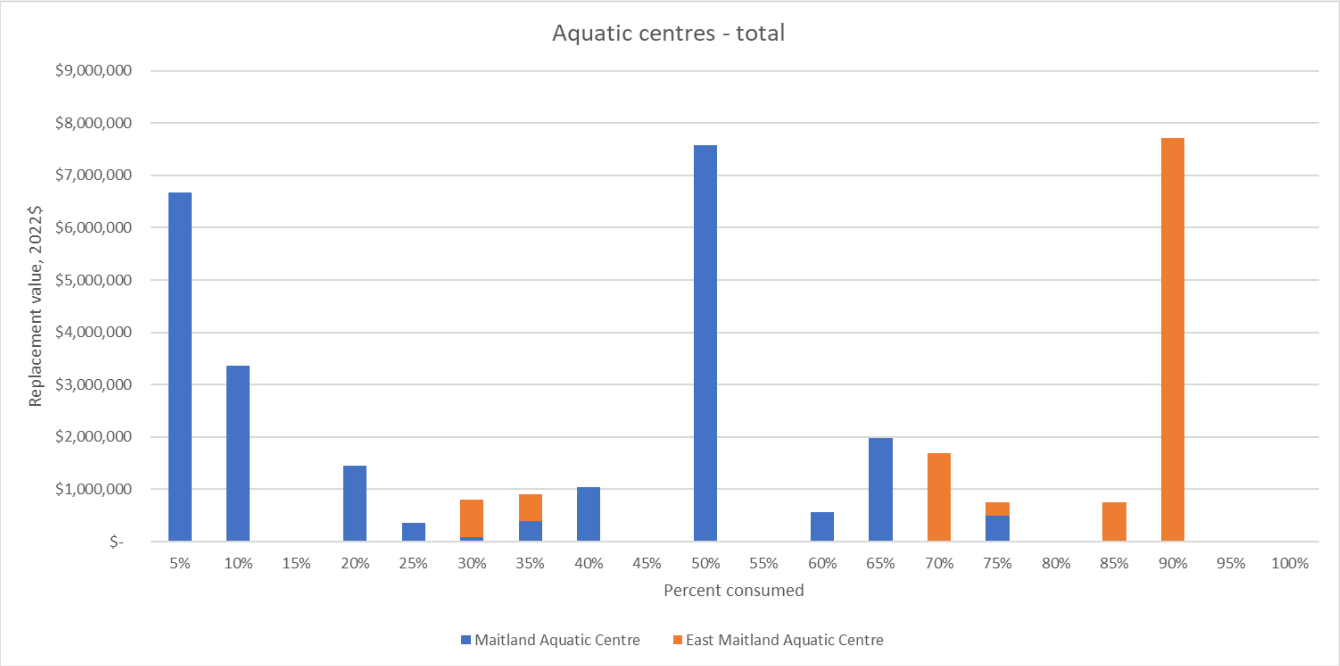

Figure 4.5 Asset consumption distribution: Aquatic centres total

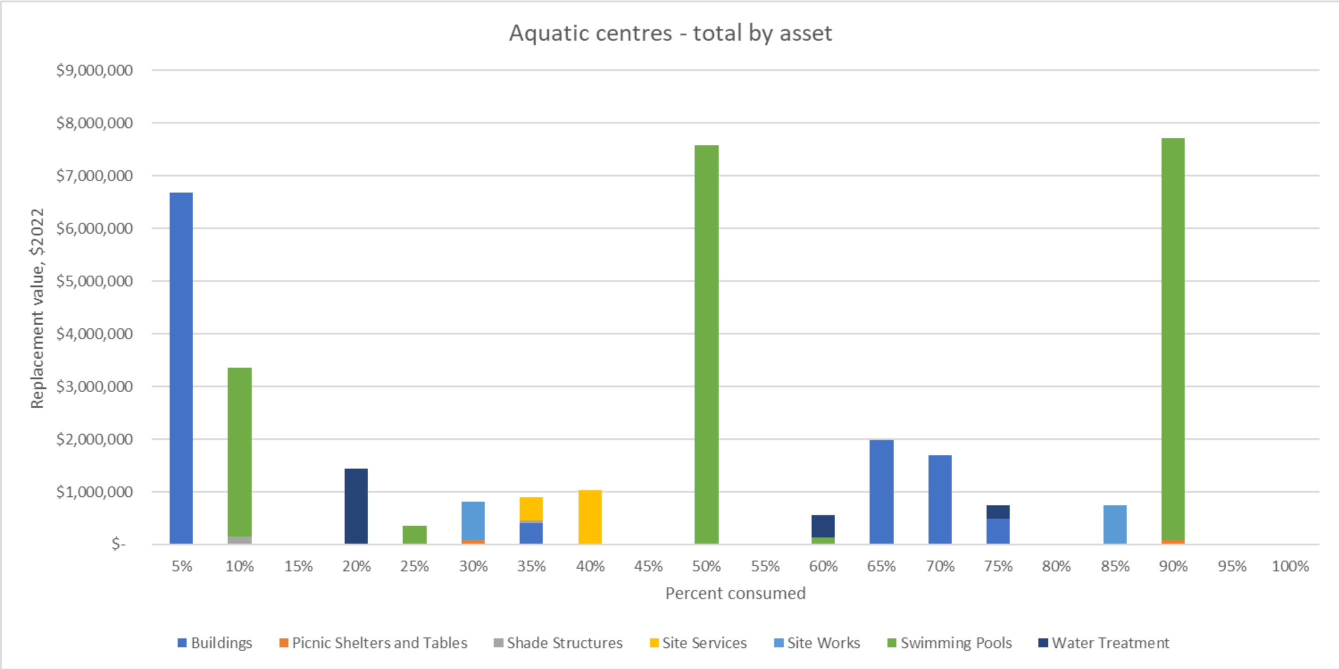

Figure 4.6 ***Asset consumption distribution: Aquatic centres total by asset***

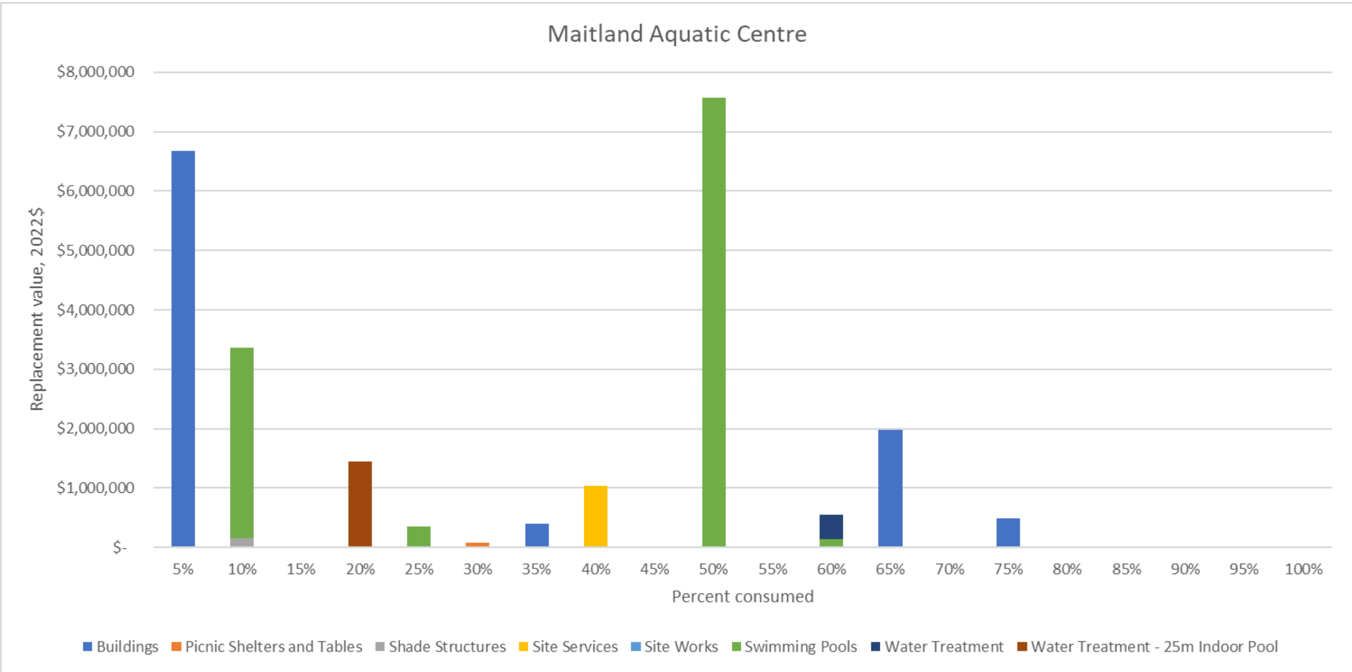

Figure 4.7 ***Asset consumption distribution: Maitland Aquatic Centre***

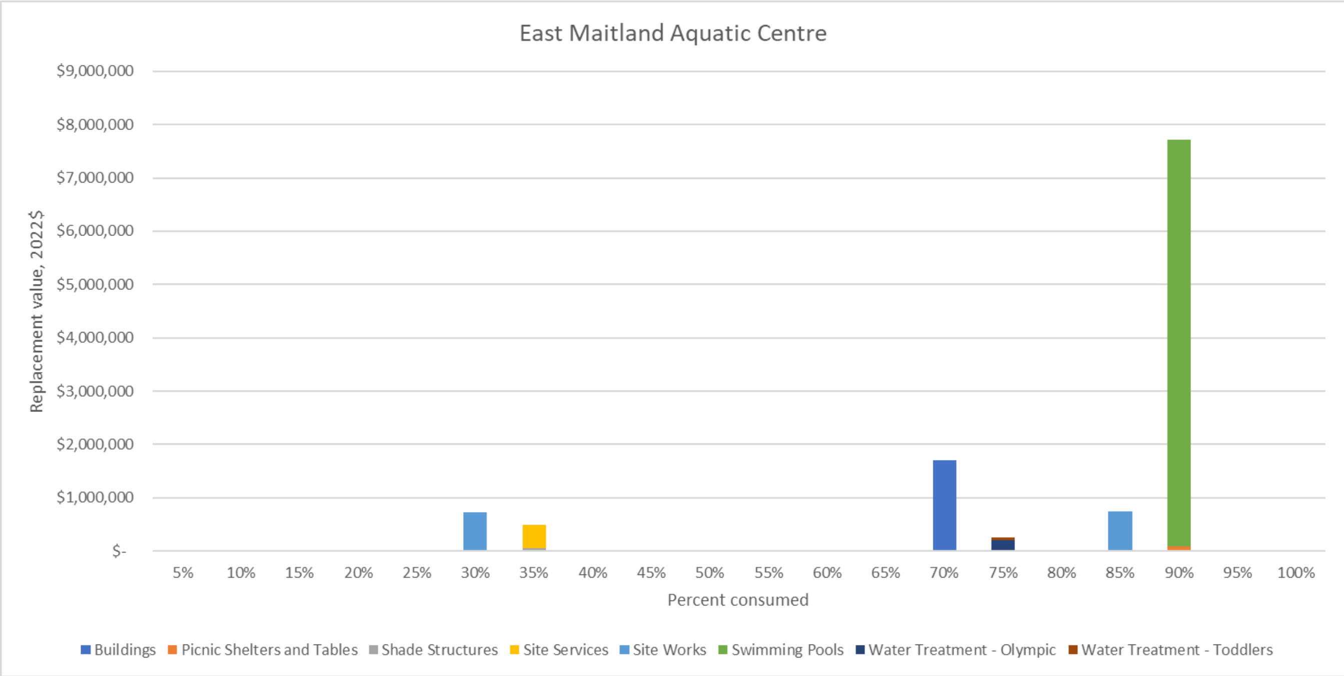

Figure 4.8 Asset consumption distribution: East Maitland Aquatic Centre

4.6 Asset risk data and risk exposure estimates

4.6.1 Overview

Not every asset is of equal importance or presents the same failure risk. Understanding which assets are critical and how they might fail helps focus lifecycle management strategies on what is most important. Critical Aquatic Centre assets are those that have major consequences or impacts if they fail and a high probability or likelihood of failing.

The asset consumptions determined in the preceding section provides an insight into the likelihood or probability of assets failing. To determine which of these assets are critical the consequence of failure must also be assessed and included in the analysis.

To determine the risk exposure of the assets, the following simple calculation is applied:

Risk Exposure = Probability of Failure (Pof) x Consequence of Failure (CoF).

The basis of determining the relative priority for each asset is the calculation of a Business Risk Exposure (BRE) rating index. The BRE is a probability-consequence risk matrix determination, using MCC's risk matrix structure as shown below:

Probabaility of Failure							
P5	Almost Certain	7	14	17	23	25
P4	Likeley	6	9	16	19	24
P3	Possible	3	8	15	18	22
P2	Unlikely	2	5	11	13	21
P1	Rare	1	4	10	12	20
		Insignificant	Minor	Moderate	Major	Catastrophic
		C1	C2	C3	C4	C5

Consequence of Failure

Figure 4.9 Risk matrix

4.6.2 Probability of failure

The probability of failure was derived by using the asset consumption defined in the previous section and MCC's likelihood scale (included in the MCC's Risk Management process), as illustrated in the following table.

Assets that are reaching the end of their estimated life (i.e. high% asset consumption) have a high probability of failure. Assets that are at the start of their estimated life (i.e. low % consumption) have a low probability of failure.

Table 4.8 Probability of failure

% Life consumed	Level	Probability / likelihood	Descriptor	Probability of occurrence
0% to 20%	P1	Rare	May occur only in exceptional circumstances	More than 20 years
21% to 40%	P2	Unlikely	Could occur at some time	Within 10-20 years
41% to 60%	P3	Possible	Might occur at some time	Within 3-5 years
60% to 80%	P4	Likely	Will probably occur in most circumstances	Within 2 years
80% to 100%	P5	Almost certain	Expected to occur in most circumstances	Within 1 year

4.6.3 Consequence of failure

Consequence of Failure was determined in a workshop with MCC staff using the following consequence ratings. These ratings are based on the ratings included the MCC's corporate Risk management process. Consequence of Failure ratings applied for each asset is defined in Table 4.9.

Table 4.9 Consequence of failure

Level	Consequence	Operational & Technical	Financial	Social	Environmental
C1	Insignificant	None or negligible service disruptions	Financial loss < $10K	No injuries No litigation exposure No media interest	None or negligible environmental impacts
C2	Minor	Isolated disruption to non-essential services	Financial loss between $10K and $50K	First Aid treatment Acceptable exposure to litigation Local media coverage	On site environmental impact immediately contained
C3	Moderate	Isolated disruption to essential services Wide disruption to non-essential services	Financial loss between $50K and $200K	Medical treatment required Moderate exposure to litigation Regional media coverage	On site environmental impact contained with outside assistance
C4	Major	Wide disruption to essential services Some non-essential services unavailable	Financial loss between $200K and $1M	Extensive (multiple) injuries Some state/national media coverage Major exposure to litigation	Off-site environmental impact with no detrimental effects
C5	Catastrophic	Essential and non-essential services unavailable	Financial loss >$1M	Loss of life Extensive state/national media coverage Unacceptable exposure to litigation	Toxic release off site

4.6.4 Asset risk exposure estimate

The following section includes risk maps showing the total replacement value of assets for Risk Exposure by asset type, based on the risk methodology and criteria described above. The risk maps have enabled the identification and prioritisation of higher risk assets that need to become candidates for closer inspection (to verify if they truly are high risk), renewal or replacement.

The determination of the BRE is a function of the selected PoF and CoF figures for each individual asset. Using the Risk Matrix shown in Figure 4.9, a ranking was determined (Very High, High, Medium or Low) for each asset included in the hierarchy.

In summary, **23%** of aquatic centre assets are a "**very high**" business risk, with a further 43**%** of assets being a "**high**" business risk. This equates to a financial replacement estimate (in 2022$) of ~**$23.8 M.** This is reflective of:

– The age and condition of the majority of aquatic centre assets, particularly East Maitland Aquatic Centre.

– The high target level of service required of Maitland Aquatic Centre, that is being a "Superior" ranked facility.

Probability of Failure			Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
	P5	Almost Certain	$ 83,430	$ -	$ -	$ 744,000	$7,635,517
	P4	Likeley	$ 263,600	$ -	$ 1,547,600	$2,607,750	$ -
	P3	Possible	$ -	$ -	$ -	$ 423,330	$7,713,797
	P2	Unlikely	$ -	$1,221,960	$ 401,700	$1,482,000	$ -
	P1	Rare	$ -	$ 150,000	$ -	$8,865,411	$3,204,595

Consequence of Failure

Figure 4.10 Asset risk exposure matrix: Total ($)

Probability of Failure			Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
	P5	Almost Certain	0%	0%	0%	2%	21%
	P4	Likeley	1%	0%	4%	7%	0%
	P3	Possible	0%	0%	0%	1%	21%
	P2	Unlikely	0%	3%	1%	4%	0%
	P1	Rare	0%	0%	0%	24%	9%

Consequence of Failure

Figure 4.11 Asset risk exposure matrix: Total (%)

Probability of Failure			Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
	P5	Almost Certain	$ -	$ -	$ -	$ -	$ -
	P4	Likeley	$ -	$ -	$ -	$2,466,250	$ -
	P3	Possible	$ -	$ -	$ -	$ 423,330	$7,713,797
	P2	Unlikely	$ -	$ 443,930	$ 401,700	$1,035,000	$ -
	P1	Rare	$ -	$ 150,000	$ -	$8,865,411	$3,204,595

Consequence of Failure

Figure 4.12 Asset risk exposure matrix: Maitland Aquatic Centre (2015$)

Probability of Failure			Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
	P5	Almost Certain	0%	0%	0%	0%	0%
	P4	Likeley	0%	0%	0%	10%	0%
	P3	Possible	0%	0%	0%	2%	31%
	P2	Unlikely	0%	2%	2%	4%	0%
	P1	Rare	0%	1%	0%	36%	13%

Consequence of Failure

Figure 4.13 Asset risk exposure matrix: Maitland Aquatic Centre (%)

Probability of Failure			Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
	P5	Almost Certain	$ 83,430	$ -	$ -	$ 744,000	$7,635,517
	P4	Likeley	$ 263,600	$ -	$ 1,547,600	$ 141,500	$ -
	P3	Possible	$ -	$ -	$ -	$ -	$ -
	P2	Unlikely	$ -	$ 778,030	$ -	$ 447,000	$ -
	P1	Rare	$ -	$ -	$ -	$ -	$ -

Consequence of Failure

Figure 4.14 Asset risk exposure matrix: East Maitland Aquatic Centre (2015$)

Probability of Failure							
P5	Almost Certain	1%	0%	0%	6%	66%
P4	Likeley	2%	0%	13%	1%	0%
P3	Possible	0%	0%	0%	0%	0%
P2	Unlikely	0%	7%	0%	4%	0%
P1	Rare	0%	0%	0%	0%	0%
		Insignificant	Minor	Moderate	Major	Catastrophic
		1	2	3	4	5
		Consequence of Failure				

Figure 4.15 Asset risk exposure matrix: East Maitland Aquatic Centre (%)

4.6.5 High priority assets

High priority assets (very high risk assets) are summarised below. These assets should be prioritised in future capital and maintenance planning and delivery. Note that whilst this plan identified these very high risk assets, it does not necessarily mean a high cost intervention is required.

Maitland Aquatic Centre

There are no assets ranked as a "very high" risk from this assessment. However, high priority assets from an operational and maintenance perspective remain as follows:

– Olympic pool, concrete shell and lining.
– Water treatment including pumps, tanks, filtration and dosing systems for both outdoor and indoor pools.
– The plant room building.
– Power supply for the site.
– Concourse and footpaths within the entire facility.
– Perimeter fencing.

East Maitland Aquatic Centre

Assets ranked as "very high" risk at East Maitland are key elements of both the Olympic and Toddlers swimming pools, being the concrete shell and lining. Due to this risk exposure of these assets it is recommended an inspection be completed to confirm any additional maintenance interventions.

Other high priority assets from an operational and maintenance perspective remain as follows:

– Water treatment including pumps, tanks, filtration and dosing systems for both outdoor and indoor pools.
– The plant room building for the outdoor pools.
– Power supply for the site.
– Concourse and footpaths within the entire facility.
– Perimeter fencing.

4.7 Renewal and enhancement plan

Short term renewal and enhancement plans are defined through MCC's annual capital and maintenance planning processes. Current renewal and enhancement plans incorporate high priority assets identified within this AM Plan consistent with the cost estimates included in the Capital Works Program. Renewal and enhancement of ageing assets over a longer period of time from this AM Plan are also consistent with the current Long Term Financial Plan.

4.8 Creation/acquisition/upgrade plan

New assets from growth (when applicable) as well as major renewals based on the outputs of this AM model are included in future financial projections of the AM Plan. These new assets will be planned, scheduled and delivered on an annual basis as per MCC's capital programming and project delivery processes and within the limits of the Council endorsed four year capital works budget.

4.9 Disposal plan

Disposal includes any activity associated with disposal of a decommissioned asset including sale, demolition or relocation. Both Maitland and East Maitland Aquatic Centres have assets marked for disposal in the near term.

5. Financial summary

This section contains the financial requirements resulting from all the information presented in the previous sections of this asset management plan. The financial projections will be improved as further information becomes available on desired levels of service and current and projected asset performance.

5.1 Financial projections for asset renewal

The estimated cost over time to sustain and/or renew MCC's Aquatic Centre assets to the target condition and level of service is shown in Figure 5.1 below. As indicated by the horizontal line, the theoretical average annual cost to sustain this asset class (based on long term replacement cycles, asset age/condition and estimated growth) is estimated to be in the order of **$0.9 M** in 2022 dollars. This includes **$0.7 M** for Maitland Aquatic Centre, and **$0.2 M** for East Maitland Aquatic Centre, as illustrated in Figure 5.2 and Figure 5.3. Most of this reinvestment relates to buildings, pools and water treatment.

This information now provides a target for short term assessments – particularly with regards to priority assets identified and those that have reach the end of their estimated life. Risk exposure can be further reduced through applying appropriate risk reduction measures or obtaining more accurate condition data that confirms extending asset life is practical.

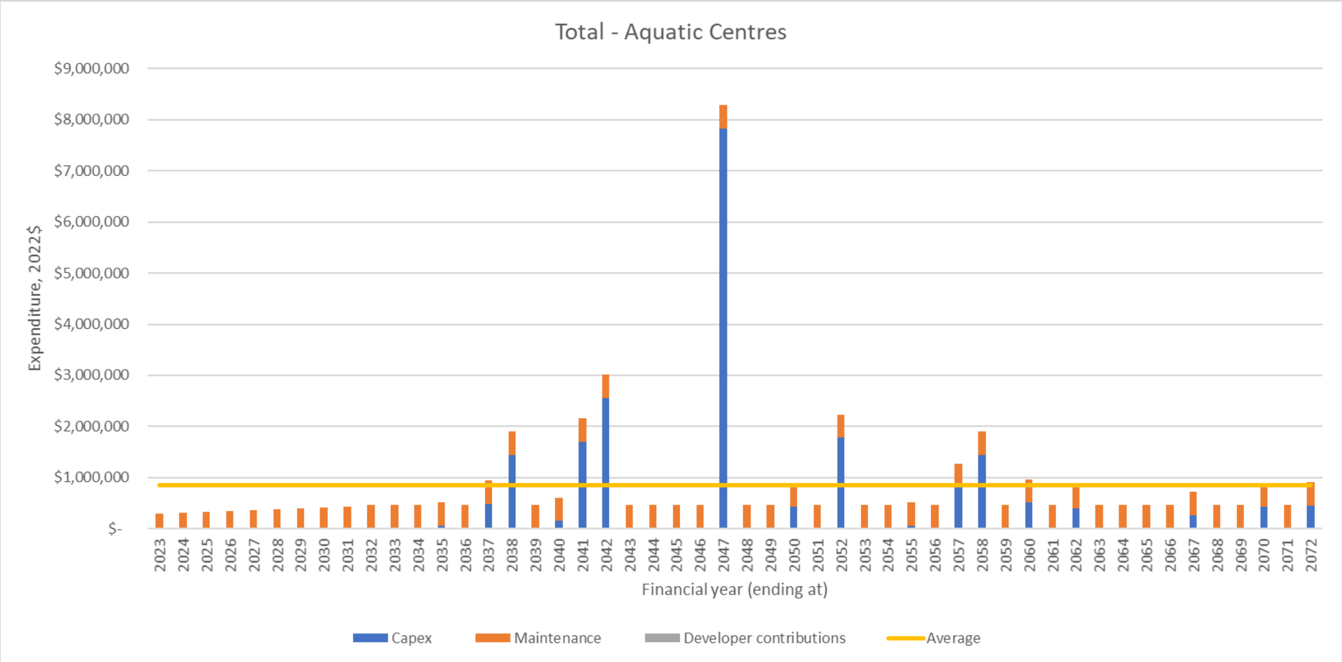

Figure 5.1 Financial projection for asset renewal - Total

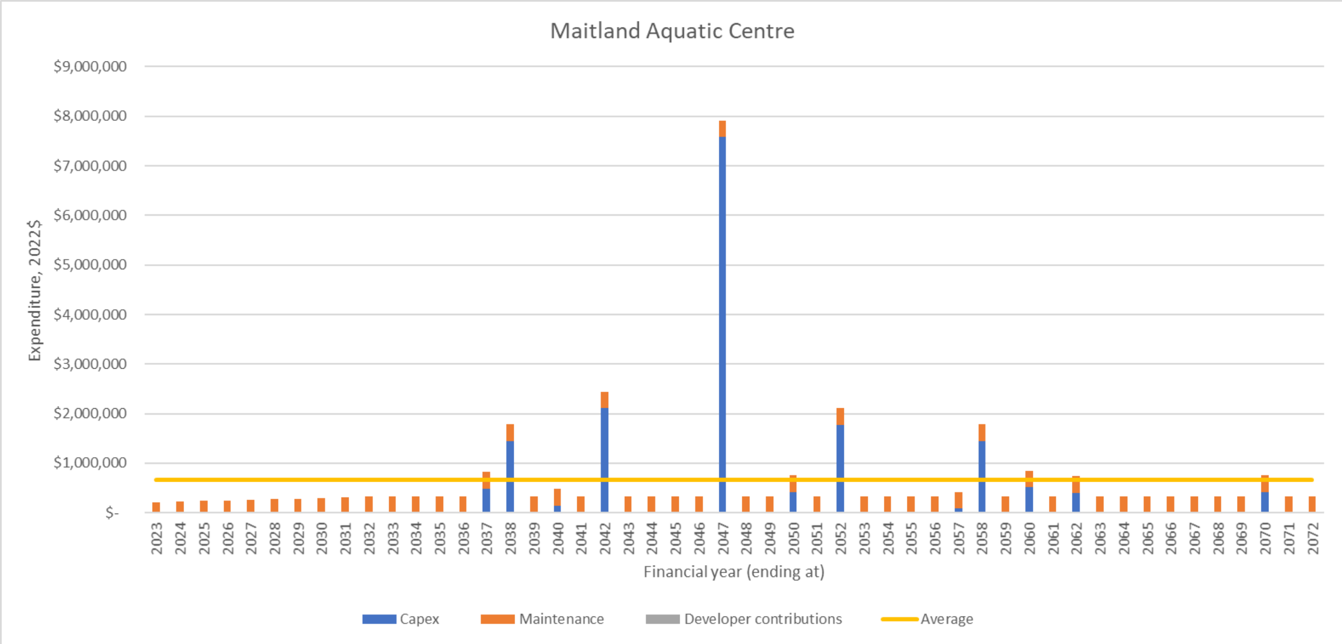

Figure 5.2 Financial projection for asset renewal: Maitland Aquatic Centre

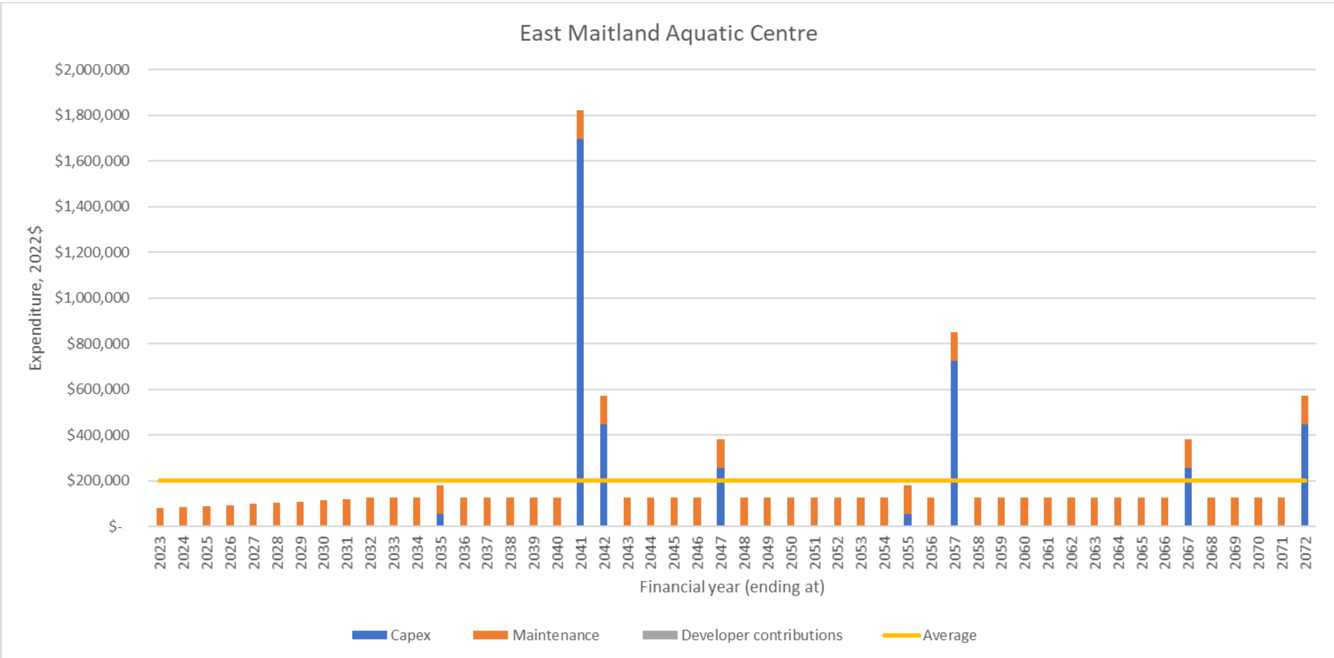

Figure 5.3 Financial projection for asset renewal: East Maitland Aquatic Centre

5.2 Long term funding mechanisms

Long term funding mechanisms will be addressed as part of Council's resourcing strategy and associated rate rises. These are currently being realised in the current capital/maintenance works program and the 2022 Long Term Financial Plan which was endorsed by Council in early 2022.

Appendices

Appendix A

Limitations and assumptions

Limitations

This report has been prepared by GHD for Maitland City Council and may only be used and relied on by Maitland City Council for the purpose agreed between GHD and Maitland City Council. GHD otherwise disclaims responsibility to any person other than Maitland City Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Maitland City Council which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has prepared financial information set out in this report ("Cost Estimate") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD and using information provided by Maitland City Council The Cost Estimate has been prepared for the purpose of asset management planning and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the [works/project] can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

Assumptions

- All data outcomes presented are commensurate with the data provided by MCC. Data provided is generally high level.
- When the condition of the asset is reflected by the age of the asset, the age of the asset is used to calculate the residual life. Conversely, when the condition of the asset is not reflected by the age of the asset, the condition of the asset is used to calculate the residual life. To determine whether the condition of the asset is reflected by the age of the asset, the residual life based on condition must be between $\frac{3}{4} \times$ residual life based on age and $\frac{4}{3} \times$ residual life based on age
- When a judgement-based residual life has been provided, it overrides the calculated residual life.
- Maintenance, capital and replacement costs are as per provided by MCC.
- % consumed has been rounded to the nearest multiple of 5.
- Maximum potential life is agreed with MCC at data collection workshops. In some cases maximum potential life is assumed based on the highest maximum potential life for assets that are classified within asset type.
- Consequence of failure ratings are as agreed with MCC at data collection workshops. In some cases consequence of failure has been assumed based on the highest consequence of failure of sub assets that are classified within the asset.
- Judgements on condition have been provided by MCC. In some cases judged condition is assumed when all the assets within the asset type have been given the same judged condition.

Appendix B

MCC Aquatic Centre maintenance and operating procedures

Table B.1 Aquatic centres annual reactive maintenance and operating procedures

Procedure No.	Activities
MA01	Opening Maitland Aquatic Centre
MA02	Opening East Maitland Pool
MA03	Closing Maitland Aquatic Centre
MA04	Closing East Maitland Pool
MA05	First Aid Equipment Checks
MA06	Cash Handling Pre Opening
MA07	Opening of Kiosk Start up and log in of Computers
MA08	Cash Handling Council Pick up
MA09	Cash Handling Post Shift
MA10	Diary Staff Book Entries
MA11	Communication Between Lifeguards
MA12	Removing Of Pool Blankets
MA13	Installing of Pool Blankets
MA14	Installation of Auto Vac and Servicing
MA15	Set up Swim Club Training / User Group
MA16	Installing Lane Ropes
MA17	Removal of Lane Ropes
MA18	Cleaning Leaf Screens
MA19	Bather Supervision
MA20	Sun Protection & Heat Protection
MA21	Lifeguard Shift Change
MA22	Opening Splash Pad
MA23	Splash Pad Supervision
MA24	Closing Splash Pad
MA25	Cleaning Amenities
MA26	Overcrowding
MA27	Picking up Litter
MA28	Emptying Garbage Bins
MA29	Sensitive Issues
MA30	Disorderly and Unruly Behaviour
MA31	Abusive and Aggressive Customers/Conflict Resolution Skill for Lifeguards
MA32	Ride On Mowing of Pool Grounds
MA33	Pool Testing i.e. Free Chlorine
MA34	Pool Testing i.e. Total Chlorine
MA35	Pool Testing i.e.ph (potential hydrogen)
MA36	Pool Testing i.e. Alkalinity
MA37	Pool Testing i.e. Cyanuric Acid
MA38	Pool Testing i.e. Calcium Hardness
MA39	Pool Testing i.e. Total Dissolved Solids (TDS)
MA40	Pool Testing i.e. Water Balance

Procedure No.	Activities
MA41	Pool Testing i.e. Quantities when adding chemicals
MA42	Uncontrolled Chemical Spill Plant
MA43	Chemical Deliveries, Storage and Handling
MA44	Adding Briquettes to Pulsar Unit
MA45	First Aid Minor Incident
MA46	First Aid Major Incident
MA47	Suspected Drowning
MA48	Suspected Spinal Injury
MA49	Standard Evacuation Response for all Occupants & Visitor's
MA50	Action Plan for Anaphylaxis
MA51	Action Plan for Asthma
MA52	Action Plan for Function Testing
MA53	Action Plan for Allergic Reaction
MA54	Confined Space
MA55	Bomb Threat
MA56	Lightning
MA57	Power Failure
MA58	Cardiac Arrest
MA59	Talking to the Media (pages 1&2)
MA60	Filling the Balance Tank
MA61	Electrical Storm
MA62	Purchase issue of Disposable Items and Supply
MA63	Keep Watch Programme
MA64	Set up Programmes for Swimming Clubs / User Groups
MA65	Sports User Groups
MA66	Maitland Triathlon Club/ User Group
MA67	Maitland Swimming Club Training / User Group
MA68	Booking and Hire Procedures
MA69	Induction Process for User Groups
MA70	Breach of Conditions of Entry
MA71	Lost Child
MA72	Banning Notice (pages 1&2)
MA73	Steps in Solid Stool Faecal Contamination
MA74	Disarming and Arming the Alarm Pad
MA75	Turning on/off the PA System
MA76	Generate PA Messages
MA77	Opening/Closing Checks for Plant Room
MA78	Damage to Pool Property
MA79	Risk Assessment
MA80	Backwash Procedure MA(pages 1,2,3 &4)
MA81	Armed Hold Ups

Procedure No.	Activities
MA82	Fire Fighting Equipment
MA83	Security CCT
MA84	Gladstone Point of Sale
MA85	Fielding Complaints
MA86	Diving Policy
MA87	Installation of LTS Platforms
MA88	Installation of Lane Dividers
MA89	Patrons Affected by Drugs and Alcohol
MA90	Programmes
MA91	Material Safety Data Sheets
MA92	Safe Work Method Statement
MA93	Duty of Care
MA94	Incident / Accident Forms
MA95	Facility Rules
MA96	Phone Protocol
MA97	MCC After Hours Contact Numbers
MA98	Unstructured Swimming Activities
MA99	Signage
MA100	Employee/ Employer Responsibilities
MA101	Timesheets Requirement
MA102	Staff Call Out Procedure
MA103	Loss of Council IT Services
MA104	Blackout Power surges on shift
MA105	Testing Pool Water
MA106	Super Chlorination
MA107	Loss of Water Quality
MA108	High Levels of Chlorine Emergency Procedure
MA109	Supervision Ratio
MA110	Blower Vacuum
MA111	Using the Pressure Cleaner
MA112	Dealing With Council Contractors
MA113	Maitland City Council Learn To Swim
MA114	Plant Start-up Above Weir Level
MA115	Mower ride on
MA116	Whipper Snipper
MA117	Edge Trimmer
MA118	Hand Lawn Mower

Procedure No.	Activities
MA41	Pool Testing i.e. Quantities when adding chemicals
MA42	Uncontrolled Chemical Spill Plant
MA43	Chemical Deliveries, Storage and Handling
MA44	Adding Briquettes to Pulsar Unit
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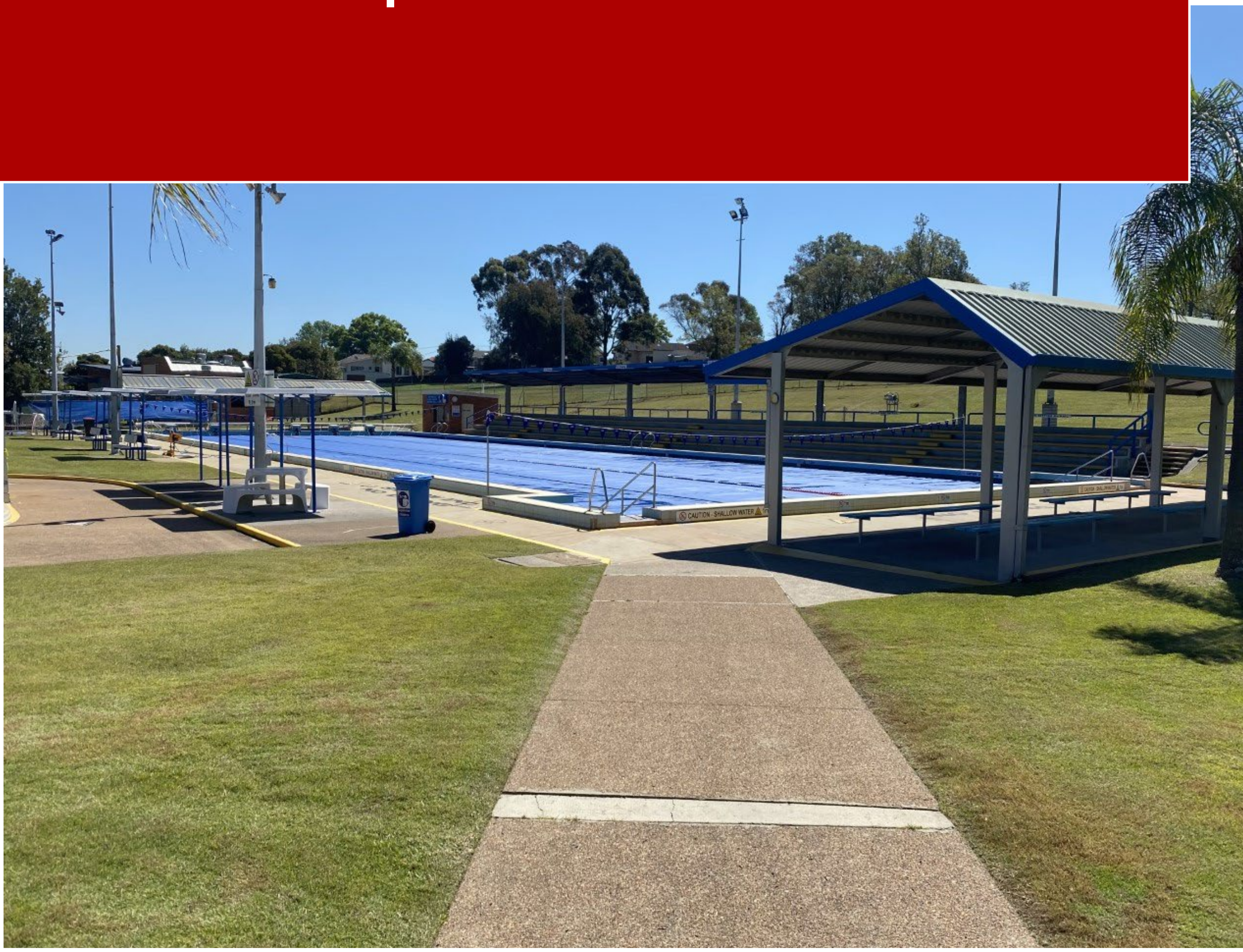
MA75	Turning on/off the PA System
MA76	Generate PA Messages
MA77	Opening/Closing Checks for Plant Room
MA78	Damage to Pool Property
MA79	Risk Assessment
MA80	Backwash Procedure MA(pages 1,2,3 &4)
MA81	Armed Hold Ups

Appendix C

MCC's East Maitland Pool Operation Manual

East Maitland Aquatic Centre Pool Operation Manual



Developed by Troy Hughes Aquatic Operations Supervisor

Developed March 2021 Review Due March 2022

Contents

EAST MAITLAND AQUATIC OPERATIONS MANUAL

The East Maitland Aquatic operations manual version 2.0 has been created and designed to provide guidance on all operation tasks at the centre. This manual has been split into three sections Pool Operations, Workplace Health and Safety, Emergency Action Plan. The ideal for this change and therein updates to this manual is for this document to be easily accessible and usable by all staff I then hope of achieving higher levels of success for the East Maitland Aquatic staff and individuals.

1. Personnel Policies and Procedures

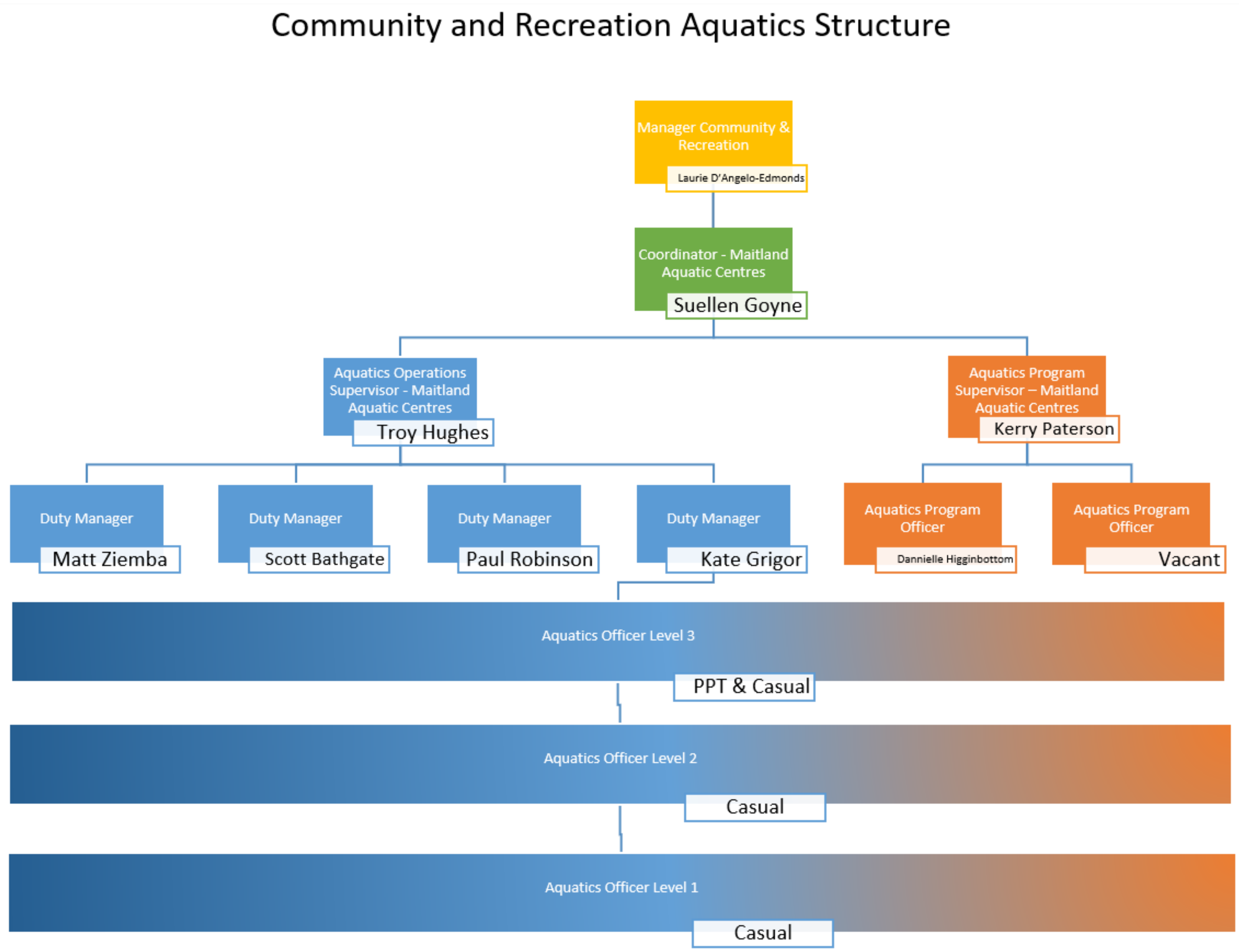
East Maitland Aquatics polices are in place so that no personal information regarding staff has been given out to anyone for any reason. If there are any problems, they are to contact the relevant supervisor/ Duty Manger on centre number or via her e-mail. This also includes Council Contract partners.

1.1 Relevant Contact Details

Position	Contact Name	Contact Details
Community & Recreation Manager	Laurie D'Angelo-Edmonds	Email: Laurie.dangelo@maitland.nsw.gov.au Ph: 02 4934 9877 Mobile: 0428 602 615
Aquatics Coordinator	Suellen Goyne	Email: Suellen.goyne@maitland.nsw.gov.au Ph: 02 4934 9807 Mobile: 0436 925 832
Operation Supervisor	Troy Hughes	Email: Troy.hughes@maitland.nsw.gov.au Mobile: 0448 189 643
Aquatics Programs Supervisor	Kerry Paterson	Email: Kerry.paterson@maitland.nsw.gov.au Mobile: 0436 852 712
Duty Managers	Scott Bathgate Paul Robinson Kate Grigor Matt Ziemba	Email: Scott.bathgate@maitland.nsw.gov.au Mobile 0448 566 542 Email: Paul.robinson@maitland.nsw.gov.au Mobile: 0448 414 836 Email: Kate.grigor@maitland.nsw.gov.au Mobile: 0417 280 416 Email: Matt.ziemba@maitland.nsw.gov.au Mobile: 0439 468 545

Aquatics Program Officer	Danielle Higginbottom	Email: Dannielle.higginbottom@maitland.nsw.gov.au Ph: 0400 792 276
WHS Officer	Troy Hughes	Email: Troy.hughes@maitland.nsw.gov.au Mobile: 0448 189 643
Council Contact (1)		

1.2 Lines of Responsibility.



1.3 Employee Position Roles and Responsibilities.

Maitland City Council East Maitland Aquatics has 5 key areas that are all a necessary role in making the facility operate in conjunction with Industry standards, WHS safety guidelines, MCC Policies and Procedures

1.3.1 Aquatic Coordinator

- Overall Operation of Centre
- Contact in case of emergency
- Ensure that policies and procedures are followed and adhered to
- Budgeting and KPI are meet

1.3.2 Workplace Health and Safety Officer

- Oversight of safe operations centre wide
- Ensuring compliance with relevant government bodies guidelines and legislation
- Conduct regular training with all staff on WHS related matters
- Develop centre policies
- Educate all staff in WHS matters

1.3.3 Operations Supervisor

- Pool Lifeguards
- Pool water quality
- Plant operation
- Pool Cleanliness
- Patron and staff safety
- Policy and Procedure Development
- Reporting on pool operations
- Facilitate Quarterly lifeguard training
- Performance manage Lifeguards
- Oversee implantation of emergency procedures
- Participate in Employee induction/retention/acquisition

1.3.4 Duty Managers

- Assume Operations manager's role in their absence
- See above
- Provide Lifeguarding service in accord with GSPO
- Provide leadership for Jnr lifeguards
- Facilitate staff inductions

1.3.5 Aquatic Officers

- Pool Supervision
- Maintain Safe Swimming environment for all users
- Maintain Centre Cleanliness
- Community Education
- Provide Lifeguarding service in accord with GSPO

1.4 Personnel Directory and Call Out Procedures.

In the event of a major emergency, refer to the emergency action plan section of the operations manual kept in a separate folder.

1. Emergency Services
2. First Point of Call – Aquatic Coordinator, who will contact Council if required
3. Second Point of Call – Operations Supervisor and WHSO
4. Relevant Chemical Company or Authorities

The information below should be next to every phone in the centre.

Contact	Number
Facility Address	**41 Narang street** **Cross Street – Narang street / Card Crescent**
Aquatic Coordinator: Suellen Goyne	0436 925 832
Operation Supervisor: Troy Hughes	0448 189 643
Safety Officer: Troy Hughes	0448 189 643
Ambulance	000
Fire	000
Police	000
Maitland Police Station	4934 0200
Snake catcher	0421 911 940
SES	132 500
East Maitland Fire Brigade	(02) 4934 7497
Power supply: AusGrid Energy	13 13 88 24hr Emergency Number
Maitland Fire Brigade	(02) 4934 7258
Poisons Information Centre	13 11 26 (NSW)
Environmental Protection Authority (EPA)	131 555
Gas Emergency	131 909
John Hunter Hospital	4921 3000
Maitland Hospital	4939 2000
Council	4980 0255
Pound / Ranger	4934 9700
Hunter water	1300 657 000

1.5 Uniforms & Expectations

Lifeguards on shift at East Maitland Aquatics must wear a Maitland City Council provided pool lifeguard uniform and in a professional standard of presentation.

- Uniform meets Maitland City Council sun safe policy
- A Whistle is considered part of the lifeguard uniform and must always be worn
- Bum bags must always be worn when on shift
- 2-Way Radio must be worn at all times while on shift
- Staff uniform is provided by Maitland City Council
- Staff uniform is listed below

Summer	Winter
• Shorts • Shirt (long sleeve for Lifeguard and short sleeve for Customer Service) • Covered in shoes • Wide Brim hat • Sunscreen • Sunglasses • Whistle • 2-way Radio • Bum bag • Name Badge	• Long pants/Hoodie/Jacket • Short (long sleeve for Lifeguard and short sleeve for Customer Service) • Shorts (optional) • Covered in shoes • Whistle • 2-way Radio • Bum bag • Name Badge

- All lifeguards on shift must always wear a bum bag. Minimum contents to include and be checked prior to commencing each shift:

- Band aids
- Saline
- Bandages
- Whistle
- Disposable gloves plus spares
- Pocket face mask
- Pocket torch

2. Physical Layout / Design

2.1 Facility Floor Plan

2.2 Pool/s Dimensions.

50-meter Pool
• 50meters in length – 17meters in width – 6 lanes • Deep end 2 meters deep, gradual decrease to 1meter deep shallow end (average 1.5m) 50m (length) x 17m (width) • Disable access via safety ramp eastern side lane *Approx. 1.275 mega litres (1.275 million litres)*
Toddler Pool
• 15meters in length – 6meters in width oval shaped • Depth 0.35 meters gradual decrease to 0.15 meters at each end (average 0.65m) 15m (length) x 6m (width) *Approx. 80,000 litres*

2.3 Maximum Number of Patrons including Bather Loads.

While the Centre does not have a determined patron capacity limit staff should use discernment when making bookings to ensure the Centre is always comfortable and safe. No specific staff to patron ratios is required for the foyer area however the pools and do have ratios that must always be adhered to.

Pool ratios:

According to the Guidelines for Safe Pool Operation (GSPO) section SV5 5.3.13 published by Royal Life Saving Society Australia (RLSSA) as a general guide to the ratio of Lifeguards to people in the water should not exceed 1:100. This number should be reduced in high-risk circumstances.
This ratio is not absolute and is influenced by a range of factors such as, but not restricted to:

- Weather
- Holidays
- Size, number, and layout of pools
- Lines of site
- Surface reflection
- Average attendance
- Anticipated attendance
- Swimming capabilities
- Special needs individuals and groups
- The number and distribution of users
- Recreational activities, either programmed or spontaneous

In accord with these guidelines the pools should always have a minimum of 1 lifeguard on duty for the small pool and 1 lifeguard on duty for the 50m pool. Should the pools exceed the ratio of 1:100 or approach this ratio the pool overcrowding action plan must be actioned. See below for the action plan.

In addition to the lifeguard to bather ratio public swimming pools must abide by the NSW Public Health Act 2011. This Act and supporting advisory documents relate to the water quality and the pool's ability to maintain the minimum standards of water quality for public health. Bather load is a measure of the number of bathers in the pool and is normally expressed as a Maximum Instantaneous Bather Load (MIBL). The MIBL also gives an indication of the amount of bather pollution being introduced into the pool. This pollution may vary according to the size of the bathers as children have a much lower surface area than adults (assuming all people toilet before entering the pool). To maintain water quality, comfort, and safety the design MIBL requirements should not be exceeded. Table 7.1 should be used as a guide

Public Swimming Pool and Spa Pool Advisory Document NSW Health PAGE 49 Table 7.1

Water depth	Maximum bathing load
< 1.0 m	1 bather per 2.2 m2
1.0 – 1.5 m	1 bather per 2.7 m2
> 1.5 m	1 bather per 4.0 m2

Maximum bather load for East Maitland Aquatics

Pool	Maximum bathing load
50m	263
Toddler Pool	20

2.4 Location of Alarms/Exit/Firefighting Equipment.

- Hose Reels in accordance with BCA 96 Clause E1.4 and AS 2441 – 1988.
- Portable fire Extinguishers in accordance with BCA 96Clause E1.6 and AS 2444 – 1995.
- Emergency Lighting in accordance with BCA 96 Clauses E4.2, E4.4and E4 and AS 2293.1 – 1995.
- Exit signs in accordance with BCA 96 Clauses E4.5, E4.6 and E4.8 and AS 2293.1 – 1998.
- Fire Hydrants in accordance with BCA 96 Clause E1.3 and AS 2419.1 – 1994.

Type of equipment	Location
 **CO2 Fire Extinguisher**	- Electrical room - Kiosk storage room - Main Office - Staff Room - Club Room
 **Dry Powder Extinguisher**	- First aid room - Cover storage shed - LTS equipment shed - Chemical storage shed - Outdoor plant room
 **Hose Reel**	- On the outside of the small pool plantroom
First Aid Kit	- First Aid Room - Mobile First Aid Bin located on the concourse 50 m pool
Hydrant	- Outside gate northern side - 2 on Card Crescent - 2 on Narang street opposite the pool
Evacuation Point	- Car Park area out gate near men's changeroom
MSB **Main Switch Board**	- Electrical storeroom to the left of main exit on the external of pool

Emergency Exit	- 4 located around 25m pool - Exit at entry point of facility - Exit through gates around perimeter

2.4.1 Carbon Dioxide Sensors

A carbon dioxide senor is fitted in 50m plant room where the CO2 bulk storage tanks are situated. It has been fitted in conjunction with AS/AZ standards and Air Liquide gases policies and procedures and serviced annually. It has an external panel on all entries to the plantroom. 50m sensor is located behind the door when entering the plantroom.

2.4.2 Family/Disability Change Rooms

The centre has 1 family / disabled change rooms which are fitted out with 1 visual alarm which are blue and above the door. 2 activation buttons have been fitted per change room to make it easy accessibility from different areas of change room. Switches are regularly serviced to comply with AS/NZ standards and disability codes and practices. Moveable seats / benches have been fitted that are corrosive resistant and are regularly maintained.

2.4.3 Security Alarm/CCTV

Security alarms and sensors beams are allocated around the centre. The alarm control pad is in the storeroom and the 50m plant room. The alarm is monitored by external security company with back to base alarms and security patrols. The centre has sensors points attached to all external doors around facility with motion detectors scatted internal. The centre is fitted with 1 CCTV cameras with monitor and recording devise in office.

2.4.4 Firefighting Equipment

2.4.6 First Aid Room

Design, size, and layout of first aid room has been taken into consideration, it complies with Safe work Australia code of practice February 2016 under the 274 Work Health and Safety Act and RLSSA industry guidelines based on medium sized facility which accommodates up to 1000 people. Where possible, the first aid room should be dedicated to the provision of first aid only.

Content of First aid room

- The room is well illuminated and ventilated.
- Telephone with emergency contact details.
- Wash basin with hot and cold water.
- Examination bed and chair provided.
- Freezer for storage of icepacks is in staff room next door.
- Lockable storage cupboards for special medication.
- Stretcher accessible if required.
- General power outlets.
- Sick Bucket.

3. Facility Opening/Closing Procedures

3.1 Opening procedures

The Opening procedure consist of completing an opening checklist, this is being completed using the iPad. While completing the opening checklist the iPad is used to take photos of any risks or foreseeable Hazards, this is then documented onto the daily toolbox talk. Duty Manager conduct a daily toolbox meeting to discuss daily events and any hazards they have seen walking around the Centre.

In completing the process below, you are determining the centre to be safe and prepared for usage and any emergency as foreseeably possible.

3.1.1 Procedure

1. To be conducted by Duty Manager.
2. Full walk around with iPad.
3. Assess for hazards or safety issues.
4. Initial when OK.
5. If anything needs to be placed in the hazard report area, document it.
6. If all is completed open the doors.

3.1.2 Opening Basics

- LG/CSO will turn all lights on.
- Check lights are working in the change rooms.
- Check plant room auto dosing readings.
- Manually test all pools.
- Remove pool cleaner from water and coil up cord in accord with the SOPS.
- Take pool covers off, move to side of pools.
- Inspect both change rooms- clean and stocked (photos to be uploaded on Promapp).
- Conduct Centre risk assessment (detailed on daily water quality sheets).
- POOL OPENS TO PUBLIC – UNLOCK DOORS IF NEEDED.
- Check oxygen and defibrillator.
- Clean pool cleaner filters and store cleaner.
- Continue with daily cleaning task.

3.2 Closing Procedures

The closing procedure consists of completing a closing checklist on Promapp, this is being completed using iPad or work mobile phone. NO photos are required when completing the closing checklist. This is designed to ensure all facilities have been checked and locked securely as closing staff are leaving the facility at the end of the day.

3.2.1 Procedure

1. To be conducted by Duty Manager or most senior staff member on shift.
2. Final sweep and make sure all patrons have left the facility.
3. Lock all doors, alarm building and exit.

3.2.2 Closing Basics

- Complete final daily water test and log correctly.
- Pool covers have been put on, cleaner in the water and going.
- Ensure all patrons have left the facility.
- Lock up all doors, turn all lights off.
- Ensure radios are put on charge for the night, ready for the next day's use.
- Facility is alarmed, exit facility via side gate and ensure padlock is locked securely.

4. Supervisory Procedures

4.1 Centre supervision Risk assessment

For lifeguards to adequately supervise the pool, the pool should be divided into Zones. Each Zone should be scanned by the Lifeguard continuously with the Lifeguard checking the pool surface, pool bottom and entry points. This method of Lifeguarding will help the Lifeguard to identify high risk bathers around higher risk areas. Lifeguards should use Vision, Hearing, Smell, and touch to monitor what is happening around them.

4.1.1 Principles of scanning

- Lifeguards must be positioned with clear unobstructed sight lines.
- Lifeguards must move to counteract patron interference (especially in ground level supervision)
- Lifeguards must practise to develop and improve their perception skills
- Focus on people and what they are doing. Make eye contact when possible.
- Use your peripheral vision to detect movement
- Never stop scanning when speaking with a patron
- In the outdoor area, monitor changes in the environment conditions (weather and water) for their potential impact on patron behaviour and safety
- Avoid turning your back on the area – walk backwards or sideways to avoid loss of eye contact
- Scan the bottom of the pool first then the surface

4.1.2 Grouping

To assist in the identification of high-risk swimmers and to comply with the Royal lifesaving ‘Keep Watch’ program the centre has adopted a wristband system. Pool lifeguards are expected to enforce while they are on shift. To help correctly identify Non swimmer from swimmer user group such as school, parties, private booking, and inflatable users are swim tested before activities commence. Also, to comply with DET guidelines.

Blue wrist bands (water): Compented swimmers. A non swimmer is identified by a carer, guardian, and swim test. Tyically these wrist bands are only used during group and school bookings

Yellow wrist bands (Keep Watch):: Non-swimmers are not to be in deepend or on inflatables. Must have consteient supervsion by career, guardian, or teacher at all times. children wearing this wrist band must be within arms reach of a person over 16 at all times.

4.1.3 Where to scan

- Sweep your eyes over your entire zone
- Take note off clients and activity directly in front of you.
- Check adjacent lifeguards for visual communication
- Ensure to scan below the surface. Attend to the danger points more often

4.1.4 Scanning Strategies

Head counting – Try to count the number of people in your area.

Grouping – Sort clients into groups by age, sex, risk potential, activity, and any combination.

Mental filing – On successive sweeps, build patron profiles that take note of swimming ability, skill, activity, or other relevant factors.

Profile Matching – On each scan, measure what you see against the characteristic profiles of potential trouble or types of persons in difficulty.

Tracking – Track the progress of individuals who submerge and those who fit the high-risk profile.

4.1.5 Screening Clients

Cooperation from clients can lighten a lifeguard's load:

Ask parents to stay close to their small children

- Encourage swimming with a friend.
- Promote the attitude that everyone should be concerned with safety at the venue.
- Educate clients about safe practice.

- **Water bobbers** – jump up and down from the floor of the pool, just breaking the surface.
- **Corner jumpers** – attempt to leap across the corner of the pool.
- **Gutter grabbers and rope holders** – move into deep water hand over hand along the rope or edge.
- **Swimmers under diving boards** – slides, ladders, or other aquatic equipment.
- **Disorientated people** – who have been doing somersaults, flip turns, dives.
- **Breath holders** – tile counters and 'dead man floating' clients who hold their breath.

Some tasks on poolside do not need to be carried out by a qualified Lifeguard. Where possible, to avoid a loss of supervision, utilise another trained team member e.g. pool testing, setting up of equipment

4.2 Pool Hazards Identifications

4.2.1 Patrons

- Young children using flotation aids- beware of aid falling off.
- Young children-especially those under 6 years' old.
- Older people who may lose their footing.
- Children who appear inadequately supervised. Locate parents and advise of RLSSA Keep Watch program.
- Boisterous youths who draw attention of the lifeguard away from other hazards.
- Children playing around the poolside may slip in the pool or on pool deck.
- Small children with toddlers/babies.
- Parents swimming laps / smoking outside/ using café.
- People with a disability –carers not in the water, balance issues, lack of behavioural control**s.**

4.2.2 Activity Hazards

- Playing around steps. Parents may not realise the sudden depth change.
- Running, bombing, diving.
- Distance swimming under water holding breath competitions.
- Shoulder carries, use of inflatable equipment.
- Ball games.
- Large flotation devices i.e., boogey boards, boats.
- Inflatable use.
- Pushing, acrobatics, poolside crawling.
- Wrestling near other patrons or near edge.
- Playing tips/tags.

4.2.3 Physical Hazards

- Prams seats or bags in front of emergency exits.
- Changes in water depth.
- Steps.
- Dividing walls.
- Areas with obscured views of the bottom.
- Deep water.
- Shallow water.
- Water features.
- Areas obscured by glare.
- Lane rope.
- Movable furniture i.e., chairs. Can be used as a platform to jump into pool.

4.3 Higher Risk Areas

Due to the design of East Maitland Aquatics has a few high-risk areas associated with pool supervision. As per active supervision risk assessment Appendix 1

4.3.1 Toddler Pool

Because of the slow descent from 0.15 on around pool to 0.35m in the middle the children believe they can touch the bottom throughout the toddler pool. This is a significant risk as this is the only pool toddlers can touch the bottom

4.3.2 Pool Steps

Pool steps are areas that young children often tend to play around. Children will experiment with the steps to see how far they can stray out of their depth; this presents an obvious danger due to the sudden depth change in comparison the child's size. A split second and a child can be out of their depth.

Particular attention should be paid to the steps near the lifeguard station as this area gets less attention and is a blind spot to most supervision points on pool deck.

4.3.4 Sun Positions

With centres location and structure of facility it allows for the early morning sun from the east and the evening sun in the west very difficult to supervise and in some cases completely non-visible around the centre. Refer to Active supervision risk assessment

Lifeguards, coaches, aquatic education teachers and party hosts need to be alert to the dangers that these areas present to users on the pool deck. All incidents including near misses must be reported using the incident report forms. Incident analysis helps to create a safer environment. All should play a part.

4.4 Communication

To supervise a pool properly you must be able to communicate with other lifeguard, members of the public and various user group. Also be able to communicate with community special need groups, various age groups.

Your most useful tool is your voice backed up with body language. Your appearance, posture and facial expressions send out all kind of messages and remember we want a positive one.

4.4.1 Types of Communication

Verbal – Verbal communication is the most common type of communication used in the aquatic industry. It is essential in emergencies between lifeguards, members of the public or emergency services. When using the verbal, you must loud and clear and direct with the message you are relaying to another.

Visual signage – Visual signage around the centre can assist with communicating to all members, special needs, and staff.

Hand Signals – Hand signal are used in emergency when two-way radios are not available. They should be reviewed/practiced regular in staff training in accordance with the RLSSA.

Two-Way radios – Two-way radios are a popular way to communicate between lifeguards for all emergencies they are also a tool that can be used to relay messages from lifeguard to reception, duty managers and management while on site.

Whistles – Whistles signals and other audible signals are useful at venues where the sound carries clearly. They can be used to get attention of other lifeguards or members of the public by one short whistle blast and 3 whistle blasts for Centre emergency

Facility PA System – Facility PA system can be used on busy days to capture the entire audience in the facility and spread any required messages and/or notices.

Teams – Teams is used between lifeguards to communicate information for staff either the next day or next week, also communicate any HAZARDS, INCIDENTS or Equipment required management team.

Toolbox Meetings – Toolbox meetings are conducted daily to help increase communication and to identify what bookings and program are running on each day. This is also used to discuss WHS issues and highlight key cleaning and staff responsibilities.

4.5 Guarding Positions

When planning, where the best position for a lifeguard, remembering that the objective is to ensure effective supervision of the entire centre. A few contributing factors are taken into consideration:

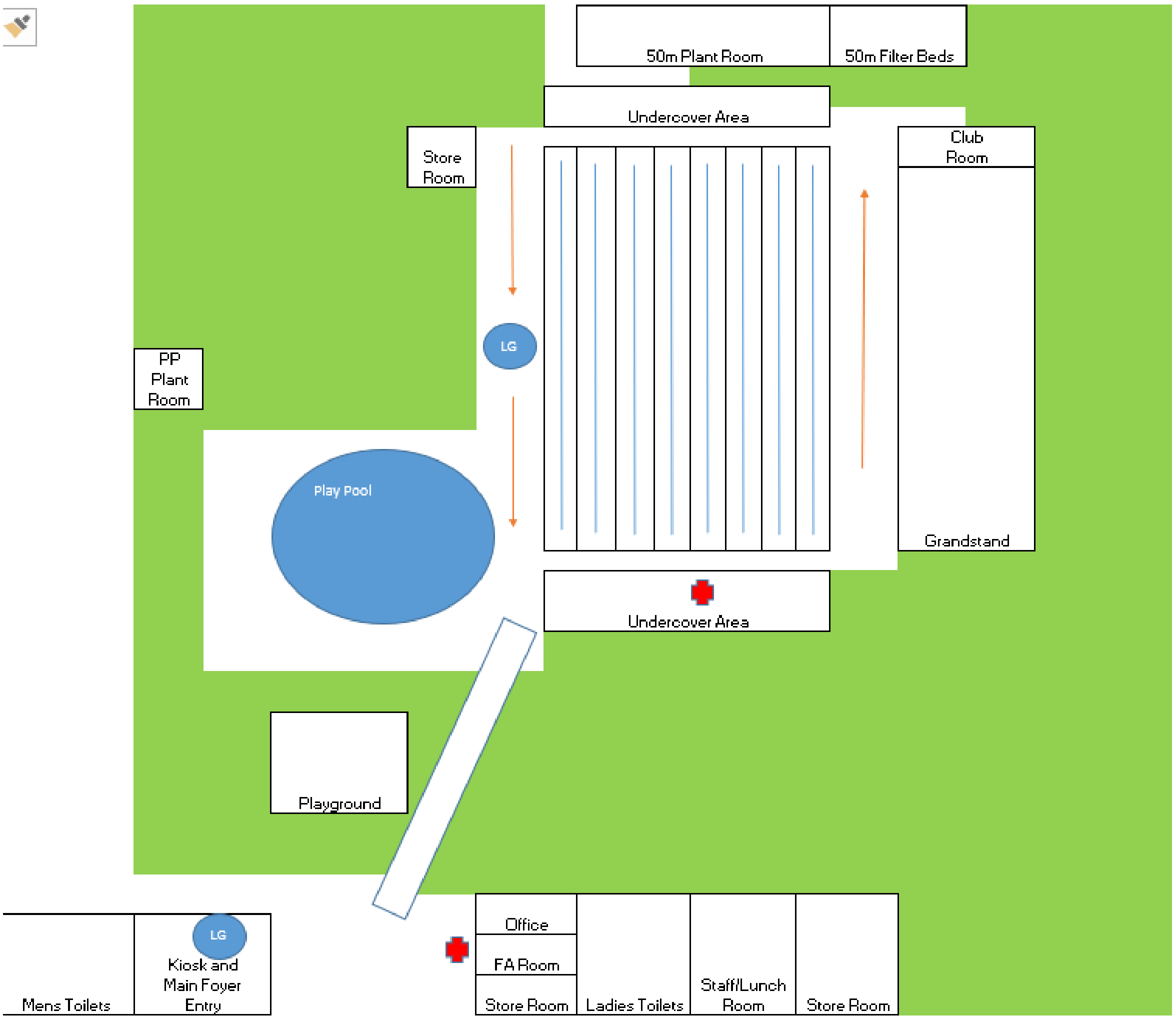
- Number of lifeguards required on duty
- Lifeguard should always be able to maintain supervision of the water
- Identification of high-risk areas throughout facility
- The design of the facility
- The ability of lifeguards to respond efficiently in and emergency
- Line of sight

The centre is required to have a minimum of 2 qualified lifeguards on site at all times, this is to comply with RLSSA set out in Section 7 of guidelines for safe pool operations and practice NOTE 15 set out by NSW local government

4.5.1 Supervision with 2 Lifeguards

With 2 lifeguards on shift you must always have they should rotate between 50m pool and small toddlers every 30 mins to help with fatigue. When rotating between pools you must meet in between both pools and change over, this allowing for both pools to be constantly supervised. Remember to take into consideration positioning factors to establish best possible position for effective lifeguarding

When lifeguarding the arrows are the areas in which you are responsible for

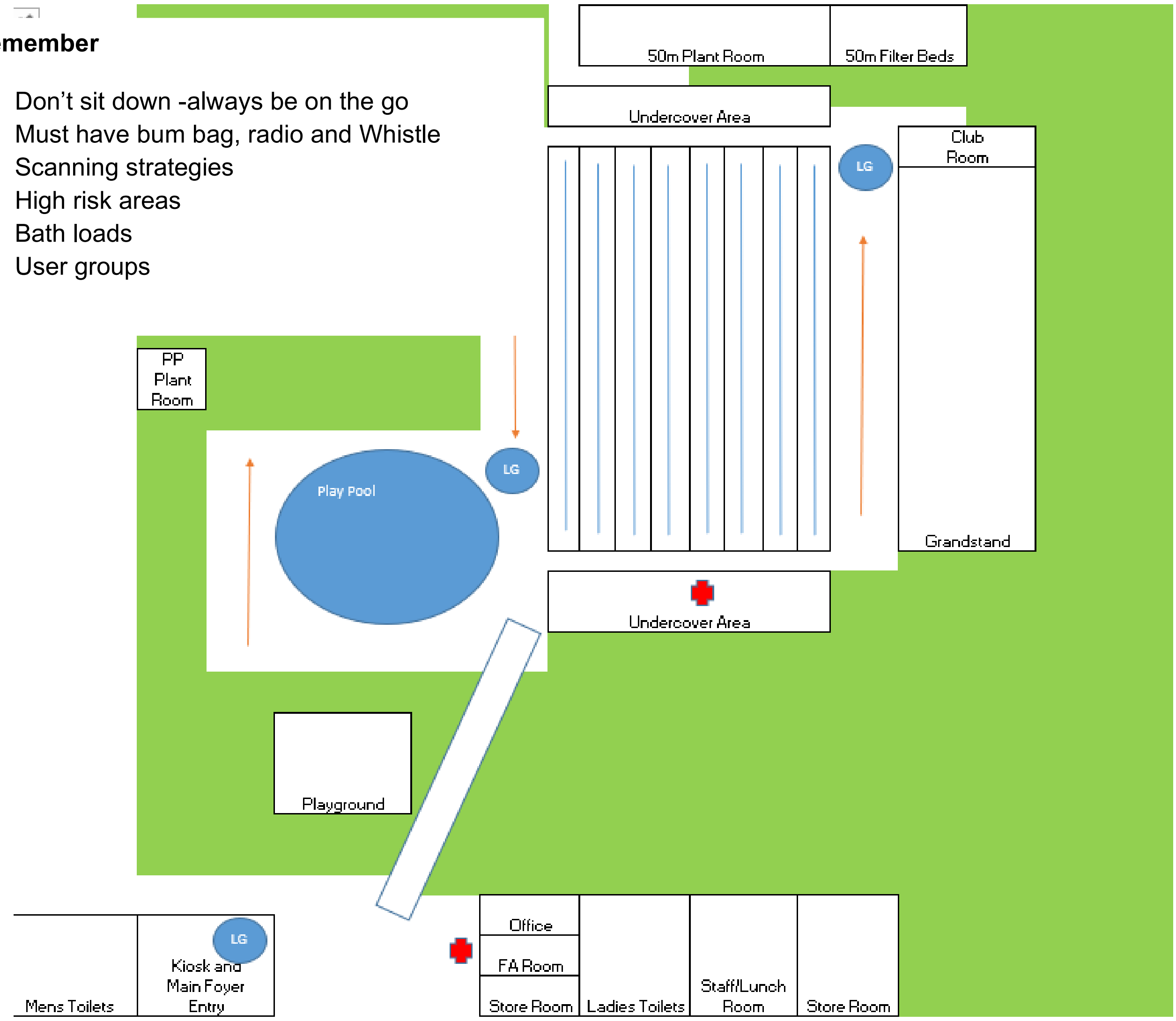


4.5.2 Supervision with 3 Lifeguards

With 3 lifeguards on shift you with must work together as a team to identify bather loads in 50m and small toddlers as this may change as the day progress. By monitoring this you will be able to establish best positioning for lifeguards for effective supervision of the centre. You will need to remember that when you are rotating between position that a lifeguard must always be watching 1 body of water at a minimum

Remember

- Don't sit down -always be on the go
- Must have bum bag, radio and Whistle
- Scanning strategies
- High risk areas
- Bath loads
- User groups



LIFEGUARD TOOL

Drowning only takes a matter of seconds…
Lifeguards need to be able to identify a potential incident in seconds and respond.
Accessibilty and duration of time to get to a casualty needs to be taken into account when deploying lifeguards to supervision stations

4.

LG 2 / 3 with information waiting for response	information back to confirm you understand the emergency.	information back to confirm you understand the emergency.
When LG 2 respond attend to the emergency	Get emergency equipment necessary for emergency and go to LG 1	Radio reception with emergency information and get them to call appropriate emergency services
Stay at emergency until emergency services arrive	Assist with emergency	Evacuate pools / areas as need to deal with emergency

When LG 2 arrives give updates and directions on what is required		Get details witness statements
After emergency has finished fill out appropriate documentation	After emergency has finished fill out appropriate documentation	After emergency has finished fill out appropriate documentation
Contact relevant management		

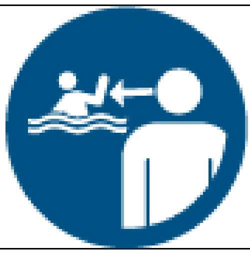
4.7 Keep Watch Program

Implementation of:

Royal Life Saving Society ‘Keep Watch’ campaign

(“Parental Supervision of your children in the water”)

The Royal Life Saving Society ‘Keep Watch @ Public Pools’ Campaign.

The Keep Watch @ Public Pool Policy	
	**0-5 YEAR OLDS AND NON-SWIMMERS** Stay within arms’ reach at all times. For 0–5-year old’s and non-swimmers, a parent or guardian always needs to be in the water and within arms' reach of the child. Parents and guardians should always actively supervise their children and be dressed ready to enter a pool. It is best if you are engaging with your child i.e. playing with them, talking to them. These patrons are required to wear a Keep Watch wrist band pictured below. 
	**6-10 YEAR OLDS AND WEAK SWIMMERS** Be close, be prepared & maintain constant visual contact. Constand active supervision is required for children aged 6-10 years old. Parents and guardians/carers must be prepared to enter the water with this age group.
	11-14 YEAR OLDS Maintain visual contact For 11–14-year old’s, recommendation is for parents regularly physically go to where they are in or around the water.

	The intent of this age bracket is designed to educate parents that this age group is still at risk despite having a high degree of independence and parental supervision is an effective means of increasing their safety. Facilities should assist in the education of parents by drawing parents' attention to the 11-14 recommendation. Facilities should also develop strategies for parental supervision of this age group as part of their policies and entry requirements
The Keep Watch @ Public Pools policy and the ages within it represent minimum standards only. Royal Life Saving encourages pools to adopt a higher standard wherever possible.	

4.7.1 Keep Watch Marketing Tools

5. Occupational Health and Safety

5.1 OHS Risk Assessment

5.2 First Aid

First aid kits are accessible in 3 key locations in the centre which are identified with signage complying with AS -1319. Portable first aid kit in on deck, wall mounted first aid kit plantroom and first aid supply in first aid room along with cupboard with back up emergency equipment. All kits are check every 3 months to comply with MCC WHS policy, Safe work Australia code of practice Feb 2016 and adhere to RLSSA standards and guidelines. An inventory check list is sign and date by appropriate staff when completed and regularly monitored.

5.2.1 First aid Content

With East Maitland Aquatics having less than 100 but more than 10 workers we are required to have First aid kit size B, this is NSW regulations which is set out in OHS regulations 2001 set out specific first aid requirements and industry standards RLSSA.

List of contents

Item	Amount
Adhesive plastic strips	50
Adhesive tape 2.5cmx5m	1
Amputation bags of 3	1
Antiseptic swabs	10
Conforming bandages 10cm	1
Conforming bandages 5cm	1
Disposable gloves pair	2
Eye pads, sterile	2
Eye wash, 15ml. sterile	5
First aid pamphlet	1
First aid scissors 12.5cm	1
No 15-wound dressing	3
Non-stick dressing 7.5cmx7.5cm	2
Safety pins, set of 12	2
Splinter forceps	1
Thermal emergency blanket	1
Triangular bandages	4
Burns module	1
Eye module	1
Tweezers	2
Liquid skin antiseptic	1
Pocket face mask	1
Icepacks	2
Sterile strips	2
First aid instructions	1

5.3 Personal Protective Equipment

Personal protective equipment (PPE) is any clothing or equipment that you use for protection – E.g., Goggles, ear plugs, Respirators, Safety shoes and gloves even sunscreen and broad brim hats. PPE is useful, but also one of the least effective ways of controlling safety problems.

ALL PPE AT EAST MAITLAND AQUATIC CENTRE CAN BE LOCATED EITHER IN FIRST AID ROOM OR 50M POOL PLANT ROOM

5.3.1 Responsibilities

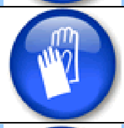
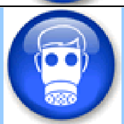
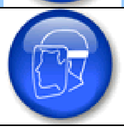
Employer

Maitland City Council are required to make sure PPE is available and maintained with all current WHS act 2011, WHS Regulations 2011and AS/NZ standards. Managers are to provide training for fresh staff on location of PPE and its correct use and ensure all employees they follow all safety procedures. All management /Supervisors and staff will ensure that supplied PPE is diligently used whenever they are exposed to hazards. Training is completed on annual calendar which is part of your contract to attend regular training

Employee

All employees are to use PPE correctly whenever it is required as per there training, any miss use can result in an injury to you or others and disciplinary action. It is also your duty care to report and foreseeable hazards with PPE equipment to your supervisor ASAP

5.3.2 Types of equipment

	**Eye protection AS/NZ 1337.1 – 2010- Med Impact**
	**Earmuffs AS/AZ 1270:2002** **Rating: Class SLC (80)2dB**
	**Black chemical Resistant Gum Boots**
	**Green Chemical Resistant gloves** **CE Compliant EN 374-03 (General Chemical Protection)**
	**Respirator mask 6000 series** **AS/NS 1716:2012**
	**Face shield AS/NZ 1337:2002**

5.4 Incident Reporting Procedures

5.4.1 Policy/Procedure

It is Maitland City Council policy that all staff have a current first aid certificate and staff responsibility to keep current. All incidents that occur whether it be minor / major at the centre are documented. This is reported to safety officer / operation Supervisor for follow up and investigation if required. All incidents are logged on Vault and witness statement and first aid report forms are uploaded. Reports are tracked to follow trends developing throughout facility in any key areas.

5.4.2 Responsibilities

All staff have a duty of care to all patron in facility and must provide first aid within their training. All Maitland Aquatic staff are first aid qualified regardless of being a lifeguard or not.

5.4.3 Reporting

All incidents must be logged, and all the appropriate documentation must be filled out. Witness statement forms are to be filled out by other staff members or public that witness a major incident. All major incidents are to be reported to Centre manager / safety office immediately so it can be investigated. All majors must be reported to

5.4.4 Minor / Major

Minor - emergency is a non-life-threatening situation that requires immediate assistance by lifeguard or qualified staff member but doesn't affect the operation of the facility and normal only requires 1 person. Examples of minors include

- Minor bleeding.
- Stubbed toe.
- Weak swimmer.

Major - emergency is not necessary life threatening but requires the immediate assistance by 2 or more lifeguards or qualified staff, it may require section of the facility to be closed while major emergency is being handled. It generally requires the call for emergency services such as Ambulance, Police and Fire fighter. Examples of majors include

- Drowning.
- Spinal incident.
- Heart attack.

5.4.5 Location

Incident report form is in main first aid room, it is also logged onto Vault via duty managers phones. Once it has been completed duty manger is to action on Vault and put hard copy in tray allocated in first aid room.

5.6 Chemical Delivery, storage, and handling

5.6.1

Delivery point for East Maitland Pool is the gate outside 50m plant room.

Maitland has 2 components when it comes to chemicals, No1 bulk storage which is CO_2 which is our primary used chemicals, No2 stored chemicals which are our secondary used chemicals with very minimal stored on site

Bulk Chemicals

- 1x Carbon Dioxide (CO_2) is delivery on a milk run, meaning every fortnight we receive approximately 140 kg. We can store 240 kg when we are full.

Stored Chemicals

Sodium Thiosulphate we have 2x25kg bags on site

Sodium Bicarbonate we have 5x25kg bags on site

Cyanuric Acid we have 2x25kg bags on site

Calcium Chloride we have 2x25kg bags on site

C-5 2 x 25 kg buckets which have 100 tablets in each

Stored chemicals are stored in dry ventilated area of the ground with bunding provided

5.7 Manual Handling

5.7.1 Definition

Manual Handling is any activity that involves lifting, pushing, pulling, carrying, or moving, holding, or restraining. It also includes sustained and awkward postures or repetitive movements.

5.7.2 Roles and Responsibilities

All parties have a responsibility in maintaining a safe workplace and following safe manual handling principles. An outline of the specific roles and responsibilities for manual handling are detailed below. Points below provides general guidelines to safe manual handling.

- When practical all objects work practices and work environment are designed, constructed, and maintained to eliminate risks arising from manual handling.
- Provision of mechanical aids if possible.
- ensure workers are trained in correct manual handling techniques and the correct use of mechanical aids
- That new workers employed by MCC are provided reinforcement in the MCC induction regarding safe manual handling techniques.
- That all workers identified as working in an environment that has been to identify to contain potential high-risk manual handling type activities are provided appropriate guidance and/or training every 3 years.

5.7.3 Managers

- Ensure appropriate lifting equipment is available for workers and the workers have attended appropriate training.
- Information relating to safe manual handling techniques is noted in the relevant SOPs, SWMS etc.

5.7.4 Supervisors/Team Leaders

- Ensure that workers are competent for tasks to be undertaken.
- Ensure that workers take appropriate breaks.
- Ensure workers are using appropriate lifting equipment to reduce the manual risk associated with the manual handling task.
- Ensure workers are using ‘team lift’ technique only when circumstances permit; and are doing so correctly.

5.7.5 Workers

- Follow Maitland City Council Procedure –Manual Handling and reasonable directives provided by their supervisor.
- With regard to team lifting, MCC considers it appropriate for participation of workers in the following circumstances:
- Where no other handling techniques or suitable mechanical aids are appropriate.
- Not to use team lifting techniques that would create a greater risk to an individual employee.
- Members of the team have been trained in the correct team lifting techniques.
- Not to perform in team lift unless they a have been appropriately trained.

5.8 Safety Data Sheets (SDS)

A safety data sheet (SDS), previously called Material safety data sheets, is a document that provides information on properties of all centre hazard’s chemicals. All supplier of dangerous good must supply SDS and must comply with WHS act 2001 and NSW regulation 2011. A SDS includes the following information:

- Identity of the chemical
- Health and physicochemical hazards
- Safe handling and storage procedures
- Emergency procedures
- Disposal considerations

A SDS is referred to when we are assessing risk involved when using chemicals in the workplace. SDS last for 5 years and are reviewed regularly during site audits. SDS are located at each chemical storage area of the centre, a second set in black and yellow folder on operation manger desk. Third set is in Chemical manifest also on operation manger desk.

5.9 Plant Inspections, Maintenance Services

Maitland City Council has a contract service agreement with Trisley's Hydraulics for East Maitland pool plant room. It is divided into, Quarterly, 6 months and annual services along with some asset replacement schedule to make sure the plantroom is operating at 100%, prevent breakdown and centre closures and provide excellent water quality to comply with NSW health swimming pool and spa guidelines 2013.

5.9.1 Contractors responsibilities

Plant inspections are completed every morning before opening and reported on opening risk assessment checklist, if hazards are found appropriate documentation is to be filled out immediately and reported to management.

5.9.2 Maintenance

Pool staff trained in pool operations are responsible for the daily running and upkeep of the plantroom. Tasks that are completed daily, weekly monthly are documented on monthly plantroom log sheet.

- Back washing of filters
- Cleaning of pots
- Cleaning of inline strainer filters for dosing unit
- Calibration of doing unit when required
- Cleanliness
- Reporting any faults to operations supervisor immediately

5.9.3 Services

Maitland City Council has a contract service agreement with Trisley's Hydraulics for Maitland Aquatic Centre Pool and plant room. It is divided into, Quarterly, 6 months and annual services along with some asset replacement schedule to make sure the plantroom is operating at its full capability, prevent breakdown, centre closures, and provide excellent water quality to comply with NSW Health Swimming Pool and Spa Advisory Document 2013.

5.9.4 Contractor Responsibilities

- Follow all facility COVID-19 Conditions of Entry.
- Sign in/out at facility entry prior to commencing any work.
- Following all regulatory WHS rules.
- Ensure to engage with Operations Supervisor or Duty Manager prior to commencing any work.
- Complete all work, ensuring safety for themselves, pool staff and pool patrons.

5.9.5 Plantroom training

It is recommended that pool staff operating and completing maintenance tasks in a Maitland City Council Aquatic Centre should have completed the RLSSA Technical Operations Course. The Technical Operations course is the industry standard for pool supervisors as documented in the department of Local Government Practice Note 15.

This course has 4 theory modules.

- Identify Risk & Apply Risk Management Processes
- Test Pool Water Quality
- Develop & Implement Pool Water Maintenance Procedures
- Aquatic Facility Maintenance

Upon successful course completion of the course participants will be issued with a Nationally Recognised Training certificate (Statement of Attainment). Units of Competency achievable through this course include:

- BSBRSK401 Identify risk and apply risk management processes
- SISCAQU001 Test pool water quality
- SISCAQU003 Maintain aquatic facility plant and equipment
- SISCAQU004 Develop and implement pool water maintenance procedures
- SISCAQU005 Develop and implement aquatic facility maintenance procedures

Along with these qualifications, Maitland City Councill have Trisley's Hydraulics run scheduled annual training on all components of the plantroom, where you are signed of to be competent or not component in the plantroom. To complete any of the above task you Must be competent in the plantroom.

5.10 COVID-19

5.10.1 What is COVID-19

Coronavirus disease (COVID-19) is an infectious disease that is caused by a newly discovered form of coronavirus. COVID-19 is a respiratory infection that was unknown before the outbreak that started in Hubei Province, China, in December 2019. Other known forms of coronaviruses include Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). Since first detection of the virus is 2019, other variations have become detected.

5.10.2 Symptoms of COVID-19

Symptoms of COVID-19 can range from mild illness to pneumonia. Some people will recover easily, and others may get extremely sick very quickly.

The common symptoms of COVID-19 may include:

- Fever.
- Coughing.
- Sore throat.
- Fatigue (tiredness), and
- Difficulty breathing or shortness of breath.

Most people infected with COVID-19 will have a mild to moderate illness and will recover without special medical treatment. Some people, such as those with underlying medical problems or disease and older people, are more likely to suffer from more serious symptoms of the diseases.

5.10.3 How does COVID-19 Spread

- The most likely way someone will catch the virus is by breathing in micro-droplets a person close to them has released by sneezing, coughing –or just breathing out.

- A person can, however, also catch it via the hand-to-face pathway: touching a surface where live virus material is present, then touching their mouth, nose, or eyes.
- Spread of COVID-19 is highest from people with symptoms.
- Spread of COVID-19 before symptoms appear is less common.

5.10.4 Dealing with COVID-19 in the Workplace

Maitland City Council Aquatics Team has developed different COVID-19 Safety Plans which allows the facility to operate under NSW Health Guidelines and Public Health Orders whilst keeping patrons and staff safe.

Some of the basics from each Safety Plan have been listed below

- All staff and patrons showing cold/flu like symptoms are not to attend the facility and staff are to advise their supervisor.
- Masks are to be worn and 1.5m social distancing always adhered to by patrons (exception being whilst in the water) and staff.
- Both patrons and staff are required to use QR Code or NSW Health Website to check in/out for each session/shift.
- Staff are encouraged to get vaccinated.
- Patrons are encouraged to turn up ready for their activity wearing appropriate swimwear to avoid cluster of patrons in the change rooms.
- Patrons and staff are encouraged to use hand sanitiser as required.
- Staff will regularly wipe down high touched areas such as handrails and door handles.

For further information regarding current restrictions and Public Health Orders in NSW, follow the below link to NSW Health Website.

https://www.health.nsw.gov.au/Infectious/covid-19/Pages/default.aspx

For further Maitland City Council COVID-19 information, follow the below link to ERIC – NSW COVID Outbreak Information Hub

https://maitland-intranet--simpplr.visualforce.com/apex/simpplr__app?u=/site/a112x000000Pf6mAAC/page/a0z2x00000VYYeqAAH

6. Water Quality

6.1 Testing Kit

Maitland Aquatics have a Palintest 25 photometer it is annually serviced and calibrated to comply with industry standards and guidelines

6.2 Test Methods

Each test is identified by a spate program number shortcut key. All staff required to test water are inducted as to water testing and test results are regularly evaluated.

6.1.1 Test 1 Free Chlorine

1. Rinse test tube with sample leaving 2 or 3 drops in the tube
2. Add one **DPD No 1** tablet, crush and then fill test tube with sample to the 10ml mark. Mix to dissolve tablet and ensure any remaining particles have settled.
3. Take photometer reading **immediately**, as a result may drift on standing.
4. Retain test solution if the total chlorine follows on test is required.

6.1.2 Test 2 – Total Chlorine

1. Add **DPD No 3** to retained free chlorine test tube, crush, mix and dissolve
2. Stand for two minutes
3. Take photometer reading. Ensure the display shows the chlorine-total 5 test is selected
4. NB: to obtain combined chlorine residual subtract free chlorine result from total chlorine result

6.1.3 Test 3- pH value

1. Fill test tube with sample to the 10ml mark
2. Add one **phenol red** tablet, crush and mix to dissolve
3. Take photometer reading

6.1.4 Test 4 – Alkalinity to be tested daily

1. Fill test tube with sample to the 10ml mark
2. Add one **Alkaphot** tablet, crush and mix to dissolve
3. Allow to stand for one minute
4. Take photometer reading

6.1.5 Test 5 – Calcium Hardness to be tested weekly

1. Use test 8
2. Fill test tube to the 10ml mark
3. Add one **calcicol No 1** tablet, crush mix and dissolve
4. Add one **calcicol No 2** tablet, crush mix and dissolve
5. Stand for two minutes
6. Take photometer reading.

6.1.6 Test 7 – Cyanuric Acid

1. Fill test tube with the sample to the 10ml mark
2. Add one cyanuric acid test tablet. DO NOT CRUSH. Allow the tablet to disintegrate for at least two minutes.
3. Crush any remaining undissolved tablet, mix and the take photometer reading

6.1.7 Saturation Index

The maintenance and scheduled testing for water quality tests are logged on the Day sheet for operations (log sheet 6.2.2). Mandatory Annual Recalibration of the test unit conducted by Palin test Australia is completed and the certificate of proof is kept with the unit.

6.2 Operating to relevant Water Quality Guidelines - Water Quality Guide parameters and corrective action plan

6.2.1 Water Testing Guide

Public Swimming Pool and Spa Pool Advisory Document NSW Health PAGE 29

Table 5.1: Chemical criteria for chlorine-based pools

Parameter	Situation	Concentration
Free Available Chlorine (1) (DPD No 1)	Outdoor Pool	Min 1.0 mg/L
	Outdoor Pool + Cyanuric Acid	Min 3.0 mg/L
	Indoor Pool	Min 2.0 mg/L
	Spa Pool	Min 2.0 mg/L
	Any pool where pH > 7.6	Raise min by 1.0 mg/L
Combined Chlorine (3)	Any pool	Max 1.0 mg/L
Total Chlorine (DPD No 1 + No 3)	Any pool	Max 10.0 mg/L
pH	Any pool	Range 7.0 to 7.8
Total Alkalinity	Any pool	80 to 200 mg/L
Cyanuric Acid	Outdoor pool only. Not spas	Max 50 mg/L]

Before taking action re-test.

Pool test tablets are sometimes unreliable, and readings can vary due to faulty equipment and poor incorrect testing methods. A retest should be conducted along with using a different sleeve of tablets

6.2.2 Blanket testing sheet

Daily Water Testing Schedule - Maitland Aquatic Centre 2020/2021													
Week:	Date:		Weather:	Morning		Afternoon		Solar	Acid On	Acid Off	Acid %	Co2 %	
MANUA	Staff	Free C	Total C	pH	Alk	Air '	H₂0 '	***AUTO***	ORP (m	PPM	pH'		
Prior to Open								**Prior to Open**					
								9:00am					
12:00pm								12:00pm					
								3:00pm					
Prior to Close								**Prior to Close**					
Screens	am		pm		Make up water	am	pm		off	Calibration			

Water Balance (weekly)							Chemical Additions	
pH		General	Notes:				time:	
Temp							Prior to Open	
Calcium							9:00am	
Alk				Calculated	by:		12:00pm	
Total		: -12.1	: =	sign:			3:00pm	
Water Balance (weekly)		: ideal range	is 0.2	range is	-0.5 to 0.5		Prior to Close	
Cyanuric	:	Weekly		sign:				
Reviewed by:				date:				
Incidents / Corrective Actions Taken:								

6.3 Corrective action

6.3.1 Turbidity and Corrective Action

Turbidity is best described as cloudiness of the water to a point where you cannot see the bottom of the pool. The procedure for this is:

1. Close the Pool
2. Ensure all water balance readings are within safe parameters
3. Backwash and Flock pool continuously
4. Repeat this process until clarity returns.

6.3.2 Chemical Dosing

Chemical dosing at East Maitland pool is done automatically through a Prominent Pro Cal automatic Dosing unit. Brief descriptions of its functions are below. In the event of the Prominent Pro Cal unit is failing, Safe Work Method Statements are used to hand dose the pools (see attached SWMS's). The SWMS are located near in the area where the task is to be performed and copies are kept on the centre hard drive

6.3.3 Prominent Auto Dosing Unit

The Prominent automatic dosing unit enables the centre to monitor essential pool water quality readings. For further information on the use of the unit refer to the product manual.

DULCOMETER® controllers and DULCOTEST® sensors ensure maximum process safety combined with a comprehensive range of use: from pH value, ORP/redox, conductivity and chlorine through to chlorine dioxide, chlorite, ozone, hydrogen peroxide and other parameters.

Pool lifeguards must record the unit's chlorine and pH value reading on the daily water testing sheet.

6.4 Chemical Leaks and Spills

Full PPE must be worn at all times when dealing with a chemical leak or spill. In the event where access to PPE is restricted an emergency spill kit is located on the fridge in the lifeguard station that contains spare PPE. Always consult SDS before taking action.

6.4.1 Procedure

For every leak or spill, the following steps should be taken:

Contain → **Dilute** → **Neutralise**

Leaks and spills should be **CONTAINED using the chemical spill kit located** next to the external plant room doors mounted to the wall. If they are left to spread, this could cause more damage and harmful fumes. Always prevent spills from entering drainage systems

DILUTE leaks and spills of liquid chemicals to help reduce the harmful fumes and reduce the risk of chemical burns.

Chemicals need to be **NEUTRALISED** to stop the harmful fuses. The use Sodium Bicarbonate or sodium thiosulphate to neutralise chemicals is a common practice but should only be carried out by trained staff that have a thorough knowledge of chemicals. Always check with the pool operations coordinator before using these chemicals and consult the SDS. The centre has an emergency spill kit that should be used when dealing with unexpected spills.

Note: Fizzing will occur due to production of CO_2

6.4.2 Gas Leak

1. Clear the area and move upwind.
2. Apply all safety equipment, as applicable.
3. Confine the affected area.
4. Contact the Fire Brigade if the gas is flammable.

Note: co2 is not a flammable gas

6.4.3 Powder Spill

1. Sweep up with a clean brush and immediately remove sweepings to a safe place outside on a slight slope.
2. Spread contents thinly.
3. Contain the powder in a bund.
4. Dilute with large volumes of water, starting at the lowest point on the slope and working upwards.
5. Clean brush used for sweeping, very thoroughly.

6.5 Super Chlorination/Shock Chlorination

If the pools become contaminated pool lifeguards must adhere to the NSW Health contamination response plans in appendix e or online at (Swimming Pools and Spa Pools (Public). The 50m pool is super chlorinated every month and at the start of every summer using Chlorine dioxide. As outlined in 6.7.3 of the swimming pool and spa advisory document the WHO recommends that the ClO_2 concentration should not exceed0.3mg/L. therefore the pools are dosed to this amount.

The centre is using C5 tablets to super chlorinate and shock chlorinate the pools. This has reduced risk to workers and increased decreased the time required to perform the task. No pool lifeguard should super chlorinate, or shock chlorinate the pools without prior approval by the duty Manager / Operation Supervisor

C5 dosing chart			
50m pool		**Toddler**	
Super	Shock	Super	Shock
52 Tablets	130 Tablets	3 Tablets	7 Tablets

In the event of a contamination the lifeguards have been trained and inducted to follow the suitable response plan provided by NSW Health. These response plans can be found in the appendix section of this manual. Laminated copies are also kept in the lifeguard station wall.

7. Programs

7.1 List of programs offered

- Aquatic Education Classes (School based program0
- Aqua Aerobics
- Birthday Parties

7.2 Program safety requirements.

All programs are fully supervised by qualified staff. All programs have a documented full risk assessment and respective Safe work method statements. See the WHS operations manual for further information. Also see pool zoning section.

7.2.1 Aquatic Education (School Programs)

- Water Quality meets standards
- All children are returned to parents
- Children are always watched/supervised
- Aquatic Education areas should display 'lesson in progress' signage
- Aquatic Education teachers must have minimum AUSTSWIM Qualification
- Classes are conducted in accord with GSPO PR8 & 10

7.2.3 Aqua Aerobics

- Equipment maintained and in Working order
- Aqua classes are conducted in accord with GSPO PR 9
- Water Quality meets standards
- Instructor to have a minimum Certificate 3 in fitness instruction
- 1 lifeguard is always to be present
- Class teacher to participant ratio maximum of 1:40
- Hydration is encouraged throughout class
- Participants to be always supervised
- Summer outdoor pool, winter leisure pool

7.2.5 Birthday Parties

- Area for party is clear and free from obstacles
- Marquee is anchored and set to a safe height
- Equipment maintained and in Working order
- Water Quality meets standards
- Supervised by fully qualified lifeguard
- Participants to be supervised at all

7.3 Pool or room set up and requirements

7.3.1Aquatic Education

Learn to swim runs both morning 9 till 12 and afternoons 3:30 till 6:30. Learn to swim staff are to arrive early and set up the areas of the pool they require for the class. Lifeguard should assist when possible but never compromise active supervision

7.3.2 Aqua aerobics

Aqua Aerobics runs different session times to cater for a broader range of ages groups. All Aquatics officers are to assist when setting up for aqua but never compromising active pool supervision. again, never compromising active pool supervision, you may need to get pool cover while you help set up.

7.3.3 Disabled Access Equipment:

The initial lifeguard induction trains lifeguard to use the following centre equipment:

- Wet chair

7.3.4 Pool Bookings

All pool bookings are required to fill out booking forms and e-mail to bookings coordinator for request of booking and then no booking is approved until confirmations e-mail has been received

8.Training

8.1 Induction and Orientation/Qualifications

Maitland City Council /RLSSA Policy that all staff complete induction and orientation of Centre before commence work. All lifeguards must have current pool lifeguard certificate and their licence MUST say East Maitland Pool. It is Maitland City Council policy that all staff have current First aid and CPR certificate to be employed. The centre will hold updates throughout the year, but it is the responsibility of the employee to make sure their certificates stay current, or they cannot work.

8.2 In Service Training

It is Maitland Aquatic policy that all staff must attend compulsory regular in-house training (minimum of 4 sessions). Some training sessions will require you to volunteer your time to come and attend skill refreshing training and keep your skills up to date with current industry standards and other training will be compulsory in which you will be paid for and must attended otherwise you will be taken off shift. Some training will be competent base where you will be assessed on involvement, knowledge, and participation in training session. All training is documented and kept on file.

Please refer to In House Training Calendar for a further detailed view.

8.2.1 Maitland & East Maitland Annual Training Plan

Maitland Aquatic Centre & East Maitland Pool Annual Training Calendar 2021

Months	January	February	March	April	May	June	July	August	September	October	November	December
Operational		Plant Room	Chemical Handling		Centre Evacuations Responsibilities		Plant Room		Chemical Handling	Lifeguard Update Royal Life Saving		Centre Evacuations Responsibilities
Emergency Preparedness	Parental Supervision Keep Watch Program	Spinal Management (Ass 1-4) Lifesaving Skills (Ass -5)	First Aid Minor and Major (Ass 9-10) Resuscitation Oxygen equipment Defibrillators (Ass6-8)	Parental Supervision Keep Watch Program	-				Spinal Management (Ass 1-4) Lifesaving Skills (Ass 5)	First Aid (Ass 9-10) Resuscitation Oxygen equipment Defibrillators (Ass6-8)	Parental Supervision Keep Watch Program	
WHS	Manual Handling		Internal Site Audit							Manual Handling		
Facility/Risk Management			Fire Warden Training	Emergency Action Plan All staff		Public Relation		Safety Sign Audit			Emergency Action Plan All staff	
Swim School				Evacuation -Child safety -Incident reporting				Level program review procedures			C.P.R Scenarios	
Kiosk CSO	Program Levels Memberships			Banking and Cash handling -Policy and procedures				Conflict resolutions Mystery Shopper procedures			Emergency procedures Incident reporting Child Safety	

9. Annual Facility Service Plan

2020 -2021 Maintenance Schedule & Service plan

Month	Contractor	July	August	September	October	November	December	January	February	March	April	May	June
Pest man spray	JRC Pest Control												
Fire Warden Training	PEP Training - Emergency fire & safety training												
Oxygen regulator	Acciedntal first Aid												
Defib Service	Acciedntal first Aid												
Palintest (water testing	Palintest												
Sanitary bins	Initial Hygiene												
external water testing	RCA Laboratories												
BOC Gases	Bulk CO2 Cylinder												
2 way Radios	GEN-COM												
Automatic pool cleaner	Orimatech												
Fire Extinguisher Testi	Approved Fire Gear												
Fire hose testing	Approved Fire Gear												
Fire Blanket Testing	Approved Fire Gear												
Electrical tagging	Council												
Air Conditioning servic	East Coast Air												
Air handling unit	East Coast Air												
Plant room service	Trisleys												
UV System	Trisleys												
Gas Boiler	Hunter Boiler												
Solar leisure/50m pool	Sunbather												
Automatic door service	Dorma door services												

Maitland / East Maitland Aquatic Centre

Created By Troy Hughes January 2021 Review date January 2022

Appendix D

MCC’s Maitland Pool Operation Manual

Maitland Aquatic Centre Pool Operation Manual

Developed by Troy Hughes Aquatic Operations Supervisor

Developed March 2021 Review Due March 2022

Contents

MAITLAND AQUATIC OPERATIONS MANUAL

The Maitland Aquatic operations manual version 2.0 has been created and designed to provide guidance on all operation tasks at the centre. This manual has been split into three sections Pool Operations, Workplace Health and Safety, Emergency Action Plan. The ideal for this change and therein updates to this manual is for this document to be easily accessible and usable by all staff in the hope of achieving higher levels of success for the Maitland Aquatic staff and individuals.

1.Personnel Policies and Procedures

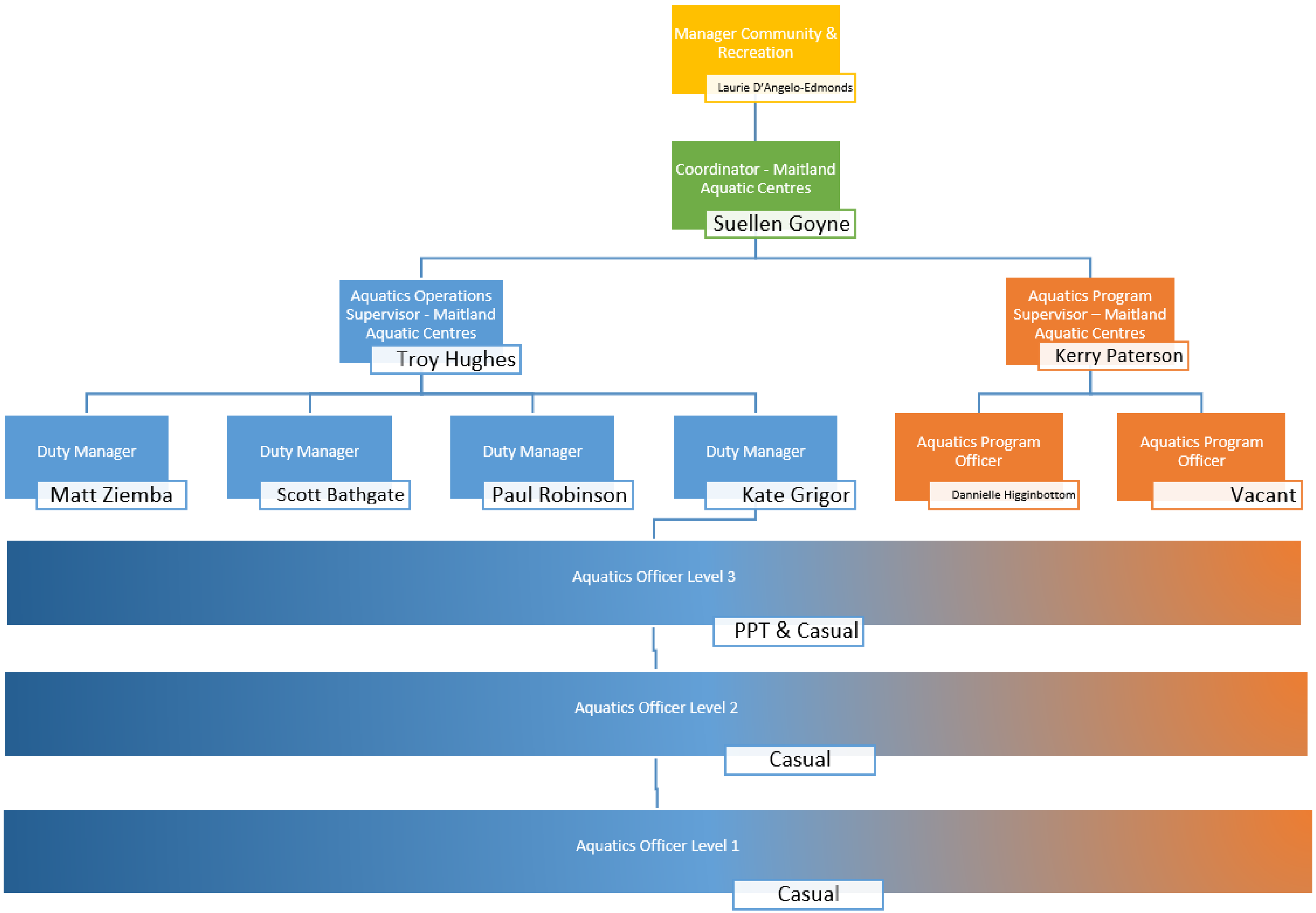
Maitland Aquatics polices are that no personal information regarding staff are to be given out to anyone for any reason, if there are any problem, they are to contact the relevant supervisor/ Duty Manger on centre number or via her e-mail. This also includes Council Contract partners.

1.1 Relevant Contact Details

Position	Contact Name	Contact Details
Community & Recreation Manager	Laurie D'Angelo-Edmonds	Email: Laurie.dangelo@maitland.nsw.gov.au Ph: 02 4934 9877 Mobile: 0428 602 615
Aquatics Coordinator	Suellen Goyne	Email: Suellen.goyne@maitland.nsw.gov.au Ph: 02 4934 9807 Mobile: 0436 925 832
Operation Supervisor	Troy Hughes	Email: Troy.hughes@maitland.nsw.gov.au Mobile: 0448 189 643
Aquatics Supervisor	Kerry Paterson	Email: Kerry.paterson@maitland.nsw.gov.au Mobile: 0436 852 712
Duty Managers	Scott Bathgate Paul Robinson	Email: Scott.bathgate@maitland.nsw.gov.au Mobile 0448 566 542 Email: Paul.robinson@maitland.nsw.gov.au Mobile: 0448 414 836 Email: Kate.grigor@maitland.nsw.gov.au Mobile: 0417 280 416
Aquatics Program Officer	Danielle Higginbottom	Email: Dannielle.higginbottom@maitland.nsw.gov.au Ph: 0400 792 276
WHS Officer	Troy Hughes	Email: Troy.hughes@maitland.nsw.gov.au Mobile: 0448 189 643
Council Contact (1)		

1.2 Lines of Responsibility

Community and Recreation Aquatics Structure



1.3 Employee Position Roles and Responsibilities.

Maitland City Council: East Maitland Aquatics has 5 key areas that are all a necessary role in making the facility operate in conjunction with Industry Standards, WHS safety guidelines, MCC Policies and Procedures.

1.3.1 Aquatics Coordinator

- Overall Operation of Centre
- Contact in case of emergency
- Ensure that policies and procedures are followed and adhered to
- Budgeting and KPI are met

1.3.2 Workplace Health and Safety Officer

- Oversight of safe operations centre wide
- Ensuring compliance with relevant government bodies guidelines and legislation
- Conduct regular training with all staff on WHS related matters
- Develop centre policies
- Educate all staff in WHS matters

1.3.3 Operations Supervisor

- Pool Lifeguards
- Pool water quality
- Plant operation
- Pool Cleanliness
- Patron and staff safety
- Policy and Procedure Development
- Reporting on pool operations
- Facilitate Quarterly lifeguard training
- Performance manage Lifeguards
- Oversee implantation of emergency procedures
- Participate in Employee induction/retention/acquisition

1.3.4 Duty Managers

- Assume Operations manager's role in their absence
- See above
- Provide Lifeguarding service in accord with GSPO
- Provide leadership for Jnr lifeguards
- Facilitate staff inductions

1.3.5 Aquatic Officers

- Pool Supervision
- Maintain Safe Swimming environment for all users
- Maintain Centre Cleanliness
- Community Education
- Provide Lifeguarding service in accord with GSPO

1.4 Personnel Directory and Call Out Procedures.

In the event of a major emergency, refer to the emergency action plan section of the operations manual kept in a separate folder.

1. Emergency Services
2. First Point of Call – Aquatic Coordinator, who will contact Council if required
3. Second Point of Call – Operations Supervisor and WHSO

4.Relevant Chemical Company or Authorities

The information below should be next to every phone in the centre.

Contact	Number
Facility Address	**Les Darcy drive – Maitland Park 2320** **Cross street 1 Walker and Elgin Streets** **Cross street 2 Cross street and Devonshire Street**
Aquatics Coordinator: Suellen Goyne	0436 925 832
Operations Supervisor: Troy Hughes	0448 189 643
Safety Officer: Troy Hughes	0448 189 643
Ambulance	000
Fire	000
Police	000
Maitland Police Station	4934 0200
Snake catcher	0421 911 940
SES	132 500
East Maitland Fire Brigade	(02) 4934 7497
Power supply: Aus grid Energy	13 13 88 24hr Emergency Number
Maitland Fire Brigade	(02) 4934 7258
Poisons Information Centre	13 11 26 (NSW)
Environmental Protection Authority (EPA)	131 555
Gas Emergency	131 909
John Hunter Hospital	4921 3000
Maitland Hospital	4939 2000
Council	4980 0255
Pound / Ranger	4934 9700
Hunter water	1300 657 000

1.5 Uniforms & Expectations

Lifeguards on shift at Maitland Aquatics must wear a Maitland City Council provided pool lifeguard uniform and in a professional standard of presentation**.**

- Uniform meets Maitland City Council sun safe policy
- A Whistle is considered part of the lifeguard uniform and must be worn at all times
- Bum bags must be worn at all times when on shift
- 2-Way Radio must be worn at all time while on shift
- Staff uniform is provided by Maitland City Council
- Staff uniform is listed below

Summer	Winter
• Shorts • Polo Shirt (long sleeve for Lifeguard and short sleeve for Customer Service) • Covered in shoes • Wide Brim hat	• Long pants/Hoodie/Jacket • Polo Short (long sleeve for Lifeguard and short sleeved for Customer Service) • Shorts (optional) • Covered in shoes

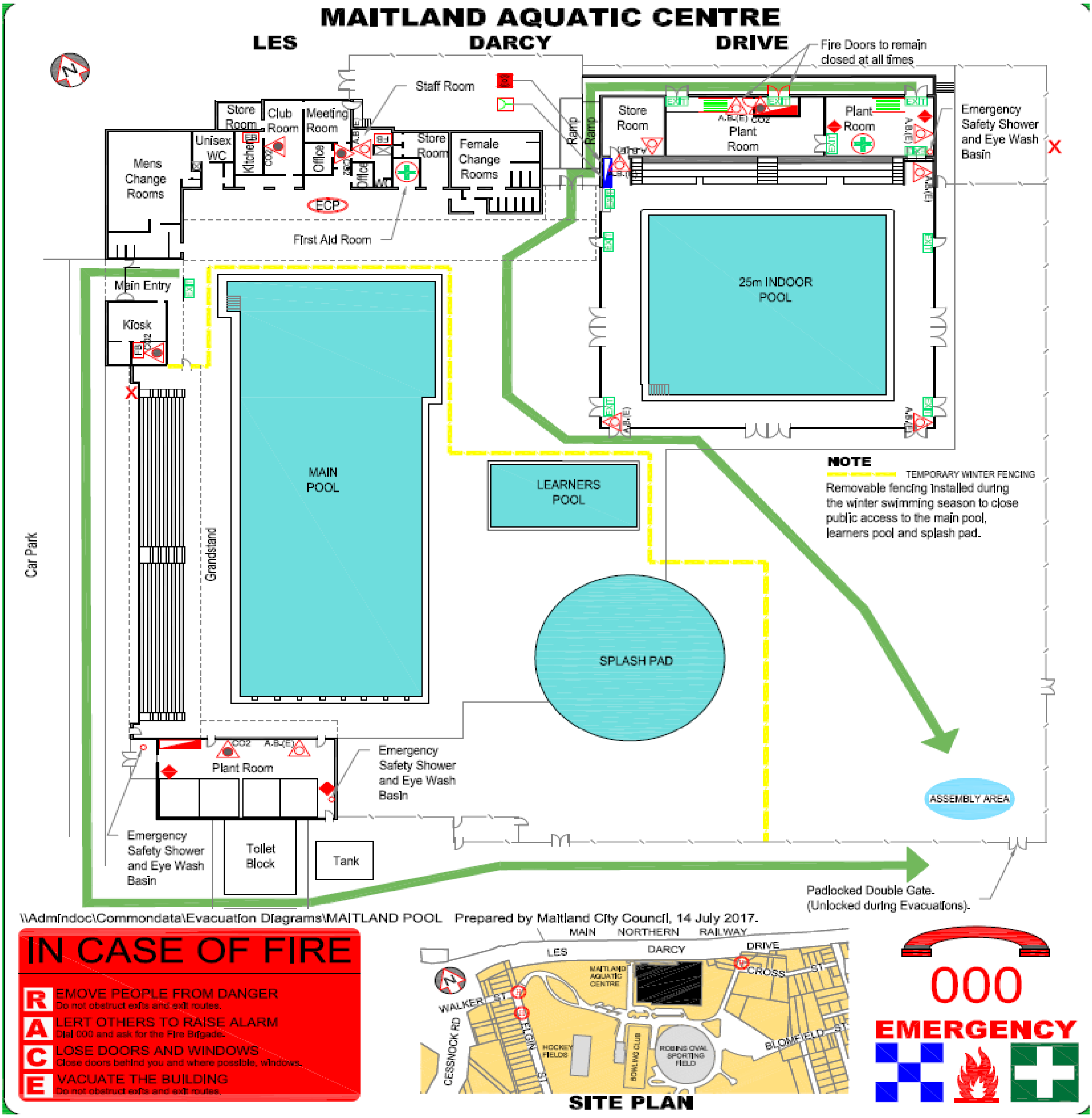
• Sunscreen • Sunglasses • Whistle • 2-way Radio • Bum bag • Name Badge	• Whistle • 2-way Radio • Bum bag • Name Badge

- All lifeguards on shift must always wear a bum bag. Minimum contents to include and be checked prior to commencing each shift:

- Band aids
- Saline
- Bandages
- Whistle
- Disposable gloves plus spares
- Pocket face mask
- Pocket torch

2. Physical Layout/Design

2.1 Facility Floor Plan - New map required with new fence



2.2 Pool/s Dimensions.

50-meter Pool
• 50meters in length – 23meters in width – 8 lanes • Deep end 2 meters deep, gradual decrease to 1meter deep shallow end (average 1.5m) 50m (length) x 23m (width) • Disable access via safety ramp eastern side lane *Approx. 1.725 mega litres (1.725 million litres)*
Learner's Pool
• 15meters in length – 6meters in width • Depth 0.85 meters gradual decrease to 0.55 meters at each end (average 0.65m) 15m (length) x 6m (width) • Disable access via safety ramp eastern side lane • Enclosed fenced area is 24m x 10m, number of patrons inside fence perimeter is maximum of 40 (Swimmers and Spectators). *Approx. 58,500 litres*
Splash Pad
• Pad Approx. 343 square meters (19m by 21m) • 800 litre tipping bucket • 2 enclosed slides (flumes) with catchment areas • 3 shower sprays operated by ropes • 2 turning wheel features • Curtain spray feature *Approx. 18, 000 litres* Balance Tank *Approx. 120, 000 litres* Filter Beds *Approx150, 000 litres*
25m Pool
• 25 meters in length – 23meters in width – 8 lanes • Deep end 1.5 meters deep, • Shallow end 1m deep • Disable access via safety ramp eastern side lane *Approx. 720,000 litres*

2.3 Maximum Number of Patrons including Bather Loads.

While the Centre does not have a determined patron capacity limit staff should use discernment when making bookings to ensure the Centre is always comfortable and safe. No specific staff to patron ratios is required for the foyer area however the pools do have ratios that must always be adhered to.

According to the Guidelines for Safe Pool Operation (GSPO) section SV5 5.3.13 published by Royal Life Saving Society Australia (RLSSA) as a general guide the ratio of Lifeguards to people in the water should not exceed 1:100. This number should be reduced in high-risk circumstances.

This ratio is not a final rule and can be influenced by a range of factors such as, but not restricted to:

- Weather
- Holidays

- Size, number, and layout of pools
- Lines of site
- Surface reflection
- Average attendance
- Anticipated attendance
- Swimming capabilities
- Special needs individuals and groups
- The number and distribution of users
- Recreational activities, either programmed or spontaneous

In accord with these guidelines the pool should always have a minimum of 1 lifeguard on duty in the Leisure pool and 1 lifeguard on duty for the outdoor pools. Should the pools exceed the ratio of 1:100 or approach this ratio the pool overcrowding action plan must be actioned. See below for the action plan.

In addition to the lifeguard to bather ratio public swimming pools must abide by the NSW Public Health Act 2011. This Act and supporting advisory documents relate to the water quality and the pool's ability to maintain the minimum standards of water quality for public health. Bather load is a measure of the number of bathers in the pool and is normally expressed as a Maximum Instantaneous Bather Load (MIBL). The MIBL also gives an indication of the amount of bather pollution being introduced into the pool. This pollution may vary according to the size of the bathers as children have a much lower surface area than adults (assuming all people toilet before entering the pool). To maintain water quality, comfort, and safety the design MIBL requirements should not be exceeded. Table 7.1 should be used as a guide

2.3.1 Public Swimming Pool and Spa Pool Advisory Document NSW Health PAGE 49 Table 7.1

Water Depth	Maximum Bathing Load
< 1.0 m	1 bather per 2.2 m2
1.0 – 1.5 m	1 bather per 2.7 m2
> 1.5 m	1 bather per 4.0 m2

Maximum bather load for Maitland Aquatics

Pool	Maximum Bathing Load
50m	287
25m	200
Small pool	40

2.4 Location of Alarms/Exit/Firefighting Equipment.

- Hose Reels in accordance with BCA 96 Clause E1.4 and AS 2441 – 1988
- Portable fire Extinguishers in accordance with BCA 96Clause E1.6 and AS 2444 – 1995
- Emergency Lighting in accordance with BCA 96 Clauses E4.2, E4.4and E4 and AS 2293.1 – 1995
- Exit signs in accordance with BCA 96 Clauses E4.5, E4.6 and E4.8 and AS 2293.1 – 1998
- Fire Hydrants in accordance with BCA 96 Clause E1.3 and AS 2419.1 – 1994

Type of equipment	Location
 **CO2 Fire Extinguisher**	- 50m Plant room - Kiosk storage room - Swim club staff room - Program office - 25m Plant room
 **Dry Powder Extinguisher**	- 50m Plant room - Staff room Kitchen - Storeroom 25m pool area - 4x locations around 25m pool area

	- 25m pool plantroom - Second plantroom 25m
Hose Reel	- Exit ramp outside 25m pool - 25m Plant room ?
First Aid Kit	- 50m pool next to storeroom - 25m pool next to plantroom - Inside both plant rooms
Hydrant	- Cross street - Behind 25m pool
Evacuation Point	- Side gate next to 25m pool
MSB **Main Switch Board**	- 50m plantroom - Main behind 50m poo - Other switchboard in swimming club room
Emergency Exit	- 5 located around 25m pool - Exit at entry point of facility - Exit through 25m pool plantroom

2.4.1 Carbon Dioxide Sensors

A carbon dioxide senor is fitted in both plant rooms where the CO2 bulk storage tanks are situated. It has been fitted in conjunction with AS/AZ standards and Air Liquide gases policies and procedures and serviced annually. It has an external panel on all entries to the plantroom. 50m senor is located behind the door when entering the plantroom and 25m senor is located under the bench where water te4sting is completed.

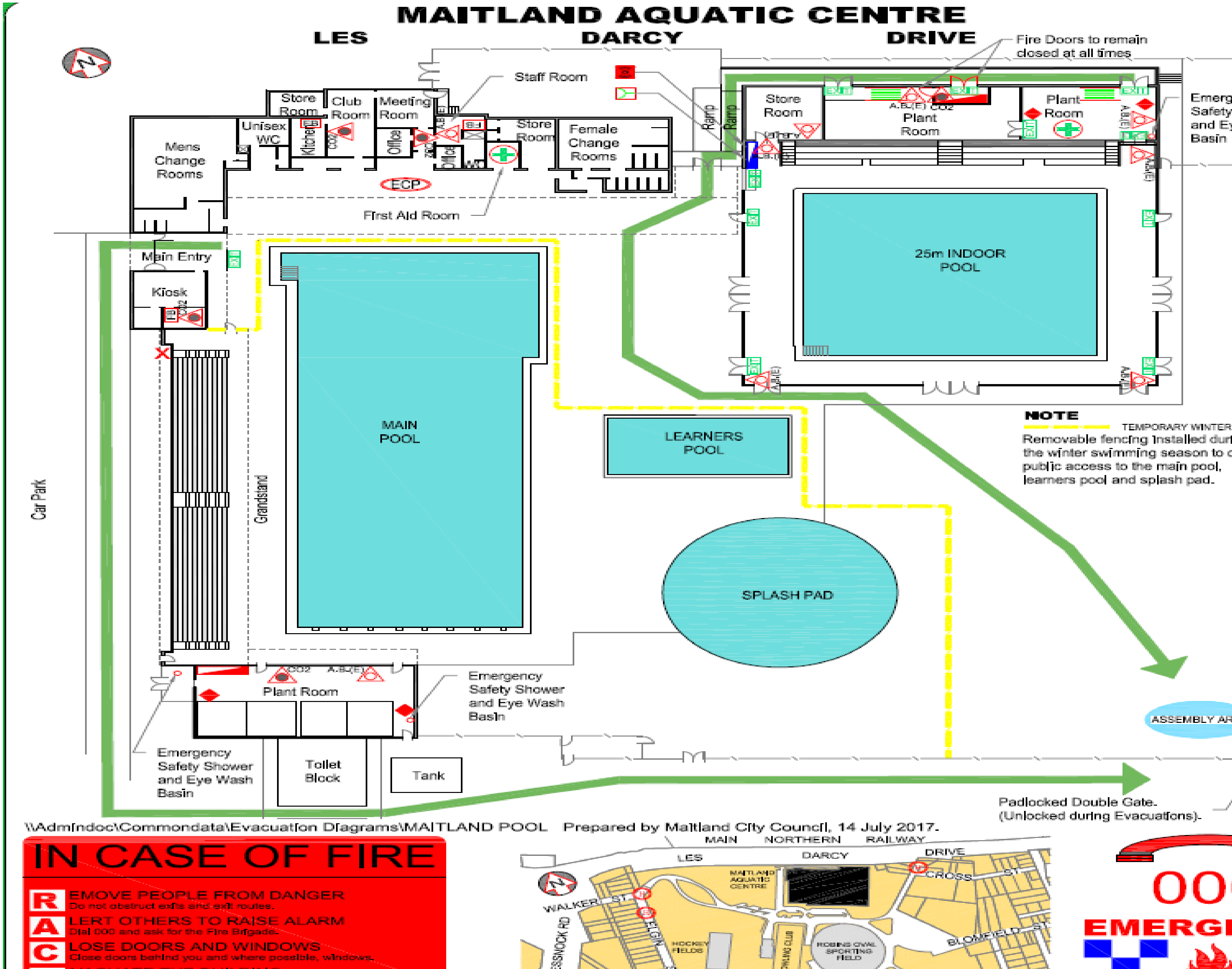
2.4.2 Family/Disability Change Rooms

The centre has 2 family / disabled change rooms which are fitted out with 2 visual alarm which are blue and above both doors. 2 activation buttons have been fitted per change room to make it easily assessable from different areas of change room. Switches are regularly serviced to comply with AS/NZ standards and disability codes and practices. Moveable seats / benches have been fitted that are corrosive resistant and are regularly maintained.

2.4.3 Security Alarm/CCTV

Security alarms and sensors beams are allocated around the centre. The alarm control pad is located at reception and alarm monitored by external security company with back to base alarms and security patrols. The centre has sensors points attached to all external doors around facility with motion detectors scatted internal. The centre is fitted with 1 CCTV cameras with monitor and recording devise in office.

2.4.4 Firefighting Equipment



MAITLAND AQUATIC CENTRE
LES DARCY DRIVE
Fire Doors to remain closed at all times
Staff Room
Store Room
Club Room
Meeting Room
Unisex WC
Kitchen
Office
Store Room
Female Change Rooms
Mens Change Rooms
ECP
First Aid Room
Ramp
Store Room
Plant Room
Plant Room
Emerg Safety and E Basin
Main Entry
Kiosk
25m INDOOR POOL
MAIN POOL
Grandstand
Car Park
LEARNERS POOL
NOTE
TEMPORARY WINTER
Removable fencing installed dur the winter swimming season to c public access to the main pool, learners pool and splash pad.
SPLASH PAD
ASSEMBLY AR
Plant Room
Emergency Safety Shower and Eye Wash Basin
Emergency Safety Shower and Eye Wash Basin
Toilet Block
Tank
Padlocked Double Gate. (Unlocked during Evacuations).
\\Admindoc\Commondata\Evacuation Diagrams\MAITLAND POOL
Prepared by Maitland City Council, 14 July 2017.
IN CASE OF FIRE
R EMOVE PEOPLE FROM DANGER
Do not obstruct exits and exit routes.
A LERT OTHERS TO RAISE ALARM
Dial 000 and ask for the Fire Brigade.
C LOSE DOORS AND WINDOWS
Close doors behind you and where possible, windows.
MAIN NORTHERN RAILWAY
LES DARCY DRIVE
CROSS ST
WALKER ST
ELGIN
BLOMFIELD ST
HOCKEY FIELDS
ROBINS OVAL SPORTING FIELD
000
EMERG

2.4.5 Special Needs

Both the 50m and 25m pool was built with considerations to special needs in the local community. It has the following feature allowing many ranges of special needs to access the centre.

- 50m & 25m pool has a ramp next to lane 8 it's compliant with AS 1428.2 - 1992.
- Nonslip floor resistive.
- Stainless steel handrails.
- 3 water wheelchairs.
- 1 moveable hoist.
- 1 moveable, washable disabled bed.
- 1 Pool side hoist for entry and exit of water.

2.4.6 First Aid Room

Design, size, and layout of first aid room has been taken into consideration, it complies with Safe work Australia code of practice February 2016 under the 274 work health and safety Act and RLSSA industry guidelines based on medium sized facility which accommodates up to 1000 people. Where possible, the first aid room should be dedicated to the provision of first aid only.

Content of First aid room

- The room is well illuminated and ventilated.
- Telephone with emergency contact details.
- Wash basin with hot and cold water.
- Examination bed and chair provided.
- Fridge and freezer for storage of icepacks is in staff room next door.
- Lockable storage cupboards for special medication.
- Stretcher accessible if required.
- General power outlets.
- Sick Bucket.

3. Facility Opening/Closing Procedures

3.1 Opening procedures

The Opening procedure consist of completing an opening checklist, this is being completed using the iPad. While completing the opening checklist the iPad is used to take photos of any risks or foreseeable Hazards, this is then documented onto the daily toolbox talk. Duty Manager conduct a daily toolbox meeting to discuss daily events and any hazards they have seen walking around the Centre.

In completing the process below, you are determining the centre to be safe and prepared for usage and any emergency as foreseeably possible.

3.1.1 Procedure

1. To be conducted by Duty Manager.
2. Full walk around with iPad/mobile phone.
3. Assess for hazards or safety issues.
4. Initial when OK.
5. If anything needs to be placed in the hazard report area, document it.
6. If all is completed open the doors.

3.1.2 Opening Basics

- LG/CSO will turn all lights on
- Check lights are working in the change rooms
- Check plant room auto dosing readings
- Manually test all pools
- Remove pool cleaner from water and coil up cord in accord with the SOPS
- Take pool covers off, move to side of pools
- Inspect both change rooms- clean and stocked (photos uploaded)

- Conduct Centre risk assessment (detailed on daily water quality sheets)
- POOL OPENS TO PUBLIC – UNLOCK DOORS IF NEEDED
- Check oxygen and defibrillator
- Clean pool cleaner filters and store cleaner
- Continue with daily cleaning task

3.2 Closing Procedures

The Closing procedure consist of completing a closing checklist on Promapp, this is being completed using the iPad or work mobile phone. No photos are required when completing the closing checklist. This is designed to ensure all facilities have been checked and locked securely as closing staff are leaving the facility at the end of the day.

3.2.1 Procedure

1. To be conducted by Duty Manager or most senior staff member on shift.
2. Final sweet and make sure all patrons have left the facility.
3. Lock all doors, alarm building and exit

3.2.2 Closing Basics

- Complete final daily water test and log correctly.
- Pool covers have been put on, cleaner in the water and going.
- Ensure all patrons have left the facility.
- Lock up all doors, turn all lights off.
- Ensure radios are put on charge for the night, ready for the next day's use.
- Facility is alarmed, exit facility via roller door and ensure both roller doors are locked securely.

4. Supervisory Procedures

4.1 Centre supervision Risk assessment

For lifeguards to adequately supervise the pool, the pool should be divided into Zones. Each Zone should be scanned by the Lifeguard continuously with the Lifeguard checking the pool surface, pool bottom and entry points. This method of Lifeguarding will help the Lifeguard to identify high risk bathers around higher risk areas. Lifeguards should use Vision, Hearing, Smell, and touch to monitor what I am happening around them.

4.1.1 Principles of scanning

- Lifeguards must be positioned with clear unobstructed sight lines.
- Lifeguards must move to counteract patron interference (especially in ground level supervision).
- Lifeguards must practice developing and improve their perception skills.
- Focus on people and what they are doing. Make eye contact when possible.
- Use your peripheral vision to detect movement.
- Never stop scanning when speaking with a patron.
- In the outdoor area, monitor changes in the environment conditions (weather and water) for their potential impact on patron behaviour and safety.
- Avoid turning your back on the area – walk backwards or sideways to avoid loss of eye contact.
- Scan the bottom of the pool first then the surface.

4.1.2 Grouping

To assist in the identification of high-risk swimmers and to comply with the Royal lifesaving ‘keep watch’ program the centre has adopted a wristband system. Pool lifeguards are expected to enforce while they are on shift. To help correctly identify Non swimmer from swimmer user group such as school, parties, private booking, and inflatable users are swim tested before activities commence. Also, to comply with DET guidelines.

Blue wrist bands (water): Competent swimmers. A non swimmer is identified by a carer, guardian, and swim test. Typically these wrist bands are only used during group and school bookings.

Yellow wrist bands(Keep Watch):: Non-swimmers are not to be in deepend or on inflatables. Must have consistent supervsion by carer, guardian, or teacher at all times. Children wearing this wrist band must be within arms reach of a person over 16 at all times

4.1.3 Where to scan

- Sweep your eyes over your entire zone
- Take note of clients and activity directly in front of you.
- Check adjacent lifeguards for visual communication
- Ensure to scan below the surface. Attend to the danger points more often

4.1.4 Scanning Strategies

Head counting – Try to count the number of people in your area.
Grouping – Sort clients into groups by age, sex, risk potential, activity, and any combination.
Mental filing – On successive sweeps, build patron profiles that take note of swimming ability, skill, activity, or other relevant factors.
Profile Matching – On each scan, measure what you see against the characteristic profiles of potential trouble or types of persons in difficulty.
Tracking – Track the progress of individuals who submerge and those who fit the high-risk profile.

4.1.5 Screening Clients

Cooperation from clients can lighten a lifeguard's load

Ask parents to stay close to their small children

- Encourage swimming with a friend.
- Promote the attitude that everyone should be concerned with safety at the venue.
- Educate clients about safe practice.
- **Water bobbers** – jump up and down from the floor of the pool, just breaking the surface.
- **Corner jumpers** – attempt to leap across the corner of the pool.
- **Slide jumpers** – who jump or leap over others coming down the slide.
- **Gutter grabbers and rope holders** – move into deep water hand over hand along the rope or edge.
- **Swimmers under diving boards** – slides, ladders, or other aquatic equipment.
- **Disorientated people** – who have been doing somersaults, flip turns, dives.
- **Breath holders** – tile counters and 'dead man floating' clients who hold their breath.

Some tasks on poolside do not need to be carried out by a qualified Lifeguard. Where possible, to avoid a loss of supervision, utilise another trained team member e.g. pool testing, setting up of equipment

4.2 Pool Hazards Identifications

4.2.1 Patrons

- Young children using flotation aids- beware of aid falling off.
- Young children-especially those under 6 years' old.
- Older people who may lose their footing.
- Children who appear inadequately supervised. Locate parents and advise of RLSSA Keep Watch program.
- Boisterous youths who draw attention of the lifeguard away from other hazards.
- Children playing around the poolside may slip in the pool or on pool deck.
- Small children with toddlers/babies.
- Parents swimming laps / smoking outside/ using café.
- People with a disability –carers not in the water, balance issues, lack of behavioural controls.

4.2.2 Activity Hazards

- Playing around steps. Parents may not realise the sudden depth change.
- Running, bombing, diving.
- Distance swimming under water holding breath competitions.
- Shoulder carries, use of inflatable equipment.
- Ball games.
- Large flotation devices i.e., boogey boards, boats.
- Inflatable use.
- Pushing, acrobatics, poolside crawling.
- Wrestling near other patrons or near edge.
- Playing tips/tags.

4.2.3 Physical Hazards

- Prams seats or bags in front of emergency exits.

- Changes in water depth.
- Steps.
- Dividing walls.
- Areas with obscured views of the bottom.
- Deep water.
- Shallow water.
- Water features.
- Areas obscured by glare.
- Lane ropes
- Movable furniture i.e., chairs. Can be used as a platform to jump into pool.

4.3 Higher Risk Areas

Due to the design, Maitland Aquatic Centre has a few high-risk areas associated with pool supervision. As per active supervision risk assessment Appendix 1

4.3.1 Small Pool

Because of the slow descent from 0.55m on both ends of the pool to 0.85m in the middle the children believe they can touch the bottom throughout the small pool. This is a big risk as this is the only pool toddlers can touch the bottom. To reduce the risk of small children running from small pool to the big pool, a perimeter fence has been erected around the small pool with child safe entry gate.

4.3.2 Pool Steps

Pool steps are areas that young children often tend to play around. Children will experiment with the steps to see how far they can stray out of their depth; this presents an obvious danger due to the sudden depth change in comparison the child's size. A split second and a child can be out of their depth.

Particular attention should be paid to the steps near the lifeguard station as this area gets less attention and is a blind spot to most supervision points on pool deck.

4.3.3 Disability Access Ramps

Disability access ramps are highly used area for non-swimmers in the centre. It isn't segregated from main pool given the non-swimmers the potential to get out of their depth quickly. It also adjacent to sudden depth change of 1m. Its location and gradual depth change which makes it hard to supervise as it creates areas that are not visible from all areas around pool.

4.3.4 Sun Positions

With centres location and structure of facility, it allows for the early morning sun from the east and the evening sun in the west very difficult to supervise and in some cases completely non-visible around the centre. Refer to Active Supervision Risk Assessment

4.3.5 Splash Pad next to 50m Pool

The splash pad being located next to the 50m pool creates a massive risk of young kids getting from splash pad to 50m pool where drop off is 1.8m. Kids will run in big groups away from bucket after it tips and directly into the 50m pool 1.8m in depth create a high-risk area with small children.

4.4 Communication

To supervise a pool properly you must be able to communicate with other lifeguard, members of the public and various user group. Also be able to communicate with community special need groups, various age groups.

Your most useful tool is your voice backed up with body language. Your appearance, posture and facial expressions send out all kind of messages and remember we want a positive one.

4.4.1 Types of Communication

Verbal – Verbal communication is the most common type of communication used in the aquatic industry. It is essential in emergencies between lifeguards, members of the public or emergency services. When using the verbal, you must be loud and clear and direct with the message you are relaying to another.

Visual signage – Visual signage around the centre can assist with communicating to all members including patrons with special needs and staff.

Hand Signals – Hand signal are used in an emergency situation when two-way radios are not available. They should be reviewed / practiced regular in staff training in accordance with the RLSSA.

Two-Way radios – Two-way radios are a popular way to communicate between lifeguards for all emergencies they are also a tool that can be used to relay messages from lifeguard to reception, duty managers and management while on site.

Whistles – Whistles signals and other audible signals are useful at venues where the sound carries clearly. They can be used to get attention of other lifeguards or members of the public by one short whistle blast and 3 whistle blasts for Centre emergency.

Facility PA system – Facility PA system can be used on busy days to capture the entire audience in the facility and spread any required messages.

Teams – Teams is used between lifeguards to communicate information for staff either the next day or next week, also communicate any HAZARDS, INCIDENTS or Equipment required management team.

Toolbox Meetings – Toolbox meetings are conducted daily to help increase communication and to identify what bookings and program are running on each day. This is also used to discuss WHS issues and highlight key cleaning and staff responsibilities

4.5 Guarding Positions

When planning, where the best position for a lifeguard, remembering that the objective is to ensure effective supervision of the entire centre. A few contributing factors are taken into consideration:

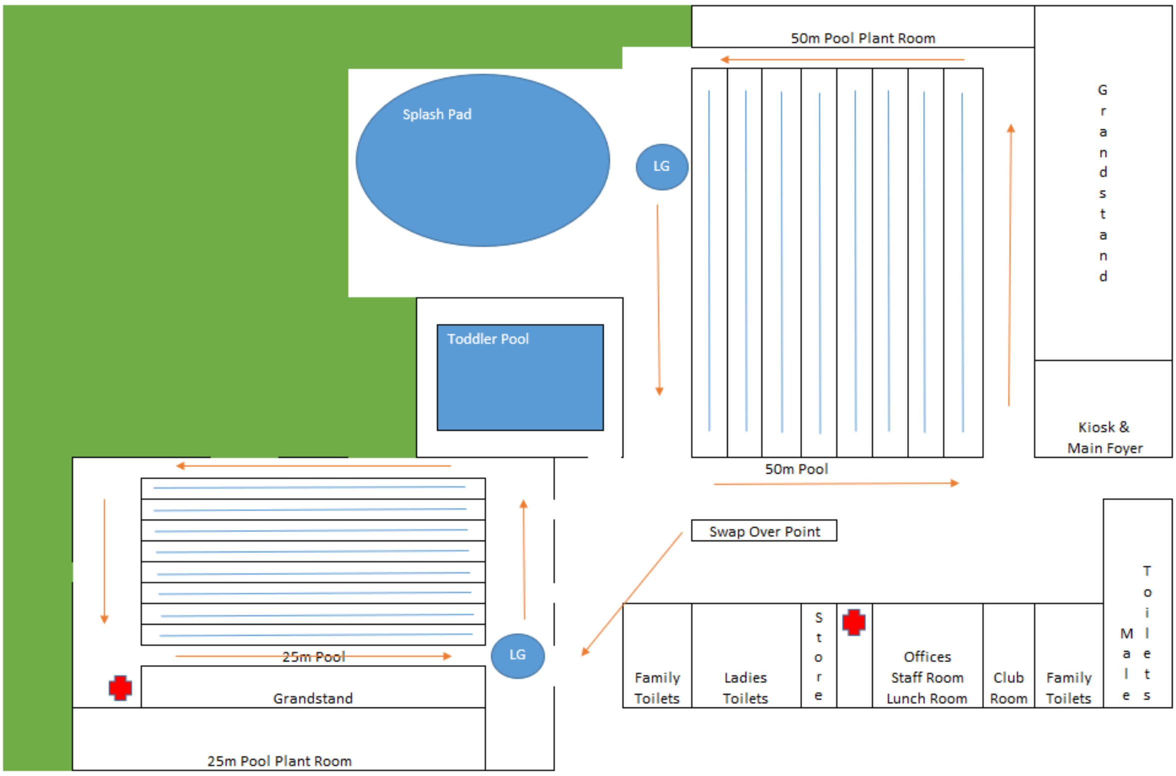
- Number of lifeguards required on duty.
- Lifeguard should always be able to maintain supervision of the water.
- Identification of high-risk areas throughout facility.
- The design of the facility.
- The ability of lifeguards to respond efficiently in and emergency.
- Line of sight.

The centre is required to always have a minimum of 2 qualified lifeguards on site, this is to comply with RLSSA set out in Section 7 of Guidelines for Safe Pool Operations and Practice NOTE 15 set out by NSW Local Government

4.5.1 Supervision with 2 Lifeguards

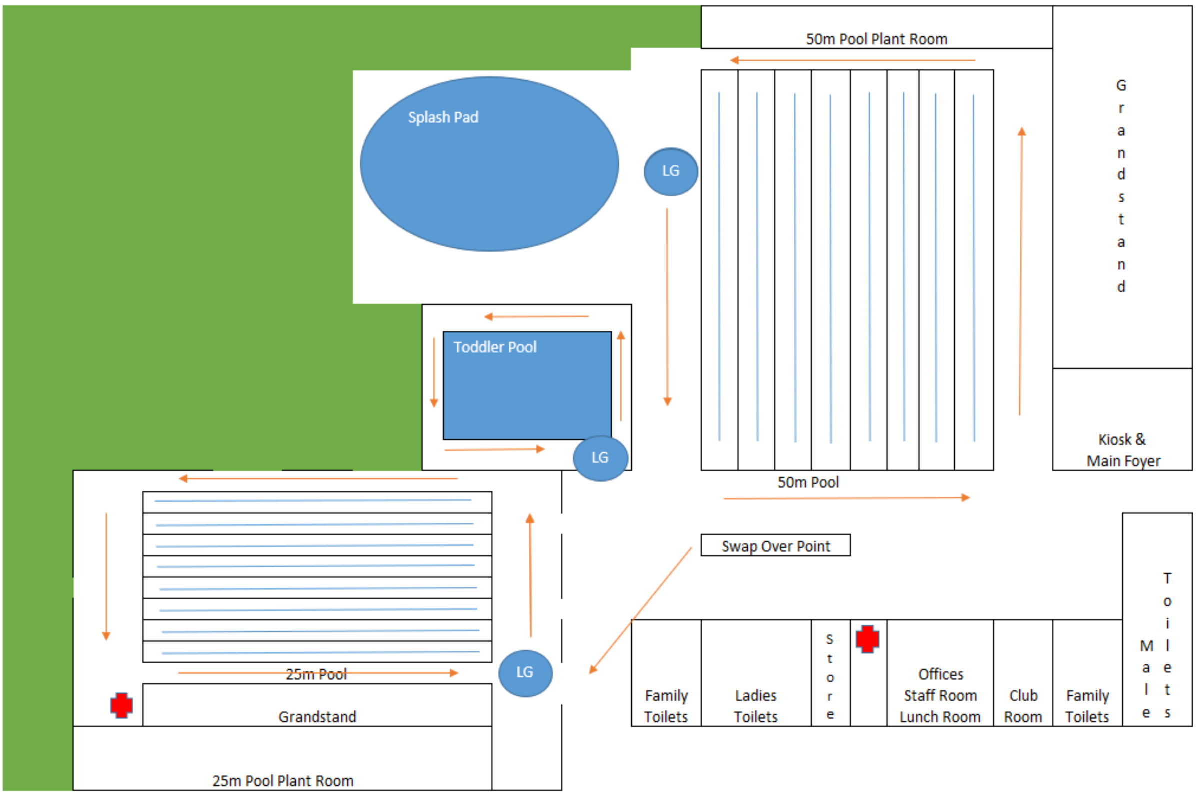
With 2 lifeguards on shift you must always have 1 lifeguard inside and other outside, they should rotate between 25m pool and 50m every 30 mins to help with fatigue. When rotating between pools you must meet in doorway that divides the 2 pools and change over, this allowing for both pools to be constantly supervised. Remember to take into consideration positioning factors to establish best possible position for effective lifeguarding

When lifeguarding the arrows are the areas in which you are responsible for



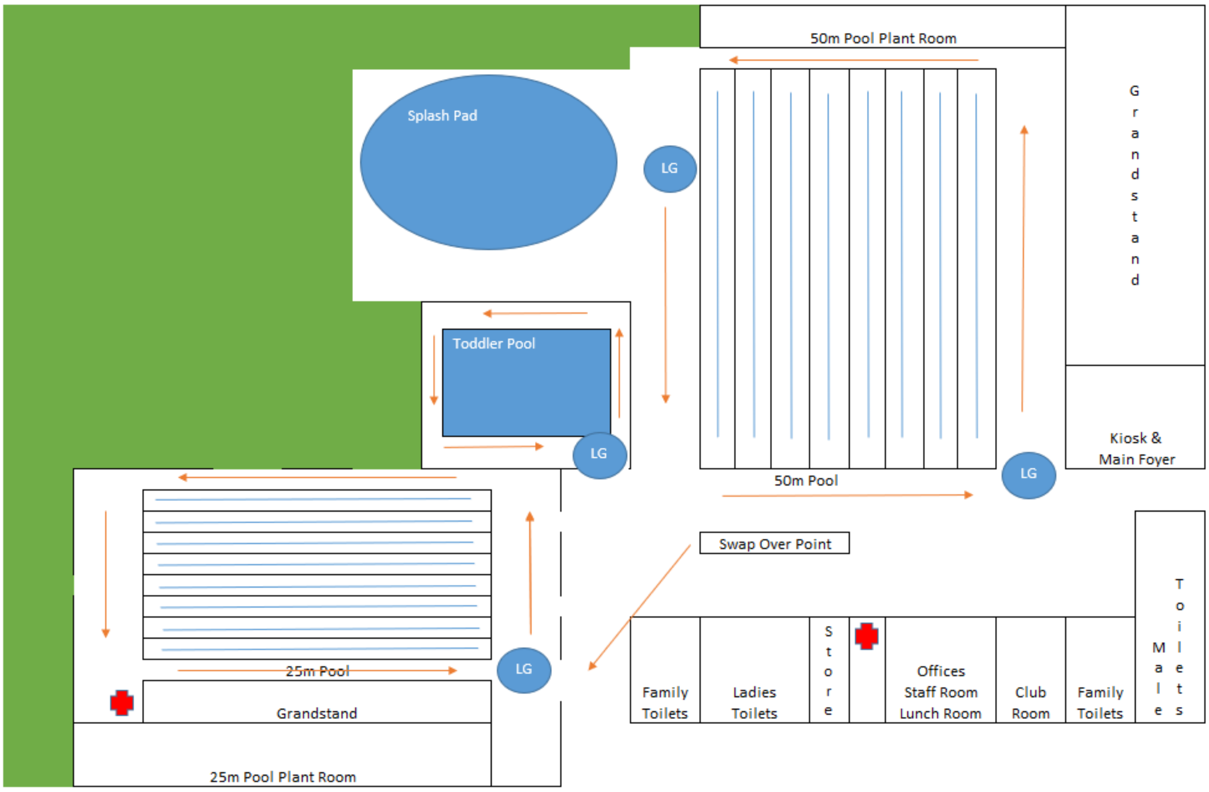
4.5.2 Supervision with 3 Lifeguards

With 3 lifeguards on shift you must work together as a team to identify bather loads 25m pool,50m and small toddlers as this may change as the day progress. By monitoring this you will be able to establish best positioning for lifeguards for effective supervision of the centre. You will need to remember that when you are rotating between position that a lifeguard must always be watching 1 body of water at a minimum



4.5.4 Supervision with 4 Lifeguards

With 4 lifeguards on shift you must work together as a team to identify bather loads 25m pool,50m, Small toddlers and Splash pad as this may change as the day progress. By monitoring this you will be able to establish best positioning for lifeguards for effective supervision of the centre. You will need to remember that when you are rotating between position that a lifeguard must always be watching 1 body of water at a minimum



Remember

- Don't sit down -always be on the go
- Must have bum bag, radio, and Whistle
- Scanning strategies
- High risk areas
- Bath loads
- User groups

LIFEGUARD TOOL

Drowning only takes a matter of seconds…
Lifeguards need to be able to identify a potential incident in seconds and respond.
Accessibilty and duration of time to get to a csaulty needs to be taken into account when deploying lifeguards to supervision stations

4.

LG 2 / 3 with information, wait for response	information back to confirm you understand emergency.	information back to confirm you understand emergency.
When LG 2 respond attend to the emergency	Get emergency equipment necessary for emergency and go to LG 1	Radio reception with emergency information and get them to call appropriate emergency services
Stay at emergency scene until emergency services arrive	Assist with emergency	Evacuate pools / areas as need to deal with emergency

When LG 2 arrives give updates and directions on what is required		Get details witness statements
After emergency has finished fill out appropriate documentation	After emergency has finished fill out appropriate documentation	After emergency has finished fill out appropriate documentation
Contact relevant management		

4.7 Keep Watch Program

Implementation of:

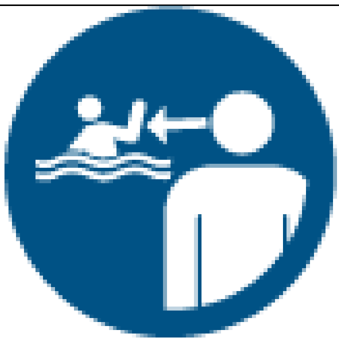
Royal Life Saving Society 'Keep Watch' campaign

("Parental Supervision of your children in the water")

The Royal Life Saving Society 'Keep Watch @ Public Pools' Campaign.

Royal Life Saving is targeting high-risk areas for toddler drowning deaths such as public pools. With lack of direct supervision by a parent or a guardian/career believed to be a contributing factor in 70% of all drowning deaths at public pools, the Keep Watch @ Public Pools program aims to eliminate all drowning deaths and reduce the number of near drowning incidents at these facilities.

The program targets parents and guardian/careers of children to help them understand their responsibilities and the dangers of leaving their children unattended at the pool.

The Keep Watch @ Public Pool Policy	
	**0-5 YEAR OLDS AND NON-SWIMMERS** Stay within arms' reach at all times. For 0–5-year old's and non-swimmers, a parent or guardian always needs to be in the water and within arms' reach of the child. Parents and guardians should always actively supervise their children and be dressed ready to enter a pool. It is best if you are engaging with your child i.e. playing with them, talking to them. These patrons are required to wear a Keep Watch wrist band pictured below. 
	**6-10 YEARS OLDS & WEAK SWIMMERS:** Be close, be prepared & maintain constant visual contact Constant active supervision is required for children aged 6–10 years old. Parents and guardian/careers must be prepared to enter the water with this age group. **Children (under 10 years) are not allowed entry unless under active supervision of a person 16 years or older.**

	**11-14 YEAR OLDS:** Maintain visual contact For 11–14-year old's, the recommendation is for parents to regularly physically go to where they are in or around the water. The intent of this age bracket is designed to educate parents that this age group is still at risk despite having a high degree of independence and parental supervision is an effective means of increasing their safety. Facilities should assist in the education of parents by drawing parents' attention to the 11–14 recommendation. Facilities should also develop strategies for parental supervision of this age group as part of their policies and entry requirements.
The Keep Watch @ Public Pools policy and the ages within it represent minimum standards only. Royal Life Saving encourages pools to adopt a higher standard wherever possible.	
	

4.7.1 Keep Watch Marketing Tools

5. Occupational Health and Safety

5.1 OHS Risk Assessment

5.2 First Aid

First aid kits are accessible in 3 key locations in the centre which are identified with signage complying with AS -1319. Portable first aid kit in 25m indoor pool lifeguard station, wall mounted first aid kit plantroom and portable first aid kit in first aid room along with cupboard with back up emergency equipment. All kits are check every 3 months to comply with MCC WHS policy, Safe work Australia code of practice Feb 2016 and adhere to RLSSA standards and guidelines. An inventory check list is sign and date by appropriate staff when completed and regularly monitored.

5.2.1 First aid Content

With Maitland Aquatic Centre having less than 100 but more than 10 workers we are required to have first aid kit size B, this is NSW regulations which is set out in OHS regulations 2001 set out specific first aid requirements and industry standards RLSSA.

List of contents

Item	Amount
Adhesive plastic strips	**50**
Adhesive tape 2.5cmx5m	**1**
Amputation bags of 3	**1**
Antiseptic swabs	**10**
Conforming bandages 10cm	**1**
Conforming bandages 5cm	**1**
Disposable gloves pair	**2**
Eye pads, sterile	**2**
Eye wash, 15ml. sterile	**5**
First aid pamphlet	**1**
First aid scissors 12.5cm	**1**
No 15-wound dressing	**3**
Non-stick dressing 7.5cmx7.5cm	**2**
Safety pins, set of 12	**2**
Splinter forceps	**1**
Thermal emergency blanket	**1**
Triangular bandages	**4**
Burns module	**1**
Eye module	**1**
Tweezers	**2**
Liquid skin antiseptic	**1**
Pocket face mask	**1**
Icepacks	**2**
Sterile strips	**2**
First aid instructions	**1**

5.3 Personal Protective Equipment

Personal Protective Equipment (PPE) is any clothing or equipment that you use for protection – Eg Goggles, ear plugs, respirators, safety shoes and gloves even sunscreen and broad brim hats. PPE is useful, but also one of the least effective ways of controlling safety problems.

Location of PPE throughout facility	
Item	**Location**
PVC Rubber Gloves	In marked PPE cabinet in both 25m and 50m pool plant rooms
Full Length PVC Aron	In marked PPE cabinet in 25m pool plant room
Full Face Respirator	In marked PPE cabinet in both 25m and 50m pool plant rooms
Rubber Boots	In marked PPE cabinet in 25m pool plant room
Hats and Long Sleeve uniform is up to the employee to provide for each shift	

5.3.1 Responsibilities

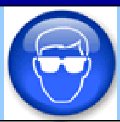
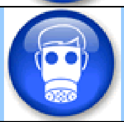
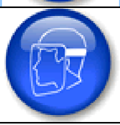
Employer

Maitland City Council are required to make sure PPE is available and maintained with all current WHS act 2011, WHS Regulations 2011and AS/NZ standards. Managers are to provide training for new staff on location of PPE and its correct use and ensure all employees follow all safety procedures. All management /Supervisors and staff will ensure that supplied PPE is diligently used whenever they are exposed to hazards. Training is completed on annual calendar which is part of your contract to attend regular training

Employee

All employees are to use PPE correctly whenever it is required as per there training, any misuse can result in an injury to you or others and disciplinary action. It is also your duty of care to report foreseeable hazards with PPE equipment to your supervisor ASAP

5.3.2 Types of equipment

	**Eye protection AS/NZ 1337.1 – 2010- Med Impact**
	**Earmuffs AS/AZ 1270:2002** **Rating: Class SLC (80)2dB**
	**Black chemical Resistant Gum Boots**
	**Green Chemical Resistant gloves** **CE Compliant EN 374-03 (General Chemical Protection)**
	**Respirator mask 6000 series** **AS/NS 1716:2012**
	**Face shield AS/NZ 1337:2002**

5.4 Incident reporting procedures

5.4.1 Policy / Procedure

It is Maitland City Council policy that all staff have a current first aid certificate and staff responsibility to keep current. All incidents that occur whether it be minor / major at the centre are documented. This is reported to safety officer / operation Supervisor for follow up and investigation if required. All incidents are logged on Vault and witness statement and first aid report forms are uploaded. Reports are tracked to follow trends developing throughout facility in any key areas.

5.4.2 Responsibilities

All staff have a duty of care to all patron in facility and must provide first aid within their training. All Maitland Aquatic staff are first aid qualified regardless of being a lifeguard or not.

5.4.3 Reporting

All incidents must be logged, and all the appropriate documentation must be filled out. Witness statement forms are to be filled out by other staff members or public that witness a major incident. All major incidents are to be reported to Centre manager / safety office immediately so it can be investigated. All majors must be reported to chain of command.

5.4.4 Minor / Major

Minor - emergency is a non-life-threatening situation that requires immediate assistance by lifeguard or qualified staff member but doesn't affect the operation of the facility and normal only requires 1 person. Examples of minors include

- Minor bleeding
- Stubbed toe
- Weak swimmer

Major - emergency is not necessary life threatening but requires the immediate assistance by 2 or more lifeguards or qualified staff, it may require section of the facility to be closed while major emergency is being handled. It requires the emergency services such as Ambulance, Police and Fire fighter. Examples of majors include

- Drowning
- Spinal incident
- Heart attack

5.4.5 Location

Incident report form is in main first aid room shallow end of 50m pool, it is also logged onto Vault via Duty Managers phones. Once it has been completed duty manger is to action on Vault and put hard copy in tray allocated in first aid room.

5.6 Chemical Delivery, storage, and handling

Maitland has 2 different delivery points. 1. Side of 50m plantroom opposite the carpark entrance. 2. Behind main building closest to the main highway, this is accessed by driving down through the carpark past the kiosk and around the corner.

Maitland has 2 components when it comes to chemicals, No1 bulk storage which is CO_2 which is our primary used chemicals, No2 stored chemicals which are our secondary used chemicals with very minimal stored on site

Bulk Chemicals

- 2 x Carbon Dioxide (CO_2) is delivery on a milk run, meaning every fortnight we receive approximately 280 kg. We can store 480 kg when we are full.

Stored Chemicals

Sodium Thiosulphate we have 10x25kg bags on site

Sodium Bicarbonate we have 10x25kg bags on site

Cyanuric Acid we have 10x25kg bags on site

Calcium Chloride we have 10x25kg bags on site

C-5 5 x 25 kg buckets which have 100 tablets in each

Stored chemicals are stored in dry ventilated area of the ground with bunding provided

5.7 Manual Handling

5.7.1 Definition

Manual handling is any activity that involves lifting, pushing, pulling, carrying, or moving, holding, or restraining. It also includes sustained and awkward postures or repetitive movements.

5.7.2 Roles and Responsibilities

All parties have a responsibility in maintaining a safe workplace and following safe manual handling principles. An outline of the specific roles and responsibilities for manual handling are detailed below. Points below provides general guidelines to safe manual handling.

- When practical all objects work practices and work environment are designed, constructed and maintained to eliminate risks arising from manual handling.
- Provision of mechanical aids if possible.
- ensure workers are trained in correct manual handling techniques and the correct use of mechanical aids
- That new workers employed by MCC are provided reinforcement in the MCC induction regarding safe manual handling techniques.
- That all workers identified as working in an environment that has been to identify to contain potential high-risk manual handling type activities are provided appropriate guidance and/or training every 3 years.

5.7.3 Managers

- Ensure appropriate lifting equipment is available for workers and the workers have attended appropriate training.
- Information relating to safe manual handling techniques is noted in the relevant SOPs, SWMS etc.

5.7.4 Supervisors/Team Leaders

- Ensure that workers are competent for tasks to be undertaken.
- Ensure that workers take appropriate breaks.
- Ensure workers are using appropriate lifting equipment to reduce the manual risk associated with the manual handling task.
- Ensure workers are using 'team lift' technique only when circumstances permit; and are doing so correctly.

5.7.5 Workers

- Follow Maitland City Council Procedure –Manual Handling and reasonable directives provided by their supervisor.
- With regard to team lifting, MCC considers it appropriate for participation of workers in the following circumstances:
- Where no other handling techniques or suitable mechanical aids are appropriate.
- Not to use team lifting techniques that would create a greater risk to an individual employee.
- Members of the team have been trained in the correct team lifting techniques.
- Not to perform in team lift unless they a have been appropriately trained.

5.8 Safety Data Sheets (SDS)

A safety data sheet (SDS), previously called Material Safety Data Sheets, is a document that provides information on properties of all hazardous chemicals used in the facility. All suppliers of dangerous good must supply SDS and must comply with WHS act 2001 and NSW regulation 2011. A SDS includes the following information:

- Identity of the chemical
- Health and physicochemical hazards
- Safe handling and storage procedures
- Emergency procedures
- Disposal considerations

A SDS is referred to when we are assessing risk involved when using chemicals in the workplace. SDS last for 5 years and are reviewed regularly during site audits. SDS are located at each chemical storage area of the centre, a second set in black and yellow folder on operation manger desk. Third set is in Chemical manifest also on operation manger desk.

5.9 Plant Inspections, Maintenance and Services

5.9.1 Plant Inspections

Plant inspections are completed every morning prior to facility opening and reported on opening checklist and daily chemical data sheet, if hazards are found appropriate documentation is to be filled out immediately and reported to management.

5.9.2 Maintenance

Pool staff trained in pool operations are responsible for the daily running and upkeep of the plantroom. Tasks that are completed daily, weekly monthly are documented on monthly plantroom log sheet.

- Back washing of filters
- Cleaning of pots
- Cleaning of inline strainer filters for dosing unit
- Calibration of doing unit when required
- Cleanliness
- Reporting any faults to operations supervisor immediately

5.9.3 Services

Maitland City Council has a contract service agreement with Trisley's Hydraulics for Maitland Aquatic Centre Pool and plant room. It is divided into, Quarterly, 6 months and annual services along with some asset replacement schedule to make sure the plantroom is operating at its full capability, prevent breakdown, centre closures, and provide excellent water quality to comply with NSW Health Swimming Pool and Spa Advisory Document 2013.

5.9.4 Contractors Responsibilities

- Follow all facility COVID-19 Conditions of Entry.
- Sign in/out at facility entry prior to commencing any work.
- Following all regulatory WHS rules.
- Ensure to engage with Operations Supervisor or Duty Manager prior to commencing any work.
- Complete all work, ensuring safety for themselves, pool staff and pool patrons.

5.9.5 Plantroom Training

It is recommended that pool staff operating and completing maintenance tasks in a Maitland City Council Aquatic Centre should have completed the RLSSA Technical Operations Course. The Technical Operations course is the industry standard for pool supervisors as documented in the department of Local Government Practice Note 15.

This course has 4 theory modules.

- Identify Risk & Apply Risk Management Processes
- Test Pool Water Quality
- Develop & Implement Pool Water Maintenance Procedures
- Aquatic Facility Maintenance

Upon successful course completion of the course participants will be issued with a Nationally Recognised Training certificate (Statement of Attainment). Units of Competency achievable through this course include:

- BSBRSK401 Identify risk and apply risk management processes
- SISCAQU001 Test pool water quality
- SISCAQU003 Maintain aquatic facility plant and equipment
- SISCAQU004 Develop and implement pool water maintenance procedures

- SISCAQU005 Develop and implement aquatic facility maintenance procedures

Along with these qualifications, Maitland City Councill have Trisley's Hydraulics run scheduled annual training on all components of the plantroom, where you are signed of to be competent or not component in the plantroom. To complete any of the above task you Must be competent in the plantroom.

5.10 COVID-19

5.10.1 What is COVID-19

Coronavirus disease (COVID-19) is an infectious disease that is caused by a newly discovered form of coronavirus. COVID-19 is a respiratory infection that was unknown before the outbreak that started in Hubei Province, China, in December 2019. Other known forms of coronaviruses include Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). Since first detection of the virus is 2019, other variations have become detected.

5.10.2 Symptoms of COVID-19

Symptoms of COVID-19 can range from mild illness to pneumonia. Some people will recover easily, and others may get very sick very quickly.

The common symptoms of COVID-19 may include:

- Fever.
- Coughing.
- Sore throat.
- Fatigue (tiredness), and
- Difficulty breathing or shortness of breath.

Most people infected with COVID-19 will have a mild to moderate illness and will recover without special medical treatment. Some people, such as those with underlying medical problems or disease and older people, are more likely to suffer from more serious symptoms of the diseases.

5.10.3 How does COVID-19 Spread

- The most likely way someone will catch the virus is by breathing in micro-droplets a person close to them has released by sneezing, coughing –or just breathing out.
- A person can, however, also catch it via the hand-to-face pathway: touching a surface where live virus material is present, then touching their mouth, nose or eyes.
- Spread of COVID-19 is highest from people with symptoms.
- Spread of COVID-19 before symptoms appear is less common.

5.10.4 Dealing with COVID-19 in the Aquatic Environment

Maitland City Council Aquatics Team has developed different COVID-19 Safety Plans which allows the facility to operate under NSW Health Guidelines and Public Health Orders whilst keeping patrons and staff safe.

Some of the basics from each Safety Plan have been listed below

- All staff and patrons showing cold/flu like symptoms are not to attend the facility and staff are to advise their supervisor.
- Masks are to be worn and 1.5m social distancing always adhered to by patrons (exception being whilst in the water) and staff.
- Both patrons and staff are required to use QR Code or NSW Health Website to check in/out for each session/shift.
- Staff are encouraged to get vaccinated.

- Patrons are encouraged to turn up ready for their activity wearing appropriate swimwear to avoid cluster of patrons in the change rooms.
- Patrons and staff are encouraged to use hand sanitiser as required.
- Staff will regularly wipe down high touched areas such as handrails and door handles.

For further information regarding current restrictions and Public Health Orders in NSW, follow the below link to NSW Health Website.

https://www.health.nsw.gov.au/Infectious/covid-19/Pages/default.aspx

For further Maitland City Council COVID-19 information, follow the below link to ERIC – NSW COVID Outbreak Information Hub

https://maitland-intranet--simpplr.visualforce.com/apex/simpplr__app?u=/site/a112x000000Pf6mAAC/page/a0z2x00000VYYeqAAH

6. Water Quality

6.1 Testing kit

Maitland Aquatics have a Palintest 25 photometer it is annually serviced and calibrated to comply with industry standards and guidelines


6.2 Test Methods

Each test is identified by a spate program number shortcut key. All staff required to test water are inducted as to water testing and test results are regularly evaluated.

6.1.1 Test 1 Free Chlorine

1. Rinse test tube with sample leaving 2 or 3 drops in the tube
2. Add one **DPD No 1** tablet, crush and then fill test tube with sample to the 10ml mark. Mix to dissolve tablet and ensure any remaining particles have settled.
3. Take photometer reading **immediately**, as a result may drift on standing.
4. Retain test solution if the total chlorine follows on test is required.

6.1.2 Test 2 – Total chlorine

1. Add **DPD No 3** to retained free chlorine test tube, crush, mix and dissolve
2. Stand for two minutes
3. Take photometer reading. Ensure the display shows the chlorine-total 5 test is selected
4. NB: to obtain combined chlorine residual subtract free chlorine result from total chlorine result

6.1.3 Test 3- PH value

1. Fill test tube with sample to the 10ml mark
2. Add one **phenol red** tablet, crush and mix to dissolve
3. Take photometer reading

6.1.4 Test 4 – Alkalinity to be tested weekly

1. Fill test tube with sample to the 10ml mark
2. Add one **Alkaphot** tablet, crush and mix to dissolve

3. Allow to stand for one minute
4. Take photometer reading

6.1.5 Test 5 – Calcium hardness to be tested weekly

1. Use test 8
2. Fill test tube to the 10ml mark
3. Add one **Calcicol No 1** tablet, crush mix and dissolve
4. Add one C**alcicol No 2** tablet, crush mix and dissolve
5. Stand for two minutes
6. Take photometer reading.

6.1.6 Test 7 – Cyanuric Acid

1. Fill test tube with the sample to the 10ml mark
2. Add one cyanuric acid test tablet. DO NOT CRUSH. Allow the tablet to disintegrate for at least two minutes.
3. Crush any remaining undissolved tablet, mix and the take photometer reading

6.1.7 Saturation Index

The maintenance and scheduled testing for water quality tests are logged on the Day sheet for operations (log sheet 6.2.2). Mandatory Annual Recalibration of the test unit conducted by Palin test Australia is completed and the certificate of proof is kept with the unit.

6.2 Operating to relevant Water Quality Guidelines - Water Quality Guide parameters and corrective action plan

6.2.1 Water Testing Guide

Public Swimming Pool and Spa Pool Advisory Document NSW Health PAGE 29

Table 5.1: Chemical criteria for chlorine-based pools

Parameter	Situation	Concentration
Free Available Chlorine (1) (DPD No 1)	Outdoor Pool	Min 1.0 mg/L
	Outdoor Pool + Cyanuric Acid	Min 3.0 mg/L
	Indoor Pool	Min 2.0 mg/L
	Spa Pool	Min 2.0 mg/L
	Any pool where pH > 7.6	Raise min by 1.0 mg/L
Combined Chlorine (3)	Any pool	Max 1.0 mg/L
Total Chlorine (DPD No 1 + No 3)	Any pool	Max 10.0 mg/L
pH	Any pool	Range 7.0 to 7.8
Total Alkalinity	Any pool	80 to 200 mg/L
Cyanuric Acid	Outdoor pool only. Not spas	Max 50 mg/L]

Before taking action re-test. Pool test tablets are sometimes unreliable, and readings can vary due to faulty equipment and poor incorrect testing methods. A retest should be conducted along with using a different sleeve of tablets

6.2.2 Blanket testing sheet

Daily Water Testing Schedule - Maitland Aquatic Centre 2020/2021

Week:	Date:		Weather:	Morning		Afternoon		Solar	Acid On	Acid Off	Acid %	Co2 %
MANUA	Staff	Free C	Total C	pH	Alk	Air '	H_2O '	***AUTC***	ORP (m	PPM	pH'	
Prior to Open								**Prior to Open**				
								9:00am				
12:00pm								12:00pm				
								3:00pm				
Prior to Close								**Prior to Close**				
Screens	am		pm		Make up water	am	pm		off	Calibration		

Water Balance (weekly)							Chemical Additions	
pH		General	Notes:				time:	
Temp							Prior to Open	
Calcium							9:00am	
Alk				Calculated	by:		12:00pm	
Total		: -12.1	: =	sign:			3:00pm	
Water Balance (weekly)		: ideal range	is 0.2	range is	-0.5 to 0.5		Prior to Close	
Cyanuric	:	Weekly		sign:				
Reviewed by:				date:				

Incidents / Corrective Actions Taken:

6.3 Corrective action

6.3.1 Turbidity and corrective action

Turbidity is best described as cloudiness of the water to a point where you cannot see the bottom of the pool. The procedure for this is:

1. Close the Pool
2. Ensure all water balance readings are within safe parameters
3. Backwash and Flock pool continuously
4. Repeat this process until clarity returns.

6.3.2 Chemical Dosing

Maitland Aquatics has 2 different dosing system, 25m pool has Aquarius Automatic dosing system and 50m pool has Prominent ProCal automatic dosing system. Brief descriptions of its functions are below. In the event of the prominent unit is failing, Safe Work Method Statements are used to hand dose the pools (see attached SWMS's). The SWMS are located near in the area where the task is to be performed and copies are kept on the centre hard drive

6.3.3 ProCal Auto dosing unit / Aquarius Auto dosing unit

Both the ProCal automatic dosing unit & Aquarius automatic dosing System enables the centre to monitor essential pool water quality readings. For further information on the use of the unit refer to the product manual in the warranty's/ folder kept in the administration office DULCOMETER® controllers and DULCOTEST® sensors ensure maximum process safety combined with a comprehensive range of use: from pH value, ORP/redox, conductivity and chlorine through to chlorine dioxide, chlorite, ozone, hydrogen peroxide and other parameters.
Pool lifeguards must record the unit's chlorine and pH value reading on the daily water testing sheet.

6.4 Chemical Leaks and Spills

Full PPE must be worn at all times when dealing with a chemical leak or spill. In the event where access to PPE is restricted an emergency spill kit is located on the fridge in the lifeguard station that contains spare PPE. Always consult SDS before taking action.

6.4.1 Procedure

For every leak or spill, the following steps should be taken:

Contain → **Dilute** → **Neutralise**

Leaks and spills should be **CONTAINED using the chemical spill kit located** inside both plant rooms mounted to the wall. If they are left to spread, this could cause more damage and harmful fumes. Always prevent spills from entering drainage systems

DILUTE leaks and spills of liquid chemicals to help reduce the harmful fumes and reduce the risk of chemical burns.

Chemicals need to be **NEUTRALISED** to stop the harmful fuses. The use Sodium Bicarbonate or sodium thiosulphate to neutralise chemicals is a common practice but should only be carried out by trained staff that have a thorough knowledge of chemicals. Always check with the pool operations coordinator before using these chemicals and consult the SDS. The centre has an emergency spill kit that should be used when dealing with unexpected spills.

Note: Fizzing will occur due to production of CO_2

6.4.2 Gas Leak

1. Clear the area and move upwind.
2. Apply all safety equipment, as applicable.
3. Confine the affected area.
4. Contact the Fire Brigade if the gas is flammable.

Note: co2 is not a flammable gas

6.4.3 Powder Spill

1. Sweep up with a clean brush and immediately remove sweepings to a safe place outside on a slight slope.
2. Spread contents thinly.
3. Contain the powder in a bund.
4. Dilute with large volumes of water, starting at the lowest point on the slope and working upwards.
5. Clean brush used for sweeping, very thoroughly.

6.5 Super Chlorination/Shock Chlorination

The 25m pool is considered a high-risk pool due to the large number of toddlers and patrons with a disability who frequent the pool on a regular basis. All strategies have been put into place with use of Health swimming template, signage, education and training. (NSW Health swimming pool and spa guidelines)

If the pools become contaminated pool lifeguards must adhere to the NSW Health contamination response plans in appendix e or online at (Swimming Pools and Spa Pools (Public). The Leisure pool and 50m pool is treated monthly and at the start of every summer using Chlorine dioxide. As outlined in 6.7.3 of the swimming pool and spa advisory document the WHO recommends that the CIO2 concentration should not exceed0.3mg/L. therefore the pools are dosed to this amount.

The centre is using C5 tablets to super chlorinate and shock chlorinate the pools. This has reduced risk to workers and increased decreased the time required to perform the task. No pool lifeguard should super chlorinate, or shock chlorinate the pools without prior approval by the duty Manager / Operation Supervisor

C5 dosing chart			
50m / small pool /splash pad		25m	
Super	Shock	Super	Shock
80 Tablets	200Tablets	30Tablets	75 Tablets

In the event of a contamination the lifeguards have been trained and inducted to follow the suitable response plan provided by NSW Health. These response plans can be found in the appendix section of this manual.

7. Programs

7.1 List of Programs Offered

- Swim School
- Swim Squads
- Swim ability (Disabled swimming program)
- Aqua Fitness Classes
- Splash Pad

7.2 Program Safety Requirements.

All programs are fully supervised by qualified staff. All programs have a documented full risk assessment and respective Safe work method statements. See the WHS operations manual for further information. Also see pool zoning section.

7.2.1 Swim School

- Water Quality meets standards
- All children are returned to parents
- Children are always watched/supervised
- Swim School areas should display ‘lesson in progress’ signage
- Swim School teachers must have minimum AUSTSWIM Qualification
- Classes are conducted in accord with GSPO PR8 & 10

7.2.2 Swim Squad

- Area is fully roped off from public Swimming area and signed as such
- The squad coach is to reduce the number of lanes used for squad to a minimum in consideration for public swimming and attempt to triple the number of swimmers per lane in ratio to the average of public lap swimming

lanes. i.e., 1 public lap swimmer per lane = 3 squad swimmers per lane. However, consideration is to be taken as regards to the number of separate squads the coach is conducting at a given time period.

- Children are always watched/supervised
- Water Quality meets standards
- Coach must have minimum Coaching qualification as determined by Australian Swimming Coaches and Teachers Association

7.2.3 Aqua Aerobics

- Equipment maintained and in Working order
- Aqua classes are conducted in accord with GSPO PR 9
- Water Quality meets standards
- Instructor to have a minimum Certificate 3 in fitness instruction
- 1 lifeguard is to be present at all times
- Class teacher to participant ratio maximum of 1:40
- Hydration is encouraged throughout class
- Participants are to be supervised at all times
- Summer outdoor pool, winter leisure pool

7.2.4 Swim School for People with Disabilities

- Lessons are conducted in accord with GSPO PR6
- Water quality meets standards
- All teachers/coaches have appropriate AUSTSWIM certificate or equivalent for teaching people with a disability

7.2.5 Splash Pad

Maitland Aquatics has a splash pad that runs weekends and school holidays 11am till 4pm. This can also be privately for birthday parties or school bookings.

7.3 Pool or room set up and requirements

7.3.1 Swim School

Swim School runs both morning 9 till 12 and afternoons 3:30 till 6:30. Learn to swim staff are to arrive early and set up the areas of the pool they require for the class. Lifeguard should assist when possible but never compromise active supervision.

7.3.2 Aqua Aerobics/Aqua Bikes

Aqua Aerobics runs different session times to cater for a broader range of ages groups. All Aquatics officers are to assist when setting up for aqua but never compromising active pool supervision. Same applies for Aqua Bikes, confirm with reception of booking numbers, and assist with getting bikes from the storeroom. Once again never compromising active pool supervision, you may need to get pool cover while you help set up.

7.3.3 Disabled Access Equipment:

The initial lifeguard induction trains lifeguard to use the following centre equipment:

- 3 x wet chairs,
- Disabled hoist
- Disabled Bed
- Various range of floatation devices

7.3.4 Pool Bookings

All pool bookings are required to fill out booking forms and e-mail to bookings coordinator for request of booking and then no booking is approved until confirmations e-mail has been received.

8.Training

8.1 Induction and Orientation/Qualifications

Maitland City Council/RLSSA Policy that all staff complete induction and orientation of each facility prior to their first shift. All lifeguards must have current pool lifeguard certificate and their licence MUST say Maitland Aquatic Centre. It is Maitland City Council policy that all staff have current First aid and CPR certificate to be employed. The centre will hold updates throughout the year, but it is the responsibility of the employee to make sure their certificates stay current, or they cannot work.

8.2 In Service Training

It is Maitland Aquatic policy that all staff must attend compulsory regular in-house training (minimum of 4 sessions). Some training sessions will require you to volunteer your time to come and attend skill refreshing training and keep your skills up to date with current industry standards and other training will be compulsory in which you will be paid for and must attended otherwise you will be taken off shift. Some training will be competent base where you will be assessed on involvement, knowledge, and participation in training session. All training is documented and kept on file.
Please refer to In House Training Calendar for a further detailed view.

8.2.1 Maitland & East Maitland Annual Training Plan

Maitland Aquatic Centre & East Maitland Pool Annual Training Calendar 2021

Months	January	February	March	April	May	June	July	August	September	October	November	December
Operational		Plant Room	Chemical Handling		Centre Evacuations Responsibilities		Plant Room		Chemical Handling	Lifeguard Update Royal Life Saving		Centre Evacuations Responsibilities
Emergency Preparedness	Parental Supervision Keep Watch Program	Spinal Management (Ass 1-4) Lifesaving Skills (Ass -5)	First Aid Minor and Major (Ass 9-10) Resuscitation Oxygen equipment Defibrillators (Ass6-8)	Parental Supervision Keep Watch Program	-				Spinal Management (Ass 1-4) Lifesaving Skills (Ass 5)	First Aid (Ass 9-10) Resuscitation Oxygen equipment Defibrillators (Ass6-8)	Parental Supervision Keep Watch Program	
WHS	Manual Handling		Internal Site Audit							Manual Handling		
Facility/Risk Management			Fire Warden Training	Emergency Action Plan All staff		Public Relation		Safety Sign Audit			Emergency Action Plan All staff	
Swim School				Evacuation -Child safety -Incident reporting				Level program review procedures			C.P.R Scenarios	
Kiosk CSO	Program Levels Memberships			Banking and Cash handling -Policy and procedures				Conflict resolutions Mystery Shopper procedures			Emergency procedures Incident reporting Child Safety	

9. Annual Facility Service Plan

2020 -2021 Maintenance Schedule & Service plan

Month	Contractor	July				August				September				October				November				December				January				February				March				April				May				June			
Pest man spray	JRC Pest Control					■	■							■	■							■	■							■	■							■	■							■	■		
Fire Warden Training	PEP Training - Emergency fire & safety training												■																								■												
Oxygen regulator	Acciedntal first Aid	■	■																							■	■																						
Defib Service	Acciedntal first Aid	■	■																							■	■																						
Palintest (water testing	Palintest	■	■	■	■																																												
Sanitary bins	Initial Hygiene				■				■				■				■				■				■				■				■				■				■				■				■
external water testing	RCA Laboratories				■				■				■				■				■				■				■				■				■				■				■				■
BOC Gases	Bulk CO2 Cylinder	■																																															
2 way Radios	GEN-COM			■	■																																												
Automatic pool cleaner	Orimatech			■	■																																												
Fire Extinguisher Testi	Approved Fire Gear	■	■	■	■																	■	■	■	■																								
Fire hose testing	Approved Fire Gear	■	■	■	■																	■	■	■	■																								
Fire Blanket Testing	Approved Fire Gear	■	■	■	■																	■	■	■	■																								
Electrical tagging	Council																									■	■	■	■																				
Air Conditioning servic	East Coast Air					■	■	■	■									■	■	■	■									■	■	■	■									■	■	■	■				
Air handling unit	East Coast Air					■	■	■	■									■	■	■	■									■	■	■	■									■	■	■	■				
Plant room service	Trisleys	■	■	■	■									■	■	■	■									■	■	■	■									■	■	■	■								
UV System	Trisleys	■	■	■	■									■	■	■	■									■	■	■	■									■	■	■	■								
Gas Boiler	Hunter Boiler					■	■	■	■										■	■	■									■	■	■	■									■	■	■	■				
Solar leisure/50m pool	Sunbather													■	■	■	■																																
Automatic door service	Dorma door services	■	■	■	■																					■	■	■	■																				

Maitland / East Maitland Aquatic Centre

Created By Troy Hughes January 2021

Review date January 2022

Appendix E

NSW Health Public Pool and Spa Advisory Document

Public Swimming Pool and Spa Pool Advisory Document

NSW GOVERNMENT | Health

Public swimming pool and spa pool advisory document

HEALTH PROTECTION NSW
73 Miller Street
NORTH SYDNEY NSW 2060
Tel. (02) 9391 9000
Fax. (02) 9391 9101
TTY. (02) 9391 9900
www.health.nsw.gov.au

For more information, please contact your local Public Health Unit whose contact details can be found at www.health.nsw.gov.au

Suggested citation: Health Protection NSW. Public swimming pool and spa pool advisory document. Sydney: 2013.

SHPN (EH) 130037
ISBN 978 1 74187 896 7

April 2013

Acknowledgements

There were many contributions made in the development of this advisory document. In particular NSW Health would like to acknowledge the Swimming Pool Industry Group, and the organisations below who provided direction and guidance.

Aquatic and Recreation Institute
Collingridge and Associates
Fulham Engineering Services Pty Ltd
Pallintest Australia
ProMinent Fluid Controls Pty Ltd
Stevenson and Associates Pty Ltd
Siemens Water Technologies
Trisley's Hydraulic Services
Bellingen Shire Council
Leichhardt Municipal Council
Ryde City Council
Shoalhaven City Council
Warringah Council
Poolwerx
Tim Batt Water Solutions Pty Ltd

Swimming is an important recreational activity. Learning to swim prevents drowning. Swimming promotes good physical, mental and cardiovascular health. In properly managed pools the benefits of swimming far outweigh any risk.

(WHO 2006)

Contents

Quick Start for Pool Operators

The three most important parts of this advisory document for pool operators are:

- Chemical criteria
- Chemical testing
- Microbiological criteria and sampling

A. Chemical criteria

The mandatory Chemical Criteria is specified in Schedule 1 to the Public Health Regulation 2012. Schedule 1 can be found at:
http://www.health.nsw.gov.au/environment/publicpools/Documents/public-health-reg-2012-schedule_1.pdf

NSW Health only recommends the use of chlorine or bromine based disinfection systems for public swimming pools and spa pools. These systems rely on proper concentrations of pH and reserve alkalinity. It is essential that pool operators also read section 5.2 of Chapter 5.

B. Chemical testing

The minimum mandatory requirements for chemical testing are also specified in Schedule 1 mentioned above. The frequency of pool testing as best practice is outlined in section 5.6 of Chapter 5. Sampling location is discussed in section 5.7, testing equipment in section 5.8 and record keeping in section 5.10.

C. Microbiological criteria

The Microbiological criteria are specified in Box 3.1 of Chapter 3. It is important for pool operators to read all of Chapter 3.

D. Fact sheets

A series of fact sheets which complement this Advisory Document can be found at:
http://www.health.nsw.gov.au/environment/publicpools/Pages/default.aspx

E. Pool occupiers information sheet

Information Sheet Number 4 for occupiers of public pools is provided at:
http://www.health.nsw.gov.au/phact/Documents/is4-public-pools.pdf

After these essential sections, it is recommended that Chapter 1 (Introduction), Chapter 4 (Disinfection), Chapter 6 (Managing water quality) and Chapter 8 (Cryptosporidium risk management) be studied. Finally, the Contents should be consulted for matters of additional interest.

CHAPTER 1

Introduction

1.1 Overview

This chapter introduces the 2013 *Public Swimming Pool and Spa Pool Advisory Document* by explaining its purpose, scope and application. This chapter also explains that the disease risk from swimming pools is always present no matter how well a pool is disinfected and its patrons are managed. There is a brief overview of the public health legislation framework to control transmission of disease in public swimming pools. A distinction is drawn between the role of NSW Health and the Australian Pesticides and Veterinary Medicines Authority (APVMA) in the approval of disinfectants which may be used in a swimming pool. At the end of this chapter, advice is available to assist in navigation of the NSW Health website for pools.

1.2 Purpose

The primary purpose of the advisory document is to provide information and guidance to pool operators, authorised officers (also known as environmental health officers), pool consultants and other swimming pool industry stakeholders on the appropriate modern standards to design, operate and maintain healthy swimming pools and spa pools.

The secondary purpose is to complement public health legislation, particularly the prescribed operating requirements in Schedule 1 to the *Public Health Regulation 2012*.

Disinfection is critical to prevent the survival and growth of micro-organisms in swimming pools and spa pools. The quality of incoming water supply, efficient filtration, well designed circulation and distribution systems, and an optimum turnover rate to deliver clean clear water are equally important. Client hygiene management is also an important aspect of disease minimisation. Disease minimisation and water quality are the core themes of the advisory document.

The most commonly known micro-organism capable of causing large outbreaks in public swimming pools is *Cryptosporidium.* Outbreaks of cryptosporidiosis are a problem in public swimming pools because *Cryptosporidium* is chlorine resistant and is easily transmitted by infants who are not toilet trained. The advisory document highlights minimising the risk of *Cryptosporidium* contamination in public swimming pools and spa pools.

The advisory document is, where possible, evidence based and risk based. The recommended frequency of chemical and microbiological sampling has been reviewed to reflect this risk-based approach. This approach means that high-risk heated pools (particularly spas and hydrotherapy pools) should be tested more frequently and low-risk automatically-dosed pools (such as diving pools) less frequently. A chapter is included on risk management of pool operations.

Although scientific evidence suggests that the emerging issue of disinfection by-products are unlikely to cause health risks in properly managed pools, some mention is made of them. Included in emerging issues are those of recycling backwash water and rainwater harvesting.

The advisory document provides comprehensive information sufficient to fulfil an identified industry need for informing operators of pools who may not have had the opportunity of formal education in swimming pool matters.

1.3 Scope and application

This advisory document has a wide informative scope and some information is provided on the derivation of disinfection concentrations. For example, information is provided on the effect of pH on chlorine disinfection and the derivation of free chlorine and pH values.

The advisory document is more relevant to those swimming pool and spa pool operators to whom the public health legislation applies. Such pools are referred to as public pools. From 1 March 2013, occupiers of premises containing public swimming pools or spa pools must notify their local council of the pool’s existence and comply with the "prescribed operating requirements". The prescribed operating requirements are set out in Schedule 1 of the Public Health Regulation. http://www.health.nsw.gov.au/environment/publicpools/Documents/public-health-reg-2012-schedule_1.pdf

It is an offence not to comply with the prescribed operating requirements and an authorised officer may issue an improvement notice for failure to comply. In serious cases, a failure to comply with the prescribed operating requirements may lead to a prohibition order or closure order being issued, closing down the pool. The advisory document, therefore, provides an understanding of what constitutes the prescribed operating requirements and explains chemical parameter values for disinfectants and pH levels for various circumstances.

An emerging type of swimming pool is the multi-residential pool such as those associated with apartments or town house developments. While such pools are not public swimming pools under the Public Health Act, they can still pose risks in terms of bather risk. The advisory document is equally applicable to this situation, but in a non-regulatory and advisory sense.

Authorised Officers (or Environmental Health Officers) should use the document to assist in developing skills in determining pool water quality, to determine when there may be a risk to public health and therefore to determine the nature of any enforcement action, if necessary.

1.4 Disease risk from swimming pools

Disease transmission, even in the best operated pool is always possible. At best, the time taken to transmit a disease can only be minimised to a fraction of a minute because it takes time for a disinfectant to kill or inactivate micro-organisms. There is no instantaneous kill of micro-organisms and swimming pools cannot be made sterile. The advisory document provides information about conditions under which a fast kill of disease-causing micro-organisms can realistically be achieved.

Public pools are more likely to be contaminated with a greater diversity of disease causing micro-organisms than single domestic swimming pools. This is because public pools are used by unrelated people and are more likely to have higher bather loads. Pathogenic (disease causing) micro-organisms must be quickly and effectively killed in the pool water in which they are introduced, otherwise a disease may be transmitted. The swimming pool or spa pool needs to be designed and operated to enhance the action of the disinfectant.

All public swimming pools and spa pools must be equipped with effective water circulation, filtration, disinfectant, and pH control systems. Ideally, the disinfection system and pH systems should be automatically controlled. Routine hand, drip or slug dosing of any chemical directly into an occupied swimming pool or spa pool from a container is not acceptable and is dangerous. Similarly, floating block dispensers are not considered appropriate.

1.5 Legislation

The *Public Health Act, 2010*, was commenced on 1 September 2012. Sections 34 to 37 apply to public swimming pools and spa pools. Section 35 however commences on 1 March 2013. Under the Act, a public swimming pool means a swimming pool or spa pool to which the public is admitted, whether free of charge, on payment of a fee or otherwise, including those swimming pools and spa pools:

- To which the public is admitted as membership of a club,
- Provided at a workplace for the use of employees,
- Provided at a hotel, motel or guest house or at holiday units, or a similar facility, for the use of guests, and
- Provided at a school or hospital,

but not including a pool situated on private residential premises.

The *Public Health Act* and *Public Health Regulation* set out specific requirements for occupiers of premises containing public swimming pools and spa pools and there are offences for non compliance. In particular:

- An occupier must give notice of the pool's existence to their local council (this requirement commenced on 1 March 2013)
- An occupier must comply with the prescribed operating requirements, which are set out in Schedule 1 of the Public Health Regulation (this requirement commences on 1 March 2013)
- The occupier must not allow a person to use the pool unless the water is disinfected in such a way as to minimise the transmission of disease to users of the pool

- The occupier must ensure that the pool surrounds, including any toilets and change rooms, are kept clean and in such condition as to minimise the transmission of disease.

Authorised Officers of both NSW Health and local councils are empowered to inspect public pools. As well as being an offence, a failure to comply with prescribed operating requirements could lead to an improvement notice directing compliance. If there is a breach of a prescribed operating requirement and the pool poses a serious risk to public health, a prohibition order may be served on the occupier to close public swimming pools and spa pools to prevent or mitigate a serious risk to public health. There is also power under the Public Health Regulation to close down a public pool or order public health action to be taken in relation to a pool that poses a risk to the public even if the prescribed operating requirements are being met.

The prescribed operating requirements for public pools can be found at *Schedule 1* of the Regulation. http://www.health.nsw.gov.au/environment/publicpools/Documents/public-health-reg-2012-schedule_1.pdf
The prescribed operating requirements require that pools may only be disinfected with chlorine or bromine using automated or continuously metered dosing systems. Dosing systems are discussed in Section 6 of this document. Disinfectant, temperature, pH, alkalinity, ozone and cyanuric acid parameters, testing requirements are also specified in Schedule 1.

The former "Guidelines for Disinfecting Public Swimming pools and Spa Pools – June 1996" have been withdrawn as they are no longer valid.

NSW Health is not an approval authority. It does not have the power to approve of chemicals, disinfectants, pool design or pool operational activities. NSW Health does not have the capacity to become involved in pool design or operation. The legal function of NSW Health and local councils is to monitor and determine public health risk and act accordingly to require the abatement of the public health risk in public pools.

1.6 Australian Pesticides and Veterinary Medicines Authority (APVMA)

Before swimming pool disinfection products can be sold, supplied, distributed or used in Australia, they must be registered by the APVMA, a Commonwealth agency based in Canberra. The registration process is governed by Commonwealth legislation and undertaken according to accepted scientific principles and through rigorous independent analysis by several government agencies and the APVMA. A list of approved sanitisers is provided on the APVMA website at:
http://www.apvma.gov.au/.

The use of APVMA unapproved packaged disinfectants in any public swimming pool or spa pool is not supported by NSW Health. Additionally, the only future disinfectants that will be recognised as primary disinfectants by NSW Health will be those which have been independently tested against the "APVMA Guide for Demonstrating Efficacy of Pool and Spa Sanitisers". This document can be accessed on the APVMA website above or on the NSW Health website below.

1.7 NSW Health website

The URL for the NSW Health is:
http://www.health.nsw.gov.au/

To navigate to the Swimming Pools and Spa Pools page click on "A to Z" on the blue banner and then click on "S" and finally click on "Swimming pools and spas".

CHAPTER 2

Microbial health risks and transmission

2.1 Overview

This chapter describes the groups of micro-organisms which may be introduced into the swimming pools and spa pools. The diseases caused by these micro-organisms and their probable modes of transmission are discussed.[1]

2.2 Micro-organisms

The main groups of micro-organisms associated with contamination of swimming pools and spa pools are listed below. Contamination of the pool may be classified as:

- Faecally derived, e.g. from bathers, animals or a contaminated water source, or
- Non-faecally derived, e.g. shedding from human skin, mucus, vomit or other secretions, or from animals, stormwater runoff and windblown.

2.2.1 Viral pathogens

Viruses cannot multiply in water and therefore their presence must be as a result of direct contamination.

i) Adenovirus: Most viral outbreaks linked to swimming pools have been attributed to adenovirus and were associated with inadequate disinfection.[2] There are over 50 types of adenoviruses[3]; and many may cause enteric infections but some are associated with respiratory and eye infections. Outbreaks of pharyngo-conjunctivitis (sore throat and sticky eyes) have been associated with adenovirus linked to swimming pools.

ii) Hepatitis A: Hepatitis A virus has been linked to three major outbreaks associated with swimming in a public swimming pool in recent times. In 1991 there was an outbreak in the USA, thought to have been caused by sewage contamination which resulted in 20 cases of hepatitis A virus infection. Another outbreak occurred in 1994 in Hungary when 31 children were hospitalised following swimming in a non-chlorinated pool during a holiday camp. The third documented outbreak was in Australia in 1997 when six boys became ill following 'whale spitting' in a public spa pool although chlorine concentration in this pool was reported to have met local health standards.[4]

The recommended levels of chlorination are effective in destroying the hepatitis A virus. Therefore outbreaks should not occur in properly managed pools that are always maintained above the required minimum disinfectant concentrations.

iii) Norovirus: There have been few reports of disease outbreaks related to norovirus (previously known as Norwalk virus or Norwalk-like virus). Kappus et al (1982) reported a gastroenteritis outbreak in Ohio, USA, affecting 103 students and teachers following swimming in a local pool.[5] In 2004, Maunula et al reported a similar outbreak in Helsinki, Finland, associated with norovirus contracted from a wading swimming pool.[6] All these cases occurred due to an inadequate system of disinfection, water quality monitoring and maintenance.

iv) Enterovirus: This group of viruses includes polioviruses, echoviruses and coxsackieviruses. The only documented enterovirus infection associated with a public swimming pool was reported by Kee et al in 1994. This outbreak caused vomiting, diarrhoea and headache in 33 people following swimming in an outdoor swimming pool. Echovirus was found to be the causative agent, and although disinfectant concentration was maintained according to health requirements, it was inadequate to contain the spread of the micro-organism due to the large numbers present in the vomit. Under such circumstances, a contaminated pool should be shut down until the contaminant is inactivated.

v) Papillomavirus: Papillomavirus causes warts and has been associated with contaminated wet surfaces. An investigation of an outbreak of 221 students found that the floors of the change rooms were the primary source of transmission.[7]

vi) Molluscipoxvirus: Molluscipoxvirus causes white or skin-coloured papule lesions (small, solid and usually conical elevation of the skin) mainly in children. The lesions are found on the hands, forearms and faces of swimmers, gymnasts and other athletes. The link between swimming and the disease, molluscum contagiosum, was confirmed in a sample of 198 patients in Princess Alexandra Hospital, Woolloongabba, Queensland. Swimming in a school swimming pool and sharing a bath sponge with an infected person were found to be the two more significant factors.[8]

2.2.2 Bacterial pathogens

i) ***Shigella:*** An outbreak of shigellosis was associated with swimming in a fill-and-drain wading pool in the USA. This outbreak resulted in 69 people becoming ill with suspected shigellosis, 26 cases of which were confirmed as *S. sonnei* by the laboratory (MMWR 2001). The pool was not disinfected and *Escherichia coli* and thermotolerant coliforms were also isolated from the pool water. The source of transmission was suspected to have been bathers with diarrhoea. The infective dose for *Shigella* is between 10 and 100 micro-organisms.

ii) ***Escherichia coli O157:*** Unlike most strains of *E. coli, E. coli O157* does not produce the enzyme glucuronidase and does not grow well at 44.5°C. As a result, it may not be detected using the normal method of analysis for indicator micro-organisms. *E. coli O157* causes non-bloody diarrhoea which may progress to bloody diarrhoea and haemolytic-uraemic syndrome (HUS). Some fatalities have been recorded. Approximately 5-10% of cases of *E. coli O157* infection develop HUS. Infants, young children and elderly people are particularly vulnerable. There have been outbreaks of infection associated with children's paddling pools. Most of these outbreaks followed a faecal accident in poorly disinfected pools.[9.10]

iii) ***Pseudomonas aeruginosa:*** *P. aeruginosa* is an opportunistic pathogen capable of metabolising a variety of organic compounds and is slightly resistant to a range of antibiotics and disinfectants. It is widely found in vegetation, soil and the aquatic environment. However, the predominant source of contamination of pools and spas is shedding from infected humans.

In swimming pools and spa pools, the primary health effects caused by *P. aeruginosa* are folliculitis and ear infection, although it has also been identified as the causative agent of eye, urinary tract, respiratory tract and wound infections. In serious cases it may also cause pneumonia.

The micro-organism is particularly problematic in warm spas as the high temperature of about 37°C and water turbulence are selective for its proliferation while suppressing the growth of other environmental microflora. *P. aeruginosa* has been found to colonise moist areas surrounding pools such as decks, benches and floors. It has also been found on pool surfaces, pool inflatable toys and within biofilms in filters, pipes and drains. Proper cleaning and disinfection (superchlorination) may be needed to prevent and control the growth of this micro-organism. It is difficult to maintain adequate disinfection levels constantly in spa pools because of the high temperature, heavy bather loads and water turbulence unless a reliable automatic disinfection system is installed.

iv) ***Legionella:*** *Legionella* bacteria are commonly found in natural sources of freshwater and also in man-made warm water systems and cooling water (tower) systems. They may also be found in moist soil.

L. pneumophila serogroup 1 is most frequently associated with human disease. There are two forms of *Legionella* infection: a serious pneumonic form known as Legionnaires' disease and a less debilitating form called Pontiac fever. *Legionella* infects humans through inhalation of infective aerosols created under specific conditions. The micro-organism is not known to cause disease by ingestion and there is no person-to-person transmission.

The majority of outbreaks have been associated with air conditioning water cooling systems. Showers may also pose a high risk of infection. Most of the reported legionellosis associated with recreational water occur in hot tubs and natural thermal spas.[11-13] Water spray from cooling towers and water agitated in spas may produce aerosols. Water from warm water systems can also form aerosols in showers, through nozzle heads or splashing in sinks and baths. Outbreaks of Legionellosis are rarely associated with properly disinfected spas. *Legionella* are easily destroyed by swimming pool chlorine and bromine disinfectants and therefore this organism should not present a problem in properly managed pools.

v) ***Staphylococcus aureus:*** *S. aureus* is a human commensal bacteria, present as part of the normal microflora of the nasal mucosa, the skin, and in the faeces of healthy individuals. It is thought to be the causative agent of most skin, wound, eye, ear and urinary infections in swimming pools.[14,15] Studies have shown that 50% or more of the total staphylococci isolated from swimming pool waters is *S. aureus*.[16]

Although *S. aureus* have been found in chlorinated swimming pools[17] maintaining a residual chlorine level of greater than 1 mg/L should eradicate the micro-organism.

vi) *Mycobacterium* spp.: Species of mycobacteria, other than the strictly pathogenic *M. tuberculosis*, are known as atypical mycobacteria. They are widely distributed in the aquatic environment. *M. avium* has been linked to hypersensitivity pneumonitis and possibly pneumonia following inhalation of contaminated aerosols generated by a spa pool.[18] *M. marinum* has been found to be responsible for localised lesions of the skin, especially on abraded elbows and knees.[19] This condition is referred to as swimming pool granuloma. The likely source of infection is contaminated pool surfaces as mycobacteria have been found to proliferate in these areas. Regular disinfection of pool surfaces and other moist areas surrounding pools is a good control measure. Regular superchlorination is also recommended to remove any biofilms which may harbour this micro-organism.

2.2.3 Protozoan pathogens

i) *Cryptosporidium:* There are several species of *Cryptosporidium* with *C. parvum* identified as the cause of a diarrhoeal illness in humans called cryptosporidiosis. This obligate protozoan parasite invades and multiplies in the gastro-intestinal tract of infected cattle, sheep and humans. It causes illness and produces oocysts, the infective form of the parasite. Large numbers of oocysts are excreted in faeces to the environment, including in water, where they can survive for a long time. As oocysts are highly resistant to standard levels of chlorine and bromine used for pool disinfection, transmission of the micro-organism in public swimming pools and spas can pose a serious public health risk, particularly to children and immuno-compromised persons. Mechanisms of transmission include faecal-oral, person to person, animal to person, waterborne and food borne. As the oocysts are very small (4-6 microns), highly chlorine resistant, and may persist in the pool water for days, filtration systems are unable to quickly remove the oocysts from pool circulation due to the principle of successive dilution (see Chapter 7.3).

Outbreaks of cryptosporidiosis have been reported around the world. The most infamous occurred in Milwaukee, USA in 1993 when about 403 000 cases were linked to the contamination of drinking water supplies[20]. Contaminated public swimming pools and other recreational water facilities have also been related to several outbreaks, including some in Australia. Between December 1997 and April 1998 over 1000 cases were notified in NSW, Queensland and the Australian Capital Territory where investigations implicated a number of pools to be a common source of contamination.[21]

In December 1996, public health legislation was amended requiring cases of cryptosporidiosis to be notifiable to NSW Health. Laboratories that detect *Cryptosporidium* in faecal samples must also notify NSW Health which may then carry out an investigation if warranted.

Cryptosporidium risk management in public swimming pools and spa pools is considered in more detail in Chapter 8.

ii) *Giardia:* *Giardia* is similar to *Cryptosporidium*, as *Giardia* species also form a cyst form that is resistant to chlorine. *Giardia* have been linked to outbreaks of gastroenteritis in public swimming pools.[22-24] It has a low infective dose of approximately 25 cysts[25] and is shed in large numbers in the faeces of infected people. However, most of the documented outbreaks of gastroenteritis in the swimming environment are *Cryptosporidium* related because its oocysts are more chlorine resistant than *Giardia* cysts. Giardiasis cases are also notifiable to NSW Health.

iii) *Naegleria fowleri:* This is a free-living amoeba, which causes primary amoebic meningo-encephalitis (PAM), a rare, but serious illness. Fortunately there have been no recent documented cases linked to swimming pools that are chlorinated. The micro-organism is thermophilic and thrives in nature in mineral springs, thermal bores, rivers and lakes. Cases of PAM have been linked to swimming in such places.

iv) *Acanthamoeba* spp.: Some species of *Acanthamoeba* are opportunistic pathogens and are found free-living in soil and all aquatic environments including chlorinated swimming pools. However, human contact with the micro-organism rarely leads to infection. Pathogenic species of *Acanthamoeba* cause granulomatous amoebic encephalitis (GAE) and inflammation of the cornea (keratitis).[26-28] Evidence suggests that properly maintained swimming pools are unlikely to be a source of infection in healthy individuals. There may however be an increased risk of GAE in immunosuppressed individuals and for people who wear contact lenses.

2.2.4 Fungal pathogens

***Trichophyton* spp. and *Epidermophyton floccosum*:** *Trichophyton* spp and *Epidermophyton floccosum* are fungal species that cause superficial infections of the hair, fingernail or skin. The most common infection is *Tinea pedis* or athletes foot. Symptoms include maceration, cracking and scaling of the skin, with intense itching. Transmission of the disease is normally by direct person-to-person contact. In swimming pools, infection usually arises from contact with contaminated surfaces, especially wet floors within shower rooms and change rooms.

To prevent transmission of fungal diseases, people with severe infections should seek medical treatment and should not use public swimming pools or spa pools. Pool operators should ensure proper cleaning and disinfection of surfaces, particularly floors. Patrons should be encouraged to wear sandals. In addition, the provision of PVC floor mesh mats may assist in maintaining hygienic conditions within change rooms.

A summary of the pathogenic micro-organisms which may be transmitted in swimming pools, the infection they cause and their source of contamination is outlined in Table 2.1 following.

Table 2.1: Pathogenic microbes associated with swimming pools

Organism	Infection	Source
Non-faecally derived bacteria		
Legionella spp.	Legionellosis (Pontiac fever and Legionnaires' disease)	Aerosols from spas and HVAC systems; Inadequate disinfection Poorly maintained showers or heated water systems
Pseudomonas aeruginosa	Folliculitis (spas) Swimmer's ear (pools)	Bather shedding in pool and spa waters and on wet surfaces around pools and spas
Mycobacterium spp.	Swimming pool granuloma Hypersensitivity; pneumonitis	Bather shedding on wet surfaces around pools and spas Aerosols from spa and HVAC systems
Staphylococcus aureus	Skin, wound and ear infections	Bather shedding in pool water
Leptospira spp.	Aseptic meningitis; Haemorrhagic jaundice	Pool water contaminated with urine from infected animals
Non-faecally derived viruses		
Adenoviruses	Pharyngo-conjunctivitis (swimming pool conjunctivitis)	Other bathers with infection
Molluscipoxvirus	*Molluscum contagiosum*	Bather shedding on benches, pool or spa decks, and swimming aids
Papillomavirus	Plantar wart	Bather shedding on pool and spa decks and floors in showers and changing rooms
Non-faecally derived protozoa		
Naegleria fowleri	Primary amoebic meningoencephalitis (PAM)	Pools, spas and natural spa water and pipes and other components
Acanthamoeba spp.	*Acanthamoeba keratitis* Granulomatous amoebic encephalitis (GAE)	Aerosols from HVAC systems
Plasmodium spp.	Malaria	Seasonally used pools may provide a breeding habitat for mosquitoes carrying *Plasmodium*
Non-faecally-derived fungi		
Trichophyton spp. *Epidermophyton floccosum*	Athlete's foot (*Tinea pedis*)	Bather shedding on floors in change rooms, showers and pool or hot tub decks
Faecally excreted viruses		
Adenovirus	Pharyngo-conjunctivitis	Nasal and eye secretions
Norovirus	Gastroenteritis	Faecal and vomit accidents
Hepatitis A virus	Hepatitis A (gastroenteritis)	Faecal accidents
Enterovirus (echovirus)	Gastroenteritis	Faecal and vomit accidents
Faecally excreted bacteria		
Shigella	Shigellosis (gastroenteritis)	Faecal accidents
E. coli	Gastroenteritis	Faecal accidents
Faecally-derived protozoa		
Giardia	Giardiasis (gastroenteritis)	Faecal accidents
Cryptosporidium	Cryptosporidiosis (gastroenteritis)	Faecal accidents

HVAC = Heating, ventilation and air conditioning

Source: adapted from WHO 2006[2]

2.3 Disease transmission theory

For a disease transmission episode to occur there must be three factors present at the one time as shown in the disease transmission pathway:

Source of pathogen → Transmission pathway → Susceptible host

Consider the transmission of the protozoan parasite *Cryptosporidium* in a swimming pool:

- There must be a **source** of pathogenic micro-organisms. In this case, the source is most likely faecal material from a person with infection, such as a non-toilet-trained infant, who has defecated into the pool. However, a source could also be an adult recovering from cryptosporidiosis and who is still shedding oocysts and who has not showered properly before entering the pool.
- The **transmission pathway** is the through the swimming pool water. Residual disinfectant must have sufficient time to disinfect the faecal material. It is very difficult in swimming pool water to disinfect faecal material which shields *Cryptosporidium* oocysts. Disinfection may take more than a day. Disinfection of *E. coli* could take less than one minute at recommended concentrations of chlorine or bromine.
- The **susceptible host** is a person in the swimming pool water capable of developing an infection.

If one of the above three factors is not present then transmission of disease will not occur. In Australia most of the effort to prevent transmission has concentrated on the transmission pathway i.e. the swimming pool. It is equally important to concentrate on the source of the pathogen by requiring all swimmers to toilet and shower before entering the pool. Infection in the susceptible host cannot be controlled because there is no vaccine.

2.4 Transmission of micro-organisms in swimming pools

Pathogenic micro-organisms can be transmitted in swimming pools from the ears, eyes, respiratory tract, skin, gastro-intestinal and urogenital tract of people with infection. Some micro-organisms, such as *Legionella* and *P. aeruginosa* are natural inhabitants of warm water environments and therefore these pathogenic micro-organisms are likely to proliferate if introduced into poorly disinfected pools.

Swimming pools and spa pools are often associated with outbreaks of infectious diseases. Commonly, these outbreaks occur in poorly chlorinated pools.[29,30] However, outbreaks of some micro-organisms, such as the protozoan parasite *Cryptosporidium*, are most likely to occur in pools following faecal accidents from infants who are not toilet trained (Furtado 1998; Hunt 1994; Sundkvist 1997; Bell 1993). Toddlers' pools are more often associated with outbreaks of infectious diseases[10,31,32] and this is supported by other studies that have found high counts of thermotolerant coliforms in pools used by toddlers.[33]

In NSW from December 1997 to April 1998, there was a state wide outbreak of 1060 laboratory-confirmed cryptosporidiosis cases. This outbreak was found to be associated with swimming in public pools.[34]

Other documented outbreaks that have been linked to swimming pools include: the skin infection folliculitis (caused by *P. aeruginosa*), respiratory illnesses (caused by *Legionella* and adenovirus), gastroenteritis (caused by *Giardia*, echovirus, norovirus, hepatitis A virus, *E. coli* and *Shigella*), haemolytic-uraemic syndrome caused by *E coli O157* and pharyngo-conjunctivitis caused by adenovirus.

While most of these outbreaks were found to be associated with poor disinfection, some outbreaks occurred in pools that were well maintained because disinfectants need time to inactivate micro-organisms. This time lag is a problem when action is not taken immediately to decontaminate a pool following a potentially infectious accident from faeces or vomit.

2.5 Conclusions

- Outbreaks of disease have frequently been linked to inadequately disinfected pools.
- Only outbreaks involving multiple cases appear to be reported. Many single cases are unreported.
- Even if a swimming pool or spa pool is properly managed and adequately disinfected, disease transmission can still occur by risky or adverse behaviour such as:
  - 'Whale spitting';
  - Faecal accidents and toddlers wearing poorly fitted pants;
  - Poor personal hygiene; and
  - Not toileting and showering before swimming.

- Disinfected swimming pools and spa pools are not sterile and cannot be made sterile.
- Contaminants are being constantly added to the pool by bathers and other sources. Sufficient time is needed for the disinfectant to inactivate the contaminants (depending on the type and concentration) once they enter the pool, e.g. *Cryptosporidium* spp., which may take days.
- It is essential for pool patrons to minimise pool contamination and to avoid risky behaviour.
- Pool operators should never allow disinfectant concentrations to fall below recommended levels and should anticipate high bather loads and raise disinfectant levels in advance.
- There are water treatment processes that may inactivate *Cryptosporidium* more quickly than others, e.g. chlorine dioxide.
- Bathers who have been ill, particularly if they have had diarrhoea in the previous two weeks, should not swim.
- All bathers should be encouraged to use a high standard of personal hygiene before entering a pool.

CHAPTER 3

Microbial criteria and sampling

3.1 Overview

This chapter begins with an explanation of indicator micro-organisms that are used to monitor the microbiological quality of swimming pool and spa pool water. An outline of the microbiological criteria, based on the characteristics of selected indicator micro-organisms, is provided, and the significance of their presence or absence in pool water briefly explained. Based on risk considerations, recommended sampling criteria for the purpose of microbiological testing are provided.

3.2 Indicator micro-organisms

Pathogenic micro-organisms are micro-organisms that are capable of causing disease. Many diseases have been linked to faecal contamination of swimming pool and spa pool water that has not been satisfactorily disinfected. Pathogens may also be released into the pool water from non-faecal sources, such as human skin or secretions, animal pets, rodents and stormwater runoff. They are invariably found in very small numbers, if at all, so testing for these pathogens (viruses, bacteria, protozoans including amoebae or fungi) frequently involves procedures that are complex, very expensive and time consuming. It is impossible to test for some pathogenic micro-organisms because they cannot be easily grown in a laboratory. Routine analysis for these many pathogenic micro-organisms is therefore impractical and inefficient.

Instead, tests are performed for micro-organisms which are expected to be present in water in much greater numbers than individual pathogens, and are therefore easier to enumerate. These are called "indicator" micro-organisms and their traditional role is to primarily indicate the presence or absence of faecal contamination. An ideal indicator micro-organism should possess the following characteristics:

- It should be found in faecally polluted water in large numbers.
- It should not be able to survive and multiply in water.
- It should possess growth and survival characteristics similar to pathogens.
- Isolating, identifying and enumerating these indicators should be relatively easy and inexpensive to perform.

As health risks in pools may be of faecal or non-faecal origin, tests should be performed for both faecally-derived (e.g. *Escherichia coli*) and non-faecally-derived (e.g. *Pseudomonas aeruginosa*) micro-organisms. Faecal indicators are used to monitor possible faecal pollution. Non-faecal indicators are used to monitor microbial growth. Microbiological indicators are a useful tool to determine whether disinfection of pool water, at the time of sampling, was adequate to kill most pathogenic organisms. The presence of any of these micro-organisms indicates a poorly operated disinfection system. Their absence, however, does not guarantee safety, as some pathogens (notably viral and protozoan parasites) are more resistant to treatment than the indicators.

When the results of microbiological testing are received it represents the microbial quality of the water at the time of sampling. Therefore water quality conditions have most likely changed since sampling. It is important that the pool water had been chemically tested at the time of microbiological sample to enable a more meaningful interpretation and correlation.

3.3 Microbiological criteria

The microbiological criteria for a well-managed swimming pool or spa pool are as follows:

Table 3.1: Microbiological criteria

Test	Criterion
Heterotrophic plate count	< 100 cfu / 1 mL of water sample
Escherichia coli (E. coli)	< 1 cfu / 100 mL of water sample
Pseudomonas aeruginosa	< 1 cfu / 100 mL of water sample

cfu = colony forming units   mL = millilitre

Microbiological samples should always be collected before chemical samples to avoid accidental contamination of the pool water with micro-organisms from the sampler. Chemical analyses of water for free and total chlorine (or bromine), pH, total alkalinity and temperature should be conducted by the pool side immediately after microbiological sampling. Microbiological tests should only be performed by laboratories accredited by the National Association of Testing Authorities (NATA).

3.3.1 Heterotrophic plate count (HPC)

Heterotrophic plate count is also known by a number of other names, including standard plate count, total plate count, total viable count or aerobic quality count. It does not differentiate between the types of bacteria present nor does it indicate the total number of bacteria present in the water – only those capable of forming visible colonies under specified conditions on certain non-selective microbiological media. Varying the incubation temperature will favour the growth of different groups of bacteria. As it gives more meaningful information about pathogenic (disease-causing) bacteria, 35°C (or 37°C) is the preferred incubation temperature.

HPC does not necessarily indicate microbiological safety as the bacteria isolated may not have been faecally-derived but it does give a measure of the overall general quality of the pool water, and whether the filtration and disinfection systems are operating satisfactorily. Results reported by the laboratory are traditionally expressed as colony forming units per millilitre (cfu/mL) which equates to the number of bacteria in each millilitre of the original sample of water tested. A HPC count of less than1 cfu/mL indicates that the disinfection system is effective. If the count is between 10 and 100 cfu/mL, indicates that a routine investigation should be conducted as soon as possible to ensure that all the management operations are functioning properly. However, counts above100 cfu/mL is indicative of a faulty disinfection system and an urgent investigation should be conducted immediately. The pool water should be re-sampled and sent to the laboratory to be tested again as soon as possible.

3.3.2 *Escherichia coli (E. coli)*

This bacterium is a normal inhabitant of the intestinal tract of warm-blooded animals and is always present in faeces in large numbers (approximately 109/g). *E. coli* is almost exclusively of faecal origin and does not multiply in water. Detection of *E. coli* indicates recent faecal contamination. Results for *E. coli* are normally reported as cfu/100 mL of water tested. Note that the criterion for *E.Coli* is more stringent than HPC because an indication of faecal contamination would mean the likely presence of pathogenic micro-organisms in the pool. It is possible to have high HPC and a low *E. coli* indicating no recent faecal contamination but low overall disinfection efficiency. A high HPC and high *E. coli* indicates a disinfection system that is severely deficient, and bathers would be likely to have been at risk of contracting disease at the time of sampling. *E. coli* is the most reliable indicator of public health risk.

3.3.3 *Pseudomonas aeruginosa*

This is an opportunistic pathogen commonly found in water, soil and vegetation. It also can be found in human and animal faeces. It rarely causes infection in healthy people but can colonise damaged systems, such as burn wounds and damaged eyes. Immunocompromised individuals are particularly at risk. *P. aeruginosa* can grow at the selective temperature of 41-42°C, where most environmental micro-organisms would not survive. This allows it to proliferate to high numbers and cause diseases like ear and eye infections and folliculate skin infections. Although slightly resistant to a range of disinfectants, chlorination of swimming pools should be sufficient to kill the bacterium. However, in environments peculiar to spas such as water turbulence, elevated temperature and high bather loads, considerably greater care is needed to ensure the safe operation of the spa and the eradication of the micro-organism. The bacterium produces a biofilm and may colonise pipes and filter media. Laboratory results for *P. aeruginosa* are normally reported as cfu/100 mL of water tested. It is a more sensitive indicator than *E. coli* and may be detected in their absence. Presence of this micro-organism in the pool indicates that the disinfectant has not been sufficiently maintained continuously at the minimum levels. The pool may need superchlorination, or at least a shock dose of chlorine added upstream to the filter to eliminate biofilm and any micro-organism that may be harbouring in the water and the filter media.

3.4 Microbiological sampling

Ideally, persons collecting samples should be trained and certified competent in the use of aseptic techniques (see below). The following points should be noted concerning sampling:

3.4.1 Sampling technique

"Aseptic technique" should be used at all times during sampling. A part of this technique means that the inside of the container and lid should not be touched otherwise the container is no longer sterile. Sterile containers of 250 to 500 mL capacity containing a trace of sodium thiosulphate (added to neutralise chlorine) should be used. Samples should be collected during periods of maximum bather load. Sampling frequency consistent with Table 3.2 is recommended.

A sampling location close to the pool outlet should be chosen so that it is representative of the water which has already circulated through the pool. The lid from the sterile container should be carefully removed while holding the jar near its base. The lid should not be inverted but held in a mouth down position at all times. The container should be filled in one sweeping movement by plunging the container mouth downwards into the pool and scooping a sample at a depth of at least 450 mm. The mouth of the container should always point ahead of the hand while scooping away from the body. Avoid contamination of the sample by floating debris. The container should not be rinsed to avoid washing out sodium thiosulphate. The top 15 mm of water should be tipped out of the bottle (to allow sufficient headspace for mixing), the lid replaced, and the sample placed in a cooler with sufficient freezer bricks to cool the sample during transport to the laboratory.

3.4.2 Timeliness

Once samples have been collected, it is equally important that they are delivered to the laboratory in a manner that does not alter their condition from that existing at the time of collection. For microbiological samples, it is important that there has been no increase or decline of microbial numbers during transport. Ideally, samples should arrive at the laboratory within six hours, but definitely no longer than 24 hours, after sample collection.

3.4.3 Interpretation

While each criterion has been explained previously, they should not be used as the basis of immediate risk assessment as it could be three days before results are received and inferences made. Results, however, need to be interpreted against the results of chemical testing performed immediately after the microbiological sampling.

3.4.4 Chemical criteria

Each chemical criterion (section 5.2) has been rounded up to give a slight safety margin. Thus, continuous maintenance of a minimum of 1 mg/L of free available chlorine in an outdoor pool (at a pH of 7.5), which is required in the chemical criterion, is slightly more than sufficient than that needed to ensure compliance with the microbiological criteria.

3.4.5 Database

All microbiological sample results should be logged in a database or spreadsheet so that a history of disinfection can be developed. Once patterns have emerged, it may be possible to reduce sample frequency, or other locations can be sampled to enable comparisons.

All three microbiological criterion need to be considered at the one time, from the one sample. The recommended minimum sampling frequencies for the analysis of these indicator micro-organisms are given in Table 3.2. Microbiological criteria is a useful guide to the performance of disinfection in a pool and that it is only an indication of past risk measured as a snapshot at one point in time. Once the snapshots have been placed in a database the whole picture of pool performance begins to emerge so that the pool operator can gain confidence in pool operations and become more competent in pool management.

Table 3.2: Minimum sampling frequency for microbiological analysis

Pool type	Heterotrophic plate count (HPC) < 100 cfu/ mL	*E. coli* < 1 cfu/100 mL	*Pseudomonas aeruginosa* < 1 cfu/100 mL
Category 1 Spas; hydrotherapy pools; pools used by swim schools; pools used by incontinent people; infant wading pools; highest risk pools (see section 3.5)	Monthly	Monthly	Monthly
Category 2 Swimming pools > 26°C (except Category 1 pools); wave, river and low depth (< 1 m) leisure pools; higher risk pools (see section 3.5)	Bi-monthly	Bi-monthly	Bi-monthly
Category 3 Swimming pools < 26°C (except Category 1 and 2 pools); diving pools; low and infrequent bathing load pools	Quarterly	Quarterly	When need arises

Source: Adapted from WHO 2006.

3.5 Micro-organism risk factors

The following risk factors have been associated with microbiological failure of pool water quality. Where three or more risk factors exist in a swimming pool, the pool should be changed to a more stringent category. For example, a Category 3 diving pool should be changed to a Category 2 pool where three or more of the following risk factors are observed:

- pH greater than 7.6 in a chlorinated pool
- Consistently poor disinfection (previous chemical or bacteriological failures)
- High turbidity
- Poor pool circulation or filtration
- High bather loads
- Presence of algae
- Regular use by birds e.g. ducks
- Easy access of foreign material e.g. litter
- Biofilms detected
- Poor quality make-up water (high in chloramines)
- Infrequent testing of disinfectant concentration
- No automatic disinfection and pH control.

When indicator micro-organisms exceed their criterion value, a thorough assessment of the pool's physical and chemical environment should be undertaken. Pool surfaces should be checked for biofilms. Backwashing of the filters may be needed. Concentrations of disinfectant, pH, cyanuric acid, total dissolved solids (TDS) and turbidity should be checked. The incoming water supply should also be checked regularly for chloramines. It may be advisable to engage a consultant.

On most occasions microbial failure is due to inadequate continuous disinfection. Failures may also occur as a result of high turbidity and biofilms, which can shield micro-organisms from disinfectants. Biofilms within pipes and filtration units may harbour micro-organisms especially in pools that are not continuously held above the minimum disinfection levels or in the proper pH range. Regularly super-chlorination or oxidant shocking may be needed to destroy biofilms.

Following rectification of any pool problems, the pool water should be re-sampled to confirm that the swimming pool or spa pool is safe for use.

CHAPTER 4

Disinfection

4.1 Overview

Chapter 2 explained that micro-organisms can be transmitted from bather to bather directly in swimming pool water. It is impossible to prevent pathogenic micro-organisms from entering the pool, particularly from bathers. It is therefore essential that a residual disinfectant be present in the pool at all times and in sufficient strength to inactivate or kill the pathogenic micro-organisms as soon as possible.

Disinfectants take time to inactivate micro-organisms, and while they do not eliminate the risk of disease entirely, disinfection significantly reduces the risk of disease transmission. It is important to understand how disinfectants work and the factors that enhance or impede their ability to kill micro-organisms.

This chapter considers disinfectant properties in general, and specifically the halogen disinfectants of chlorine and bromine. Disinfection systems which are not primarily based on chlorine or bromine are not accepted in NSW.

Swimming pool and spa pool chemical parameters are included in Chapter 5.

4.2 Disinfectant properties

There is no perfect disinfectant. An ideal disinfectant however, would have the following properties:

- **Residual:** The disinfectant needs to remain active in the body of pool water. For example, ultra violet (UV) light does not impart any residual effect to the pool water while chlorine and bromine do. A good disinfectant does not dissipate quickly but slowly decreases as it disinfects.
- **Oxidiser:** It is important that there is an oxidising effect in the pool to oxidise organic matter, particularly inorganic nitrogen compounds. These impurities are responsible for algal growth, reducing the effectiveness of chlorine disinfection, are irritants and are pollutants.
- **Efficiency:** The disinfectant needs to be wide spectrum and rapid in its action so that there is not enough time for the diverse types of micro-organisms to transmit through the pool.
- **Measurable:** The concentration of the disinfectant needs to be measurable at the pool side using an easy and accurate test methodology to enable rapid corrective action.
- **Economic:** The disinfectant needs to be cost effective.
- **Dosing:** The disinfectant needs to be in a form that is easy to dose automatically in a pool. A liquid is the easiest and safest form to use. Devices to dose both solids and powders are now available.
- **Safety:** The disinfectant needs to be relatively safe to handle. It should not be flammable, explosive or toxic in a gaseous form. It should be easy to transport and to contain spillages. The disinfectant should not generate fine dust or respirable particles.
- **Side effects:** The disinfectant should have the least unwanted side effects.

The halogens of chlorine and bromine are the most popular because of their known properties, proven effectiveness, ease of use and being cost effective when used properly with automated equipment. While neither disinfectant is perfect, each has its relative advantages and disadvantages. The APVMA guide previously mentioned in Section 1.6, "Guide to demonstrating efficacy of pool and spa sanitisers" is a guide for establishing the efficacy of new sanitisers apart from chlorine and bromine sanitisers.

4.3 Disinfection concepts

Pool operators need to be aware of some basic concepts of disinfection.

- **Logarithms:** In the following logarithmic scale: 1 Log = 10; 2 Log = 100; 3 Log = 1000; 4 Log = 10000 each increased log number equals an additional "0" or multiplication by 10. Therefore a 1 Log reduction means the same as removing a "0" or a reduction by 90%, since a 90% reduction is the same as dividing by 10. A 2 Log reduction means the same as a 99%

reduction since a 99% reduction is the same as dividing by 100, and so on.

- **Percentage kill:** A swimming pool can be easily faecally contaminated with 1 gram of faeces (1 gram of faeces is about the size of a small pill and can contain well over 1 million (or 1 x 106 in scientific notation) pathogenic bacteria. A 90% kill (or 1 Log kill) inactivates 900 000 and still leaves about 100 000 bacteria. A 99% kill rate (2 Log kill) leaves 10 000 bacteria, and so on. A kill rate of 99.9% seems good but the 1000 bacteria remaining can still cause an infection and if the disinfectant is exhausted during the disinfection process then the bacteria may regrow under the right conditions. Disinfection should aim for at least a 4 Log (99.99%) reduction and preferably a 5 Log (99.999%) reduction.
- **Kill time:** Ideally an effective disinfectant should cause a 99.99% (4 Log) reduction in bacteria in about 60 seconds or less. This is achievable by 1 mg/L of free chlorine at a pH of 7.5 in an outdoor pool for many micro-organisms. However, bacteria protected by biofilm, spores or encapsulated in organic matter will take longer to kill.
- **Bacteriostatic:** This term means that the micro-organisms are prevented from multiplying, their numbers are held static, and they die from natural attrition processes but not as a result of chemical disinfection. **Bactericidal** means that the chemical kills or inactivates the micro-organism.
- **Oxidising:** It is an advantage if the disinfectant also oxidises or breaks down organic matter particularly nitrogen-containing compounds which would encourage the growth of algae. Periodic addition an oxidising chemical such as hydrogen peroxide or potassium monopersulphate may enhance the disinfection capacity of chlorine or bromine after heavy bathing loads.
- **Ct value:** Studies have been undertaken to assess the effectiveness of various disinfectants. The effectiveness of a disinfectant can be expressed by its Ct value. This is the concentration (C) of the disinfectant (expressed in mg/L) multiplied by the time (t, expressed in minutes) required to give a certain log reduction (inactivation) of micro-organisms. It is recommended that a free chlorine Ct value of 15 300 mg-min/L is required to achieve 3 Log inactivation of *Cryptosporidium parvum* spores. For example, to achieve a Ct value of 15 300 using a chlorine concentration of 15 mg/L then:

  Ct = 15 300 = 15 mg/L (C) x time (t)
  Therefore Time (t) = 15 300 ÷ 15 = 1020 minutes or 17 hours

- **Temperature:** As temperature increases, the growth rate of micro-organisms also increases until an optimum growth temperature is reached. After the optimum growth temperature is reached the micro-organism does not grow as quickly. It has been found that *Pseudomonas aeruginosa* cannot be sufficiently controlled by 1 mg/L of free chlorine at temperatures greater than 26°C. Heated indoor swimming pools and spa pools therefore need a higher concentration of free chlorine to control this micro-organism.

4.4 Characteristics of various disinfectants

4.4.1 Chlorine-based disinfectants that produce hypochlorous acid

Chlorination is the most commonly used swimming pool disinfection technique and is available in the compounds below in Table 4.1 Common Chlorine Compounds (although chlorine gas is rarely used).

Table 4.1: Common Chlorine Compounds

	Sodium hypochlorite	Calcium hypochlorite	Lithium hypochlorite	Chlorine gas	Trichloro isocyanurate	Dichloro isocyanurate
% Available Chlorine	10-12	65-78	35	100	90	50-63
% Active Strength	10-12	65-78	29	100	>99	>99
pH in 1% solution	13	8.5-11	10.8	0	2.8-3.5	6.5-6.8
pH effect in water	Raises	Raises	Raises	Lowers	Lowers	Neutral
Physical appearance	Liquid	Granular Tablet Briquette	Granular	Yellow green gas	Granular Tablet	Granular

(Source: USA National Swimming Pool Foundation)

When a hypochlorite compound e.g. sodium hypochlorite or calcium hypochlorite, is added to water, hypochlorous acid (HOCl) is formed. Hypochlorous acid partially dissociates (splits apart) in water in equilibrium with H^+ (hydrogen ion) and OCl^- (hypochlorite ion), as shown in the following chemical reaction:

HOCl		**H^+**		**OCl^-**
Hypochlorous acid (Strong disinfectant)	⇆	Hydrogen ion	+	Hypochlorite ion (Weak disinfectant)

This is a chemical equation that uses a dissociation sign (⇆) because the chemical equation can react in either direction depending on conditions in the water environment. It uses the dissociation sign because the equation is always trying to reach equilibrium or a balance between the concentrations of hypochlorous acid (HOCl), the hydrogen ion (H^+) and the OCl^- (hypochlorite ion). The balanced proportion can vary with pH changes. When pool water becomes more acidic (towards pH 7), the hydrogen ion concentration increases, combines with the hypochlorite ion and drives the equation to the left to form more hypochlorous acid. When pool water becomes more alkaline (towards pH 8) the hydrogen ion concentration decreases. To make up for the shortage H^+ splits from the HOCl and drives the equation to the right to also form OCl^-. The concentration of HOCL will therefore decrease. This effect will be explored further when considering the effect of pH on the disinfection power of free chlorine.

(i) Free available chlorine (free chlorine)

Free available chlorine (also called free chlorine or FAC) is a measure of the concentration of hypochlorous acid plus the concentration of the hypochlorite ion expressed in milligrams per litre (mg/L). The reagent used to measure free chlorine is diethyl-p-phenylene diamine (DPD) commonly known as DPD Tablet No. 1. When a DPD No. 1 tablet is dissolved into a 10 mL sample of pool water a deep pink/purple coloured solution will develop depending on the concentration of free chlorine present.

Hypochlorous acid (HOCl) is the active disinfecting component of free chlorine. The hypochlorite ion (OCl^-) is not effective as a disinfecting component of free chlorine. It is logical to maximise hypochlorous acid and to minimise the hypochlorite ion because this affects the potency of free chlorine as a disinfectant. This aspect of disinfection will be discussed more in the next section.

(ii) The effect of pH on chlorine disinfection power

Hypochlorous acid (HOCl) is a powerful disinfectant and the hypochlorite ion (OCl^-) is a weak disinfectant. The disinfection power of free chlorine is the opposite to the pH of the pool water; as pH increases then free chlorine disinfection power decreases. Table 4.2 shows how the percentage concentration of hypochlorous acid in free chlorine decreases with increasing pH because the hypochlorous acid converts to the hypochlorite ion. Free chlorine at pH 7.5 is only half as powerful as at pH 6.0. Above pH 7.8, free chlorine has lost most of its disinfection power.

Table 4.2: Percentage of hypochlorous acid determined by pH:

pH	Percentage Disinfection Power of Hypochlorous acid (HOCl) as Free Chlorine
6.0	97
7.0	75
7.2	63
7.5	49
7.6	39
7.8	28
8.0	3

Because the relationship between HOCl and OCl^- is pH dependent, a higher concentration of hypochlorous acid must therefore be maintained when the pH exceeds 7.6 to maintain overall disinfection power. Preferably, pH should be maintained between 7.2-7.6 because more hypochlorous acid is available for disinfection. If pH rises above 7.6 then free chlorine must be increased by an additional 1.0 mg/L to compensate for the loss of HOCl potency. pH must never rise above 7.8 in a chlorine disinfection system because of the significant loss of disinfection power.

Regularly monitored and maintained automatic control systems are capable of maintaining pH and free chlorine within acceptable disinfection limits. Automatic control is considered essential best practice for all public swimming pools and spa pools.

(iii) Total chlorine, free chlorine and combined chlorine

As mentioned, free chlorine is determined using DPD No. 1 tablet. Total chlorine is a measure of all of the chlorine compounds which may be found in a pool. Also measured in mg/L, it is determined by adding a DPD No. 3 tablet to the free chlorine water sample and after two minutes, the purple colour represents the total chlorine concentration. The relationship between total chlorine, free chlorine and combined chlorine is as follows:

Free Chlorine (DPD 1) + Combined Chlorine = Total Chlorine (DPD 1+3)

Therefore the difference between Total Chlorine (DPD 1+3) and Free Chlorine (DPD1) is combined chlorine or:

Total Chlorine (DPD 1+3) – Free Chlorine (DPD 1) = Combined Chlorine

Combined chlorine is also called chloramines and is a measure of the chlorine that has combined with various forms of nitrogen compounds, particularly ammonia. Chloramines can be either inorganic or organic.

Chloramine compounds cause skin irritation, eye irritation, corrosion, and a strong and offensive chlorine odour that can be sometimes smelled when entering a swimming pool area. Chloramine compounds are very poor disinfectants (about 60 to 100 times less effective than hypochlorous acid). It is essential to eradicate or at least minimise chloramines.

(iv) Bather pollution and the formation of chloramines

Combined chlorines are formed when chlorine combines with other compounds. In a swimming pool chlorine mainly combines with compounds that enter the pool from bather contamination. As these contaminating compounds breakdown they form two types of chloramines:

- *Inorganic chloramines:* Chlorine reacts with ammonia mainly derived from human excretions. The ammonia comes from the breakdown of urea, creatinine, uric acid, glycine, histidine, arginine and other compounds from urine and to a lesser extent from perspiration. Ammonia reacts with chlorine to form chloramines (monochloramine, dichloramine and trichloramine). Ammonia may also be introduced from a water supply which has been disinfected using chloramination techniques. Chloramines severely reduce disinfection efficiency and may cause harm to bathers. The following equations show the chloramine compound formation reactions:

Formation of monochloramine from ammonia

$HOCl$	+ NH_3	→ NH_2Cl	+ H_2O
Hypochlorous acid	Ammonia	Monochloramine	Water

Formation of dichloramine from monochloramine

$HOCl$	+ NH_2Cl	→ $NHCl_2$	+ H_2O
Hypochlorous acid	Monochloramine	Dichloramine	Water

Formation of trichloramine from dichloramine

$HOCl$	+ $NHCl_2$	→ $NHCl_3$	+ H_2O
Hypochlorous acid	Dichloramine	Trichloramine	Water

Nitrogen gas, nitrate and other by-products form from these reactions in varying proportions depending upon pH, temperature, contact time and the ratios of chlorine to ammonia and chlorine to ammonia nitrogen concentrations.

Trichloramine is more prone to formation at relatively low pool pH of 7. Trichloramine, and to a lesser extent dichloramine, cause severe irritations to the skin, eyes and respiratory tract. Trichloramine is the most volatile chloramine and is responsible for the strong chlorine-like odour associated with poorly maintained indoor swimming pools and spa pools. This problem should not arise in properly managed outdoor aquatic centres.

Inorganic chloramines tend to persist in indoor pools for hours until oxidised. Chloramines are volatile and are slowly given off from pool water. If there is insufficient ventilation or if pool blankets are used during overnight chlorination then the chloramines might not be able to dissipate and may be reabsorbed into the pool water. Volatile chloramines will also cause corrosion to fabrics and fittings.

- *Organic chloramines*. Organic chloramines are formed when chlorine combines directly with the organic molecules of urea, creatinine, uric acid, glycine, histidine, arginine and other compounds from urine and to a lesser extent from perspiration. Organic chloramines are very persistent and it may be many days before they are broken down. Organic chloramines also adversely affect disinfection rates, cause eye stinging and cause odours. It is essential that people not urinate in the pool and the practice should be actively discouraged.

(v) Reducing chloramines

Breakpoint chlorination and superchlorination are common techniques used to control inorganic combined chlorine. Breakpoint chlorination and superchlorination do not control organic combined chlorine. A detailed explanation may be found in Appendix A.

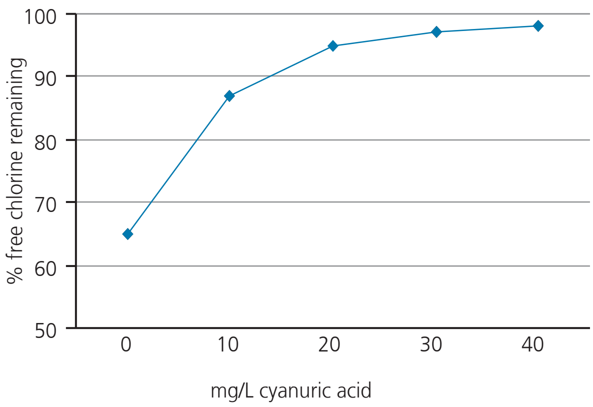
Other techniques may need to be employed to reduce organic chloramines that use non-chlorine oxidisers such as hydrogen peroxide, ozone, medium pressure UV light lamps and potassium monopersulphate. The use of these chemicals is also known as "oxy shocking" and in some indoor pools may need to be practiced once a week. Oxy shocking may interfere temporarily (perhaps overnight) with total chlorine measurement and ORP controllers. These techniques are also effective against inorganic chloramines. The use of oxy shock chemicals and UV light assist the disinfection power of free chlorine by reducing chlorine demand to perform oxidation. Generally oxidisers are poor disinfectants but are better oxidisers than free chlorine. Competent professional swimming pool consultants should be engaged when considering these chloramine-reducing techniques.

(vi) Stabilised chlorine – cyanurate products and cyanuric acid

When UV light from the sun shines on a swimming pool it converts hypochlorous acid (HOCl) to hydrochloric acid (HCl) which has no disinfection power. The conversion of hypochlorous acid by UV light from the sun therefore gradually decreases the disinfection capacity of the pool water. Even more chlorine then has to be added to the pool to maintain minimum disinfection levels.

Cyanuric acid (cyanurate) is a chemical which, when added to pool water, forms a weak bond with hypochlorous acid. It stabilises hypochlorous acid to reduce losses from the pool caused by UV light from the sun. Some of the hypochlorite ion converts to hypochlorite to compensate for some of the loss of hypochlorous acid. Testing has shown that pool water without cyanuric acid, when exposed to the sun, loses approximately 35% of the free chlorine each hour (Graph 4.1). As the concentration of cyanuric acid rises in a swimming pool, less proportionately free chlorine is lost from the pool. Above 20 mg/L of cyanuric acid, the law of diminishing return applies where there is very little extra loss of free chlorine with the addition of more cyanuric acid. On a sunny day, outdoor pools without cyanuric acid may lose up to 90% of the free chlorine residual over the whole day, compared with only a 15% loss when cyanuric acid was used.

Graph 4.1: Cyanuric acid concentration vs percentage free chlorine loss in one hour



There is no benefit using cyanuric acid in an indoor pool because the pool water is not exposed to direct UV light, even if the pool is covered with Perspex® or glass little UV light is transmitted.

Unfortunately, the addition of cyanuric acid also reduces the disinfection power of hypochlorous acid because of the weak bonds formed between these compounds. A 50 mg/L concentration of cyanuric acid may increase the time needed for a 4 Log reduction of *Pseudomonas aeruginosa* from 1 minute to approximately 5 minutes. It is therefore necessary to operate an outdoor pool at 3 mg/L free chlorine when using cyanuric acid. Cyanuric acid greatly reduces the power of free chlorine to disinfect *Cryptosporidium* oocysts. Further studies using oxidation-reduction potential (ORP – see section 8.3.1), have shown a loss of ORP when cyanuric acid has been added to swimming pool water. A significant loss of disinfection power is commonly called chlorine lock and is the subject of some debate among pool professionals and chemical companies.

Cyanuric acid is only lost from the pool through backwashing and splashing and only diluted by the addition of water so it only needs to be added occasionally, but not continuously. It is best practice to add cyanuric acid until the maximum concentration in the pool is 50 mg/L. The concentration gradually drops over weeks until it reaches 20 mg/L. The pool should then be dosed again to 50 mg/L.

Where a chlorinated cyanurate compounds, such as tri- or dichloroisocyanurate are used to chlorinate a pool, it must be discontinued when the cyanuric acid concentration exceeds 50 mg/L and another form of chlorine used. If cyanurate concentration exceeds the maximum concentration of 50 mg/L the disinfection rate is too slow and diseases could be more readily transmitted. The optimal concentration of cyanuric acid is 30 mg/L. The continuous use of chlorinated cyanurate compounds is discouraged otherwise a very high cyanuric acid level can be reached which greatly impede disinfection rates.

In summary, while cyanurate bonds to free chlorine to reduce losses of free chlorine in sunlight it also reduces the disinfection effect. Increasing the free chlorine concentration in an outdoor pool from 1 mg/L to 3 mg/L compensates for this loss of disinfection effect. The overall result is a net saving in the use of chlorine disinfectant and a monetary saving to the pool operator.

(vii) Electrolytic generation of hypochlorous acid

There are two methods of on-site electrolytic generation of hypochlorous acid:

i) In line salt-water generation,
ii) Brine solution generation.

Both methods employ electrodes immersed in salt water. Electrolytic generation does not need to be registered with the APVMA (see section 1.5) as a disinfectant because it is an on-site generation process.

In line salt-water generation is commonly known as salt-water chlorination. A common salt (NaCl) concentration of approximately 3000 mg/L is maintained in the swimming pool. Circulating pool water passes through a coarse filter, a pump, a filter and a heat exchanger, if fitted, and then through an electrolytic cell containing a cathode and anode, before being returned to the pool inlets. The cell may be located on a side stream to the circulation system. This system operates only while the circulation system operates. Chlorine gas is generated at the anode while hydrogen gas is generated at the cathode. The chlorine gas rapidly dissolves into the pool water leaving no gas residue while the hydrogen gas is vented directly to the atmosphere. The system uses DC electricity that periodically reverses polarity to reduce scale formation on the electrodes. The chlorine gas immediately dissolves to form hypochlorous acid and the pool operates according to normal chlorine chemistry. It appears that the high level of hypochlorous acid generated in the electrolytic cell may oxidise chloramines in the cell and in the return line to the pool thus constantly reducing chloramine concentration. Salt is lost from the system by backwashing and splashing and salt needs to be infrequently added to the pool. This system is more suited to smaller pools as it is limited in the amount of free chlorine that can be produced. Generally, additional chlorine can only be introduced by operating the system for a longer time or installing additional cells that come on-line when chlorine demand is high.

Brine solution generation uses a separate container of brine (salt water) for generation. Brine is produced in a tank to the required strength using softened water and common salt. Common salt also contains bromine. The brine is passed through the electrolytic cell, as outlined above, which generates hypochlorous acid and hypobromous acid for storage in a day cell at a concentration of about 8000 mg/L (0.8 % solution). The swimming pool is automatically dosed from the day tank. A low level switch in the day tank activates the production of more hypochlorous acid. Apparently mixed oxidants are also produced, in addition to free chlorine, which leads to the destruction of chloramines. The mixed oxidants may interfere with total chlorine measurement resulting in a false high result for combined chlorine.

4.4.2 Bromine-based disinfectants

The use of bromine disinfectants became popular during World War II when chlorine was scarce. Bromine is mainly used in heated spas as it is more stable than chlorine at higher temperatures. Bromine is less suitable for outdoor pool use because it cannot be stabilised against losses due to UV light and is more expensive than chlorine-based disinfectants. However, in a mixed system (see sodium bromide systems below) where the bromine is activated by chlorine or ozone it may be cheaper than adding chlorine alone.

Bromine belongs to the halogen elemental group in the period table of elements, which consists of fluorine, chlorine, bromine, iodine and astatine. Bromine is a larger atom than chlorine and its compounds disinfection rate is slower than those of chlorine. While bromine chemistry is similar to chlorine chemistry, hypobromus acid (HOBr) has about half the disinfection efficacy or potency of hypochlorous acid (HOCl). Similarly, hypobromus acid is not as strong an oxidiser as hypochlorous acid.

Bromine is used to disinfect swimming pool and spas by two different mechanisms:

***Bromo-chloro-dimethylhydantoin* (BCDMH)** is the most common bromine-based swimming pool disinfectant. BCDMH is known to cause skin and eye irritations. However irritations are less likely to occur in properly maintained pools where water balance and adequate dilution prevent a build-up of disinfection by-products and other chemicals.

Dimethylhydantoin (DMH) is a disinfection by-product of BCDMH, which has been associated with skin irritation (bromine itch) when the DMH concentration in pool water becomes too high. Pool operators need to maintain DMH below 200 mg/L. This is achieved by frequent backwashing and dilution with fresh water. Heavily used spa pools within high-risk premises (such as nursing homes) should be emptied and cleaned weekly. Spa pools which are infrequently used and well maintained are likely to maintain good water quality and therefore could be emptied less frequently (maximum three months).

Sodium bromide (NaBr) systems, also known as bromine bank systems, use an oxidising activator (hypochlorite, ozone or potassium monopersulphate) to generate hypobromous acid to disinfect swimming pool and spa pool water. It is important to maintain an excess of sodium bromide at all times and the amount of activator cannot exceed the sodium bromide. This ensures that excess activator such as ozone is not generated and released (de-gassed) from the pool. The controllers used for chlorine control can also be used for bromine control. Generally, such systems generate less volatile chloramines than chlorine alone.

Systems using ozone to re-generate bromine require skilled designers and trained operators to ensure system performance, safety and healthy conditions. The operator needs to ensure that the correct disinfection concentration is maintained as well as ensuring the prevention of ozone de-gassing and safe levels of bromate. Bromide ions react with ozone to form free bromine. Hence, the prevention of ozone contamination and the maintenance of adequate bromine for disinfection depend on a continual supply of bromide ions, which needs to be carefully monitored and controlled.

(i) The hydrolysis of bromine to form hypobromous acid

Similar to chlorine, bromine in water hydrolyses to form hypobromous acid. Hypobromous acid also dissociates in water to form the hypobromite ion as follows:

HOBR	⇆ H+	+ OBr^-
Hypobromous acid	Hydrogen Ion	Hypobromite Ion

Unlike free chlorine, the DPD No 1 tablet measures the concentrations of hypobromous acid, the hypobromite ion as well as bromamines. Therefore the DPD tablet No. 1 effectively measures total bromine. If using chlorine measuring methodology, the free chlorine result should be multiplied by 2.25 to obtain the equivalent total bromine concentration.

(ii) The formation of bromamines

Like chlorine, bromine reacts with ammonia to form bromamines, all of which have similar disinfection properties to bromine, unlike chloramines. Nitrogen tribromide also forms in bromine treated pools, which can cause irritations to the eyes and respiratory tract .36 Unlike trichloramine, tribromamine does not produce offensive odours.

(iii) The effect of pH on bromine disinfection power

Table 4.3: Percentage of hypobromous acid in free bromine determined by pH

pH	Percentage of free bromine as	
	Hypobromous acid (HOBr)	Hypobromite ion (OBr^-)
6.0	100	0
7.0	98	2
7.2	96	4
7.5	94	6
7.6	91	9
7.8	87	13
8.0	83	17

Similar to chlorine, the hypobromite ion is a poor disinfectant, and its formation is pH dependent similar to the hypochlorite ion. However, the disinfection power of free bromine does not decrease significantly when the pH of the water is raised whereas free chlorine would. Additional bromine is therefore not required at elevated pH levels above 7.6. Compare Table 4.2 to Table 4.3.

(iv) Isocyanuric acid and bromine

Isocyanurate has no stabilising effect on bromine against the action of UV light unlike with chlorine. Isocyanurate is therefore of no use in outdoor bromine treated swimming pools.

(v) Breakpoint bromination and super-bromination

Because oxidisers more rapidly oxidise bromamines than chloramines, breakpoint bromination techniques are not as significant in swimming pool operation. To inactivate *Cryptosporidium* oocysts, and to remove resistant biofilms and nitrogen compounds, bromine-treated pools still need to be shock-dosed with chlorine (WHO 2006) or with a non-halogen based oxidiser such as hydrogen peroxide or potassium monopersulphate, but not ozone. Care must be taken to ensure that bromates are not produced. Excessively high bromine concentrations can cause pools to turn green or black.

4.4.3 Chlorine dioxide

Chlorine dioxide (ClO_2) is an unstable gas at room temperature. It is heavier than air and readily dissolves in water. ClO_2 is not a strong oxidiser but it is a powerful disinfectant. ClO_2 is particularly efficacious against *Cryptosporidium* and *Giardia* being up to 32 times more effective than hypochlorous acid. The Ct value of ClO_2 is 78 mg-min/L while the Ct value for free chlorine is 15 300 mg-min/L. ClO_2 does not oxidise ammonia to form amines. It does not cause odours.

ClO_2 cannot be stored and transported because it is explosive and must be generated on site. ClO_2 may be generated electrochemically, from tablets or from a liquid stabilised chlorine dioxide chemical in the chlorite form. The liquid form must be activated by dilution and acidification to pH 2. ClO_2 is a more expensive disinfectant than chlorine or bromine. The activator contains a small quantity of cyanuric acid but it is not in sufficient quantity to be considered to be a stabiliser for the purposes of clause 11 of Schedule 1 of the *Public Health Regulation 2012.*

ClO_2 is measured using a modified DPD tablet using glycine as an additional reagent. Otherwise it is impossible to distinguish from other forms of chlorine particularly hypochlorous acid. ClO_2 generates chlorite, which is harmful to human health and should not exceed 0.3 mg/L, a concentration derived from the National Drinking Water Guidelines. Such a scenario is more likely with permanent use of ClO_2 on its own but greatly reduced when ClO_2 is used as an adjunct to hypochlorite-based disinfection.

The ideal use of ClO_2 appears to be in the periodic control of *Cryptosporidium* and *Giardia* particularly in conjunction with chlorine pools where its action is enhanced. During periodic control, the pool needs to be closed for a shorter period than is required if hypochlorous acid is used on its own. ClO_2 is also effective in controlling biofilms by oxidising the polysaccharide matrix.

4.5 Other disinfection systems

There are a number of APVMA approved disinfection treatment chemicals and systems for use in swimming pools and spa pools. Table 4.4 lists satisfactory disinfectant systems based on either chlorine or bromine. Also listed are disinfectant systems considered unsatisfactory when used without chlorine or bromine. Polyhexanide is only considered suitable for lightly loaded domestic pools.

Table 4.4: Satisfactory and unsatisfactory disinfectant systems for public swimming pools and spa pools

Satisfactory disinfectant	Unsatisfactory disinfectant
Chlorine	Ultra violet light without chlorine or bromine
Isocyanurated chlorine in outdoor pools – temporary use	Ozone without chlorine or bromine
Bromine (indoor use)	Silver/copper without chlorine or bromine
Chlorine/bromine systems	Hydrogen peroxide
Ozone with chlorine	Magnetism
Ozone with bromine	Iodine
Ultra violet light with chlorine	Products containing polyhexanide *

* Polyhexanide is used to disinfect some domestic swimming pools. Chlorine should not be mixed with Polyhexanide as a red precipitate may form.

While chlorine and bromine are the recognised primary disinfectant systems in NSW, there are no objections to the use of adjuncts such as oxidisers, copper/silver ionisation, UV light and ozone. Such adjuncts are viewed as treatment methods that may assist chlorination or bromination but are not recognised as disinfectant systems on their own.

4.6 Disinfection by-products (DPBs)

Disinfection by-products (DPBs) are unwanted chemical compounds that may form during the disinfection process and that have suspected health implications such as triggering asthma attacks and certain cancers. Some of these chemicals such as the trihalomethanes (THMs), chlorate, chlorite and bromate can cause health problems that may develop after many years of exposure. Studies however, have indicated that THMs in swimming pools are below drinking water standards and pose little risk in well maintained pools.

The most notable indicator of possible DPB formation is total organic carbon (TOC) which should be maintained as low as possible in swimming pool water prior to disinfection. TOCs are introduced through most swimming pool contaminants particularly urine, perspiration and cosmetics. While perspiration is difficult to control, urine and cosmetics can be minimised.

The microbiological control of swimming pool water should be maintained while minimising the formation of DPBs. The health risks associated with DPBs are very small compared to the health risks of waterborne diseases. Waterborne diseases present an acute risk from immediate exposure.

In properly managed pools evidence suggests that the low concentration of disinfection by-products should not pose a risk to public health (WHO 2006).

CHAPTER 5

Disinfection chemical criteria, other chemicals, sampling and monitoring

5.1 Overview

Disinfection of swimming pool and spa pool water is essential for protecting public health. Monitoring of swimming pool and spa pool water quality ensures that the water quality is maintained. It is necessary that an evidence-based chemical disinfection criterion be available to ensure that disinfection is effective. The disinfection chemical criteria are evidence based. It therefore provides confidence of adequate disinfection protection in all but exceptional circumstances of faecal and vomit contamination and contamination by *Cryptosporidium* and *Giardia* (see Chapter 8).

5.2 Chemical criteria

There are two primary disinfection paradigms acceptable and they are based on the halogens of chlorine and bromine. Other chemicals or systems, such as ozone or UV light, may be used in conjunction with chlorine or bromine. Schedule 1 of the *Public Health Regulation 2012* should be consulted as the prescribed operating requirements for public swimming pools and spa pools.

5.2.1 Dosing

It is best practice that automatic dosing equipment either utilising amperometric or oxidation-reduction potential technology is installed at all public pools and spas. Such equipment should control both the disinfectant and pH. It is recommended that data-logging technology also be used.

It is mandatory that at least, continuous disinfectant dosing equipment be installed (See Section 6.3). It is best practice to install automatic dosing equipment.

Continuous dosing equipment is where the disinfectant addition can be set at a predetermined rate to introduce the disinfectant into the circulation system and mixed prior to the water re-entering the pool. Automatic dosing refers to a dosing system dependent on a disinfectant sensory and feedback system to determine the dosing rate and adjusting the dosing equipment accordingly.

Slug, hand dosing or broadcasting may only be used for special chemical applications, such as isocyanuric acid or dry acid, and only at a time when the pool is closed to patrons. The pool should not be opened to the public until the chemical reactions have been completed and this may take some hours or overnight.

5.2.2 Chlorine systems chemical criteria

The following Table 5.1 is a summary of the prescribed operating requirements of Schedule 1, *Public Health Regulation 2012* (see 1.5) for chlorine based disinfection of public swimming pools and spa pools. Schedule 1 should be consulted as the primary source of information and takes precedence over Table 5.1.

5.2.3 Bromine systems chemical criteria

The following Table 5.2 is a summary of the prescribed operating requirements of Schedule 1, *Public Health Regulation 2012* for bromine based disinfection of public swimming pools and spa pools. Schedule 1 should be consulted as the primary source of information and takes precedence over Table 5.2.

Table 5.1: Chemical criteria for chlorine-based pools

Parameter	Situation	Concentration
Free Available Chlorine (1) (DPD No 1)	Outdoor Pool	Min 1.0 mg/L
	Outdoor Pool + Cyanuric Acid	Min 3.0 mg/L
	Indoor Pool	Min 2.0 mg/L
	Spa Pool	Min 2.0 mg/L
	Any pool where pH > 7.6	Raise min by 1.0 mg/L
Oxidation Reduction Potential (ORP)(4)	ORP automation	Min 720 mV
Combined Chlorine (3)	Any pool	Max 1.0 mg/L
Total Chlorine (DPD No 1 + No 3)	Any pool	Max 10.0 mg/L
pH	Any pool	Range 7.0 to 7.8
Total Alkalinity	Any pool	80 to 200 mg/L
Cyanuric Acid	Outdoor pool only. Not spas	Max 50 mg/L
Ozone (2)	Any pool	Zero

(1) **Free Available Chlorine** concentration should be increased when high bather loads are anticipated to ensure that concentrations are never less than the minimum. Super-chlorination should only be carried out when the pool is closed.

(2) Residual excess **ozone** is to be quenched in an activated carbon filter bed before the circulated water is returned to the pool. The contact time between the pool water and the ozone should be at least 2 minutes at an ozone concentration of 1 mg/L where injected before filtration, and at least 0.8 mg/L where injected after filtration. Where ozone is generated at the rate of less than 2mg/hour quenching should not be required where the ozone is introduced into the circulation system by a venturi and completely dissolved in the pool water.

(3) Some oxidants may interfere with reagents used to measure **combined chlorine**. Interference must be demonstrated by the pool operator to allow exemption from the combined chlorine maximum.

(4) Where **Oxidation Reduction Potential** (ORP) measuring equipment or automatic dosing equipment is installed, the ORP should be set to the equivalence of the minimum free chlorine concentration and shall be not less than 720mV.

Table 5.2: Chemical criteria for bromine-based pools

Parameter	Situation	Concentration
Bromine (1) (DPD No 1)	Outdoor Pool	Min 2.25 mg/L
	Indoor Pool	Min 4.5 mg/L
	Spa Pool	Min 4.5 mg/L
Bromine	Any Pool	Max 9.0 mg/L
pH	Any pool	7.0 to 8.0
Sodium Bromide (NaBr)	Bromine Bank System	Max 9.0 mg/L
Sodium Bromide (NaBr)	Ozone (2) / Br System	Max 15 mg/L
Total Alkalinity	Any pool	80 to 200 mg/L
Di-methylhydantoin	Any pool	Max 200 mg/L
Cyanuric Acid	Any pool	None – no benefit
ORP (3)	Any pool	700 mV

(1) **Bromine** concentration should be increased when high bather loads are anticipated to ensure that values are never less than the minimum. Super-chlorination should only be carried out when the pool is closed.

(2) **Ozone** quenching is not required in the Ozone / Bromide system. In other systems residual excess ozone is to be quenched in an activated carbon filter bed before the circulated water is returned to the pool. The contact time between the pool water and the ozone should be at least 2 minutes at an ozone concentration of 1 mg/L where injected before filtration, and at least 0.8 mg/L where injected after filtration. Where ozone is generated at the rate of less than 2mg/hour quenching should not be required where the ozone is introduced into the circulation system by a venturi and completely dissolved in the pool water.

(3) Where **Oxidation Reduction Potential** (ORP) measuring equipment or automatic dosing equipment is installed, the ORP should be set to the equivalence of the minimum bromine (DPD #1) concentration and shall be not less than 700mV.

5.2.4 Alternate disinfection systems

No other disinfectant system, apart from chlorine or bromine based systems may be used on their own. Stand alone UV light/hydrogen peroxide systems and copper/silver ionic systems are not acceptable in NSW.

5.2.5 Oxidation-reduction potential

Where oxidation-reduction potential (ORP) measuring equipment or automatic dosing equipment is installed, the ORP should be set to the equivalence of the minimum free chlorine concentration at a pH of 7.2 and shall not be less than 720 mV and 700 mV for bromine (see Section 6.3).

5.2.6 Pool operating periods

Swimming pools and spa pools need to be operated for a period of time after closure to the public without additional bather contamination to recover and to achieve breakpoint chlorination. This period of time can only be determined by the experience of the pool operator as it will vary according to temperature, chlorine/bromine demand, contamination amount, contamination type, ventilation and the use of ancillary equipment such as pool blankets.

Large swimming pool plants may need to be operated continuously because shut down and start up may be complex and difficult procedures. Conversely, a swimming pool should not necessarily operate continuously for 24 hours. The pool should be operated for its own efficiency and should not waste electricity, gas or ancillary equipment. This is a matter best determined by the pool operator through daily pool operations. It has been suggested that all pools might be operated continuously but with flow reduction during low use and overnight periods.

5.3 Other chemicals used in swimming pools

There is a wide range of chemicals, apart from disinfectants, which may need to be used in the treatment of swimming pools and spa pools. The following are some commonly used chemicals.

5.3.1 Chemicals for raising pH

(i) Soda ash (sodium carbonate Na_2CO_3)

Soda ash is a strong alkali powder or liquid, which is used to quickly raise the pH of a pool. Soda ash should not be added to a pool by slug dosing but should be added slowly and gradually over an extended period when the pool is closed to the public or through the balance tank. It is a dangerous chemical and should be handled by trained personnel with appropriate personal protective equipment. It is mainly used in a 1:1 weight ratio with chlorine gas swimming pool applications as the use of chlorine gas substantially reduces pH. The note below Table 5.3 outlines how this chemical can be added to a pool to increase pH.

(ii) Bicarb (sodium bicarbonate $NaHCO_3$ – pH buffer)

Bicarb is a weak alkali powder, which is used to raise total alkalinity and gently raise pH. It may also be used to contain and neutralise acid spills. Accidental overdosing will not raise the pH to greater than 8.3. Table 5.3 outlines how this chemical can be added to a pool to increase pH.

Table 5.3: Dosage chart to raise pH to 7.5

Pool volume (kL)	Dose of sodium bicarbonate ($NaHCO_3$) to raise pH to 7.5			
	Measured pH			
	5.5	6.0	6.5	7.0
10	0.5 kg	0.36 kg	0.24 kg	0.16 kg
20	1.0 kg	0.72 kg	0.48 kg	0.3 kg
30	1.5 kg	1.08 kg	0.72 kg	0.48 kg
50	2.4 kg	1.8 kg	1.2 kg	0.8 kg
100	7.0 kg	3.6 kg	2.4 kg	1.6 kg

Note: When using sodium carbonate (soda ash) to increase pH to 7.5, halve the quantity i.e. 2 kg sodium bicarbonate (dry alkali or pH buffer) = 1 kg sodium carbonate (soda ash)

Table 5.4: Dosage chart to lower pH to 7.5

Pool volume (kL)	Dose of dry acid (sodium bisulphate NaHSO4) to lower pH to 7.5			
	Measured pH			
	7.8	8.0	8.5	9.0
10	0.05 kg	0.11 kg	0.18 kg	0.26 kg
20	0.1 kg	0.22 kg	0.36 kg	0.52 kg
30	0.15 kg	0.33 kg	0.54 kg	0.78 kg
50	0.25 kg	0.55 kg	0.9 kg	1.3 kg
100	0.5 kg	1.1 kg	1.8 kg	2.6 kg

5.3.2 Chemicals for lowering pH

(i) Dry acid (sodium bisulphate $NaHSO_4$)

Dry acid is a strong acid powder, which may be used to quickly reduce pH and lower alkalinity. Dry acid should not be added to a pool by slug dosing but should be added slowly and gradually over an extended period when the pool is closed to the public or gradually to the balance tank. It is a dangerous chemical and should be handled by trained personnel with appropriate personal protective equipment. Table 5.4 outlines how this chemical can be added to a pool to decrease pH.

(ii) Hydrochloric acid (muriatic acid HCl)

Hydrochloric acid is a strongly acidic liquid, which is highly corrosive and may be used to reduce pH quickly particularly when the reserve alkalinity is greater than 120 mg/L. It is a dangerous chemical and should only be handled by trained personnel with appropriate personal protective equipment.

(iii) Carbon dioxide (CO_2)

Carbon dioxide is a gas which when added to water forms a weak acid (carbonic acid) and may be used to reduce pH when the reserve alkalinity is less than 120 mg/L. It is best used in an automated pH correction system.

5.3.3 Other chemicals

(i) Calcium chloride ($CaCl_2$)

Calcium chloride is added to pools when the water is unbalanced with too little calcium (see Water Balancing in Section 6.4). The addition of calcium chloride raises calcium hardness and prevents damage to pool surfaces. If calcium imbalance is not corrected, the pool water will extract calcium from pool surfaces such as concrete and grout (causing etching).

(ii) Potassium monopersulphate ($KHSO_4$)

Potassium monopersulphate, a white free flowing powder, is also used as a shock treatment to control chloramines in heavily used pools. Potassium monopersulphate works by lowering the chlorine demand by oxidising ammonia, proteins and other pool contaminants. It can improve the disinfection ability of free chlorine and free bromine; and oxidise the hypochlorite and hypobromite ions to the more active hypochlorous and hypobromus acids respectively.

Potassium monopersulphate interferes with the DPD tablet No 3, causing water samples to turn dark red. The monopersulphate is oxidised by this reagent and a false high total chlorine measurement is given although the effect usually ceases after 24 hours.

(iii) Hydrogen peroxide (H_2O_2)

Hydrogen peroxide is a stronger oxidiser than chlorine, but weaker than ozone. On its own it is not a strong disinfectant but it can greatly improve the disinfection ability of free chlorine and free bromine by lowering chlorine/bromine demand by oxidising pool contaminants. It also oxidises hypochlorite and hypobromite ions to the more active hypochlorous and hypobromus acids respectively.

(iv) Ozone (O_3)

Ozone is an excellent oxidiser and an excellent disinfectant. Unfortunately ozone is dangerous if breathed and causes scarring of the lung tissue. For this reason ozone should be quenched, usually by passing the pool water through a granular activated carbon (GAC) bed before the water is returned into the pool. Where ozone is used in an excess of sodium bromide, such as a sodium bromide/ozone system to generate hypobromus acid, no quenching is necessary. (See Table 5.2: The ozone / bromide system).

Ozone has to be generated on site and in the past the capital outlay for ozone generation was cost prohibitive for many pools. More recent technologies decrease the capital costs. Ozone may be generated by corona discharge or UV light technologies. Corona discharge generally produces much larger quantities of ozone.

Ozone may be injected either pre-filter or post-filter depending on the necessity to oxidise organic material in the filter bed. Ozone is always injected and removed before re-chlorination because the GAC bed used to remove ozone will also remove the chlorine.

A recent development is the use of low dose corona discharge ozone where ozone is generated at 1 to 2 grams per hour. The ozone is pumped with air through a venturi into a mixing chamber and reaction vessel in the circulation system after the pool water has been filtered. Provided the ozone is thoroughly mixed and dissolved, it reacts rapidly to destroy chloramines and disinfection by-products to reduce tastes, odours and eye stinging compounds. After an initial milkiness the colour and clarity of the pool water is improved. It is important to ensure degassing before the treated water is returned to the pool. It is not necessary to use GAC to quench excess ozone because the small amount of ozone is either consumed in the reactions or rapidly degrades. Because ozone is a stronger oxidiser than chlorine, it substantially reduces chlorine demand and allows chlorine to be more efficient in residual disinfection allowing for lower chlorine levels (if operating by ORP technology) and less chlorine will be used. The water returning to the pool should be monitored regularly for ozone. A pool cover should not be used. The ozone generator should be located in a well ventilated, dust-free room.

Ozone is not compatible with rubber and some plastics.

(v) Sodium thiosulphate ($Na_2S_2O_3.5H_2O$)

Sodium thiosulphate is a white crystalline substance that is used to reduce excess chlorine in a swimming or spa pool. An adequate small supply of this chemical should be maintained on site in case of an over-chlorination accident. It can also be used to return free chlorine to normal levels after superchlorination. This chemical should not be used in excess, as it will continue to remove free chlorine until all of the thiosulphate has been consumed. Appropriate personal protective equipment must be worn when using this chemical.

(vi) Isocyanuric acid ($C_3N_3O_3H_3$) (Cyanuric Acid)

Isocyanuric acid's weak bonding to hypochlorous acid helps to reduce the degradation of hypochlorous acid to hydrochloric acid in sunlight. See Section 4.4.1 for more information.

(vii) Algaecides

Algae growth is a common problem in outdoor pools, because algae requires sunlight, warmth and nutrients such as nitrogen and phosphorous for growth. Maintaining an adequate concentration of chlorine in pH-controlled pools and regular superchlorination usually prevents algae problems. However, rectification of any pool circulation problems and removal of phosphate may also be necessary to prevent algae growth (see (viii) Flocculants).

Care must be taken to ensure that any chemicals used to treat algae (algaecides) such as copper are approved by the APVMA and do not build up causing possible health risks. The concentration of copper in swimming pools should not exceed 2 mg/L as recommended by the Australian Drinking Water Guidelines (2004).

Swimming pool water containing copper must not be discharged to the general environment, such as the street gutter or watercourses because of the deleterious effects on many life forms and its pollutant nature. All waste pool water should be discharged to the sewer unless properly recycled.

Concentrations of ortho-phosphate exceeding 0.5 mg/L are conducive to algal blooms. Concentrations below 0.2 mg/L should be maintained. Aluminium sulphate, a flocculent [see (viii)], removes phosphates. Lanthanum compounds are also effective as they bond with phosphate to form insoluble phosphate precipitates which can be removed by filtration.

(viii) Flocculants

Flocculants are used to coagulate or aggregate small particles so that they may be more easily removed during sand filtration. Common flocculants include: aluminium sulphate (alum), polyaluminium chloride (PAC), polyaluminium sulpho silicate (PASS) and sodium aluminate. Care must be taken to add flocculants to the circulation system before the filter and in small doses. The pH of the pool should be high enough to prevent the gelatinous flocc which develops on the filter from dissolving and reappearing in the pool. The manufacturer's instructions should be followed carefully.

5.4 Health and safety issues of chemicals

Gas chlorination is an effective swimming pool disinfection system because all of the free chlorine is available for disinfection unlike other disinfection systems. Due to the work health and safety hazards of gas chlorination and the highly onerous installation requirements, it is rarely installed within aquatic centres, although older installations do exist. Many other chemicals have work health and safety hazards. If these hazards are avoided then in most cases public health hazards will also be avoided.

The NSW WorkCover Authority regulates the storage and handling of dangerous goods and should be consulted to obtain the necessary occupational, health and safety requirements for the storage and handling of swimming pool and spa pool chemicals. The NSW WorkCover Authority website URL is: www.workcover.nsw.gov.au

The requirements of the WorkCover Authority are expressed in their document *Storage and Handling of Dangerous Goods – Code of Practice* (2005) which can be downloaded from the WorkCover Authority website. (Catalogue Number WC01354).

WARNING: Never add acid directly to a chlorine-containing substance as chlorine gas will be generated and released.

Never add water to a powder, granular or solid compound; always slowly add the compound to water while stirring.

One of the greatest hazards of handling chemicals is slug dosing directly into swimming pools. This should never be done directly into swimming pools or spa pools when the pool is open to the public. If performed, appropriate personal protective equipment must be worn.

5.5 Disinfection by-products

Disinfection by-products (DPBs) are unwanted chemicals that may form during the disinfection process. Some of these chemicals such as the trihalomethanes, chlorate, chlorite and bromate can cause latent health problems.

In properly managed pools evidence suggests that the low concentration of these chemicals should not pose a risk to public health (WHO 2006). The most common chemical disinfectants used in pool water treatment are listed in Table 5.5 together with the DPBs that could form.

Very few DBPs are caused through the addition of water from the water mains. DBPs are more likely to arise from pollutants introduced by bathers and therefore bathers should be encouraged to toilet and shower before entering a pool.

Table 5.5: Chemical disinfectants and their disinfection by-products

Disinfectant	By-product
Chlorine/hypochlorite	Trihalomethanes Haloacetic acids Haloacetonitriles Haloketones Chloralhydrate (trichloroacetaldelhyde) Chloropicrin (trichloronitrimethane) Cyanogens chloride Chlorate Chloramines
Ozone/bromine	Bromate Aldehydes Ketones Ketoacids Carboxylic acids Bromoform Brominated acetic acids
Chlorine dioxide	Chlorite Chlorate
Bromine/hypochlorite Bromo-chloro-dimethylhydantoin	Trihalomethanes, mainly bromoform Bromal hydrate Bromate Bromamines Dimethylhydantoin
Chlorine/bromine with copper Silver	Silver (0.1 mg/L) Copper (2 mg/L)

Based on WHO 2006 and the Australian Drinking Water Guidelines 2004

5.6 Frequency of pool testing

It is a **mandatory requirement** (prescribed operating requirement of Schedule 1, *Public Health Regulation 2012*) for all non-automatic continuously dosed public swimming pools that the disinfectant and pH levels be tested prior to the opening of the pool. The disinfectant and pH levels shall then be tested as frequently as determined by the pool operator depending on the circumstances of pool operation.

It is a **mandatory requirement** (prescribed operating requirement of Schedule 1, *Public Health Regulation 2012*) that the disinfectant and pH levels of automatically dosed public pools be recorded prior to opening and once during the opening period. Additionally, the public pool shall be manually tested once a day.

Other mandatory requirements (prescribed operating requirement) are marked by an asterisk (*****) in Table 5.6.

The following recommendations on the frequency of manual pool chemical testing are risk based. This risk is determined according to whether a pool is automatically dosed and the likelihood of a large rapid change in bathing loads. A motel or hotel pool tends to be low risk while learn-to-swim centres for infants are high risk. Spa pools and hydrotherapy pools are all generally high risk.

Evidence has shown that pools which are automatically dosed and frequently tested are more likely to be adjusted according to the bathing load to comply with the criteria. Unfortunately, most manually dosed pools are not frequently tested and studies have shown that these pools are less likely to comply with the criteria (Ford 2004). Testing of pool water to determine its disinfection capacity and to protect public health should be carried out in accordance with the requirements of Table 5.6.

Table 5.6: Swimming pool and spa pool testing frequency

Test	Recommended Minimum Manual Testing Frequency (Mandatory Testing Frequency = *)
Non-automatic continuous dosing /metering high risk(1) pools:	
■ Free chlorine / bromine ■ Total / combined chlorine	■ Prior to opening* and thence every **two** hours (or every **one** hour when bather loads exceed design capacity)
■ pH	■ Prior to opening thence as deemed necessary*
Non-automatic continuous dosing / metering low risk pools:	
■ Free chlorine / bromine ■ Total / combined chlorine	■ Prior to opening* and thence every **four** hours when there is a bather load.
■ pH	■ Prior to opening thence as deemed necessary*
Automatic control dosing: ■ Free chlorine/bromine (ORP) ■ Total / combined chlorine ■ pH	■ Once during the day to confirm automatic readings* (provided that there is in-line automated testing and recording which is checked and logged hourly)
Other Tests:	
■ Total alkalinity	■ Daily * ■ Weekly if using liquid chlorine disinfection or carbon dioxide (CO_2) pH control*
■ Turbidity and/or clarity ■ Ozone ■ Cyanuric Acid ■ Water balance	■ Weekly ■ Weekly* ■ Weekly* ■ Weekly
■ Total Dissolved Solids ■ Dimethylhydantoin (BCDMH systems)	■ Monthly ■ Monthly

High risk pools include spa pools, hydrotherapy pools, baby and infant learn to swim pools, infant wading pools, water features in pools, pools used by incontinent people, or a pool with three or more of the following risk factors:

- pH greater than 7.6 in a chlorinated pool
- Consistently poor disinfection (previous chemical or bacteriological criteria failures).
- High turbidity
- Poor pool circulation and/or filtration
- High bather loads
- Presence of algae
- Regular use by birds e.g., ducks
- Easy access of foreign material e.g., litter
- Biofilms detected
- Poor quality make-up water (high in chloramines)

5.7 Sampling location

Water samples for chemical testing should be tested immediately after collection. Water should be sampled from a depth of at least 450 mm using an inverted plastic (not glass) beaker in a location away from the inlets (returns). Except for ozone testing, a water sampling point closer to the outlets, gutters or wet deck return, should be selected because it represents the quality of the water leaving the pool. The plastic beaker should be rinsed in the pool water, emptied and then the sample taken by plunging the inverted plastic beaker into the pool, inverting and lifting in the one scooping motion in the direction opposite to the water current.

Water samples for testing ozone should be collected in the same manner as above in a location representing a point closest to an inlet (return).

Sampling to confirm automatic control dosing should be taken from a sample tap strategically located on the return line as close as possible to the control probes and in accordance with any manufacturer's instructions.

As the difference between manual pool readings and automatic control measurements will vary, it is the consistency of variation that is paramount. Diverging or converging readings should be investigated.

For microbiological sampling and testing refer to Chapter 3.

5.8 Testing equipment and testing

Suitable testing equipment needs to be used to ensure accurate results. All glassware and plastic ware should be thoroughly washed and rinsed after each testing session. The test methodology specified by the manufacturer of the test kit should be strictly followed. Plastic or Perspex® kits known as '4 in 1' or '5 in 1' kits for backyard pools or test strips are not suitable for testing public swimming pools and spa pools. Photometric test kits are the most reliable test kits, and should be used in preference to colorimetric kits. Males with red/green colour blindness cannot use colorimetric kits.

Testing should be performed in the shade preferably in a cool, well lit room. Tests of the most volatile chemicals, such as ozone, free chlorine and free bromine should be conducted immediately. If possible, temperature should be measured directly from the pool.

Table 5.7: Chemical testing equipment

Water quality parameter	Best Practice Test kit / Methodology
Chlorine/bromine	Photometric method based on DPD reagents capable of measuring to 0.1 mg/L units within the recommended disinfectant range
Ozone	Photometric method based on DPD reagents
Hydrogen peroxide	Photometric method based on potassium iodide under acidic conditions and capable of measuring in 10 mg/L increments within the range of 0-100 mg/L; Any electronic meter
pH	pH meter Photometric method
Total alkalinity	Photometric method
Cyanuric acid	Photometric based method within 0-200 mg/L range
Clarity	Water clarity should be maintained so that lane markings or other features on the pool bottom at its greatest depth are clearly visible when viewed from the side of the pool
Copper	Photometric method
Chlorite	Photometric method or laboratory analysis
Bromate	Photometric method or laboratory analysis
Bromide	Laboratory (test kits test do not necessarily differentiate between bromide and chloride)
Dimethylhydantoin (DMH)	Photometric method or laboratory analysis
Sulphate	Photometric method or laboratory analysis
Turbidity	Any test apparatus capable of measuring to 0.5 nephelometric turbidity units Laboratory analysis; Turbidity meter
Silver	Photometric method or laboratory analysis
Total trihalomethanes	Laboratory analysis
Total dissolved solids (TDS)	TDS meter, laboratory analysis or sensor (measured as conductivity)
Phosphate	Photometric method or laboratory analysis
Oxidation-reduction potential (ORP)	An electronic ORP meter

1. All equipment needs to be checked and calibrated in accordance with the manufacturer's specifications and maintenance manuals.
2. Bleaching of DPD reagents occurs when free chlorine concentration is high and will give a false low reading. The manufacturer's manual should be followed and a dilution prior to testing should be performed if free chlorine is suspected of being higher than 5 mg/L.

Table 5.8: Other chemical and physical criteria for swimming pools and spa pools

Parameter	Maximum criteria
Temperature (mandatory maximum value)	38°C. A sign should be erected near high temperature pools warning of the dangers of heat stress from bathing for too long. High temperature pools should not be used for laps and aerobic exercise due to potential health risk from heat stress
Total dissolved solids (TDS)	As a general rule, TDS should not be permitted to rise to more than 1500 mg/L above the source water and should not be permitted to exceed 3000 mg/L
Turbidity	1.0 nephelometric turbidity units
Dimethylhydantoin	200 mg/L
Copper	2 mg/L
Silver	0.1 mg/L
Total trihalomethanes	0.25 mg/L
Chlorite (disinfection by-product of chlorine dioxide)	0.3 mg/L
Chlorate (disinfection by-product of chlorine dioxide)	0.7 mg/L
Bromate (disinfection by-product of bromine/ozone pools	0.02 mg/L

Fresh tablet reagents in unbroken foil should be purchased frequently and stored under optimal conditions specified by the manufacturer. Similarly, fresh liquid reagents should be stored as a minimum in dark, cool conditions until just before use at each test. Out-of-date reagents should be discarded. Table 5.7 lists the water quality parameter and the best type of kit or methodology appropriate for that test.

5.9 Other chemical and physical parameters

Table 5.8 is a list of common chemical parameters or physical attributes and a recommended maximum criterion for each. Temperature has a mandatory maximum value of 38°C specified in Schedule 1, *Public Health Regulation 2012*. The recommended values are not stringent and are provided as a guide only. Some of the values have been taken from the Australian Drinking Water Guidelines (2004).

5.10 Record keeping

It is **mandatory** that records of all mandatory tests be kept for six months.

A log sheet or register should be used to record the results of every test performed at a swimming pool, spa pool or pool complex. The keeping of records is a professional activity and can be used to demonstrate competency in pool operations. Log books containing all of the log sheets should be maintained in a register for assessment of any technical issues and problems that may arise. Log sheets tend to be individual for each premises and location.

Where automated in-line tests are recorded electronically, these should be downloaded monthly and kept with any other records. It is also possible to represent the data graphically which may add further meaning to the results. For example, free chlorine may be graphed against bather loads.

The items in Table 5.9 may be included in a log sheet and those items marked with a "#" are considered essential. One person should be responsible for pool testing and recording of results each working shift and the log sheet should bear their name.

Table 5.9: Suggested items to be included in a log sheet (# = essential)

- # date and time of test
- # disinfectant concentrations
- pH
- # total alkalinity
- # temperature
- bathing loads
- operational comments
- total dissolved solids (TDS)
- # cyanuric acid concentration
- water meter reading
- electricity meter readings
- admission data
- dose settings
- mechanical maintenance items
- # oxidation-reduction potential (ORP) (if applicable)
- chemical usage and stocks on hand
- backwashing
- water balance

An example of a log sheet is contained in Appendix B which is also available in MS Word format from the NSW Department of Health website: http://www.health.nsw.gov.au/.

CHAPTER 6

Managing water quality

6.1 Overview

The effective management of swimming pool and spa pool water quality is dependent upon:

- An efficient pool water circulation and filtration system to adequately remove pollutants and effectively distribute residually disinfected water throughout the pool
- A water disinfection system which maintains a set disinfectant concentration (or ORP) upon demand (i.e. will adjust to varying bather loads)
- Balanced water to ensure bather comfort and protection of pool materials and equipment
- A trained and experienced pool operator capable of monitoring and rectifying pool water quality problems.

This chapter considers maintenance of pool water quality and disinfectant concentrations. Topics discussed include automatic dosing equipment, water balancing, backwashing and reuse of backwashing wastewater, minimising pool pollution and chloramine control.

6.2 Chlorine demand

Once the required free chlorine (or bromine) residual has been achieved with the minimum of combined chlorine, there are many pollutants and weather conditions that will consume the disinfectant in chemical reactions and quickly reduce the free residual chlorine concentration. Such pollutants and conditions in pools include:

- Sunlight/shade
- Indoor/outdoor
- Aeration/ventilation
- Wind and wind-blown debris, particularly debris high in organic matter
- Rain
- Bather pollution: perspiration, urine, cosmetics, faecal material, sputum, vomitus, dead skin cells, hair, lint and micro-organisms.

The amount of chlorine that needs to be replaced to maintain the desired free residual is known as chlorine demand. Most of the chlorine is consumed by reaction with organic material and sunlight rather than in disinfection of micro-organisms. Chlorine demand is reduced by filtration and backwashing, and by occasionally supplementing chlorine with alternative oxidisers such as hydrogen peroxide, UV light, ozone or potassium monopersulphate.

In order to maintain the desired free chlorine residual for rapid disinfection, the chlorine dose has to be matched to chlorine demand. This matching cannot be done easily with just a continuous dosing system unless the pool operator is constantly sampling the pool and adjusting the dose in anticipation of chlorine demand. Matching of chlorine dose to chlorine demand can more easily and effectively be achieved with automatic chemical dosing equipment. For this reason, automatic dosing equipment is considered to be best practice.

6.3 Chemical dosing control equipment

Automatic chemical dosing for disinfectant (chlorine or bromine) and pH control is the most effective mechanism to match residual disinfectant control to demand. There are two main technologies available to achieve automatic dosing:

- Oxidation-reduction potential (ORP) using millivolts (mV)
- Amperometric, using mg/L of disinfectant.

Clause 3(1), Schedule 1, *Public Health Regulation 2012,* requires that a pool must be fitted with an automated or a continuous metered disinfectant dosing system.

6.3.1 Continuous metered disinfectant dosing system

A "continuous metered disinfectant dosing system" is a device or apparatus which delivers the disinfectant in a positively controlled continuous and steady rate.

The disinfectant should be delivered at some point into the pool circulation system and not directly into the pool. It is preferable that the disinfectant be added just after the filtration system to lessen the formation of disinfection by-products.

A pump which delivers liquid chlorine at a particular rate i.e. millilitres per hour, is a good example of a continuous metered disinfectant dosing system. Other examples include dry chemical feeders, and electrolytic disinfectant generation.

Obviously hand dosing or broadcasting is not a continuous metered disinfectant dosing system. Similarly a floating device with a block of dichloroisiocyanurate is not a continuous metered disinfectant dosing system. An erosion feeder is not a continuous metered disinfectant dosing system unless it can deliver the disinfectant at a constant rate instead of at a diminishing rate.

One of the cheapest forms of a continuous metered disinfectant dosing system is a peristaltic pump drawing from a shaded drum of liquid chlorine (sodium hypochlorite) and slowly injecting the liquid chlorine into the pool circulation system after the filter. The peristaltic pump can be set up to deliver a dose of chlorine at particular time intervals. A continuous metered disinfectant dosing system can also be controlled by a timing switch to activate it at some time prior to opening and de-activate it at some time after closing. The dosing rate or frequency on some pumps can be varied allowing the pool operator greater scope in delivering disinfectant to the pool at varying continuous rates.

6.3.2 Oxidation-reduction potential

Oxidation-reduction potential (ORP, redox) measures the rate of oxidative disinfection caused by the addition of the effects of all oxidants in the pool water. ORP is determined by using a high quality ORP probe and meter. The unit of measurement of ORP is millivolts (mV).

Oxidisers (mainly disinfectants) consume electrons while reductants (mainly contaminants) donate electrons. As chlorine is continuously added to the swimming pool the disinfection action is mainly due to chlorine compounds, particularly hypochlorous acid (HOCl). The ORP is the potential of a disinfectant to do its work of inactivating micro-organisms and oxidising organic materials. The higher the millivolt reading, the more powerfully the swimming pool water is able to oxidise and disinfect.

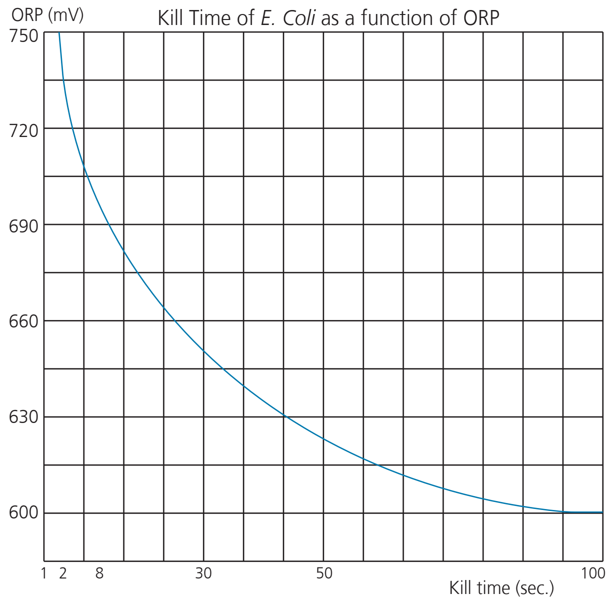
Oxidisers cause the millivolt value to increase and therefore increase disinfection. Typical oxidisers are hypochlorous acid (a component of free chlorine), ozone, hydrogen peroxide, and potassium monopersulphate.

Reductants cause the millivolt value to decrease and therefore decrease disinfection. Typical reductants are the hypochlorite ion (a component of free chlorine), chloramines, cyanuric acid, organic matter (dust and dirt), urine, perspiration, sputum, micro-organisms, cosmetics, and faecal material.

A drop in the ORP indicates an increase in chlorine demand caused by reducing agents or contaminants entering the water. A decrease in ORP indicates that chemical reactions are about to occur. Compared to amperometric control, ORP is considered to be a more accurate measure of disinfection rate. Also, ORP controllers can automatically add disinfectant according to demand. They therefore anticipate the disinfecting and oxidising chemical reactions that are about to occur.

ORP is an indicator of micro-organism inactivation. Studies on specific micro-organisms have found a direct correlation between increasing ORP and micro-organism inactivation as shown in Graph 6.1. Drinking water is adequately disinfected at an ORP of 650 mV. In swimming pools, an ORP of 700 to 720 mV allows for both a quick disinfection and for breakpoint chlorination (destruction of chloramines) where conditions permit.

Graph 6.1: Kill Time for a log 3 Reduction of *E. coli* as a function of ORP



Source: Eutech Instruments Pty Ltd

The ORP value required in swimming pools is higher than that required for water supplies because contamination is constantly being added to swimming pools.

Section 4.4.1 (ii) *The effect of pH on chlorine disinfection power*, explained that pH affects the concentration of hypochlorous acid (HOCl) while the concentration of free chlorine remains the same. An increasing pH decreases the concentration of HOCl and hence its disinfection power. Similarly a decreasing pH increases ORP because the oxidative power of free chlorine increases.

ORP measurement correlates weakly with free chlorine measurement because they measure two different entities. ORP measures oxidative disinfection power not the concentration of free residual chlorine. Free chlorine measures the concentrations of hypochlorous acid (HOCl) and the hypochlorite ion (OCl^-) not the oxidation disinfection power. Free chlorine is a variable component of ORP. Oxidative disinfection does not correlate well to free chlorine for two reasons:

- When free chlorine exists as the hypochlorite ion (OCl^-) the ORP will be low. This will occur when the pH is high. Therefore free chlorine could be high and the ORP low at a pH greater than 7.6.
- Reductants lower ORP. Therefore free chlorine could be high, but the ORP will be low if combined chlorine is high, cyanurate is present, contamination is high, etc.

A pool with satisfactory ORP could have low free chlorine if the reductants are low. That is, there is low combined chlorine (i.e. breakpoint chlorination), low pH, no cyanuric acid, and low organic contaminants. Such a pool will have satisfactory disinfection power.

It is often difficult to obtain a satisfactory ORP reading in an outdoor pool stabilised with cyanuric acid. It may be necessary to limit the cyanuric concentration to 25 mg/L or even 20 mg/L to obtain a satisfactory ORP reading.

It is often difficult to obtain a satisfactory ORP reading in an indoor pool with excessive combined chlorine. It may be necessary to control combined chlorine by the installation and use of medium pressure UV light lamps or low dose ozone to obtain a satisfactory ORP reading.

ORP will also vary according to the water source used to fill the swimming pool. ORP will vary according to the materials used to construct the swimming pool.

However, the constant is that ORP is an accurate measure of killing power as it takes all of the variables into account due to the combined effect of their respective ORP values.

Careful calibration of the probe and controller is required. There are two methods or calibration:

- By the use of buffer solutions, and
- By using electronic calibrators

It is essential that the ORP system is calibrated every six months by an independent person who might reasonably be expected to be competent to do so and a certificate of calibration should be obtained.

Where shock oxidation or superchlorination is practiced, the shock dose will temporarily raise the ORP. Shock oxidisers tend to raise the ORP short term whereas superchlorination raises ORP for a longer period.

To detect and prevent failures due to instrument errors, ORP should be checked against manual free and total chlorine measurement daily and the probes and other equipment must be regularly maintained in accordance with the manufacturer's specification.

6.3.3 Direct chlorine residual measurement (amperometric)

There are two types of amperometric free chlorine sensing probes commonly available:

- Membrane amperometric probes
- Potentiostatic three electrode amperometric probes

Membrane amperometric probes measure free chlorine using platinum or gold covered membrane and a silver/ silver chloride covered membrane.

The other type of amperometric probe is known as potentiostatic three electrode amperometric (or tri-amperometric) and uses an integral electrolyte salt supply for probe buffering. Quartz grit is used for hydro-mechanical self cleaning of the sensor tip in a specially designed flowcell ensuring probe reliability, stability and accuracy in the constantly varying water conditions of heavily loaded swimming pools. This type of probe has an advantage over the membrane chlorine probe as it is lower in maintenance, needs no membrane cap replacement and is cheaper to replace.

The amperometric method of control relies on measuring free chlorine (hypochlorous acid) using probes which are calibrated at specific set points. Unlike ORP, which gives a good measure of disinfection, a pool operator using the amperometric method may inaccurately believe that disinfection is adequate based on free chlorine alone. To effectively use amperometric control, a pool operator needs to understand that disinfection efficiency is affected by interferences from extremely high TDS, turbidity, chloramines, high pH and cyanuric acid, and to continually monitor these parameters to prevent poor disinfection.

The amperometric method places greater reliance on a skilled pool operator to ensure the maintenance of water quality for good disinfection rates.

6.3.4 Automatic controllers

Recently, some overseas manufacturers have developed advanced controllers which are reported to make the most of the benefits of each sensor technology and are capable of combining the inputs of both free chlorine probes, total chlorine probes and/or redox (ORP) probes using patented control algorithms. This approach ensures both consistent disinfection under varying water conditions and reliable free chlorine residual levels. This technology is soon to be introduced into Australia.

6.3.5 pH probes

pH probes and automatic pH control are best practice for maintaining disinfection concentration and disinfection power. The pH probe needs to be calibrated regularly and should be serviced and cleaned regularly in accordance with the manufacturer's specification.

6.4 Water balancing

6.4.1 Overview

The term 'chemical water balance' means that pH, total alkalinity and calcium hardness are within an optimum range to prevent calcium scaling, calcium corrosion and bather discomfort.

Balanced pool water prolongs the life of a pool and its fittings, assists with preventing stains and improves bather comfort. Where dissolved salts in the pool water are too high, salt precipitates out of solution and deposits known as scaling may occur. Scale is more likely to form within heating units because as the temperature of water increases the solubility of calcium decreases. However, scale may also form within pipes and can cause mud balls within filters.

Water balance is most significantly affected by:

- pH
- Total alkalinity
- Calcium hardness
- Temperature

Total dissolved solids (TDS) have a minor effect on swimming pool water balance unless at an extremely high level not normally encountered in swimming pools. TDS has a major effect in high evaporative water use in devices such as boilers and cooling towers. This is further discussed in section 7.6.2.

6.4.2 pH

pH is a measure of the hydrogen ion concentration in water or more simply a measure of how acid or alkaline a pool is. The pH scale ranges from 0 to 14, with 7.0 being neutral. A pH below 7.0 indicates acidic conditions and a pH above 7.0 indicates alkaline conditions. To maintain disinfection levels and bather comfort, pH should be maintained between 7.2-7.6 (maximum 7.8). At a pH below 7.2 there is discomfort to bathers and corrosion to pool equipment. See section 4.4.1 for a discussion on the effect of pH on chlorine disinfection.

6.4.3 Total alkalinity

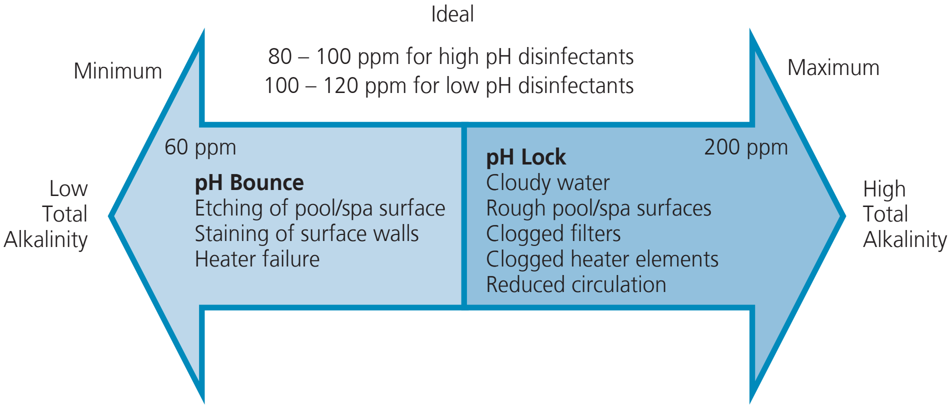
Total alkalinity is a measure of the alkaline salts (bi-carbonates, carbonates and hydroxides) present in water. Total alkalinity prevents large fluctuations in pH, known as pH bounce. To increase total alkalinity, a buffer such as sodium bicarbonate is added to the water; to lower total alkalinity, acid is added. pH will need to be re-adjusted as a change in total alkalinity alters pH. Table 6.1 is an overview of total alkalinity levels.

6.4.4 Calcium hardness

Calcium hardness is a measure of the amount of dissolved calcium salts present in the water. Pool water that is very high in calcium hardness can cause scaling of heaters and pool finishes. Pools that have low calcium hardness can cause corrosion of pool equipment and etching of cement and tile grout.

Some raw water sources from rural areas are naturally hard (hardness over 250 mg/L $CaCO_3$) making these water sources more suited to treatment using sodium hypochlorite rather than calcium hypochlorite. Similarly, soft waters (hardness under 50 mg/L $CaCO_3$) should be treated with an alkaline disinfectant such as calcium

Table 6.1: Total alkalinity-related pool problems



hypochlorite or sodium hypochlorite plus calcium chloride, and a gentle acid such as carbonic acid from carbon dioxide should be used to decrease pH with a gentle buffering effect. A pool consultant should be engaged to determine the most suitable pool treatment system.

6.4.5 Temperature

Temperature has an important effect on water balance, mainly because calcium salts become less soluble at higher temperatures. Hence high temperature pools are often subject to scaling as the calcium salts deposit on equipment and pipes. At a lower temperature the water can absorb more calcium which could cause etching of pool surfaces.

6.4.6 Langelier saturation index

In order to measure or to give an indication of the solubility of calcium carbonate ($CaCO_3$) in the swimming pool water, the Langelier saturation index (LSI) is used. There are four parameters that need measuring and input into a formula to calculate the index:

- pH
- Temperature – temperature factor (TF)
- Total alkalinity – alkalinity factor (AF)
- Calcium hardness – calcium factor (CF).

The LSI formula is:
pH + TF + AF + CF – 12.1 = LSI where 12.1 is an adjustment constant. The ideal result for the LSI is –0.2 with a range of –0.5 to + 0.5.

The temperature factor (TF), the alkalinity factor (AF) and the calcium factor (CF) are obtained from using the Tables below and extrapolating factors as required.

Table 6.2: Temperature factor (TF)

Temperature °C	Factor
0	0.0
3	0.1
8	0.2
12	0.3
16	0.4
19	0.5
24	0.6
29	0.7
34	0.8
41	0.9

Table 6.3: Alkalinity factor (AF)

Total alkalinity (mg/L)	Factor
5	0.7
25	1.4
50	1.7
75	1.9
100	2.0
150	2.2
200	2.3
300	2.5
400	2.6
800	2.9

Table 6.4: Calcium factor (CF)

Calcium hardness (mg/L)	Factor
5	0.3
25	1.0
50	1.3
75	1.5
100	1.6
150	1.8
200	1.9
300	2.1
400	2.2
800	2.5

Example LSI calculation

A hydrotherapy pool is tested and the following results determined:
pH 8.2; total alkalinity 200 mg/L; calcium hardness 800 mg/L and temperature at 33°C.

LSI = 8.2 + 0.8 + 2.3 + 2.5 – 12.1 = +1.7

The index is too positive and needs to be lowered to less than +0.5 to prevent scale forming. The temperature is fixed so adjustments need to be made to the other parameters. pH needs to be adjusted to 7.5 (which also improves the disinfection power of chlorine), total alkalinity to 150 mg/L and calcium hardness to150 mg/L.

LSI = 7.5 + 0.8 + 2.2 + 1.8 – 12.1 = +0.2

6.4.7 Corrosive water – the Ryznar index

The Ryznar index (RI) should be used to predict more accurately than the LSI the scaling or corrosive tendencies of swimming pool water.[37] Similar to the LSI, the RI uses pH, pool temperature, calcium, total alkalinity and TDS to calculate the pH of saturation (pHs) and then the RI. There are various RI calculators that can be found on the web, for example
http://www.lenntech.com/ro/index/ryznar.htm

Ryznar index example

Consider a swimming pool with the following water chemistry parameters:
pH 7.5;Temperature 27ºC; Calcium 250 mg/L; Total alkalinity 100 mg/L; TDS 2000 mg/L

The pH of saturation (pHs) for this water is calculated at 7.4 and an RI of 7.3 (using the above URL reference). Based on these parameters, the LSI equates to 0.1. However the Ryznar index of 7.3 indicates that a corrosive condition exists. Ideally water should be maintained within the RI range of 6.3 – 6.7 with 6.5 being the ideal target.

The above example shows that water with an acceptable LSI can be corrosive. For additional information regarding corrosion or water balance a pool specialist should be contacted.

6.5 Backwashing of sand filters

Regular backwashing of sand filters in accordance with the manufacturer's specification is essential for proper cleaning, maintenance and operation of pool filters. Backwashing, when indicated by a back pressure gauge, is done by reversing the flow of pool water through the filters allowing the trapped material to flow to waste. Backwashing should continue until the backwash water runs clear. Some backwashing systems have a rinse cycle. A well cleaned filter greatly assists filtration.

Swimming pool backwash wastewater consists of all of the pollutants that are filtered from a pool. The majority of pollutants are introduced into the pool from bathers. Backwash water may be heavily polluted with a wide range of pathogenic micro-organisms, and chemicals from oil, lotions, urine, detergents, saliva, faeces and disinfection by-products. While some sections of the swimming pool industry advocate the occasional addition of liquid soap during backwashing to remove grease and oils from the sand, the filter manufacturer should be contacted for an opinion.

6.5.1 Reuse of backwash water (externally)

Usually the wastewater generated from backwashing is discharged to the sewerage system in accordance with a trade waste agreement with the local sewerage authority. Trade waste agreements are becoming more expensive. As water is scarce in many areas of Australia, treated backwash water is increasingly being reused for cleaning and irrigation purposes and, highly treated, for recycling into the pool and for toilet flushing.

Under no circumstances should backwash wastewater be directly discharged to the environment or to the stormwater system. The wastewater is extremely harmful to the environment and promotes weed growth in natural bushland areas.

The backwash wastewater may be suitable for reuse on parks and gardens or for dust suppression on road works if properly assessed and pre-treated. Untreated and un-disinfected backwash wastewater must never come into direct contact with people.

The reuse of backwash wastewater must be fully assessed and a water reuse plan developed. A health risk assessment should be performed using *Environmental Health Risk Assessment – Guidelines for assessing human health risks from environmental hazards*.[38]

Issues to consider in the health risk assessment include:

- Reduction of salinity / total dissolved solids
- Potential reuse options
- Storage
- Savings on discharge to trade waste
- Costs of reuse
- Environmental grants
- Treatment / pre-treatment / disinfection

The advice of a consultant in developing reuse options is recommended.

6.5.2 Recycling of swimming pool backwash wastewater

Backwash water

Backwash water may be heavily contaminated with pathogenic micro-organisms and harmful chemicals. Backwash water should never be reused or recycled without adequate treatment.

To conserve water, recycling of treated backwash water to top-up swimming pools and spa pools is supported provided the backwash is treated to an acceptable standard and controls are in place to protect public health.

Recycling swimming pool backwash water involves treatment to a suitable standard to allow recycling into the pool. As pool water will be accidentally swallowed, the quality of recycled backwash water should meet the *Australian Drinking Water Guidelines (2004)*[39] and controls need to be in place to protect against system failures. Any deviations from these guidelines should be supported by a health risk assessment. The National Water Quality Management Strategy, *Australian Guidelines for Water Recycling: Managing Health and Environmental Risk (Phase 1)* should be used as a guide.[40] *Environmental Health Risk Assessment – Guidelines for assessing human health risks from environmental hazards (*2002*)* also includes useful information.[38]

Appendix C provides an example of some of the components to consider for recycling of swimming pool backwash water based on *Australian Guidelines for Water Recycling: Managing Health and Environmental Risk (Phase 1).* [40]

Reverse osmosis is presently the best available technology for the treatment of backwash water for recycling. Pre-treatment using ultra-fine filtration and granular activated carbon may be necessary to prolong the life of the reverse osmosis membrane.

Reverse osmosis has been shown to remove the majority of dissolved contaminants (more than 99.5% dissolved salt and up to 97% of most dissolved organics), and 99.99% of micro-organisms. However because of the high set up, operational and maintenance costs, the cost of recycling backwash may outweigh any benefits.[40] Reverse osmosis should be installed with supporting treatments to greatly enhance its efficiency. The advice of a consultant in designing a recycling plant is essential.

6.6 Minimising pool pollution

6.6.1 Restricting bather load and encouraging bather hygiene

Restricting bather loads and encouraging bathers to toilet and shower before using a public pool is important for maintaining water quality. Filtration systems are designed for a maximum bather load and this limit should not be exceeded. The bather load should be expressed and documented by the pool designer.

Additional strategies to maintain water quality through patron behaviour are recommended in Chapter 8, section 8.5, *Education*.

6.6.2 Total dissolved solids

Total dissolved solids (TDS) increases as minerals and chemicals dissolve in water. TDS is an indication of the total amount of the dissolved solids in the water. As TDS increases so does the conductivity of the water. Conductivity can be measured in the field while TDS cannot. An estimation of TDS is therefore made from conductivity.

The main effect of TDS is to indicate the possible corrosiveness and solubility of minerals in water. As TDS rises the concentration of corrosion inducing ions increases and the oxidisers efficiency generally improves, unless the main component of TDS is reductants. However, if pools are properly balanced according to the Ryznar Index (see section 7.4.7) the effect of TDS on corrosion or scaling is negligible.

A high TDS may indicate a high salinity and salty taste that is caused by a high concentration of sodium ions. A high TDS may also indicate a build up of disinfection by-products or organic chemicals that cannot be readily removed from solution. Specific chemical testing is required to identify and determine a course of action. High TDS is also a confounder which may affect both ORP and amperometric sensing equipment.

TDS (and conductivity) is more important in industrial processes where high evaporation rates lead to high TDS. This situation occurs in cooling towers and boiler applications but in swimming pools it has a minor effect overall.

To reduce TDS levels, water dumping which occurs during backwashing, followed by dilution with fresh water with a low TDS is needed. Alternatively, reverse osmosis can be used but this is an expensive process to control a minor effect.

6.6.3 Water sources

(i) Mains water

The quality of the water source used to fill and top-up the swimming pool needs to be regularly checked for the basic parameters of free chlorine, total chlorine, pH, alkalinity, ORP, turbidity, TDS and colour. The incoming water may greatly affect the swimming pool water quality. For example, disinfection of the mains water may be by the use of chlorine and ammonia – a process known as chloramination which may elevate the pool combined chlorine concentration and prevent breakpoint chlorination.

Although the mains water may be disinfected it may not be filtered. This could lead to temporary clarity and sediment problems. It is appropriate that mains water is introduced into the pool either through the balance tank or at night to allow sufficient time for treatment before bathers enter the pool.

(ii) Borewater

Some bore waters are hard and high in calcium and magnesium carbonates. Such water may cause difficulties in balancing pool water, heating and scaling. The use of calcium hypochlorite as a disinfectant may worsen the problem. The advice of water treatment experts should be sought.

(iii) Rainwater (roof water) harvesting

The use of filtered clean rainwater collected from the roof (not general stormwater runoff) to fill spa pools and swimming pools is supported provided controls are in place to protect public health. Rainwater collected in tanks can be safely used for pools provided it is introduced into the pool through either the balance tank or into the pool at night to allow sufficient time for treatment before bathers enter the pool.

Safe rainwater use for swimming pools is achievable in most situations, unless rainwater is collected from roofs either constructed of hazardous materials (such as lead or preservative-treated timber) or located in heavily polluted areas where particulate pollution from vehicles, aircraft and industrial activities may contaminate rainwater.

First flush systems effectively minimise particulate and microbial pollution. First flush systems reduce contamination because the first few litres of rainwater, which contain the highest concentration of pollutants, are discarded to stormwater. First flush systems have been installed in various industrial and commercial applications and have proved to be a reliable way of reducing rainwater contamination. Microbial contamination of rainwater can also be easily controlled by chlorination in the collection tank. The area of the roof being used needs to be considered when determining the quantity of first flush water to discard.

Rainwater can have the added benefits of being low in TDS and being soft water, i.e. low in carbonates.
In heavily polluted areas, the cost of pre-treatment to maintain safe water may outweigh any benefits, especially where a reliable water source exists.

Further information is contained in *Rainwater Tanks* [41] and *Guidance on use of rainwater tanks*.[42]

The use of filtered clean rainwater to top-up swimming pools is supported provided controls are in place to protect public health. A suggested risk assessment and management framework is outlined in Annexure D.

6.7 Prevention and control of chloramines in indoor aquatic centres

Chloramines can cause eye and respiratory irritations, interfere with disinfection, place extra demands on chlorine and ruin the fun of swimming. They must be maintained below 1mg/L. The following measures may assist to prevent and control chloramines particularly in indoor aquatic centres. Refer to section 4.4.1 for a discussion on chloramines.

6.7.1 Education

Bather hygiene is essential to prevent excess chloramine formation. Educational strategies and pool policies should encourage or require patrons to:

- Use the toilet on entry to the pool change rooms
- Thoroughly wash themselves with soap before swimming to remove faecal and chemical contamination (cosmetics, deodorant and perspiration)
- Ensure children have regular toilet breaks
- Ensure infants who are not toilet-trained wear tight-fitting waterproof swimming pants or swimming nappies
- Ensure nappies are changed regularly, away from the pool in the change room. Nappies should be disposed of in a bin and then hands thoroughly washed.

There is overseas evidence that compliance with these hygiene practices has enabled lower chlorine usage because chlorine demand and the need for oxidation have been lowered. See section 8.5 for the *Healthy Swimming* program materials for pool operators.

6.7.2 Superchlorination

Superchlorination can be used to control chloramines. However if it is not performed properly it can result in more problems for the pool operator. Superchlorination should be carried out when the pool is closed and adequate ventilation must be provided to remove any volatile chloramines that may form. Regular superchlorination may be necessary, depending on the ammonia nitrogen concentration and its ratio to chlorine.

The aim of superchlorination is to achieve a condition known as breakpoint (see Appendix A), the point at which free chlorine is present with very little, if any, chloramine. Breakpoint reactions are dependent upon pH, temperature, contact time and initial concentrations of chlorine to ammonia and chlorine to ammonia nitrogen ratios.

Indoor swimming pools may have difficulty obtaining breakpoint and may require additional treatment using UV light, ozone, or the addition of other oxidisers such as hydrogen peroxide and potassium monopersulphate. Some pool materials may be adversely affected by high concentrations of chlorine. A pool chemistry expert should be consulted to ensure that superchlorination is carried out in a safe and efficient manner.

6.7.3 Shock dosing

(i) Chlorine dioxide

Chlorine dioxide can be used as a shock treatment for swimming pools and spa pools as it is an effective oxidiser and more effectively inactivates *Cryptosporidium* oocysts than hypochlorous acid. Chlorine dioxide does not form chloramines. The formation of chlorite and chlorate may cause adverse health effects and it is necessary to ensure these harmful chemicals do not accumulate. The World Health Organization recommends that the chlorite (ClO_2^-) concentration should not exceed 0.3 mg/L and a provisional guideline of 0.7 mg/L has been set for chlorate (ClO_3^-).

Chlorine dioxide should not be used in conjunction with ozone or an activated carbon filter as these combinations will increase the concentration of chlorite. Dilution with fresh water may be necessary to maintain acceptable water quality.

(ii) Potassium monopersulphate

Potassium monopersulphate can also be used to control chloramines in heavily used pools. These products lower the chlorine demand by oxidising ammonia and other pool contaminants. Care must be taken to ensure that potassium monopersulphate is not overused, because long-term use has been associated with skin irritation. Potassium monopersulphate interferes with the DPD reagent No 3, causing water samples to turn dark red. The monopersulphate is oxidised by this reagent and a false high total chlorine measurement is given. This effect usually ceases after 24 hours after which time total chlorine may be measured more accurately.

6.7.4 Ultra violet light treatment systems

Ultraviolet (UV) light treatment systems may be installed in indoor swimming pool circulation systems to lower chloramine concentrations. Medium pressure UV light systems which produce high intensity light between wavelengths of 180 to 400 nanometers (nm) are most effective at destroying chloramines because the chlorine to nitrogen bond is broken between a wavelength range of 245 and 340 nm. Medium pressure UV lamps are not affected by water temperature. Low pressure UV lamps with an electromagnetic spectrum between 185 and 254 nm are unsuitable for chloramine destruction although some are reported to destroy chloramines.

UV light systems provide additional disinfection by inactivating micro-organisms, especially protozoans such as *Cryptosporidium parvum*. Destruction of micro-organisms is greatest between the wavelengths of 240 and 280 nm and is thus another reason supporting the installation of UV light treatment.

UV light treatment systems do not produce a residual disinfection effect and must therefore be used with an approved residual disinfectant such as chlorine or bromine. There is also some concern that UV light treatment may increase disinfection by-products under some circumstances.

UV lamp sleeves need regular cleaning because they may continually foul with oils and greases such as cosmetics and sun screening lotions. Manual or automatic UV lamp wiping systems are usually provided in modern pool UV light systems for this reason. The latest medium pressure UV lamps also include the capacity to adjust UV intensity to the water's light transmission ability or clarity so that they operate at the highest output under heavy loading conditions and at the lowest output at night to save energy. This more effectively targets combined chlorine while prolonging lamp life. UV lamps have a useful life of approximately 12 to 18 months and should be replaced in accordance with the manufacturer's recommendations.

6.7.5 Ozone

Ozone is a powerful oxidant which is used to control chloramines and provide additional disinfection. Any residual ozone must be quenched before the water is returned to the pool to prevent it from de-gassing from the pool into the breathing zone of deeply breathing swimmers. A residual disinfectant such as chlorine or bromine must be reinstated after ozone quenching.

Ozone is produced commercially by discharging high voltage electricity (4,000 v to 30,000 v) through clean, cool, dry air or oxygen. This is known as the corona discharge method. Ozone may also be produced as a by-product by specific wavelength UV lamps. Corona discharge produces large quantities of ozone in comparison to the UV light method. Ozone's occupational threshold limit value is 0.1 mg/m^3 in air. At 1.0 mg/m^3 in air it is extremely hazardous to health.

Ozone is a short lived, unstable but powerful oxidising and disinfection agent and does not react with porcelain or glass. Ozone disappears quickly from water; a characteristic which is advantageous, but disadvantageous because it cannot be relied upon to provide continuous residual disinfection.

See 5.3.3 for information on the use of low dose ozone.

Where ozone is used in conjunction with bromine, an activated carbon filter bed is not required to quench the ozone, provided that there is always an excess concentration of bromide in the water. This ensures the complete destruction of residual ozone. This treatment system requires a highly skilled designer and operator to ensure safe operating conditions.

6.7.6 Granulated activated carbon filters

In some swimming pool installations, incoming source water is filtered using a granulated activated carbon (GAC) filter to adsorb ammonia. GAC filters are also used to filter ozone and sometimes organic materials. Unfortunately GAC filters also remove chlorine, which is expensive to replace.

6.7.7 Zeolite

Zeolites are porous volcanic materials and their properties vary according to geographical source. It is claimed that zeolites reduce the formation of chloramines by adsorbing ammonia and solid particles to 5 microns. Investigations are still being performed into the attributes of zeolite.

6.7.8 Ventilation – indoor

Adequate exhaust ventilation and fresh air are essential for efficient removal of chloramines and other air impurities. Chloramines, particularly trichloramine, are volatile, that is, they readily move from the water to the air. However, when the air becomes saturated with chloramine they will no longer be given off and can be re-dissolved into the same or other swimming pools in the same room. Pool covers, while preventing heat loss can also prevent chloramines from volatilising and being removed from the building.

There is a balance between losses of warm air, re-circulating warm air and off-gassing of chloramines. This balance needs to be determined without causing drafts and requires the expertise of suitably qualified ventilation professionals.

Recent articles suggest that there are associated health risks with poor indoor pool ventilation. In the absence of definitive studies this may be an emerging health issue.

CHAPTER 7

Design, construction and amenities

7.1 Overview and introduction

Public swimming pools and spa pools are designed to contain a large volume of water to enable swimming. A new public swimming pool should be equipped with an effective water circulation system, a water filtration system, and an automatic disinfectant dosing system.

Continuous non-automatic metered disinfectant dosing systems are more suited to low bather load and low risk pools such as motel pools where very low disinfection demand would be experienced. It is recommended that all high bathing load pools and variable bathing load pools should have automatic dosing systems.

All swimming pools and spa pools should be constructed according to the Building Code of Australia and recognising any appropriate Australian Standards / New Zealand Standards. Competition swimming pools also need to be constructed to satisfy the rules and regulations of the Federation Internationale de Natation (FINA – www.fina.org/project/index.php) All pools should comply with the NSW *Swimming Pool Act 1992* administered by local councils.

There are some common sense health and safety features for swimming pools:

- Clearly visible depth markings
- No sudden steep floor changes of greater than 1:15 in shallow areas to a depth of 1.6 m
- No projections into the pool
- Non-slip surfaces at depths less than 1.2 metres
- Recessed ladders and lane divider hooks
- Suctions and covers that are maintained in good working order
- The pool surrounds should be of a non-slip material, extend at least 1m from the pool, be graded away from the pool and drained to waste
- No overcrowding which could lead to safety issues
- Light pool colours which would not disguise a submerged body

7.2 Circulation and filtration

Effective circulation and filtration of swimming pool water is essential for clear, clean water. Pools with poor clarity and turbidity are more likely to contain higher numbers of micro-organisms because turbidity reduces disinfection efficiency and may shield micro-organisms from disinfection. Also, it is essential to clearly see the bottom of the pool in order to detect submerged or drowning people, particularly children. Water clarity (turbidity) can be measured and an upper limit of 0.5 nephelometric turbidity units (NTU) is recommended by WHO (2006).[2]

Efficient pool filtration and circulation systems need to be designed by an experienced professional water treatment plant designer and correctly installed. Well designed filtration ensures efficient removal of particulates (suspended solids) and effective distribution ensures application of residually disinfected water uniformly throughout the pool. Poor circulation leads to dead spots of poor quality water.

All of the water treatment plant must be specifically designed for the type of pool it is to serve. For example, a water treatment plant for a 25 m pool would be significantly different to that for a children's shallow pool.

Ideally, 75-80% of the pool water should be taken from the surface of the pool because it contains the highest concentration of pollutants. The remainder should be drawn from the bottom of the pool to remove grit and other matter that accumulates on the pool floor.

7.2.1 Surface water removal

Efficient removal of surface water is critical for maintaining water quality because surface water contains the highest concentration of pollutants from body fats, oils, sunscreens, sputum and windblown debris. Surface water removal occurs at deck-level or through overflow channels or skimmers.

All pool surrounds and concourse areas should be constructed of water impervious, non-slip materials and be graded away from the pool. A pool concourse should not be less than 1 m in width and be graded and drained to waste, not to the pool circulation system.

Deck-level (wet decks): Most modern pools incorporate deck-level surface water removal into their design. These systems are the most efficient at removing pollutants from pool surface water because the surface water continuously flows into the wet deck. To achieve this, the pool water must always remain at the same level as the wet deck. Wet decks have the added advantage of reducing wave rebound action and provide a stable water level. Excess water is stored in a balance tank and is utilised when needed and for backwashing.

Overflow channels (gutters): Overflow channels or gutters are more common in older pools built prior to the 1970s. Overflow channels collect surface water continuously from the pool in a sill like gutter structure. Similar to wet decks, water displaced by swimmers flows into the overflow channel. The overflow channel is connected to a drain. In some systems the excess water is stored in a balance tank which may be used for backwashing or topping up the pool when needed. Careful attention needs to be paid to the pool water level if a balance tank is not used as surface water removal may not be effective. Similarly, depending on design, wave action may render skimming less effective until the pool is relatively still.

Skimmers (skimmer box): These are small open ended boxes with a flap type floating weir and trash basket to trap floating debris. These act in a similar manner to overflow channels, but are considered unsuitable for public swimming pools because they have limited capacity to remove flotsam and do not cope well with variations in water level arising from displaced pool water. Skimmers are also less effecting during wave action and perform better when bathers are absent from the pool. **Skimmer boxes, although not recommended in public pools, must be designed and installed to prevent entrapment and disembowelment.**

Water features: The water used to supply water features should not be drawn from the distribution / circulation system. Water feature supply water should be drawn from the body of the pool and pumped directly to the water feature. The water feature water must be drawn from the pool using multiple suctions of a velocity of not more than 0.25 m/s. Each suction should be fitted with a vacuum device to ensure that bathers cannot be trapped.

Foot baths for bathers are not recommended as they are more likely to transmit infections than wash contamination from feet.

Pool circulation

At least 75-80% of the pool water should be taken from the surface of the pool and the remainder from the bottom. Bottom suction should be achieved using multiple suctions of a velocity of not more than 0.25 m/s (metres per second) and a minimum separation distance of 0.8 m. Deep-end suction outlets are considered essential and should be designed to prevent entrapment.

7.2.2 Bather load

Bather load is a measure of the number of bathers in the pool and is normally expressed as a Maximum Instantaneous Bather Load (MIBL). Before turnover, circulation rates and filtration rates can be considered, bather load must be determined. WHO (2006)[2] has adopted the Pool Water Treatment Advisory Group (PWTAG) methodology for determining turnover through bather load and circulation rate.[44]

Bather load is determined by the surface area of the pool required per bather and as a function of water depth. As water depth increases the greater pool surface area needed to swim. The MIBL also gives an indication of the amount of bather pollution being introduced into the pool. This pollution may vary according to the size of bathers as children have a much lower surface area than adults (assuming that all people toilet before entering the pool). To maintain water quality, comfort and safety, the design MIBL requirements should not be exceeded, Table 7.1 should be used as a guide where the design MIBL requirements have not been specified by the design consultant

Table 7.1: Maximum instantaneous bather load according to water depth

Water depth	Maximum bathing load
< 1.0 m	1 bather per 2.2 m^2
1.0 – 1.5 m	1 bather per 2.7 m^2
> 1.5 m	1 bather per 4.0 m^2

Source: PWTAG 1999[44] and WHO 2006[2]

7.2.3 Circulation rate and pool turnover

The circulation rate is the flow of water, measured in cubic metres per hour (m^3/h), to and from the pool through all the pipe work and treatment system. To calculate circulation rate PWTAG (1999) uses the formula of:

Circulation rate (m^3/h) = Maximum instantaneous bathing load (persons) × 1.7 (a constant)

Pool turnover is the time taken for the entire pool water volume to pass through the filters and treatment plant and back to the pool (WHO, 2006). This does not mean that all of the water will leave the pool and be re-circulated. Rather it is a measurement of the equivalent pool volume, as some of the pool water will not actually be recirculated. Turnover time is expressed in the number of hours to complete one turnover. The type, size and particularly the depth of the pool determine pool turnover time. Shallow wading pools and spas require a shorter turnover time as they are subject to more bather pollution per volume of water (bather load). Diving pools need a slower turnover time because there is a very low pollution to volume ratio.

There are four reasons for specifying minimum turnover rates:

- To ensure that there is sufficient water for effective distribution in the pool and adequate surface water velocity for the removal of surface contaminants
- To ensure that contaminated swimming pool water is returned to the water treatment plant with sufficient speed
- To ensure a large enough water treatment plant to effectively remove turbidity to achieve acceptable standards of clarity
- To ensure sufficient water disinfection.

The relationship between circulation rate and turnover is:

$$\text{Turnover period (h)} = \frac{\text{Water volume (m}^3\text{)}}{\text{Circulation rate (m}^3\text{/h)}}$$

When a turnover period is too long, disinfectant levels will decay and turbidity will increase. A faster turnover period allows greater control over disinfectant levels and turbidity. Because the bather load is a function of water depth, calculations of turnover can lead to step-wise calculations. The recommended pool turnover times as a function of water volume and circulation rates formulae have been derived by Stevenson and Associates (pers comm.) and are specified in Table 7.2.

It has been recommended by some swimming pool designers that where ultrafine filters are used, which filter pool water to 2 μm or less, that the turnover time in indoor swimming pools can be increased by 15% and outdoor swimming pools increased by 10%. The Stevenson formulae for pool turnover times are derived from the previous NSW Health 1996 guideline[45], together with PWTAG[44] and WHO[2] recommendations by removing the stepwise increments due to varying pool depth categories. No pool should have a turnover period longer than six hours.

Table 7.2: Recommended pool turnover times

Pool type	Maximum turnover time
Spa pools	20 minutes maximum
Stevenson formula for indoor swimming pools	(1.3 × depth) + 0.2 hours
Stevenson formula for outdoor swimming pools	(1.8 × depth) + 0.2 hours
Multiplier for indoor swimming pools where an ultrafine filter is used: 1.15	Multiplier for outdoor swimming pools where an ultrafine filter is used: 1.10

NOTES: Water playgrounds and splash pools are not included in the above calculations as they must be specifically designed. Where pools are greater than 4m deep they shall be calculated as a 4m pool.

EXAMPLE 1: The maximum turnover time for an indoor pool of 1.2 m uniform depth using an ultrafine filter is: ((1.3 × 1.2) + 0.2) × 1.15 = 2.0 hours

EXAMPLE 2: The maximum turnover time for an outdoor pool of 1.2 m uniform depth using a granular filter is: ((1.8 × 1.2) + 0.2) = 2.36 hours

EXAMPLE 3: The maximum turnover time for an outdoor pool of 1.2 m uniform depth using an ultrafine filter is: ((1.8 × 1.2) + 0.2) × 1.10 = 2.6 hours

There are many special pool applications where the methodology needs to be modified to account for: pool water features, bubble pools, waterslide splash pools, beach pools, pools with moveable floors, spa pools, shallow leisure pools, wave pools and hydrotherapy pools. Such pools need to be designed by experienced professional pool designers.

7.2.4 Water distribution – zonal and non-zonal

Calculations of water flow for each depth should be done separately, not on an average depth of the whole pool. This results in zonal distribution. To ensure that all areas of a pool are disinfected and filtered, no part of a pool should be further than 5.0 m from an inlet.

In applying the recommended turnover rates most pools will have varying flow rates that may result in a zonal water supply system. The volume of water to be circulated in any one zone is the volume of the pool zone divided by the turnover rate. Therefore the turnover (hours) is equal to the zone volume (m^3) divided by the circulation rate (m^3/h).

7.2.5 Separate plant for high risk pools

Because toddler pools, infant learn-to-swim pools and pools used by faecally incontinent persons are high risk pools in regard to *Cryptosporidium* and *Giardia* contamination, these pools should have their own circulation and treatment systems and be separate from other pool circulation systems.

7.2.6 Dye Testing

It is recommended that all new pools be dye tested so that the pool owner / operator / designer / engineer gains an understanding of the overall effectiveness of circulation patterns and identifies any possible dead spots.

7.2.7 Entrapment prevention

Swimming pools and spa pools must be designed to prevent entrapment. Relevant standards should be consulted.

7.2.8 Upgrading existing outdoor pools

Upgrading and refurbishing of existing outdoor pools often presents a dilemma for pool owners, particularly local councils with limited funding. Where it is not possible to upgrade to this Advisory Document, but funds are available to effect some improvements, attempts should be made to upgrade to the most economically feasible optimum design configuration. The following issues should be considered:

- Turnover should not be longer than 4 hours for depths less than 3 metres for a swimming pool and longer than 30 minutes for a spa pool
- Strategies should be developed to compensate for the lack of turnover. Such strategies could include:
  - A risk management plan to ensure that possible public health risks are minimised
  - Full automation of disinfection and pH processes
  - Limiting bather numbers
  - Elevation of minimum disinfectant concentrations
  - Improving filtration.

7.3 Filtration systems

It is a common misconception that all of the water in a swimming pool or spa pool will be filtered during one pool turnover. At the start of filtration the first flows will be dirty water and, as this water is filtered and returned to the pool, it will mix with and dilute the remaining dirty water. Filtration is accomplished by consecutive dilution which relies on continuous turnover and dilution to remove impurities. About 67% of the filterable material is removed on the first turnover and then in accordance with Table 7.3.

Table 7.3: Consecutive dilution of a pool

No. of turnovers	Filterable suspended solids removed (%)
1	67.0
2	86.0
3	95.0
4	98.0
5	99.3
6	99.7
7	99.9
10	99.99

In reality, the pool will be in use and contaminants will be continuously added while being continuously filtered. Therefore the contaminants will reach equilibrium with turnover rates and remain fairly constant according to the bathing load. The more rapid the turnover rate the less time to reach equilibrium and the lower the contaminant level as shown in Table 7.4.

Table 7.4: Turnover equilibrium times

Turnover (hours)	Days to reach equilibrium	Filterable suspended solids removed (%) (Original 100%)
48	19	155
24	9	58
12	4	16
8	3	5
6	2	2

For these reasons filtration should never be relied upon to remove live micro-organisms, particularly *Cryptosporidium* and *Giardia,* from pool water.

It is not the intention of this Advisory Document to recommend specific flow rates, filtration rates and pipe sizes as only turnover periods are specified. A professional pool designer should be engaged to design filtration systems according to the pool type, size and the anticipated bather load. Other factors such as budget, maintenance and space requirements may also determine the type of filtration system to be installed.

There are three main types of filters: element (cartridge), granular (sand) and ultra fine (diatomaceous earth). A comparison of some of the parameters of these filters may be found in Table 7.5.

7.3.1 Element filters (cartridge filters)

Element filters are able to filter to 7 µm (micrometres or microns). However, because of their short life span and their limited capacity to cope with large flows, they are only suitable for small, low bather load pools. Some pool engineers will not recommend element filters for public pools.

7.3.2 Granular filters (typically sand filters)

Granular filtration, when used with a flocculant, is a very efficient method of filtration provided the filters are specified by a water treatment engineer and that air scouring is used when appropriate for backwashing the filter.

Granular filtration can be categorised according to filtration flow rates:

- Low rate (gravity) up to 10 m^3/h: have a large footprint and were commonly associated with swimming pools built before 1990. They are efficient when used with a flocculating agent and often utilise an air scour backwash.
- Medium rate (pressure) 11-30 m^3/h: can filter to about 7µm using a suitable coagulant. These filtration systems are most common in large commercial pools and the use of a suitable flocculation agent significantly improves efficiency.
- High rate 31 to 50 m^3/h: are not well suited to heavy-use public swimming pools. They may not be efficient at removing particles even when flocculation agents are used and need to be well designed to cope with higher velocity flows.

Coagulation/flocculation: Coagulants are filter aids for the additional removal of dissolved, colloidal and suspended matter by coagulation and then clumping together to form a flocc. A filter more easily captures a flocc.

Aluminium-based flocculents include:

- Aluminium sulphate (ALUM) – filter surface blanket type flocculent;
- Polyaluminium chloride or aluminium hydroxychloride (PAC) – depth of filter bed flocculent;
- Polyaluminium sulpho silicate (PASS) – depth of filter bed flocculent;
- Sodium aluminate – filter surface blanket type flocculent.

Aluminium-based flocculants operate best between a pH of 6.5 – 7.2 and where total alkalinity is greater than 75 mg/L calcium carbonate ($CaCO_3$). Pool pH should ideally be maintained between 7.2 and 7.6. Polyelectrolytes such as PAC and PASS produce tough flocc (which is more stable than ALUM floccs) and are capable of flocculating bacteria and algae for more efficient removal. Flocculants should be dosed continuously in accordance with the manufacturer's specification and never hand dosed (unless commissioning a new pool with dirty water).

PAC and similar polyelectrolytes are dosed as micro-feeds related to specific filter flows on a continuing basis. ALUM floccs are generally dosed at the beginning of filter cycles as they form flocc blankets on the filter bed surface. Generally, ALUM floccs are not suitable for filter flow rates exceeding 10m^3/h because they are driven into the media body and may be difficult to backwash clear or will coagulate on the pool floor and internal surfaces of pipes.

7.3.3 Ultrafine filters incorporating diatomaceous earth filters

Ultrafine pre-coat filters (UFF) provide excellent particle removal efficiencies as they can filter to 1-2 µm. This is effective for the removal of *Cryptosporidium* oocysts. UFF is therefore recommended for all high-risk pools where the risk of *Cryptosporidium* contamination is greater.

UFF rely on a replaceable filter medium such as diatomaceous earth (celite) and perlite, which is replaced after each backwash. The effectiveness of filtration is dependent upon filter media, hydraulic loading and maintenance.

Table 7.5: A comparison of some filter types

Criteria	Filter type		
	Ultrafine	Medium granular	Element
Common filter sizes	Up to 80 m^2	Up to 10 m^2	Up to 20 m^2
Design filter flow rate	3-5 $m^3/m^2/h$	25-30 $m^3/m^2/h$	1.5 $m^3/m^2/h$
Cleaning flow rate	5 $m^3/m^2/h$	37-42 $m^3/m^2/hr$	Not applicable
Cleaning	Periodic disassembly and septum cleaning	Backwash and rare sand replacement	Manual, hose down
Average wash water	0.25 m^3/m^2 filter	3.0 m^3/m^2 filter air scour 3.3 m^3/m^2 filter water only	0.02 m^3/m^2 filter
Filter cleaning period	3 weekly (typically)	Weekly (typically)	Weekly or less (typically)
Filter aid	None	Micro-flocculants are recommended	None
Cleaning implications	Backwash tank with separation zone for used filter media. Disposal of filter media and sludge waste. Trade Waste Agreement with a discharge rate of 2 L/s	A backwash tank. Trade Waste Agreement with a discharge rate of 2 L/s	A hose-down and waste drain facility is required
Particulate collection	Surface	Depth	Surface
Particle removal	1-2 µm	10 µm; 7µm with flocc	5 µm
Use	All pools	All pools	Spas – small
Recommended maximum filtration rate	5 $m^3/h/m^2$	30 $m^3/h/m^2$	1.5 $m^3/h/m^2$

Source: Modified from WHO (2006)[2]

7.4 Maintenance of swimming pools and spa pools

Reliable pool operation depends on regular maintenance of filtration equipment, probes, electrical and hydraulic equipment. All swimming pools and spa pools should be maintained according to the manufacturer's specifications. Table 7.6 outlines some of the maintenance requirements that are required for the proper operation of public swimming pools and spa pools.

7.5 Change rooms, pool hall and amenities

7.5.1 Floors, walls and change areas

Floors within change rooms, bathrooms and toilets should be coved at corners, graded and drained. Matting which can be easily cleaned and sanitised (such as PVC) should be used within change rooms and shower rooms to prevent the transmission of fungal infections such as tinea. Matting materials made from natural or woven materials should not be used. Patrons should be encouraged to wear sandals or thongs to limit contact with potentially contaminated wet change room floors.

Benches should be constructed of smooth impervious material and, if timber is used, it should be maintained by a lacquer or paint, which is easy to clean. All floors, walls and ceilings should be light in colour. Lockers should be inspected and cleaned weekly.

7.5.2 Light and ventilation

Adequate artificial and natural lighting and ventilation should be provided in accordance with the Building Code of Australia and relevant Australian Standards.

Adequate fresh make up air for indoor pools is necessary to dilute volatile air contaminants. Where chlorine is used as a disinfectant, inadequate ventilation results in the build up of volatile combined chlorine in the air. This build up can condense onto surfaces causing corrosion of stainless steel and other building fabrics.

Where a cooling tower is provided in water cooled ventilation systems, it should be registered with the local authority and must comply with the microbial control provisions of the *Public Health Act 2010* and *Public Health Regulation 2012,* which can be accessed via: http://www.health.nsw.gov.au/environment/legionellacontrol/Pages/default.aspx

7.5.3 Showers

Ideally, swimming pool centres should be designed to encourage all people to toilet and then shower before entering a swimming pool. To facilitate this, an adequate number of showers should be located in the dressing room in positions where patrons have to pass by them before entry to the pool area.

Table 7.6: Minimum maintenance requirements of swimming pools and spa pools

Plant	Maintenance
Balance tank	Balance tanks need to be cleaned annually to remove any debris, mud and organic matter. Balance tanks, which do not drain to waste, need to be pumped out.
Foot valve	If fitted, the foot valve should be serviced annually.
Supply (filtered) water inlets	Pool supply water inlets and surrounding tiles should be checked after each shut down for damage and compliance with the specifications. It is important to check the diameter of the supply return inlet because obstructions will reduce flow rates (increase turnover times). Reduced flow rate could lead to poor water quality.
Return (soiled) water outlets	Outlet screens should be cleaned daily. Gutters, wet deck outlets and skimmer boxes should be inspected weekly. Similar to supply fittings (inlets), any obstruction will increase turnover times and may lead to poor water quality. More particularly, blocked screens will starve the filter plant and pumps of water.
Cleaning filters: backwashing	The filter should be backwashed on a regular basis or when indicated by loss of head gauges (if fitted) or a reduction in the rate of flow measured by a flow meter. Waiting for an observable flow reduction will be too late. Pool filters should be backwashed weekly regardless of head loss because the entrapped oxidised body fats and sun screens are not detained but only restricted from travelling through the filter bed. They may build up with little evidence of head loss but will ultimately penetrate the filter bed. Preferably, backwashing should continue until the water runs clear (or only slightly cloudy). In a closed system (where the backwash effluent is not visible) a reduction in the head loss after each backwash should indicate adequate cleaning of the filter(s). If the pressure level is increasing after each backwash, a longer backwash time may be required. Head loss should always reduce after backwashing. A filter which does not show reduction should be investigated.
Cleaning filters: sand inspection and maintenance	Inspect condition of filter yearly. If the sand is unclean (indicated by the presence of mud, grease or alum balls) it is usually recommended to replace the dirty sand layer with clean sand. Sand may need to be visually inspected every 5 years depending on filter performance.
Cleaning filters: ultrafine filters (UFF)	UFF media should be replaced when backwashing is undertaken. The media should be re-generated weekly. If the pool is implicated in a *Cryptosporidium* outbreak the filter should be backwashed immediately.
In line filters or strainers	The main hair and lint strainer should be checked daily and cleaned when required.
Pool suctions	All pool suctions should be checked every three months.
Suction cleaning	The frequency of suction cleaning to remove large contaminants depends upon the bather loads and usage conditions of the pool. A plan of management should be developed accordingly. Under normal operating conditions, suction cleaning may be required two or three times a week or once per week when the pool is not heavily loaded. Large items such as rubber bands, hair clips and leaves should be removed with a net. It is recommended that larger pools use an automatic pool cleaner each night.
Automatic control probes	The pH and oxidation-reduction potential (ORP) probes need to be calibrated and serviced to remove any scale that has developed. They should be inspected, cleaned and calibrated at minimum six monthly intervals. Electrical inspection should be conducted yearly by a licensed electrician.
Main circulation pumps and motors	The main circulation pumps and pump motors should be serviced annually and checked regularly. All maintenance should be in accordance with the manufacturer's specification. Ideally multiple spare pumps should be available in case of a failure.
Chlorine pump/ chlorinator	The chemical dosing system including any pumps (chlorinator) should be serviced annually and chlorine pumps with an oil reservoir checked weekly. Upgrading to a larger capacity output system to cope with superchlorination needs due to *Cryptosporidium* contamination should be considered.
Cleaning	Daily cleaning of any dirty water marks (biofilm) around the water line is recommended to prevent the harbourage of any pathogenic micro-organisms. Regular superchlorination or oxidation is recommended to remove any biofilms within pipes, fittings and filters.
Electrical	Electrical inspection should be performed annually by a licensed electrician experienced with swimming pools.

Soap should be provided in all showers and signs should be erected to require showering before swimming. Cleaning and disinfection of shower floors should be performed daily and scrubbing to remove soap and dirt accumulation should be undertaken weekly. Most importantly all tap ware, shower stalls and basins should be cleaned and disinfected regularly to inhibit cross contamination.

Where a warm water system is installed, the local authority should be advised and consulted about Legionnaires' disease control. The NSW Health website should be visited to consult the *Public Health Regulation 2012* and the *NSW Code of Practice for the Control of Legionnaires' Disease*. http://www.health.nsw.gov.au/environment/legionellacontrol/Pages/default.aspx

7.5.4 Hand basins

Hand basins should be located adjacent to toilets with an adequate supply of soap and paper towels or air hand drying machines. Communal towels should not be provided. All tap ware and basins should be cleaned and disinfected regularly to inhibit cross contamination.

7.5.5 Toilets (water closets)

Toilets should be located in close proximity to the dressing room and adjacent to the showers. Toilets should be easily accessed from the pool concourse to encourage regular toileting. Toilet numbers should be in accordance with the Building Code of Australia.

Children in particular, as well as adults, should be encouraged to use a toilet prior to swimming. Toilets should be provided with an adequate supply of toilet paper and maintained clean at all times. Lidded sanitary disposal bins for the disposal of sanitary napkins and tampons should be provided in the women's bathrooms. The toilet should not be used to dispose of sanitary products or hand towels.

All tap ware, pans and basins regularly cleaned and disinfected to minimise cross contamination.

7.5.6 Baby nappy change / parent facilities

Babies' nappies should not be changed adjacent to the pool. Comfortable baby nappy change facilities should be provided in close proximity to the toddlers' pool. Babies wearing nappies should be prohibited from bathing as the risk of faecal contamination is too great. Children who are not toilet trained should wear specially designed bathing pants before pool entry. All tap ware, change tables, baths, and basins should be cleaned and disinfected regularly to inhibit cross contamination.

7.5.7 Waste removal (garbage)

Adequate garbage bins should be provided particularly in the spectator and lawn areas, and adjacent to the kiosk. All receptacles used for the storage and removal of waste should be cleaned and sanitised regularly to prevent attracting vermin and rodents. Bin liners will assist in maintaining bins clean. Bulk garbage should be stored in a cool, bunded, secure area and should preferably be located under cover. The storage area should be maintained in a clean condition and free from vermin.

Yellow sharps disposal containers conforming to Australian Standards should be located in all toilet areas.

7.5.8 Storage of hazardous and dangerous chemicals

The NSW WorkCover Authority regulates the storage and handling of dangerous goods through the *Work Health and Safety Act 2011 and Work Health and Safety Regulation 2011*. WorkCover Authority should be consulted to obtain any information with regard to the storage and handling of swimming pool and spa pool chemicals. (See Section 5.4)

7.5.9 Water temperature

Where spa pools are heated, the temperature must never exceed 38°C. Signs should be displayed restricting bathing to 20 minutes in high temperature pools warning of the dangers of heat stress.

Overheating of the body can cause heat illness. The body has no mechanism to warn of overheating. In saunas and high temperature pools such as spas dehydration, heat exhaustion and fainting may occur. On entering a heated pool or sauna, the skin blood vessels dilate to help lose heat and keep the body cool. The heart pumps faster and heart rate increases. If there is insufficient blood to the brain, there is a lack of oxygen and dizziness and fainting may result. Deaths have resulted when alcohol has been consumed and the body subjected to heat stress.

Heat exhaustion is caused by a loss of water and electrolytes. Any sustained muscular exertion can cause loss of water and electrolytes. It is relieved by rest, fluid and electrolyte (salt) replacement. Children and those with medical conditions, especially heart conditions, are particularly at risk and should seek medical advice before using spas or saunas.

Spa pool heat warning: Bathing for longer than 20 minutes in hot pools and spas may cause heat illness. Parents of children under the age of 6 years, persons with medical conditions and pregnant women should seek medical advice before using a heated spa pool.

7.5.10 Towel and costume hire

Towel and costume hire is not recommended but where provided separate storage facilities should be provided for clean and used costumes and towels. Used costumes and towels should be laundered as soon as possible, using commercial laundry facilities.

7.5.11 First aid

First aid equipment and a sick bay should be provided as appropriate. Cardio-pulmonary resuscitation signage must be provided in accordance with the Royal Life Saving Society, St John's Ambulance Australia and local authority requirements.

7.5.12 Shade

The use of an outdoor swimming pool complex by patrons exposes them to harmful UV radiation. Shade should be provided at all outdoor public swimming pools to protect the public. Guidelines for the provision of shade are available from the Cancer Council at:
http://www.cancercouncil.com.au/reduce-risks/sun-protection/

7.5.13 Glass

All glass and glass products should be banned from public swimming pools and spa pools. Clear broken glass cannot be seen under water. Water samples should be taken in plastic beakers or sampling containers.

7.5.14 Kiosk

Kiosks must comply with the Food Standards Code administered by the NSW Food Authority and local authorities:
http://www.foodauthority.nsw.gov.au/

CHAPTER 8

Cryptosporidium risk management

8.1 Overview

The purpose of this chapter is to provide best practice guidance on prevention and control measures to reduce public health risk associated with *Cryptosporidium* contamination of swimming and spa pools. This chapter is relevant for similar disinfectant resistant micro-organisms, such as *Giardia*. For general information on microbiology see Chapters 2 and 3.

8.2 Epidemiology of cryptosporidiosis

Cryptosporidium parvum is the parasite responsible for cryptosporidiosis, a diarrhoeal illness in humans, which can also occur in a variety of animals such as cattle and sheep. In a person with the infection, the parasite invades and multiplies in the gastro-intestinal tract, causing illness and producing oocysts, the infective form of the parasite. Oocysts are excreted in faeces into the environment where they can survive for a many months.

Cryptosporidiosis transmission is by the faecal-oral route, including person-to-person, animal-to-person, waterborne and foodborne transmission. Animal droppings and human faeces containing oocysts may easily contaminate hands. Good personal hygiene practices are important. Oocysts are also deposited from animals in soil, water and food.

The first symptoms of cryptosporidiosis may appear 1 to 12 days after a person ingests the infective oocysts. Symptoms of the disease usually include profuse watery diarrhoea, abdominal cramps, fever, nausea and vomiting. These symptoms may lead to weight loss and dehydration. Some people with the infection may not have symptoms, yet excrete oocysts in their faeces. **There is no specific treatment for cryptosporidiosis.**

People with healthy immune systems usually have symptoms for one to two weeks and then recover fully. After symptoms subside, they may still continue to pass *Cryptosporidium* oocysts in their faeces for several days and therefore may still spread the disease to others.

Those with a weakened immune system, may have cryptosporidiosis for a longer period of time. In some cases the illness can be serious or even life threatening. People with compromised immune systems should discuss with their doctor their risk of getting cryptosporidiosis, including swimming at public pools and spas, and their need to take precautionary measures. Examples of people with weakened immunity include people with HIV, cancer and transplant patients on immunosuppressive drugs and people with inherited diseases affecting the immune system.

A review of the outbreaks of cryptosporidiosis associated with swimming pools shows that most occur in pools following faecal accidents by infants who are not toilet trained. The majority of other illnesses transmitted in swimming pools and spa pools are associated with poor disinfection.

The health risk of bathing in a pool contaminated with *Cryptosporidium* is directly related to the organism's characteristics, transmission and the epidemiology of the disease. Infective oocysts are resistant to standard levels of chemicals used in pool disinfection and are unlikely to be efficiently removed by a pool filtration system because of their small size and the lengthy time taken during the process of consecutive dilution (see Section 6.3).

8.3 Control measures and strategies

To reduce the risk of C*ryptosporidium* entering a pool, it is recommended that pool operators prepare a risk management plan with strategies to prevent the introduction of *Cryptosporidium* into pools and implement control measures to inactivate *Cryptosporidium*.

Risk assessment should address the following risk management areas:

- Swimmer hygiene practices
- Education
- Operational control and maintenance
- Sampling.

This is expanded in the following sections.

8.4 Swimmer hygiene practices

The single most effective method to prevent the transmission of *Cryptosporidium* in swimming pools is to stop oocysts from entering the pools in the first instance. This is done by improving swimmer personal hygiene practices. There are two priority areas:

- Personal hygiene
- Awareness of infants who are not toilet trained

8.4.1 Personal hygiene

People, particularly children, who have had diarrhoea within the previous two weeks, should not enter a pool. Many children's learn-to-swim centres have adopted the sensible policy of offering catch-up lessons when children have had vomiting, diarrhoea or conjunctivitis in the previous 7 days. Parents are asked to sign a declaration that their child has not been sick with vomiting, diarrhoea or conjunctivitis in the previous 7 days. Parents with healthy children are pleased that such a protective measure has been adopted. An example of such a form follows:

All patrons should be encouraged to:

- Use the toilet before entering the pool
- Shower and wash thoroughly all over with soap before entering the pool
- Avoid swallowing pool water as it may contain pathogenic micro-organisms

Basic hygiene facilities

- Soap dispensers should be installed next to the showers and hand basins.
- Hand-dryers or disposable hand towel dispensers should also be installed and maintained.
- Nappy changing facilities and bins for soiled nappies should be provided in a room adjacent to and accessible from the toddlers' pool.
- Hand washing posters.

8.4.2 Awareness of infants who are not toilet trained

To assist with the control of *Cryptosporidium*:

- Infants who are not toilet trained should have their water activities restricted to the toddlers' pool (where possible)
- Appropriate bathing attire should be worn at all times otherwise swimming should be prohibited
- Infants who are not toilet trained should wear tight fitting waterproof pants or swimming nappies at all times
- Swimming nappies should be changed in change rooms and not at the poolside

To enable us to have the highest level of sanitisation in our pool, all parents / guardians must sign this declaration before your child's lesson.

HAS YOUR CHILD BEEN SICK WITHIN THE LAST 7 CONSECUTIVE DAYS WITH VOMITING, DIARRHOEA OR CONJUNCTIVITIS? If yes, do not have a lesson today and we will give you a catch-up lesson when your child has not been sick for 7 consecutive days.

Date	Child name	Parent / guardian name	Yes	No	Signature

- Hands should be thoroughly washed with soap after changing swimming nappies
- Soiled nappies should be disposed of in bins provided
- Toddlers should be encouraged to use the toilet frequently

8.5 Education

Education of both the public and pool staff is essential in minimising the transmission of Cryptosporidiosis and fulfils part of the pool management's duty of care to its patrons. Because there is growing community awareness of *Cryptosporidium,* it is important to reinforce educational messages about personal hygiene.

NSW Health has developed educational resources to assist pool operators in preventing C*ryptosporidium* contamination of swimming pools. The following materials have been developed and are available from Public Health Units, Councils and on the NSW Health website at:
http://www.health.nsw.gov.au/environment/publicpools/Pages/default.aspx

Education for members of the public: The 2007 *Clean Pools for Healthy Swimming* campaign allowed production of the following brochures and posters.

- The Clean Pools for Healthy Swimming brochure. Available at:
  http://www.health.nsw.gov.au/pubs/2007/Clean_Pools.html
- The Steps to Healthy Swimming poster. Available at:
  http://www.health.nsw.gov.au/pubs/2007/Healthy_Swimming.html

Education for pool operators

- *Cryptosporidium* contamination response plan. Available at: Faecal accident response plan (loose stool in a pool) Available at:
  http://www.health.nsw.gov.au/environment/publicpools/Documents/cryptosporidium-notification-response-plan.pdf
- Faecal accident response plan (solid stool) Available at:
  http://www.health.nsw.gov.au/environment/publicpools/Documents/faecal-incident-loose-stool-response-plan.pdf

Clean Pools for Healthy Swimming brochure

Steps to Healthy Swimming poster

- Faecal accident response plan (loose stool). Available at: http://www.health.nsw.gov.au/environment/publicpools/Documents/faecal-incident-loose-stool-response-plan.pdf
- Accident response plan (vomit in pools) Available at: http://www.health.nsw.gov.au/environment/public pools/Documents/vomit-incident-response-plan.pdf
- Hard surface accident response plan (concourse, bathroom floors and pool surfaces) Available at: http://www.health.nsw.gov.au/environment/publicpools/Documents/hard-surface-incident-response-plan.pdf

The following educational strategies are also recommended as part of pool management:

- Ensure all pool staff are fully trained in pool/spa operational procedures
- Ensure that all pool staff are empowered to act immediately on incidents and behaviour which may cause contamination (e.g. infants with unsuitable swim wear, or patrons who may present a risk such as those who are incontinent or indicate they have had a diarrhoeal illness)
- Ensure patrons are aware that management will reserve the right to prevent patrons from swimming if there is reason to believe that they may cause a risk to other swimmers. Patrons need to be assured that management is keen to protect their health and that of their children
- Provide public information about the risks of spreading cryptosporidiosis. Methods for providing information could include information on noticeboards and distribution of the NSW Health *Clean Pools for Healthy Swimming* brochures to parents with swim school enrolments
- Display the NSW Health *Steps to Healthy Swimming* poster.

New pools
Consideration should be given to designing amenities so that all patrons have no choice but to walk through toilet and shower areas before gaining access to the pool. To encourage showering, warm showers with soap should be provided with temperature control devices to prevent scalding.

8.6 Operational control and management

Additional management strategies and policies should be developed to suit individual pools and be consistent with this Advisory Dociment. The following could specifically be considered:

- Circulation and filtration systems should be maintained to provide maximum filtration efficiency and run 24 hours a day
- Pool water disinfectant levels should be maintained in anticipation of bather numbers such that disinfectant concentrations always remain above the minimum recommended levels specified in Schedule 1 of the Public Health Regulation 2012
- Regular backwashing and superchlorination is important for the maintenance of good water quality and the prevention of biofilms in the circulation system
- All pools should be regularly cleaned
- NSW Health Response Plans for responding to potentially infectious accidents and notifications of cryptosporidiosis should be followed
- Pool water quality should be regularly tested on site in accordance with Chapter 5
- Samples for bacteriological analysis should be regularly submitted to a National Association of Testing Authorities (NATA) accredited laboratory according to Chapter 3.

NOTE
Bacteriological testing does not include testing for *Cryptosporidium;* however, the presence of *E. coli* is an indicator of possible faecal contamination. Note that *Cryptosporidium* has been detected in the absence of bacterial indicators (see section 8.6.2)

8.6.1 Barriers used in pool operations

Barriers are mechanisms used to prevent transmission of any disease from its source to a susceptible host. Barriers can include source control, cleaning and disinfection and pool closure. Two main barriers used in normal operating practices to minimise the transmission of micro-organisms to swimmers are:

- Filtration
- Disinfection

(i) Filters

Ultrafine filtration (UFF) is capable of removing *Cryptosporidium* oocysts. UFF however, cannot be relied upon as a control measure since it takes time to filter all pool water and some pool water will not be filtered because of circulation problems, dead spots and the principle of successive dilution (see Section 6.3). Where pools are being upgraded, separate circulation and treatment systems for hydrotherapy pools and toddler pools using UFF is essential. Upgrading of any hydraulic system to ensure good circulation of pool water should be considered.

> **Separate circulation systems**
> Separate circulation systems should be installed for toddler pools, hydrotherapy pools and other high-risk pools. Where separate circulation systems are installed bulk water should not be fed from one system to the other through balance tanks to avoid cross contamination.

(ii) Disinfection

Routine disinfection procedures, on their own, are not sufficient to quickly destroy *Cryptosporidium* oocysts unless a pool is shock dosed with chlorine. While chlorine and bromine at the recommended levels will eventually kill the oocysts over many days or even weeks, assuming no further contamination, the time lag is insufficient to adequately protect swimmers from infection.

- **Ct shock dosing – to inactivate *Cryptosporidium* oocysts**: Following notification of two or more cases of cryptosporidiosis that are linked in time to a public swimming pool, the pool should be Ct shock dosed to inactivate the *Cryptosporidium* oocysts. To achieve inactivation a pool should be shock dosed with a high concentration of chlorine over a long period of time to achieve a *Ct* (concentration x time) value of 15 300. (see section 4.3 for an explanation of Ct values).
  - A Ct value of 15 300 achieves a 4 Log (99.99%) reduction of oocysts. Examples are by dosing a pool with 10 mg/L of free available chlorine for 26 hours, 20 mg/L of free available chlorine for 13 hours, or 30 mg/L for 8½ hours (or other corresponding dose). A dose needs to be selected that will not adversely affect pool finishes, fittings and equipment while ensuring a suitably swift inactivation rate.
  - Chlorine dioxide may also be used to inactivate *Cryptosporidium* oocysts using a Ct value of 70 to inactivate 99.99% of oocysts (4 Log reduction). The circulation and filtration system must be operated during this time.
  - An oxidation-reduction potential (ORP) value of 865 mV for 30 minutes or 800 mV for 24 hours will also achieve a 4 Log (99.99%) reduction of *Cryptosporidium* oocysts.

- **Superchlorination:** Regular superchlorination should be practised as a maintenance procedure as it:
  - allows the pool to recover oxidation and disinfection while there is no contamination entering the pool
  - aids filtration, by clarifying and polishing of the pool water
  - destroys biofilms which may harbour pathogenic micro-organisms
  - inactivates *Cryptosporidium* oocysts.

Regular superchlorination should be performed when swimmers are not present (usually overnight) for an eight-hour period. Ideally superchlorination should be linked to the frequency of backwashing. Superchlorination usually requires approximately 6-8 mg/L (maximum 10 mg/L) of chlorine or ten times the combined chlorine concentration. A higher shock dose may be required for pools heavily polluted with chloramines and to remove biofilms.

8.6.2 Water sampling for *Cryptosporidium*

Water sampling for *Cryptosporidium* is not recommended unless a joint decision is made between the pool operator and NSW Health. Test methodologies are based on a 100 litre water sample and are very expensive. Testing only represents the status of the water at the time of sampling. Negative results may give a false sense of security and there is a long time delay before results are received. Also, the primary tests do not determine whether any oocysts detected are viable and able to cause infection.

CHAPTER 9

Pool designer and operator competencies

9.1 Overview

Modern swimming pools and their associated equipment are a complex and costly infrastructure investment. It is essential therefore that swimming pools be designed, commissioned, operated and maintained effectively and efficiently to ensure a long serviceable life.

Pool operators should be competent in all areas of water treatment and quality. They should also be competent with a range of matters like occupational health and safety, business operations, financial management, customer relations, and staff and recruitment procedures. For this reason all public swimming pool operators should undertake a course which includes all managerial and operational matters.

9.2 Pool designers

Swimming pool water treatment plants should be designed by experienced engineers / architects who are suitably qualified in the field of water treatment engineering, hydraulics or similar disciplines. Pool structures should be designed by suitably qualified and experienced structural engineers.

9.3 Operator competencies

Appendix 3 of Practice Note 15 (Water safety), issued by the Division of Local Government:
http://www.dlg.nsw.gov.au/dlg/dlghome/documents/PracticeNotes/Water_Safety_Oct_2005%20.pdf

lists the appropriate competencies for aquatic operations at the management level, the operations level and the supervisor level. Appendix 2 of the same document, for pre-defined water facility categories, lists areas of expertise, qualifications and professional development of staff.

9.4 Formal operator qualifications

Formal swimming pool operator qualifications are attained through the completion of units / modules of study delivered by Registered Training Organisations (RTOs) such as the NSW Department of Technical and Further Education (TAFE). RTOs and the units / modules of study must be recognised (accredited) by the Australian Skills Quality Authority. There are private RTOs that also offer accredited training courses. Operators should continually seek to develop their professionalism through attendance at appropriate conferences and short courses.

9.5 Pool safety qualifications

Pool safety courses are offered by The Royal Life Saving Society Australia (http://www.royallifesaving.com.au). It is also important to have a current Pool Lifeguard Certificate and a current approved First Aid Certificate. These requirements are mandatory for municipal pools (See Practice Note 15).

CHAPTER 10

Health risk management planning

10.1 Overview

Public pool managers depend on providing safe and comfortable facilities to their customers. Risk management is a tool which allows pool managers to minimise and even eliminate harmful situations at swimming facilities. This chapter develops a risk management framework which can be applied to public swimming pool management.

10.2 Public health risk

Risk is the likelihood of the occurrence of some adverse event, or in the case of public health, the risk of either disease transmission or the occurrence of some other health related event. For the purposes of public health risk analysis, disease transmission occurs when there is a source of disease or contamination, a transmission pathway or exposure route exists and there is a susceptible host (see Chapter 2, Section 2.3).

Contamination source + Transmission pathway + Susceptible host = Disease

For a public health risk to occur all three factors must be present. If just one of the factors is absent then disease transmission will not occur. Normally, risk management attempts to remove the transmission pathway through disinfection of pool water. For example, because of resistance to disinfection, *Cryptosporidium* needs to be controlled at the source. The only way to ensure susceptible hosts are protected is to exclude them from swimming in a public pool. This approach may be the only option for people who are highly susceptible to cryptosporidiosis.

10.2.1 Risk identification

Risk identification involves isolating and naming each type of hazard. It is appropriate to identify risk in the categories of source, transmission pathway and susceptible host. Each category may be divided into subcategories. A framework therefore starts to develop through the creation of the first column (Table 10.1).

Table 10.1: Risk identification column of the risk management framework

Identified risk
1. Contamination source - Identified risk - Identified risk - Identified risk - Identified risk
2. Transmission pathway - Identified risk - Identified risk
3. Susceptible host - Identified risk - Identified risk

10.2.2 Risk assessment / characterisation

Once a hazard has been identified, it is assessed as low, medium or high risk in two main ways:

- The likelihood or chance of the adverse public health event occurring;
- The magnitude of the adverse health event and the impact of its consequences.

A combination of the likelihood and impact can be used to determine priorities by using the risk priority table (Table 10.2). From left to right in the risk priority table headed *Likelihood,* the likelihood of an outbreak is assigned a value of high, medium or low. On the right column headed

Table 10.2: Risk priority table

Likelihood	Low	Medium	High	***Impact***
PRIORITY	MEDIUM	HIGH	HIGH	**High**
	LOW	MEDIUM	HIGH	**Medium**
	LOW	LOW	MEDIUM	**Low**

Increasing priority

Impact, the impact of an outbreak is assigned a value of high, medium or low. The two values are then used to select a corresponding priority box and its value of high, medium or low priority.

For example, the likelihood of an outbreak of cryptosporidiosis (the disease caused by *Cryptosporidium parvum*) may be medium because learn-to-swim classes for toddlers who are not toilet trained are held twice a week. The impact could be high as it could be debilitating for those who become ill, and devastating for the pool business for a few weeks when the community learns of the outbreak attributable to the pool. Therefore this risk can be assessed as:

- *Likelihood* – Medium
- *Impact* – High
- *Priority* – High

A second column can then be built into the framework based on the risk priority, known as risk assessment (Table 10.3).

Table 10.3: Risk assessment column of the risk management framework

Identified risk	Risk assessment
1. Contamination source	
1.1 People	
Identified risk	Likelihood – Impact – Priority =
1.2 External contamination	
Identified risk	Likelihood – Impact – Priority =
2. Transmission pathway	
Identified risks	
3. Susceptible host	
Identified risks	

10.2.3 Risk management plan

Risk management is the process of developing strategies, policies and procedures to lessen either the likelihood of the risk, the impact of the risk or both. Risk management adds the third column to the framework.

A rudimentary risk assessment / management framework has been commenced and is presented in a table format (Table 10.4) building on the two columns already developed.

The entries made in this table are simplified, incomplete and need to be further developed by pool management according to the specific attributes and administration of each public swimming pool or spa pool premises.

10.2.4 Implementation

A fourth column recording date of implementation (Date implemented) may be added to audit progress in the implementation of risk management strategies. Therefore the column headings become:

Table 10.5: Date implemented column of the risk management framework

Identified risk	Risk assessment	Management strategies	Date implemented

10.3 Dynamics of risk analysis

The risk analysis procedure is both externally and internally dynamic. The procedure is externally dynamic because risks and their characteristics will change over time and according to external forces and characteristics. A structured periodic review should be an essential component of the risk analysis.

The risk analysis procedure is also internally dynamic as the risk management strategies on one section may affect the strategies in another section. For example, the strategies in 1.1 iii) Bather load may be in conflict or enhance 2 iii) Disinfection.

Some tips for maintaining current health risk analysis procedures:

- When the first risk analysis framework is complete and independently confirmed, it should be signed by all pool management staff and accepted by the controlling organisation.
- The risk analysis should be reviewed annually.
- The risk analysis should be reviewed before corporate business planning and budgeting as the risk analysis may require planning and funding for particular risk management strategies.

Table 10.4: Management plan framework

Identified risk	Risk assessment	Management strategies
1. Contamination source		
1.1 Patrons		
i) General bather faecal pathogen load. Faecal pathogen load carried by bathers is always present	Likelihood – Medium Impact – Medium Priority = Medium	■ Develop techniques to decrease pathogen load into the premises ■ Encourage all bathers to enter the pool though the change room and ablutions facilities ■ Ensure ablutions facilities are private, convenient, comfortable and equipped with warm water and soap to encourage showering
ii) Bather pathogen load from skin infections. Infected skin may transmit micro-organisms to the pool, furnishings and directly to other bathers	Likelihood – Low Impact – Medium Priority = Low	■ Ensure all patrons pass through turnstiles and sufficient staff are available so that patrons can be scanned for obvious skin infections and lesions ■ Patrons with skin infections should be requested to refrain from swimming and to cover infections ■ Provide equipment which may be used to cover skin infections
iii) Bather load. Bather load may overwhelm circulation and disinfection capabilities	Likelihood – High in summer Impact – High Priority = High	■ Determine maximum instantaneous bather load as a function of pool depth and circulation rate ■ Develop protocols to ensure that bather load is not exceeded ■ Investigate ability to reduce turnover time during high bather loads
iv) Bather behaviour. Some behaviour such as spitting, spouting and nose blowing increases the pathogen load in the pool	Likelihood – High Impact – Medium	■ Discourage spitting, spouting and nose blowing or at least request patrons to use the scum gutter
v) Incontinent babies. Faecally incontinent babies are most likely to transmit disease	Likelihood – Impact – Priority =	■ Provide sufficient, conveniently located and well equipped baby change rooms ■ Prohibit the use of nappies and encourage the use of alternative catch all bathers ■ Prohibit pool side nappy changing ■ Provide suitable signage
vi) Crowd control. Unaware patrons may breach policy and procedures	Likelihood – Impact – Priority =	■ Employ sufficient staff to encourage compliance
vii) Bather ignorance. May lead to unhygienic practices	Likelihood – Impact – Priority =	■ Develop educational strategies ■ Use signs to encourage the most important hygienic practices e.g. Patrons are requested to shower before entering the pool
1.2 External contamination		
i) Windblown debris	L I P	■
ii) Bird contamination	L I P	■
iii) Litter	L I P	■
iv) Chemical control	L I P	■
2. Transmission pathway		■
i) Filtration	L I P	■
ii) Circulation	L I P	■
iii) Disinfection	L I P	■
iv) Raw water	L I P	■
v) Water temperature	L I P	■
vi) Emerging chlorine resistant diseases	L I P	■
vii) New disinfection techniques	L I P	■
viii) Faecal incidents	L I P	■
ix) Other incidents – blood spill	L I P	■
x) Pool surrounds – apron, grassed areas	L I P	■
xi) Stale water	L I P	■
3. Susceptible host		
i) Age profile	L I P	■
ii) Shock loads	L I P	■
iii) Immune deficiencies	L I P	■
iv) Behaviour	L I P	■
v) Comfort vs disinfection (mucous membrane attack)	L I P	■
vi) Personal equipment storage (towels)	L I P	■

10.4 Other plans

There are other plans, schedules and monitoring which could be incorporated into the health risk management framework. The other plans may include:

- Sanitation and cleaning schedules
- Maintenance schedules
- Pool sampling and monitoring
- Work Health and Safety plans.

10.5 Descriptive risk assessment and management of pools and spas

Appendix E provides an example of a descriptive risk assessment and management of pools and spas.

CHAPTER 11

Legislation

11.1 Overview

Public swimming pools and spa pools are controlled and regulated by the *Public Health Act 2010 and the Public Health Regulation 2012.* The legislation may be downloaded from the NSW Health website at: http://www.health.nsw.gov.au/environment/publicpools/Pages/default.aspx

This chapter provides an overview of the legislation.

11.2 The *Public Health Act 2010* (the Act)

The Act commenced on 1 September 2012. Some provisions do not commence until 1 March 2013. Control of public swimming pools and spa pools is contained in Part 3, Division 3, and sections 34 to 37.

Under the Act, a public swimming pool or spa pool is defined as means a swimming pool or spa pool to which the public is admitted, whether free of charge, on payment of a fee or otherwise, including:

(a) a pool to which the public is admitted as an entitlement of membership of a club, or
(b) a pool provided at a workplace for the use of employees, or
(c) a pool provided at a hotel, motel or guest house or at holiday units, or similar facility, for the use of guests, or
(d) a pool provided at a school or hospital,

but not including a pool situated at private residential premises.

The Act defines spa pool as including any structure (other than a swimming pool) that:

(a) holds more than 680 litres of water, and
(b) is used or intended to be used for human bathing, and
(c) has facilities for injecting jets of water or air into the water.

Under the Act, a swimming pool includes any structure that is used or intended to be used for human bathing, swimming or diving, and includes a water slide or other recreational aquatic structure.

Section 35 of the Act, which commences on 1 March 2013, requires occupiers of public swimming pools and spa pools to notify their local council of the existence of the pool and comply with the prescribed operating requirements, which are set out in schedule 1 of the Public Health Regulation (note that the prescribed operating requirements do not apply to natural swimming pools.

Section 36 of the Act requires the occupier of the public pool premises to disinfect the pool properly and keep the pool surrounds and amenities in a clean and hygienic condition. Compliance with Schedule 1 of the Regulation is a defence to prosecution under this section.

Section 37 requires the conspicuous display of any prohibition order which may be served on the occupier of the premises.

11.3 The *Public Health Regulation 2012*

Section 35 of the Public Health Act requires occupiers of public swimming pools and spa pools to comply with the prescribed operating requirements, which are set out in schedule 1 of the Public Health Regulation. Occupiers of natural swimming pools are exempt from this requirement. It is an offence not to comply with a prescribed operating requirement with a maximum penalty of 100 penalty units for an individual or 500 penalty units for a corporation for failure to comply.

The prescribed operating requirements sets out in schedule 1 of the Regulation is similar to the

Schedule 1 former NSW Health “Guidelines for the Disinfection of Swimming Pools and Spa Pools” known as the blue book.

If an occupier fails to comply with the prescribed operating requirements, an authorised officer can issue an improvement notice directing compliance with the prescribed operating requirement. If a prescribed operating requirement has not complied with a prescribed operating requirement, a prohibition order may also be issued if it is necessary to prevent or mitigate a serious risk to public health.

In addition, and the Regulation allows the Director-General (or delegate), by order in writing, to direct the occupier of the pool premises to close the pool if satisfied on reasonable grounds that the pool is a risk to public health. The order must state the reasons for closure and the occupier must comply with the order while it is in force and display the order at any entrance to the pool. The order can only be revoked in writing if the pool is no longer a risk to public health. The Director-General also has powers to direct an occupier of the pool to disinfect the pool or take other action if it is considered that the pool is a risk to public health.

Occupiers should be aware that from 1 March 2013 they will be required to notify the local council of the existence of the pool in the approved form and pay the prescribed fee.

From 1 March 2013, local councils will be required to maintain a register of the details of swimming pools and spa pools notified in its area.

11.4 Schedule 1 of the Regulation

Schedule 1 contains the necessary chemical parameters which must be followed to prevent risk to public health in a public pool. Additionally Schedule 1 specifies the frequency of testing and the keeping of records of testing. The contents of Schedule 1 are evidence based and the chemical parameters are based on the contents of this advisory document which have in turn been derived over many years. The chemical parameters conform with international requirements and recommendations of the World Health Organisation (WHO – Geneva), Centres for Disease Control (CDC – Atlanta, Georgia, USA), and the Pool Water Treatment Advisory Group (PWTAG – England).

Compliance with the requirements set out in schedule 1 is also a defence for prosecution under section 36 of the Act.

11.5 Enforcement of the Act and Regulation

Under the *Public Health Act 2010* and *Public Health Regulation 2012* there is a larger range of enforcement options. Of course the preferred option is the health education approach where swimming pool operators act in cooperation with Authorised Officers and consultants to produce pool water with absence of health risk.

However, where this does not occur there are a number of enforcement measures which range through:

- Warning letters
- On-the spot-fines (PINS)
- Improvement Notices
- Prohibition Orders, and
- Prosecution

The *Public Health Act 2010* and *Public Health Regulation 2012* should be consulted directly to determine these measures, the penalties and right of appeal.

Breakpoint chlorination (see section 4.4.1)

1. Combined chlorine and chloramines

Chloramines are probably the largest component of combined chlorine. Combined chlorine lowers disinfection rates, causes severe eye stinging and strong odours. Breakpoint chlorination is one technique to control combined chlorine, particularly inorganic chloramines.

Combined chlorine, commonly known as chloramines, forms when the hypochlorous acid component of free chlorine reacts with certain ammonia and organic nitrogen compounds. Ammonia and organic nitrogen compounds are introduced into a swimming pool or spa by components such as perspiration, urine, dust, dirt, leaves, cosmetics and incoming water supply. Perspiration and urine contain urea, some of which decomposes to form ammonia (NH_3). The amount of urine being excreted into a pool should be reduced as much as possible, as it is the most significant source of ammonia. High nitrogen levels, particularly in outdoor pools, are a precursor to unsightly and slippery algal growth and can support the growth of other micro-organisms.

The basic chemistry of chlorine and chloramines is outlined in section 4.4.1. In summary, ammonia (NH_3) can bond to a varying number of chlorines: monochloramine has one chlorine atom; dichloramine has two chlorine atoms; and trichloramine has three chlorine atoms. Each chloramine behaves slightly differently.

If the ratio of the weight of chlorine to ammonia is less than 5:1 and the pH is greater than 7.5

($HOCl + NH_3 \rightarrow H_2O + NH_2Cl$)

monochloramine is formed. Monochloramine is stable, unaffected by sunlight, not particularly odorous and is not very volatile. It has a low disinfection capacity.

If the ratio of the weight of chlorine to ammonia is greater than 10:1 and pH decreases below 7.5

($HOCl + NH_2Cl \rightarrow H_2O + NHCl_2$)

dichloramine is formed. Dichloramine is less stable, is more volatile being released on aeration by bathers, is almost unaffected by sunlight, and is odorous and offensive.

If the ratio of the weight of chlorine to ammonia is greater than 15:1 and pH is less than 7.4

($HOCl + NHCl_2 \rightarrow H_2O + NCl_3$)

trichloramine is formed. Trichloramine is unstable, breaks down in sunlight, has a nauseous and offensive odour and is very volatile being readily given off on aeration. It is particularly associated with severe eye stinging. Trichloramine is less a problem in outdoor pools but can be a major problem in poorly ventilated, indoor pools where it is released by bather agitation of the pool.

However, in an excess of free chlorine and a pH of 7.5 or higher and if the ratio of the weight of chlorine to ammonia is between 10:1 to 12:1, dichloramine is more likely to decompose to nitrogen gas (N_2) or nitrous oxide gas (NO) or nitrate (NO_3) and not produce trichloramine. These reactions can be competing depending on the pH and the excess of free chlorine available. An ideal pH based on chloramine destruction chemistry is 7.5.

When water supplies are chlorinated, ammonia is often added to form monochloramine to prolong disinfection throughout the reticulated water mains and reduce the growth of biofilms. This often increases the difficulty for pool operators who have to reduce the monochloramine in the water supply in the first instance before reaching breakpoint chlorination. Ideally, there should not be chloramines in a swimming pool, although some organic chloramines are unavoidable.

In best practice, an automatically controlled pool should never exceed 0.2 mg/L combined chlorine and the criteria limit of 0.5 mg/L chloramines should be set. Operators of older pools with non-compliant turnover rates will struggle to achieve a limit of 0.5 mg/L combined chlorine and should set an absolute upper limit of 1.0 mg/L combined chlorine. It may be necessary to install equipment such as ultraviolet (UV) light treatment to control combined chlorine in poorly performing indoor pools. A swimming pool consultant should be engaged for professional advice.

A constant and strong chlorine odour indicates a poorly operated pool. The smell is a result of di or trichloramine. If it is trichloramine, then patrons will also experience severe eye stinging.

Combined chlorine can be reduced in the following ways:

- A large proportion of combined chlorine comes from urine. Urine in a pool can be minimised by requiring people to walk through a change room and toilet area before entering the main concourse and by adequate signage directing people to go to the toilet before going to the pool area.
- Continuous or shock breakpoint chlorination is another technique to reduce chloramines.
- Chloramines can be reduced by continuously dumping pool water and diluting with fresh water that is lower in chloramines. However, water dumping is hard to justify in terms of water conservation practice. Where mains water is dosed with monochloramine to prolong disinfection in the water supply distribution system it will not dilute pool chloramines. Collecting and storing rainwater for dilution of total dissolved solids is becoming more popular.
- Ozone and UV light treatment is being increasingly used to reduce chloramines, particularly organic chloramines that are difficult to oxidise. Such treatment may require capital investment.
- Filtration enhancers are not necessarily helpful in removing chloramines, but they are helpful in reducing organic matter that could release nutrients and inorganic nitrogen into the pool water.
- Oxidisers, such as hydrogen peroxide and potassium monopersulphate, are helpful in oxidising or burning up organic material and removing chloramines. Firstly, oxidisers reduce the demand on free chlorine to oxidise pollutants. Secondly, oxidisers allow free chlorine to act more rapidly at a lower pH level and at a higher concentration. An occasional preventive shock dose of an oxidiser helps to lower chloramines and restore clarity and sparkle to the pool. The use of some oxidisers, particularly sodium monopersulphate, will lead to falsely elevated total and combined chlorine measurements.

2. Continual breakpoint chlorination theory

The following graph demonstrates the theory of breakpoint chlorination. On the left vertical axis is the chlorine concentration in mg/L which is zero at the bottom of the axis and increases with height. On the right vertical axis is the ammonia-nitrogen (i.e. ammonia measured as nitrogen) concentration also in mg/L which is zero at the bottom of the axis and increases with height. The bottom horizontal axis represents the ratio of chlorine (Cl_2) to ammonia (NH_3) by weight which is zero on the left and increases to the right. The bottom horizontal axis also represents time and increases from left to right. There are three inter-related lines on the graph:

- N CONC: (sigma ammonia-nitrogen concentration) represents the concentration of the sum of all forms of ammonia-nitrogen in the pool.
- Total Chlorine Applied: the constant dose of chlorine being introduced into the pool.
- Measured Chlorine Residual: the measured total chlorine residual in the pool.

The breakpoint curve is a graphical representation of chemical relationship that exists with constant addition of chlorine to swimming pool water containing a small amount of ammonia-nitrogen. This graph represents a swimming pool where bathing has ceased and no further ammonia-nitrogen is introduced into the pool. During an overnight period sodium hypochlorite is added at a constant rate. This curve has three zones.

Zone 1: Staring from the left side of the graph; there is already a concentration of ammonia-nitrogen (N CONC) in the pool from bathers. Chlorine has been allowed to fall to zero and Total Applied Chlorine and Measured Chlorine Residual are both zero. Chlorine is then added at a constant rate. The principal reaction in Zone 1 is the reaction between chlorine and the ammonium ion. This reaction results in a Measured Total Chlorine of only monochloramine to the hump in the curve. The hump occurs, theoretically, at chlorine to ammonia-nitrogen weight ratio of 5:1. This ratio indicates the point where the reacting chlorine and ammonia-nitrogen molecules are present in solution in equal numbers. Monochloramine does not readily degrade.

Zone 2: The breakpoint phenomenon occurs in this zone which is also known as the chloramine destruction zone.

As the weight ratio exceeds 5:1, some of the monochloramine starts reacting with further addition of chlorine to form dichloramine, which is about twice as germicidal as monochloramine. A pure dichloramine residual has a noticeable disagreeable taste and odour, while monochloramine does not. Total Chlorine Applied is still increasing and both the Concentration of ammonia-nitrogen and Measured Chlorine Residual decrease rapidly. This rapid decrease occurs because the dichloramine is reacting immediately with additional hypochlorous acid in a series of destruction reactions to form volatile compounds and other by-products such as nitrogen gas, nitrate and chloride. Therefore, ammonia and chlorine are consumed in the reactions and lost from the pool. Thus, additional chlorine is required to destroy ammonia and chloramines.

The breakpoint (Point A) is the point of the lowest concentration of Measured Chlorine Residual where nuisance chlorine residuals remain and where ammonia-nitrogen is not detected. The nuisance chlorine residuals are mainly organic chloramines which cannot be oxidised any further by reacting with hypochlorous acid.

Zone 3 is to the right of the breakpoint (Point A) and is where a free chlorine residual will appear. The total residual consists of the nuisance residuals plus free chlorine. If trichloramine is formed, it will appear in this zone. In practice it has been found the most pleasant water for bathing will occur if more than 85% of the total chlorine is free chlorine.

In reality, ammonia-nitrogen does not stay static but is continually added while the pool is open to the public. **To achieve breakpoint chlorination, chlorination must continue after the pool has been closed to the public to ensure oxidation of the additional chloramines every night.**

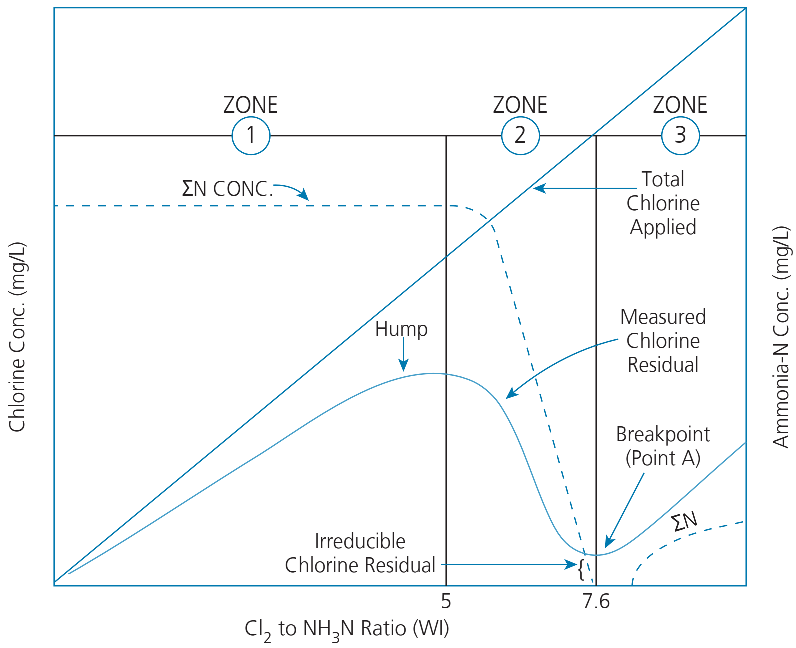
The shape of the breakpoint curve is affected by contact time, temperature, concentration of chlorine and ammonia, and pH. Higher concentrations of the chemicals increase the speed of the reactions.

3. Shock breakpoint chlorination

Shock breakpoint chlorination involves oxidising combined chlorine with a slug or shock dose of chlorine to generate sufficient free chlorine which is at least ten times the concentration of the combined chlorine.

It is preferable to operate the pool at a pH between 7.5 and 7.6 to reduce the likelihood of trichloramine formation.

- Adding any less chlorine than calculated will not achieve breakpoint.
- Adding insufficient chlorine will not eliminate combined chlorine and could worsen the situation.
- In indoor pools it is critical to have good ventilation when reaching breakpoint. Some chloramines can evaporate and then re-dissolve in the water and if a pool blanket is used none of the volatile reaction by-products can evaporate.



Example of shock breakpoint chlorination

At the start of the weekend, the Saturday morning testing of a 200 000-litre indoor swimming pool revealed total chlorine of 2.3 mg/L and a free chlorine concentration of 1.8 mg/L giving a barely acceptable combined chlorine reading of 0.5 mg/L.

After a heavy weekend of bathing, testing on Sunday night revealed total chlorine of 2.3 mg/L and free chlorine of 0.5 mg/L giving an unacceptable combined chlorine concentration of 1.8 mg/L. The pH was 7.4. In order to prepare for a swimming school class on Monday, it was decided to shock breakpoint chlorinate overnight to reduce the chloramines to an acceptable level.

The general rule is to shock dose free chlorine to 10 times the chloramine concentration. In this case, 10 times the chloramine concentration equates to 18.0 mg/L of free chlorine. In order to do this, the pool was closed to bathers. A calculation was made to add 36 L of sodium hypochlorite (liquid chlorine) by broadcasting using a plastic (not metal as metal may react adversely with the chlorine) watering bucket around the edges of the pool. The pool circulation system (but not the dosing system) was run all night. Because, at a pH of 7.4, trichloramine may be formed, an aerator was inserted into the pool to release the volatile chloramines and the windows and doors were all opened to maximum. By the next morning, the chloramines were 0.2 mg/L although the free chlorine was elevated to 5.0 mg/L giving oxidation capacity for the swimming class due that morning.

The ideal way to minimise the formation of trichloramine is to ensure that free chlorine is more than 85% of total chlorine at all times. In addition, some oxidiser such as hydrogen peroxide can be added that leaves no residual and boosts the performance of free chlorine without over adding chlorine.

The benefits of shock breakpoint chlorination are that it:

- Allows disinfection to rapidly catch up
- Eliminates chloramines
- Controls *Cryptosporidium* more effectively
- Controls biofilms
- Provides extra oxidation
- Aids filtration
- Aids clarification.

Performing shock breakpoint too frequently and at too high of a free chlorine concentration could affect pool materials and finishes and it is preferable to operate using continuous breakpoint chlorination.

Sample log sheet

(See Chapter 5, section 5.10.) This sheet should be modified to suit the type of pool.

Appendix B - Sample Log Sheet

(see Chapter 5, section 5.10) This sheet should be modified to suit the type of pool

<Insert Name of Centre> <Insert Name of Pool> Date ______________

Pool water testing

			<Insert POR range for this pool>	< Insert POR range for this pool>	Break point 0.0 mg/L at the first test of the day	pH range 7.0-7.8	Total alkalinity range 80-200 mg/L	Calcium hardness mg/L	Incidents / Corrective actions taken	Name of tester	Signature of tester
Time testing due	Time testing conducted	Temp °C	ORP mV or Free chlorine mg/L DPD tablets No.1(F)	Total chlorine mg/L DPD tablets Nos.1+3 (T)	Combined chlorine mg/L Total-Free (T) - (F)	pH	Total alkalinity	Calcium hardness			
6 am											
9 am											
12pm											
3 pm											
6pm											
9pm											
Daily average											

Combined chlorine must not exceed 1.0 mg/L and should not be more than half of free chlorine

Cyanurate acid concentration (weekly measurement) ____________ Date __________

Water Balance

Using the water balance chart on reverse, calculate the Langelier Saturation Index (LSI). The ideal LSI is 0.2 and the range is –0.5 to 0.5.

LSI = pH + TF + CF + AF - 12.1
where:
TF = Temperature factor
CF = Calcium Hardness factor
AF = Alkalinity Factor

___ (pH) + ___ (TF) + ___ (CF) + ___ (AF) - 12.1 = ___ (LSI)

Calculated by (initial) ________________________

Daily Maintenance Log

Detail what was undertaken and at what time of the day.

Maintenance area	Maintenance undertaken	Time of maintenance	Signature

Review by manager

Data and corrective action to be reviewed by facility manager daily

Further action required or taken or other comments	Name of Manager	Signature of manager	Date

Water balance chart

Temperature (C°)	Temperature Factor	Calcium (hardness)	Calcium hardness factor	Total alkalinity	Alkalinity factor
0	0.0	5	0.3	5	0.7
3	0.1	25	1.0	25	1.4
8	0.2	50	1.3	50	1.7
12	0.3	75	1.5	75	1.9
16	0.4	100	1.6	100	2.0
19	0.5	150	1.8	150	2.2
24	0.6	200	1.9	200	2.3
29	0.7	300	2.1	300	2.5
34	0.8	400	2.2	400	2.6
40	0.9	800	2.5	800	2.9
53	1.0	1000	2.6	1000	3.0

Notes for modifying this log sheet for your pool:

- This log sheet is available electronically from the Department's web site: www.health.nsw.gov.au
- Use a separate sheet for each pool for each day.
- Print on different coloured paper for each pool.
- *Change the Health Prescribed Operating Requirements (POR)* levels so they are appropriate for the type of pool. This depends on if the pool is indoor or outdoor, the temperature and the type of disinfection used. See the *Public Health Regulation 2012, Schedule 1*
- If used for a bromine disinfected pool the breakpoint is really important and DPD1 measures bromine.
- If used for an ozone pool, insert a space to record when a check is done and the results.
- If an automatic controller is used, and the results are input, then there needs to be a place to enter a manual reading to compare with the automatic reading.

APPENDIX C

Components to consider in recycling swimming pool backwash water

(See Chapter 6, section 6.5.2)

(Developed for use with Australian Guidelines for Water Recycling: Managing Health and Environmental Risk (Phase 1) 2006)[40]

Framework element	Activity
Element 1: Commitment to responsible use and management of recycled water quality **Components:** ■ Recycled water policy ■ Regulatory and formal requirements ■ Engaging stakeholder	**Regulatory framework – compliance** **Water Quality Guidelines:** ■ NSW Health. Public Swimming Pool and Spa Pool Guidelines[45] ■ Australian Drinking Water Guidelines[39] **Health Risk Assessment Guidelines:** ■ Australian Guidelines for Water Recycling: Managing Health and Environmental Risk (Phase 1), 2006[40] **Develop a recycled water policy**
Element 2: Assessment of the recycled water system **Components**: ■ Identify intended uses and source of recycled water ■ Recycled water system analysis	**Source of water** ■ Backwash from swimming pool(s) **Treatment** ■ Reverse osmosis ■ Ultrafine filtration (UFF) and/or granular activated carbon (GAC) may be recommended **Intended uses** ■ Recreational swimming ■ Hydrotherapy (possibly immunocompromised clients) ■ Learn to swim (infants not toilet trained) **Exposure routes** ■ Ingestion (100 mL) – more for infants ■ Dermal: disinfection by-product (DBP) – trihalomethanes (THM) ■ Inhalation: DBP – THM **Assessment of water quality data** ■ Turbidity, pH ■ Microbial quality ■ Chemical quality (DBP-THMs) ■ Water quality indicators: total dissolved solids (TDS) /conductivity
Component: ■ Hazard identification and risk assessment	**Treated backwash water to be tested prior to reuse** ■ Microbial hazards ■ Chemical hazards ■ Hazards from failures ■ Control to prevent failures
Element 3: *Preventive measures for recycled water management* **Components:** ■ Preventive measures and multiple barriers ■ Critical control points	**Preventive measures** ■ Control of bather hygiene, showers prior to pool entry ■ Treatment: best available technology (RO, UFF, GAC, ultraviolet [UV]) ■ Validation of treatment system ■ Pipework purple with reuse caution and signage (may be needed) ■ Documentation of responsibilities, operational procedures ■ Backflow and cross connection prevention ■ Controls – monitoring, shutdown upon failure **Communication** ■ Recycled water should be tested prior to reuse, otherwise alternative clean water source should be used ■ Failures should be communicated and reported ■ Education program for operational staff ■ Validation prior to commissioning to ensure that recycled water complies with the standards for drinking water ■ On-line monitoring of pool water for TDS, free chlorine and/or oxidation-reduction potential (ORP) ■ Determine critical control points
Element 4: *Operational procedures and process control*	**Documented procedures** ■ Operational monitoring (auditing of critical limits for TDS/conductivity) ■ A contingency plan should be developed to effectively deal with pool contamination events ■ Corrective active

Framework element	Activity
Element 5: *Verification of recycled water quality and environmental sustainability*	**Water quality monitoring (turbidity, TDS, DBP, microbial)** ■ Receiving water monitoring – swimming pool water ■ Documentation and reliability ■ Annual reporting of water quality monitoring results to Public Health Unit (PHU) ■ Short-term evaluation of results ■ Corrective action
Element 6: *Management of incidents and emergencies*	■ Potential public health problems should be reported to PHU ■ Non-compliance with approval conditions to be reported immediately to PHU ■ Incident and emergency response protocol
Element 7: *Operator, contractor and end user awareness and training*	■ Skilled and trained operator
Element 8: *Community involvement and awareness*	■ Community consultation and education
Element 9: *Validation, research and development*	■ Validation of processes ■ Design of equipment ■ Investigative studies and research monitoring
Element 10: *Documentation and reporting*	■ Management of documentation and records ■ Reporting
Element 11: *Evaluation and audit*	■ Long term evaluation of results ■ Audit of recycled water quality management
Element 12: *Review and continual improvement*	■ Review by senior management ■ Recycled water quality management improvement plan

* For irrigation reuse applications refer to the Department of Environment and Climate Change Environmental Guidelines *Use of Effluent by Irrigation*

Components to consider in water harvesting

(See Chapter 6, Section 6.6.) (Developed for use with *Australian Guidelines for Water Recycling: Managing Health and Environmental Risk (Phase 1),* 2006) [40]

Framework element	Activity
Element 1: *Commitment to responsible use and management of rainwater to top-up swimming pools* **Components:** Rainwater use policy Regulatory and formal requirements Engaging stakeholders	Regulatory framework – compliance **Water Quality Guidelines:** ■ NSW Health. Public Swimming Pool and Spa Pool Guidelines[46] **Heath risk assessment guidelines:** ■ Australian Guidelines for Water Recycling: Managing Health and Environmental Risk (Phase 1), 2006[40] ■ EnHealth. Guidance on use of rainwater tanks. May 2004[42] ■ Develop a rainwater use policy
Element 2: *Assessment of the water system* **Components:** Identify intended uses	**Source of water** ■ Rainwater tank **Treatment** ■ First flush system ■ UFF filtration or other pre-treatment ■ Disinfection: ultraviolet (UV) ■ Introduced into the pool plant and not directly into the pool **Intended uses** ■ Recreational swimming **Exposure routes** ■ Ingestion (100 mL) – more for infants ■ Dermal: disinfection by-product (DBP) – trihalomethanes (THM) ■ Inhalation: DBP - THM **Assessment of water quality data** ■ Microbial quality ■ Chemical quality (heavy metals) pH, total dissolved solids (TDS), turbidity **Water Quality Indicators** ■ Turbidity (NTU), TDS ■ Oils and grease ■ Salts (coastal locations) ■ Heavy metals (lead, copper) ■ Microbiological indicators
Component: Hazard identification and risk assessment	**Rainwater to be validated prior to use** ■ Microbial hazards ■ Chemical hazards ■ Hazards from failures
Element 3: *Preventive measures for recycled water management* **Components:** Preventive measures and multiple barriers Critical control points	■ Prevention – roofing materials, flashing (not lead) ■ Treatment – best available technology (first flush system) ■ Validation of treatment system ■ Documentation of responsibilities, operational procedures ■ Controls – monitoring, shutdown **Multiple barriers/prevention/communication** ■ Rainwater water should be tested prior to use. ■ Failures should be communicated and reported to the Public Health Unit (PHU) ■ A contingency plan should be developed to effectively deal with rainwater contamination events. ■ Education program for operational staff ■ Validation prior to commissioning to ensure that rainwater complies with the Australian Drinking Water Guidelines in relation to e.g. turbidity, TDS, oils and grease, heavy metals, and microbial indicators. ■ On-line monitoring of pool water for TDS, turbidity, free chlorine and oxidation-reduction potential (ORP) (may be required) ■ Determine critical control points
Element 4: *Operational procedures and process control*	**Documented procedures** ■ Operational monitoring ■ Develop a contingency plan for contamination events ■ Corrective advice

Framework element	Activity
Element 5: *Verification of rainwater quality*	■ Water quality monitoring ■ Receiving water monitoring ■ Documentation and reliability ■ User satisfaction ■ Short-term evaluation of results ■ Corrective action
Element 6: *Management of incidents and emergencies*	■ Communication ■ Incident and emergency response protocol
Element 7: *Equipment capability and maintenance*	■ Operator, contractor and end user awareness and training
Element 8: *Community involvement and awareness*	■ Community consultation and education
Element 9: *Validation, research and development*	■ Validation of processes ■ Design of equipment ■ Investigative studies and research monitoring
Element 10: *Documentation and reporting*	■ Management of documentation and records ■ Reporting
Element 11: *Evaluation and audit*	■ Long term evaluation of results ■ Audit of rainwater - water quality management
Element 12: *Review and continual improvement*	■ Review by senior management ■ Continual improvement

APPENDIX E

Descriptive risk assessment and management of pools and spas

(See section 10.5)

Hazards **Illnesses that may be transmitted in swimming pools and spa pools from pathogenic micro-organisms e.g. bacteria, viruses, and protozoa**	
Risk factors/issues	**Risk management**
Inadequate disinfection High risk: non-automated chlorination, high pH, high turbidity, high organic load, high combined chlorine, high cyanuric acid	*Education* Ongoing education of pool operators Pool policy to recommend showering *Regulation* Disinfection safeguards (compliance checks/closure of pools when they present a serious public health risk) Frequently testing of pools and verification by analysis of Heterotrophic Plate Count, Thermotolerant coliforms (or *Escherichia coli)* and *Pseudomonas aeruginosa* Training and certification of pool operators (nationally standardised)
Infectious accident High risk: toddlers pools, hydrotherapy pools and where loose faecal accidents occur	*Education* To inform the community about the risks of faecal accidents and the ways to avoid contaminating a pool People with a diarrhoeal illness or for a two week period following a diarrhoea illness should not use a swimming pool or a spa pool Bowel incontinent adults should avoid using a swimming pool or spa pool Babies and children that are not toilet trained should wear waterproof pants Recommend showering with soap prior to bathing Parents should encourage children to use a toilet regularly *Regulation* Decontamination safeguards to reduce risks by ensuring a prompt response to a potentially infectious incident. Pool closures may be warranted where a pool presents a serious public health risk Spa pools and other small pools should be emptied and cleaned following an infectious accident Separate filtration system for toddlers' pools and hydrotherapy pools. Pool supervisors need to be trained and certified to ensure that they know how to deal with a faecal accident
High bather load/bather shedding High risk: spa pools. (High bather load correlates with low levels of free chlorine)	*Education* To inform the community about the risks associated with high bather loads / bather shedding *Regulation* Restrict bather numbers, especially in spa pools Ensure adequate filtration and backwashing to remove pollutants Frequent draining and cleaning of spa pools (dependent on water restrictions) Ensure adequate disinfection and that cyanuric acid is not too high
Pollution from bathers and the environment Bathers: lotions, dirt, bubble bath, sweat, skin and hair Environment: vegetation, insects, birds, animal hair, dust	*Education* Recommend showering before entering a pool Inform the community about the risk of pollution from bathers and the environment *Regulation* Prevent the entry of polluted material into a pool Ensure the provision of easy access toilets and showers (with soap) Adequate filtration and disinfection Dilution of pool water with fresh water
Microbiological failure High risk: stagnant, turbid pools Poor disinfection Poor pool filtration	*Education* Pool operators *Regulation* Ensure that new pools are designed appropriately Ensure disinfection levels are adequate Ensure efficient pool turnover and filtration Recommend that pool operators are trained in pool maintenance Closure of pool until problem is rectified
Ingestion of water High risk: head emersion, wave pools, water slides	*Education* Educate parents and young children that pool water may contain pathogens and that it should not be swallowed
Length of exposure High risk: spas with *P. aeruginosa*; heat stress	*Education* Risk associated with length of exposure *Regulation* To ensure that the presence of *P. aeruginosa* is regularly monitored To prevent high temperatures.

Hazards Illnesses that may be transmitted in swimming pools and spa pools from pathogenic micro-organisms e.g. bacteria, viruses, and protozoa	
Risk factors/issues	**Risk management**
Open wound or infection High risk: infectious material (e.g. blood, pus)	*Education* To inform the community about the risk to others and self from entering a pool with an open wound. *Regulation* To prevent people with open wounds or infections from entering a public pool
Turbidity High risk: poor pool filtration	*Education* To ensure that pool operators properly maintain their pool(s) *Regulation* Compliance checks and appropriate upgrading of pool filtration equipment if required
Outbreaks of infectious diseases Poorly maintained pools Faecal accidents Use of pools by infectious people	*Education* Inform the community about the outbreak, symptoms of the illness, treatment, and if necessary precautions to prevent further spread *Regulation* Close the pool and require appropriate safeguards to prevent further infection e.g. shock dosing / flocculation and coagulation
Pool malfunction	*Regulation* On pool commissioning or pool upgrade appropriate microbiological and dye testing should be undertaken to confirm microbiological safe conditions and adequate pool circulation (and absence of dead spots)
Poor compliance of disinfection and microbiological criteria	*Education* Publication/distribution of compliance studies/results *Regulation* Development of an Environmental Health Management System to better monitor and control compliance problems

Glossary / Abbreviations

Term	Definition
Acidic	Solution with a pH between 0 and 7 (see pH)
Alkaline (basic)	Solution with a pH between 7 and 14 (see pH)
Alkalinity	Alkalinity is the acid neutralising capacity of water
Amperometric	Measurement of a chemical concentration using an electrical current (amperes)
APHA	American Public Health Association
APVMA	Australian Pesticides and Veterinary Medicines Authority
AS/NZS	Australian Standard / New Zealand Standard
Active chlorine	Free chlorine that is within the acceptable pH range of 7.2-7.6
Backwash	The process of cleaning a pool filter by reversing water flow
Bather load	The number of bathers per pool area
BCDMH	Bromo-chloro-dimethylhydantoin: the most common bromine-based swimming pool disinfectant
Biofilm	A complex of micro-organisms held in a slime layer of polysaccharides often covering the inner surface of pipes
Breakpoint chlorination	The process of maintaining sufficient free available chlorine in the pool water to chemically convert chloramines and ammonia-nitrogen compounds to inert nitrogen gas. Theoretically where total chlorine equals free available chlorine and combined chlorine is zero
CFU	Colony forming units: a unit expressing the number of counted bacterial colonies grown on a plate
Chloramines	Compounds formed from reaction of chlorine with amine groups (ammonia)
Chlorine	Chlorine gas is Cl_2 which when dissolved in water forms hypochlorous acid and the hypochlorite ion
Chlorination	The application of chlorine to water for disinfection
Clarity	Clearness or lack of cloudiness in water; indicated by the distance through the water at which an object can be seen
Coagulation	The process of particles clumping together to form a mass with the aid of a flocculent material
Coliforms	A group of bacteria normally present in the colon of warm blooded animals
Colorimetric	A chemical determination method involving a colour change in the substrate detectable by the eye
Combined chlorine	Chlorine that has combined with ammonia, ammonium compounds or organic matter. Chloramines are a major component of combined chlorine
Cryptosporidiosis	A gastrointestinal illness caused by the protozoan parasite *Cryptosporidium parvum*
Ct	A measure of the concentration (C) of disinfectant multiplied by its contact time (t) to produce a measured inactivation rate of a particular micro-organism
Disinfectant	Also called sanitiser or biocide. A compound or substance used for disinfection
Disinfection	Also called sanitising. A process intended to inactivate, kill or remove the vegetative cells of pathogenic (disease causing) micro-organisms, by direct exposure to chemical or physical agents. Disinfection does not necessarily inactivate spores and other resistant structures such as oocysts
DBP	Disinfection by-product
DPD method	The N,N-diethyl-p-phyenylene diamine method of measuring free available chlorine and total chlorine concentrations or equivalent bromine concentrations in swimming pool or spa pool water
Epidemiology	The study of the distribution and determinants of health-related states or events in specified populations, and the application of the study to the control of health problems
Faecal-oral route of transmission	Spread of a communicable (infectious) disease through the ingestion of faecally-contaminated material
Filter	A device or material for removing suspended particles from swimming pool or spa pool water fitted to the circulation system
Free bromine	Also known as free available bromine. The sum of hypobromus acid and hypobromite ion. When measured using the DPD tablet No. 1 method monobromamine is included in the measurement
Free chlorine	Also known as free available chlorine"or free residual chlorine. The sum of the concentrations of hypochlorous acid and hypochlorite ion. Measured by using DPD tablet No. 1

Term	Definition
FC	Faecal coliforms are facultatively-anaerobic, rod-shaped, gram negative, non-sporulating, bacteria. They are capable of growth in the presence of bile salts or similar surface agents, oxidase negative, and produce acid and gas from lactose within 48 hours at 44 ± 0.5°C. The faecal coliform assay should only be used to assess the presence of faecal matter in situations where faecal coliforms of non-faecal origin are not commonly encountered
FS	Faecal streptococci present in human and animal intestines, but also in the stomach. Many species of strepotcoccus are pathogenic. They cause diseases such as bacterial pneumonia, ear infection and bacterial meningitis.
h	Hour
Halogen	Chemicals in the halogen group of the periodic table, including fluorine, chlorine, bromine and iodine
Hazard	The capacity of an agent to produce a particular type of adverse health or environmental effect; or a set of circumstances that could lead to harm
Hazard identification	The identification, from animal and human studies, in vitro studies and structure-activity relationships, of adverse health effects associated with exposure to an agent
Host	A person or other living animal or plant that harbours or nourishes another organism (parasite)
HPC	The heterotrophic plate count, formerly known as the standard plate count, is a procedure for estimating the number of live heterotrophic (an organism that cannot synthesise its own food and is dependent on complex organic substances for nutrition) bacteria in water
Health risk assessment	The process of estimating the potential impact of a chemical, biological, physical or social agent on a specified human population system under a specific set of conditions and for a certain timeframe
Health risk management	The process of evaluating alternative actions, selecting options and implementing them in response to health risk assessments. The decision making will incorporate scientific, technological, social, economic and political information. The process requires value judgements, e.g. on the tolerability and reasonableness of costs
Indicator	Any parameter used to produce a specific measure of the quality of water
Make-up-water	Water used to replace lost swimming pool or spa pool water
mg	milligram; one thousandth of a gram (10^{-3}g)
mg/L	milligram per litre (roughly equivalent to ppm: parts per million)
micron	Micrometre: one millionth of a meter (10^{-6}m) (µm)
micro-organism	Any organism too small to be seen by the naked eye
mL	millilitre; one thousandth of a litre (10^{-3}L)
Oocyst	Encapsulated eggs that are the infective form of a parasite
Operator / occupier	That person who has control and management of the swimming pool and/or spa pool.
ORP	Oxidation-reduction potential; also known as Redox
Outbreak	Two or more cases of a communicable (infectious) disease related in the same place and time and with a common exposure; cluster has a similar meaning but usually refers to smaller numbers
Pa	*Pseudomonas aeruginosa*: a Gram-negative, aerobic, rod-shaped bacterium. It is an opportunistic human pathogen (does not normally cause disease at a particular site but may cause a disease as a result of a compromised immune system)
Parasite	An organism that uses the body of another organism to support its growth and reproduction
Pathogen	An organism capable of causing disease symptoms in another organism
pH	A scale (ranging from 0 to 14) which measures the inverse logarithmic concentration of the H^+ ion in water that indicates the acid or alkali condition of the water. pH 7 is neutral
Photometric	A chemical determination method involving a colour change intensity in the substrate detectable a beam of light set at a particular wavelength
Pool turnover	see turnover rate
Pool inlet	The point where treated water is returned to the pool
Pool outlet	The point where pool water flows from the pool to the circulation and treatment systems
PWTAG	Pool Water Treatment Advisory Group (England)
Recycle	Recycle means to use some material or matter again after suitable treatment
Reuse	Reuse is to use some material or matter again without treatment
Risk	The probability that, in a certain time frame, an adverse outcome will occur in a person etc that is exposed to a particular dose or concentration of a hazardous agent, i.e. it depends on both the level of toxicity of the agent and the level of exposure
Shock dose	The addition of pool chemicals to pool or spa water to achieve concentrations of at least 10 mg/L of chlorine for the destruction of combined chlorine, micro-organisms, and other impurities
Skimmer gutter	A drainage system provided to collect surface water flow from the swimming pool or spa pool and return it to the treatment plant or to waste

Term	Definition
Skimmer weir	A device provided to ensure that swimming pool or spa pool water is drawn from the surface for return to the treatment plant or to waste
Spa pool	A pool or other water-retaining structure designed for human use (but not for swimming): (a) that is capable of holding more than 680 L water; and (b) that incorporates, or is connected to, equipment that is capable of heating water contained in it to above 26ºC and injecting air bubbles or water into it under pressure so as to cause general turbulence in the water
Superchlorination	The addition of sufficient chlorine to a swimming pool or spa pool to raise the level of free available chlorine to greater than ten times the combined chlorine concentration (usually about 8-10 mg/L) for the destruction of chloramines
Total alkalinity	Sometimes called reserve alkalinity. A measure of the total amount of alkaline compounds in a water body, usually expressed as mg/L calcium carbonate ($CaCO_3$)
Total chlorine	The sum of combined chlorine and free available chlorine. Measured by adding DPD tablet No. 3 after a DPD tablet No. 1 to a sample of pool water
Thermotolerant Coliforms	Bacteria that originate from the gut of warm blooded animals and are used as an indicator of faecal contamination. Similar to faecal coliforms
TDS	Total dissolved solids. A measure of the total amount of dissolved elements and compounds in water expressed as mg/L
TPC	Total plate count: see Heterotrophic Plate Count
Turbidity	The degree to which suspended particles in a pool water obscure visibility
Turnover rate	The period of time required to achieve complete exchange the equivalent of one complete volume of pool water through the filter
WHO	World Health Organization

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