GEOFF NINNES FONG AND PARTNERS PTY LTD
ACN 001 849 289

# The Kogarah War Memorial Olympic Swimming Pool Centre
# At
# Carss Park

**Geoff Ninnes Fong & Partners Pty Ltd**

**Report**

**Pools and Tanks Structures and Finishes**
**and**
**Filtration and Water Treatment Plant**

**For**

**Kogarah City Council**

**19 April 2011**

## 1.0 PREAMBLE

Geoff Ninnes Fong & Partners were commissioned by Kogarah City Council to carry out an audit and condition assessment of the pools, tanks and associated plant at the Kogarah War Memorial Olympic Swimming Pool Centre at Carss Park.

The assessment has included a review of the performance of the pools and a comparison with the requirements of the NSW Health Department's final draft "Public Swimming Pool and Spa Pool Code of Practice". The requirements needed to upgrade the pools and plant to compliance level have been assessed and the associated costs estimated.

The report has been prepared in a number of discrete sections, these being a detailed report on the pools and tanks structures, finishes and associated works, a detailed report on the filtration, water treatment and heating plant associated with the pools, a section examining compliance with the NSW Health Department's Guidelines and a final section providing a summary of the investigation findings.

## 2.0 POOLS AND TANKS STRUCTURES, FINISHES AND JOINTS

### 2.1 Structural Finishes and Fitout

#### 2.1.1 50m Pool

#### 2.1.2 50m Pool Structure

The 50m lap pool is approximately 18m wide and is around 45 years old. The pool depths are 1.1m deep to 1.8m deep with scum gutters each long side, with a hob around the full pool perimeter and entry stairs in the two shallow end corners. A full width balance tank is located across the deep (south) end. There were no structural drawings available.

The structure has settled differentially over time toward the north west, evidenced by water flowing over the northern gutters with significant depth, and very little water flowing over the southern end sections of the gutters. The pool appears to have settled diagonally, with greater settlement in the north western corner. A distinct hump is observable across the shallow end of the pool with its high point on the eastern side of the pool centreline, indicative of additional settlement of the corners relative to the centre area of the pool. A diagonal crack extends from the shallow end wall to close to the eastern wall. This was the only significant crack observed.

The pool manager advised that some water leaking was occurring from the main control joints in the floor of the pool and from immediately below the top line of tiles in the scum gutters. A previous leak had occurred in a pipe from the balance tank to the plant room due to settlement. Presumably this leak has been rectified.

Anecdotal advice received indicates that the site was at least in part filled under the pool area. GNFP were also advised that a large diameter storm water drain runs under and across the shallow end of the pool, which appears to be confirmed from the works visible from the car park.

The pool settlement is highly likely to be the result of both general settlement of fill under the northern (shallow) end and additional settlement due to the consolidation of the fill around the stormwater pipe. We would advise a geotechnical investigation and report should be commissioned to determine subsurface conditions under the pool. An assessment of any remedial works required to arrest the settlement and any future structural problems could then be made. However it is likely that any remedial works would involve extensive piling or underpinning of the pool.

The report by CTI Consultants has revealed that the concrete is in excellent condition, shows very little chloride ingress or carbonation and is of high strength, around 40MPa, a high result, indicative of a fully hydrated good quality concrete. Concrete quality will hence not be an issue in the determination of the future life and other issues related to the pools.

A well-constructed normally reinforced concrete pool would generally have a life span of between 40 to 60 years. Although the concrete itself is sound, as noted above, the pools have suffered significant settlement problems and these would be most likely to be ongoing, eventually causing structural failure. Serious consideration should be given to its replacement within the next few years.

#### 2.1.3 50m Pool Finishes

The pool floor is tiled with small square mosaic ceramic tiles, the walls and gutters are tiled with normally sized ceramic tiles, and the hob surface is tiled with terra cotta tiles or similar. Fingergrip tiles were not used on the hob.The tiles are generally in average to poor condition, with evidence of many replacements, chipping, fractures and significant other defects, particularly around the hob. The hob itself also appears to be in poor condition with some localised structural cracking and repairs. Chipped and cracked tiles should be repaired or preferably replaced to avoid sharp edges cutting skin of pool users. There will be ongoing maintenance for all tiling as the tiles have already passed their expected functional life.

If the pool is emptied for any reason tile bond may be compromised as the tiles expand due to increased temperature, requiring many tiles to be replaced particular around expansion joints. We note that the pool has not been emptied for the last 25 years, a fact that may have saved many of the tiles in the pool. The pool should be retiled within the next three years.

#### 2.1.4 50m Pool Joints

There are three major control joints across the pool running transverse to the pool, and the joints appear to be in reasonable condition. There are also numerous tile joints across and along the pool which also appear to be in reasonable condition. It is quite likely that the tile joints also act as minor control joints, particularly when the lack of structural cracking is considered although pool differential settlement has been large.

Joints normally have a 10 to 15 year life span and the joints in this pool should be replaced within 5 years. Wall joints should be sealed properly to protect the joint and cover sharp edges of tiles either side of the joint.

#### 2.1.5 50m Pool Metal Work

There are stainless steel handrails on both sides of both stairs at the shallow end and stainless steel grab rails at all niche steps. These items all appear to be in good condition.

#### 2.1.6 50m Pool Concourse

The concourses are covered with an artificial "grass" carpet, and appear to be in poor condition, with settlement evident. Although the concourses appear to have settled significantly and variably, no direct visual confirmation could be made of the extent.

### 2.2.1 Children's Pool

### 2.2.2 Children's Pool Structure

The program pool is approximately 12m x 6m and varies between 600mm and 750mm in depth. approximately 900mm deep. The pool has a set of entry steps full width on the eastern side. The pool has settled about 50mm differentially on the diagonal, towards the north-western corner.

Minor evidence of cracking was observed through the southern hob.

### 2.2.3 Children's Pool Finishes

All horizontal surfaces of the pool, steps and hob are tiled with small mosaic tiles. All vertical surfaces have been tiled with normal larger tiles. The tiles and joints are generally in reasonable condition

## 3.0 FILTRATION, WATER TREATMENT AND HEATING PLANT

### 3.1 Description of Existing Plant

#### 3.1.1 Plant for 50m pool and children's pool

A common filtration and water treatment system is used for the two pools, with a common balance tank, filter, chemical controller and dosing. The use of a common filtration plant was the usual procedure when this centre was built but is not now acceptable.

#### 3.1.2 Filtration

The common filter is a six cell concrete pressure filter vessel of approximate overall plan dimensions 3.6m x 7.4m, giving a filter area of 3 filters at 2.2m x 3.2m, i.e. a filter area of 21.1m$^2$. No internal inspection of the filter was carried out. Filter media (sand) is being returned to the pool and has been for some time. This type of filter has a life expectancy of around fifty years, and this filter would hence be reaching the end of its functional life.

No advice was given as to when full maintenance was carried out or the sand replaced. The filter has been estimated to have a life expectation of about five more years, with reducing filtration efficiency over that period. These filters have been noted to exhibit very long lives, although often by that age the concrete filter vessels are in a very poor structural state with related poor filtration efficiency.

#### 3.1.3 Pumps

A single Monarch 15kW pump provides the total recirculation capacity for the pools. No interlocking has been carried out of the pump's operation with any of the other pool plant. The other plant should be interlinked with the pump to ensure all other plant shuts down if the recirculation pump shuts down, and this refers in particular to the pool water heating system.

The total flow rate is approximately 200m$^3$/hr, and is shared between the 50m pool (50L/s, equivalent to 180m$^3$/hr) and the children's pool (5L/s equivalent to 18m$^3$/hr).

#### 3.1.4 Chemical controller and dosing pump:

Sodium hypochlorite is used for disinfection and has a manually controlled Wallace & Tiernan Encore 26.5Lph dosing pump. Manual dosing is not permitted currently in public pools. No provision appears to have been made for pH control.

### 3.1.5 Sodium hypochlorite storage:

The sodium hypochlorite is stored in a 2500 litre polypropylene tank within a bunded area that does not comply with current Orica requirements for storage of sodium hypochlorite. The tank is also located within the general plant area and would cause corrosion of the metallic elements within the plant room.

### 3.1.6 Heating plant

Pool water is heated by an ageing TCK Tasso boiler with evidence of serious corrosion problems on various parts of the system.

### 3.1.7 Backwash water recovery

A backwash water recovery and storage system, with meter, pump, control board and external tank, has been installed recently and appears to be in excellent condition.

### 3.1.8 Summary

The filtration system is very old and needs replacement in the very near future. Under the current Guidelines, the two pools must be treated by separate filtration and water treatment systems, and this is a serious non-compliance of the current system. The pool plant system is also otherwise ageing and needs replacement in the relatively near future. The chemical treatment system is inadequate, does not comply with current requirements, and needs a total upgrade. The bunded hypo storage system should be upgraded to comply with Orica's requirements. The hypo delivery area also needs bunding to comply with Orica's current standards.

GNFP was not able to check the internal condition of the reinforced concrete pressure filter in this inspection, but given the age of the filter vessel, we believe some comment is necessary. The pipework and the valve have not been checked for considerable time, and given its age, the concrete vessel itself is almost certainly in very poor condition. This is evidenced in part by the presence of considerable quantities of filter sand on the floors of the pools. The sand presence is generally caused by a failure of the roses to the filtered water laterals embedded in the floor of the filter cells. Replacement of the roses is a very difficult procedure and these items are not readily available and generally need to be specially fabricated. Failure of the roses is indicative of more general serious overall deterioration of the filter cells.

The overall filtration rate at the estimated total flow rate of $198m^3/hr$ is $9.4\ m^3/hr/m^2$ for the reinforced concrete pressure filter. While the filtration rate itself is acceptable, the efficiency must be questioned of a filter of this age, exhibiting significant signs of deterioration. The turnover rates are checked in the next section against those recommended by the NSW Health

Department's code. The compliance of a common filtration and water treatment system for pools of significantly varying bather loads is discussed in detail in the following Compliance section.

The heating system is ageing, exhibits major signs of corrosion in various elements, and needs replacement in the short term.

## 4.0 Compliance with the current draft NSW Health Department's "Public Swimming Pool and Spa Pool Code of Practice"

The pools' turnover periods and rates have been estimated and assessed in comparison with the recommendations of the above publication and the results have been tabulated in the following. In brief, neither pool complies with the Code's recommendations. Both pools have unacceptably long turnover periods and associated low turnover rates.

### 4.1 Current Pools Performance and Compliance with NSW Guidelines

| Pool | Dimensions (approx.) | Depths (varies in most pools) | Area ($m^2$) | Volume ($m^3$) | NSW Guidelines /PWTAG Turnover Period (hrs) | NSW Guidelines /PWTAG Turnover Rate ($m^3$/hr) | Actual Turnover Period (hrs) | Actual Turnover Rate ($m^3$/hr) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 50m (outdoor) | 50m x 18m | 1.1m to 1.8m | 900 | 1305 | 2.67 | 490 | 7.25 | 180 |
| Children's (outdoor) | 12m x 6m | 0.6m to 0.75m | 72 | 49 | 0.82 | 60 | 2.72 | 18 |

### 4.3 Review of the Use of Common Filtration Systems for Numbers of Pools

Clause 7.2.5 of the current draft NSW Health Department's "Public Swimming Pool and Spa Pool Code of Practice" recommends strongly that all pools considered as high risk pools are provided with separate circulation and treatment systems including separate balance tanks and that each of these systems is totally separate from any other pool system. High risk pools include toddler pools, spa pools, Learn-To-Swim pools, hydrotherapy pools, warm water pools, many shallow indoor pools and leisure pools. In particular, any pools frequented by faecally incontinent or unreliable people are high risk pools, especially with respect to Cryptosporidium and Giardia contamination. Compliance with this recommendation, a very important criterion in terms of pool health, would mean that the children's pool should have its own recirculation and water treatment system.

### 4.4 Reuse of the Existing Reinforced Concrete Pressure Filter

Although the existing pressure filter's reinforced concrete vessel is likely to be in poor condition, it would be feasible to retain this filter to service the 50m pool alone for the very short term. This filter will however not provide an adequate turnover capacity in compliance with the NSW code and is not acceptable for any more than the very short term future.

## 4.2 Comments, Estimates and Recommendations

| Pool | Comment on Compliance | Structural Replacement Cost Estimate (excl. GST) | FWT Replacement Cost Estimate (excl. GST) | Total Replacement Estimate (excl. GST) | Maximum Recommended Delay (years) Before Upgrade |
|---|---|---|---|---|---|
| | | | | | |
| 50m (outdoor) | Unacceptable | $1,950,000 | $950,000 | $2,900,000 | 3 |
| Children's (outdoor) | Unacceptable | $170,000 | $110,000 | $280,000 | None |

## 5.0 SUMMARY

### 5.1 Structural

The 50m pool has settled toward the northern (shallow) end such that water flow only flows over the northern ends of the east and west side gutters. This greatly reduces turnover of water in the pool, creates large dead water flow areas at the deep end and could have long term detrimental structural implications on the pool structure such as cracking leading to substantial leakage, corrosion of reinforcement and possible structural failure. Further investigations could be undertaken to determine long term stability of the structure, but the reality is that the pool has failed in functional terms already and the flow patterns are currently unacceptable due to the differential settlement experienced.

The childrens pool is in sound structural condition but has also settled differentially in a diagonal line across the pool towards the north-west corner.

Tile finishes are recommended to be replaced for the 50m pool in the near future, as are major control joints. The tile finish to the children's pool is in currently acceptable condition with a future life expectancy of at least five years.

### 5.2 Filtration, water treatment and heating plant

Many of the elements comprising the existing pools' plant are nearing or have reached the ends of their functional lives.

The analysis of the performance of the centre's pools indicates that none of the centre's pools are currently operating in compliance with the current draft NSW Health Department's code. The pools should be upgraded or replaced to achieve compliance, and the suggested maximum period before upgrade of each pool is nominated in the table in section 4.2.

In terms of priority, the children's pool should be removed as soon as possible from the common system and provided with its own balance tank, filtration and water treatment plant and heating system. The plant for this pool could be located in a separate plant room adjacent to the northern wall of the children's pool area. Given that the pool has settled, and that the upgrade would require stabilising the pool against further settlement as well as installation of a central filtered water return line within the pool floor and perimeter soiled water removal gutters around the pool, it would almost certainly be more cost effective to replace this pool as noted in the 4.2 table.

The 50m pool has settled significantly and is not able to be rectified within any reasonable cost framework. The pool could be kept operational in its current condition for the short term (say three years) if the children's pool was separated as noted above. It must however be upgraded in the longer term given its totally inadequate turnover rate even when separated from the children's pool. As has been noted for the children's pool, both the soiled water removal and the filtered water return lines in the 50m pool are grossly inadequate and would need to be upgraded. The pool needs significant structural work done to stabilise the pool from a settlement consideration, and the cost of this work would be very high. The entire pool tiling system would also need to be replaced. Given these costs, it would be far more cost-effective to replace this pool.

The pool water heating system has reached the end of its functional life and is under capacity for effective heating of both pools, and should also be replaced.

Gordon Smith

**Gordon Smith** BE(Civ) MIEAust RPEQ
Director, Aquatic Projects, East Coast
for and on behalf of
**GEOFF NINNES FONG AND PARTNERS PTY LTD**

# APPENDIX A

## CARSS PARK AQUATIC CENTRE

## TRISLEYS HYDRAULIC SERVICES

## FILTRATION AND WATER TREATMENT PLANT

## REPORT AND RECOMMENDATIONS ON EXISTING FACILITIES

THS COMMERCIAL POOL SPECIALIST Ltd

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*ID Number 100490

Mr Gordon Smith
Geoff Ninnes, Fong & Partners
68-70 Crown St
WOOLLOOMOOLLOO NSW 2011

14th March, 2011 Ref : Carss Park Report01

Re : Carss Park Aquatic Centre – Report and recommendations on existing facilities

Dear Gordon,

Further to my site visit with yourself, please find below our report and recommendations on the Centre's filtration plants.

**General**

The Centre has one filtration plant for both pools (50m & Toddlers pool). When the Centre was constructed in the 1960's, this was considered normal practice.

The pool volumes are as follows;

| | |
|---|---|
| 50m Pool | 1,350m3 |
| Toddlers Pool | 35m3 |
| Total Volume | 1,385m3 |

Water filtration is provided by a low rate sand pressure system with approximately 24m2 of filter area split between 6 chambers. The sole recirculation pump delivers a flow of approximately 200m3/hr. This calculates to a turnover rate of 6.925hrs.

It is difficult to determine the exact flow to each of the pools but given the filtered water line sizes we believe the flows to be as follows;

| | | Est turnover time |
|---|---|---|
| 50m Pool | 50lt/sec | 7.5hrs |
| Toddlers Pool | 5lt/sec | 2.0hrs |

**Current day requirements and best industry practice**

If the Centre was to be constructed today, the requirements of NSW Health would be as follows

| | Flow Rate | Turnover time |
|---|---|---|
| 50m Pool | 132lt/sec | 2.84 hrs |
| Toddlers Pool | 14lt/sec | 0.69 hrs |
| Total | 146lt/sec (526m3/hr) | 2.63 hrs |

As can be seen from the figures above, the filtration plant is well down on current best practice and NSW Health requirements in respect of turnover times.

The required filter area for a plant of this size would be 21m2 in total using sand filtration or 138m2 using UFF filtration.

NSWH recommend that modern designed Centre's use separate filtration plants for each body of water. They especially encourage this with high risk pools such as Spa's and Toddlers pools.

**Existing Equipment**

**Sand Filter**
This is a concrete vessel and typical of that style of filter constructed in the 60's. At the time of visit no internal inspection was carried out. There are signs of filter media returning to the pool (Toddlers Pool) and the operator commented that this has been an issue for some time. The cost to rejuvenate this filter is in our opinion un-supportable from a cost point of view/

These style of filters have a realistic life of approximately 50 years and we would suggest that this filter would be showing signs of Chloride attack in the concrete walls of the filter.

The backwash valve is original and no parts are available for this valve.

**Recirculation Pump & Filtered water boost pump**
The Centre has a sole pump for the delivery of water to all pools. As stated, this pump is producing about 200m3 of water per hour.

There is no interlocking of associated pumps and equipment with the Pool's recirculation pump. These pumps should be interlocked so that if the main recirculation pump is turned off then the ancillary equipment should automatically be shut down as well. This is not presently the case.

**Electrics**
The electrics are quite simply antiquated and would not meet any current AS3000 wiring standards. There is virtually no electrical interlocking, flow switches etc to safeguard the plant or the operators. There is no board as such that houses all of the components in an orderly manner.

**Chemical Dosing Systems**
The existing Sodium Hypochlorite storage does not meet current standards for bunding. It is also inside the plantroom and not separated from other plant. This will cause an increase in corrosion and reduce the air quality in a room that has no mechanical ventilation systems in place.

There is no chemical controller system in place. The Centre has a chlorine dosing pump that is manually controlled.

**Pipework / Valves**
Pools of this age were built using Concrete Lined Cast Iron (C.L.C.I.) pipe for the bulk of the pipework systems. We sometimes see that there is also the use of either Asbestos pipe or Asbestos lined pipe underground. With time, modifications, repairs etc have been carried out using mostly uPVC pipework.

The filtered water line to the 50m pool would only go as far as terminating inside the pool wall. The 50m floor would have a trench constructed typically 400mm wide by 300mm deep that goes all the way from end to end. The trench is covered with concrete panels that were grouted in and outlets drilled through at certain intervals to let the filtered water flow into the pool.

There are obvious signs of the grouting collapsing and deteriorating. The numerous patches along this channel are obvious signs. It is our experience that this is not all unusual given the age of the pool.

**Recommendations**

We would suggest that the entire filtration system be upgraded. This would include the following;

50m Pool 476m3/hr filtration plant

This would require 19.5m2 of filter area for sand filtration or 120m2 for UFF filtration. It would also require all of the existing scum gutters to be replaced to handle the new flow capacity. All of the pipework would need replacing to also handle the new flows including the installation of new filtered water lines in the floor and walls of the pool.

Toddlers Pool 50m3/hr filtration plant

This would require 2m2 of filter area or 13.5m2 for UFF filtration. It would also require all of the existing scum gutters to be replaced to handle the new flow capacity. All of the pipework would need replacing to also handle the new flows. We would not support the installation of suction lines into a Toddlers pool for safety reasons.

We are of the opinion that the work required to upgrade the Toddlers pool structure and associated tanks etc to accommodate the plant requirements is such that the costs of this renovation type of work would nearly be as much as a new pool. It would be better for Council to invest their money in demolishing the Toddlers pool entirely and constructing a modern purpose built splashpad /leisure area with beaches, water features etc or increasing the size of the pool to better accommodate the large Learn to Swim programs in place or to attract an increasing need for Hydrotherapy facilities. This pool would then have its own chemical dosing, heating & filtration systems and as an added benefit would provide a lot more fun and enjoyment to the bathers .

**Staging of Works**
In respect of priorities, we would suggest that in a staged program situation, the Toddlers pool is the highest priority and should be taken off line and have its own filtration plant installed.

A new plant should be built for the Toddlers pool. There is an area behind the pool and adjacent to the changerooms that would have the room to accommodate the plant for the Toddlers plant.

As further funds became available, the 50m pool filtration plant and pool upgrade works could then be carried out.

Yours sincerely

*Robert Trisley*

Robert Trisley
Managing Director


**TRISLEY'S HYDRAULIC SERVICES PTY LTD**

***Sydney Office (Head Office)**
7-9 Carrington Rd, Marrickville 2204
Ph (02) 8566 3666 Fax (02) 8566 3667
email stuart@trisley.com.au

**Brisbane Office**
Unit 5/15 Porter St, Hemmant 4174
Ph (07) 3890 7217 Fax (07) 3890 7237
email luke@trisley.com.au

**Perth Office**
Unit3/23 Catherine St, Bentley 6102
Ph (08) 9258 7764 Fax (08) 9258 7763
email rod@trisley.com.au

# APPENDIX B

# CARSS PARK AQUATIC CENTRE

## CTI CONSULTANTS PTY LTD

## <u>CONCRETE ASSESSMENT</u>

## <u>EXISTING POOLS AND TANKS</u>

# CTI Consultants Pty Ltd

**Head Office:**
4 Rothwell Avenue,
Concord West NSW 2138

ABN 56 003 824 815
PO Box 153,
North Strathfield NSW 2137

**www.cticonsultants.com.au**
P: (02) 9736 3911
F: (02) 9736 3287

## Concrete Assessment

## Carss Park Aquatic Centre

| | | | |
|---|---|---|---|
| **Prepared for:**<br>Geoff Ninnes Fong<br>68-70 Crown Street<br>Woolloomooloo NSW 2011 | | **Contact:**<br>**Phone:**<br>**Fax:** | Gordon Smith<br>(02) 9332 5100<br>(02) 9331 2963 |
| **Date:** 10th April, 2011 | **Job Number:** 2713 | **Report Number:**<br>Revision 0: | C11188<br>Original |

**Report No. C11188**

**Issued by**

**Fred Salome,** B.Sc. (Hons.)
ACA Corrosion Technologist
NACE Protective Coatings Specialist
NACE Certified Coating Inspector Level 3 Marine

**Director**
CTI Consultants Pty Ltd
(ABN 56 003 824 815)

4 Rothwell Avenue, Concord West NSW 2138 Australia
PO Box 153, Nth Strathfield NSW 2137 Australia
Telephone (02) 9736 3911 Facsimile (02) 9736 3287

e-mail: fred@cticonsultants.com.au

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|---|---|---|---|
| 0 | 10/04/2011 | Original | F. Salome |
| | | | |
| | | | |

**Disclaimer**

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# 1. INTRODUCTION

Geoff Ninnes Fong (GNF) are advising Kogarah Council on the current condition, estimated residual life and probable future maintenance requirements associated with the concrete swimming pools at the Carss Park Aquatic Centre.

The pools are in-ground and of various ages.

CTI Consultants were engaged by GNF to conduct a program of on-site sampling and testing of the concrete pools. As the aquatic centre was in full operation at time of sampling, all coring was required to be performed underwater, using small diameter coring bits.

In particular, CTI were asked to carry out the following works.

- Core sampling and analysis to determine the chloride ion concentration profiles (typically over three depth horizons) at a nominal 3 locations (2 in the main pool and one in the toddlers pool)
- Determine the depth of carbonation at each location
- Determine cement content from composite samples for each pool
- Conduct such compressive strength testing as possible on retrieved core samples.

This report presents the details and findings of the investigation.

# 2. METHODOLOGY

## 2.1 Details of Inspection

The site sampling was conducted on Wednesday, March 23rd, 2011 by Robert Sutcliffe and Carol Bodle, both of CTI.

Access to all target surfaces was from inside the pools, and all coring was carried out underwater, using a hand-held hydraulic coring rig fitted with a 43 mm internal diameter coring bit.

To minimise the impact of coring slurry on water quality, the water flow through the bit was reversed, using a natural syphon to suck pool water into and through the bit.

## 2.2 Test Procedures

### *2.2.1 Core Sampling*

Cores to approximately 60-80mm depth were extracted from the target sampling locations for chemical analysis.

### *2.2.2 Visual Assessment of Cores*

All cores were assessed visually for the type and size of aggregate and overall condition of the cement matrix.

### *2.2.3 Chloride Ion Profile Determination*

On return to the laboratory, the core samples were divided into 10 mm slices, corresponding to depths of 0-10, 20-30 and 40-50 mm (unless otherwise noted). The slices were pulverised in a laboratory disc mill and the resultant powders were analysed as follows.

Analysis for chloride content was performed by digesting in Nitric Acid (in accordance with BS 1881 Part 124-1988), making the extract up to a known volume, and determining the chloride concentration using a chloride ion selective electrode.

The final results were expressed both as the chloride concentration in parts per million (ppm) and as the percent by weight of cement (% bwoc) calculated from the analytically determined cement content.

### *2.2.4 Depth of Carbonation*

The depth of carbonation was determined on cores by first splitting the cores. A 0.5% solution of phenolphthalein in aqueous alcohol was then applied to the freshly exposed faces.

The thickness of the outer layer which did not undergo a colour change to red/purple, indicating carbonated concrete, was measured and recorded as the depth of carbonation.

### *2.2.5 Analysis for Cement Content*

Composite powdered samples were submitted to Watertest Pty Ltd for analysis of cement content using the acid-soluble calcium method (AS1012.15).

### *2.2.6 Compressive Strength Determinations*

Three of the cores taken were of sufficient length and quality to allow samples of the concrete to be crushed for determination of compressive strength. These tests were conducted by Testrite using the procedure of AS 1012.14, adapted for the lower-than-specified diameter.

### *2.2.7 Repair of Core Holes*

Prior to departing from site, all core holes were repaired using a proprietary concrete repair material (Guncrete E from Parchem Construction Products).

# 3. RESULTS

## 3.1 Description

There are two separate pools that comprise the Carss Park Swimming Centre in Carwar Avenue, Blakehurst. These are the open-air main 50 m pool and the covered toddler's pool. These pools are both fully tiled.

The main pool has the traditional covered return gutters built into the side walls and with a solid raised kerb on top of the walls at both ends.

## 3.2 Sampling Locations

Sampling locations, selected to be representative of both pools are presented in Table 1. Specific locations were selected to minimise disruption to the ongoing operation of the pool during the inspection, and to minimise the visual impact of the repairs.

**Table 1 Sampling Locations**

| Location | Pool | Description |
|---|---|---|
| A | Toddlers | N wall |
| B | Main | North wall (shallow end), east end at stairs |
| C | Main | North wall (shallow end), west end at stairs |

Photographs of each sampling location are presented on the following page.

## 3.3 Core Samples

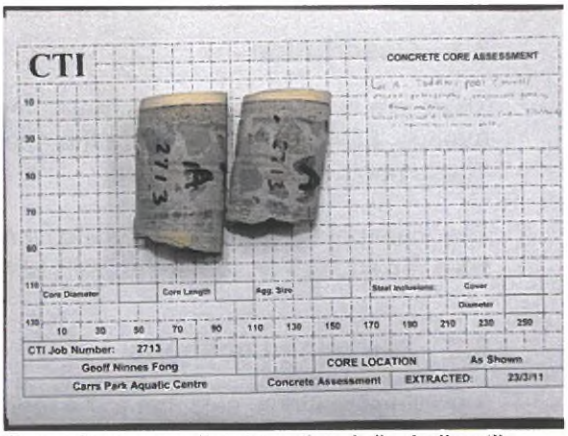
Details of the core samples extracted from each location are given in Table 2.

**Table 2 Details of Core Samples**

| Location | Core Length (mm) (exclusive of tile and mortar) | Additional Comments |
|---|---|---|
| A | 60 | Tile + mortar layer 16 mm thick<br>Winged steel @ 45mm cover in concrete – imprint has minor scale |
| B | 87 | Tile + mortar layer 18 mm thick<br>No steel |
| C | 66 | Tile + mortar layer 45 mm thick<br>No steel |

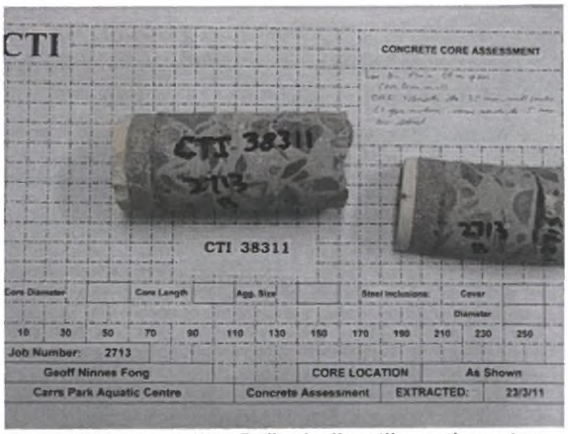
Photographs of the core(s) from each location are presented on the following page.

Location A, Toddlers pool, North Wall



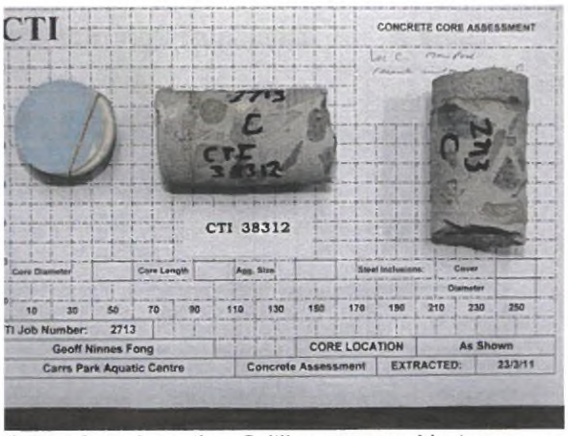

Cores from sampling Location A (including tile and mortar layer)

Location B, at stairs on eastern end of northern wall of main pool




Cores from Location B (including tile and mortar layer)

Location C, at stairs on western end of northern wall of main pool




Cores from Location C (tiles removed but some mortar remaining)

## 3.4 Concrete Assessment

### *3.4.1 Description*

The concrete of the two outdoor pools was found to be of simialr appearance at all sampling locations.

The coarse aggregate from the Toddlers pool was of mixed petrography (most of not all river gravel), reasonably graded to 25 mm. The matrix was generally dense.

The coarse aggregate from the Main Pool was also crushed river gravel, well graded to 25mm in a light grey matrix with some voids to 5mm.

There was, in each instance, a layer of tiles and bedding mortar, of varying thickness (refer Table 2 above).

| | |
|---|---|
|  Core from Toddlers Pool showing aggregate of mixed petrography indicative of crushed river gravel |  Core from Main Pool showing aggregate of mixed petrography indicative of crushed river gravel |

### 3.4.2 Cement Content

Cement content was determined for composite samples from each structure. The results are presented in Table 3.

**Table 3 Cement Content**

| Sample | Cement Content (Wt %) | Cement Content (kg/m$^3$) |
|---|---|---|
| Toddlers Pool | 15.3 | 350 |
| Main Pool (composite of cores B and C) | 14.7 | 340 |

### 3.4.3 Depth of Carbonation

Carbonation was not present in any of the concrete.

This is as expected for concrete that has been covered with a mortar layer and which has been fully immersed for essentially all of its service life.

### 3.4.4 Compressive Strength

The compressive strength and density, as determined from the 43 mm diameter cores are presented in Table 4.

**Table 4 Details of Core Samples**

| Location | Compressive Strength (MPa) | Density (kg/m$^3$) |
|---|---|---|
| A | 59.0 | 2,300 |
| B | 55.0 | 2,320 |
| C | 54.5 | 2,280 |

NOTE: As these results were from small cores, and with a low height to diameter aspect ratio, these figures should not be treated as being absolute. However they do indicate that the concrete has high strength, and a characteristic strength of 40MPa can be assumed in any calculations.

If more accurate strength data is required, it will be necessary to take larger core samples which comply with AS 1012.14 (at least 75 mm diameter and 150 mm depth) for testing. This will require the pool to be at least partially emptied.

### *3.4.5 Chloride Ion Profiles*

The chloride ion profiles for the sampling locations are shown on the following page, in both tabular and graphical form. The scale on the Y-axis of the graphs has a maximum of 1%bwoc.

The commonly accepted threshold of concern for chloride concentrations in reinforced concrete structures is 0.4% by weight of cement (%bwoc), although this depends on the quality of the concrete and the exposure conditions[1]. Above this threshold, the risk of corrosion increases until the concentration reaches 1% bwoc, above which the corrosion risk is considered to be very high.

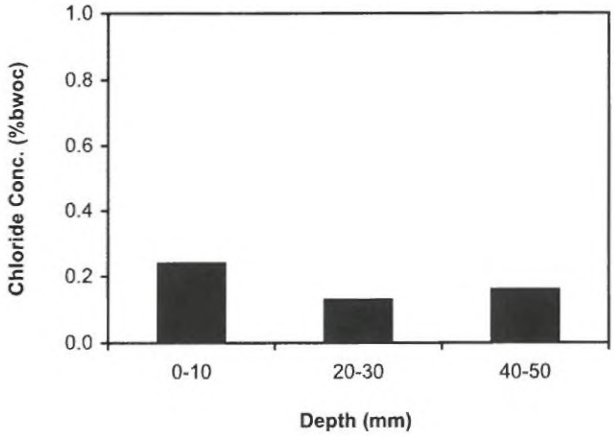
The results indicate that the intrinsic chloride content of the concrete was relatively low, at slightly above 0.1 % bwoc.

There has been minor chloride migration into the concrete, more so at Location C, but the absolute values remain below the threshold of concern.

1 Refer Standards Australia HB84:2006, *Guide to Concrete Repair and Protection*, Section 2.2.3 and Figure 2.2.

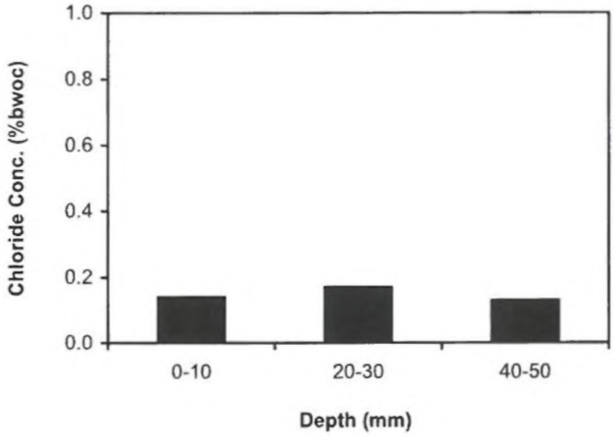
**Location A – Toddlers Pool, N wall**

| Depth (mm) | Chloride (ppm) | Chloride (%bwoc) |
|---|---|---|
| 0-10 | 360 | 0.24 |
| 20-30 | 200 | 0.13 |
| 40-50 | 240 | 0.16 |



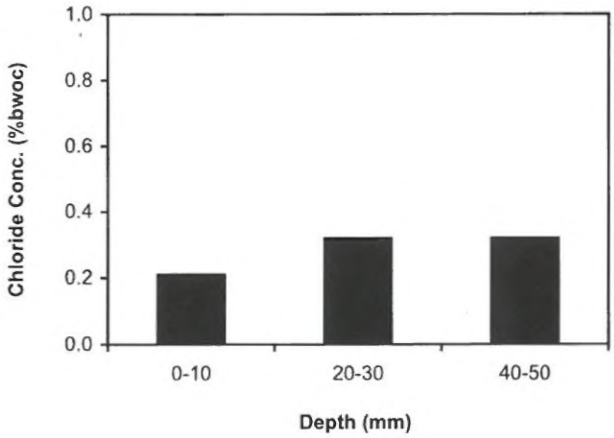

**Location B – Main Pool, N wall, E end**

| Depth (mm) | Chloride (ppm) | Chloride (%bwoc) |
|---|---|---|
| 0-10 | 220 | 0.14 |
| 20-30 | 260 | 0.17 |
| 40-50 | 200 | 0.13 |




**Location C – Main Pool, N wall, W end**

| Depth (mm) | Chloride (ppm) | Chloride (%bwoc) |
|---|---|---|
| 0-10 | 320 | 0.21 |
| 20-30 | 480 | 0.32 |
| 40-50 | 480 | 0.32 |



# 4. DISCUSSION AND RECOMMENDATIONS

## 4.1 Concrete Quality

Although the scope of the investigation was limited to the upper parts of the walls, accessible whilst the pool was full, the results indicate that the concrete used in the construction of these pools was of a high quality with good intrinsic durability.

The cement content of approximately 350 $kg/m^3$ is reasonable, and the compressive strength (as indicated from the small diameter cores) is quite high. These results are consistent with an older style coarse ground cement having now fully hydrated. A characteristic strength of 40MPa may be assumed for these pools.

Carbonation has not occurred on the internal surfaces of the walls, which is consistent with immersed concrete protected by a tile and mortar layer.

## 4.2 Chloride Ion Profiles

The above results show the intrinsic chloride content of the concrete to be very low, around 0.1% bwoc. This indicates good control of the composition of the concrete by the designers and builders.

Slightly elevated chlorides were experienced in the western end of the north wall of the main pool, but even these remain well below the threshold for corrosion concerns.

Overall, the results do not indicate any risk of chloride-induced corrosion in these pools where the concrete itself remains in sound condition.

## 4.3 Residual Life and Maintenance

The concrete durability appears to be excellent, and there is considered to be no significant risk of chloride-induced corrosion of the reinforcing steel developing in the medium to long term where the concrete itself remains sound.

Although a defect survey was not part of the scope of this survey, it was observed that there are instances of visible corrosion associated with repaired joints and cracks. These are considered localised problems, possible structural in origin, which can be addressed by targeted conventional repairs.

If the current operating and exposure conditions remain unchanged, and assuming localised repairs are carried out where needed, it is expected that these pools will continue to provide satisfactory performance for the foreseeable future.