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Feasibility Study for Hallett Cove Ocean Pool, South Australia

WRL TR 2018/37 | April 2019

By J T Carley, I R Coghlan, D B Lord and M Western

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Executive summary

ES.1 Overview

There are more than 150 ocean pools in the world, predominantly in NSW and South Africa. Ocean pools are highly valued community assets in the areas where they are present. This study has combined case studies from existing pools, discussions with pool managers, experts and pool users, with contemporary coastal engineering techniques and consideration of the coastal processes prevailing at Hallett Cove, to assess the feasibility and develop a preliminary design for an ocean pool at Hallett Cove. This report does not cover ecological and cultural heritage factors, which are covered in separate studies by others.

ES.2 Preliminary design for Hallett Cove

While this report canvassed slatted and netted ocean pools, a concrete ocean pool is recommended for Hallett Cove in this report.

Due to the different wave and tidal characteristics occurring between Hallett Cove and NSW, an ocean pool at Hallett Cove would be less able to operate on the basis of tidal and wave flushing, but would operate best with the use of a pump as the primary means for filling and circulating the water, noting that many NSW ocean pools also use this method. This will also allow a wall level of 1.5 m AHD or higher (AHD is approximately mean sea level). It will result in substantial wave overtopping into the pool only during storm waves and high tides, thereby improving pool safety under ambient conditions, and reducing the potential for sand, seagrass wrack, litter and debris to enter the pool. The proposed wall level could be further optimised with further design development.

Five locations were considered in this report, with the recommended location shown in Figure ES.1. The slight northerly aspect of this location also has the advantage of enhanced sun in winter.

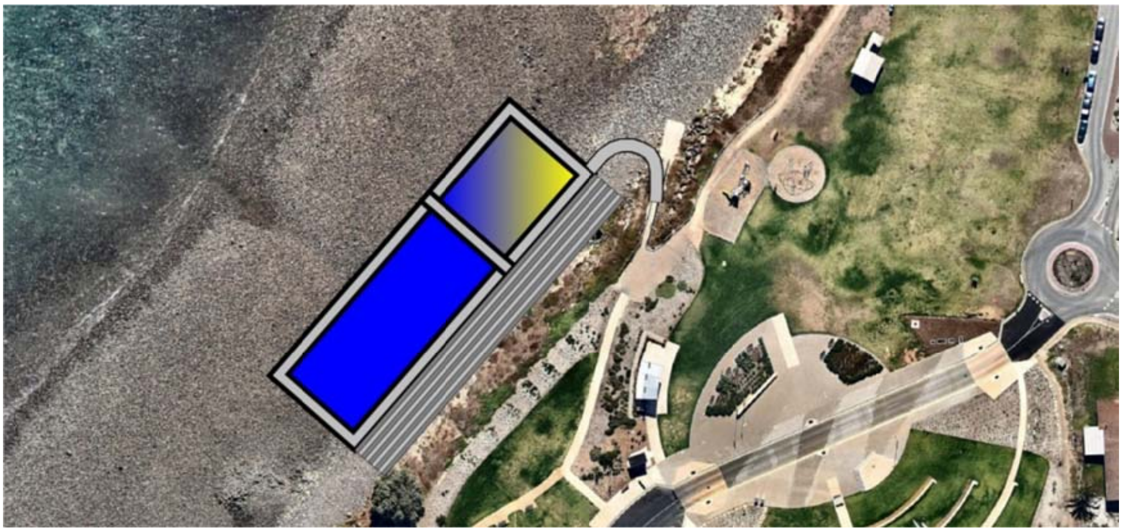

Figure ES.1 Potential pool location

ES.3 Embankment Protection

Previous studies have identified that approximately 400 m of embankment fronting Heron Way Reserve may need coastal protection works into the future, with rock armour and/or cobbles being options, to establish an artificial headland on an otherwise eroding beach. Short sections of this have already been undertaken, however, the full 400 m length could be staged. A stepped concrete seawall associated with an ocean pool would enhance this objective and could cover approximately 75 m of this, albeit at a higher cost. Estimated costs for this would be:

- Stepped concrete seawall: 75 m @ $12,000 = $900,000
- Rock rubble embankment protection: 325 m @ $3,000 = $975,000
- Total cost for embankment protection: $1,875,000.

Assuming that the protection works will be undertaken regardless of an ocean pool, the additional cost for the stepped concrete portion would be:

- 75 m @ ($12,000 - $3,000) = $675,000.

ES.4 Creation of a sandy beach at Hallett Cove

Previous studies have examined the feasibility and costs to create and maintain a sandy beach at Hallett Cove. This would likely involve a sand retention structure, such as an offshore breakwater (comparable to Semaphore Park) or groyne, initial sand nourishment of 500,000 m^3 (if compatible sand was able to be sourced), and the addition of 100,000 m^3/year of compatible sand to feed alongshore losses. Sufficient studies have not yet been undertaken to determine if this would be technically feasible for Hallett Cove. Indicative costs for this (assuming it was technically feasible and adjusted to 2019) would be:

- Sand retention structure: $3 million;
- Initial nourishment: $10 million
- Annual maintenance: $2 million.

This cost is multiple times that of an ocean pool. It would be technically feasible to integrate an ocean pool into a scheme to create a sandy beach, with the ocean pool acting as a groyne or being part of an offshore breakwater, however, this would introduce additional complexities, uncertainties and risks, which are detailed in the report. A more detailed understanding of sediment movement (supply and potential transport rates) would be required, should these options be contemplated. As an ocean pool could be constructed and maintained for a much lower amount than the construction and maintenance of a beach, and could be viable, independent of a beach, it is not recommended that an ocean pool be dependent on any scheme to create and maintain a beach at Hallett Cove. The construction of an ocean pool at the recommended location does not preclude further consideration of a sandy beach for Hallett Cove.

ES.5 Costs for ocean pool

Costs for a “best practice” ocean pool would cover:

- A 50 m x 20 m main pool;
- A 250 to 450 m^2 wading pool;
- 250 to 450 m^2 of constructed public space (decking, promenade and seating); and
- Ancillary works such as toilets, change rooms, lighting and disabled access.

The range of cost estimates and techniques is presented in the body of this report. Central/best estimates of costs (including in-house council labour, materials, external contracts and electricity) are:

- Initial capital: $3 million;
- Refurbishment at 10 to 20 years: $800,000, net present cost: $206,000;
- Maintenance costs: $78,000 per annum, 20 year net present cost: $826,000;
- Pump operation: $13,000 per annum, 20 year net present cost: $137,000.

ES.6 Maintenance

Typical maintenance of an ocean pool involves:

- Planning, asset management, supervision;
- Cleaning;
- Cleaning materials;
- Trash pump and pressure cleaner;
- Sand and wrack removal;
- Minor concrete patching;
- Balustrade repairs;
- Painting;
- Lane marking;
- Pump overhauls;
- Pump replacement;
- Rock removal;
- Lighting maintenance;
- Joint sealing (“Sikaflex”); and
- Service vehicle.

Depending on local factors, most ocean pools are emptied and cleaned at frequencies of once per week to once per month. The most popular pools are sometimes also half drained and refilled overnight once per week in the peak of summer, while more remote pools are cleaned only once or twice per year. Minimal chemicals are used for cleaning of all ocean pools. The water is not chlorinated.

ES.7 Usage, benefits and car parking

Based on available data, this study has found that there may presently be approximately 64,000 individual visits from November to March each year to the beach and foreshore at Hallett Cove. Additional facilities such as toilets would be needed for increased patronage of the area. The body of this report has identified options to increase available parking and presents more lateral options to manage access during peak times.

The following are central/best estimates of a range of economic and social parameters for an ocean pool, which are derived from the Royal Life Saving Society and other data:

- Plausible individual visits: 100,000 per annum;
- Plausible economic benefit $1,400,000 per annum;
- Plausible health economic benefit $2,600,000 per annum; and
- Plausible total economic benefit $4,000,000 per annum.

ES.8 Safety and Risk Assessment

Of the approximately 70 ocean pools in NSW, less than five have dedicated lifeguards and/or fencing, with some having nearby volunteer patrols on weekends during the patrol season. Most are open 24 hours per day, 7 days per week. Ocean pools are almost always safer than the neighbouring beach and rock shelves. A range of risk control measures are presented in the report, with more detailed studies recommended if the project is to progress further.

ES.9 Feasibility

Existing ocean pools are a highly valued community asset. An ocean pool at Hallett Cove is technically feasible. It would involve an initial capital cost of several million dollars and a commitment to ongoing maintenance. Additional studies would be needed to progress the project towards detailed design.

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1 Introduction

The Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering at UNSW Sydney was engaged by the City of Marion to undertake a coastal engineering assessment of the feasibility of an ocean pool at Hallett Cove, South Australia. The work was undertaken in conjunction with Coastal Environment (Doug Lord) and Integrated Coasts (Mark Western).

The following tasks were undertaken for this project:

1. Assess different pool design options;
2. Create preliminary design for pool;
3. Assess costs and benefits of developing a sea pool;
4. Assess local geology and coastal processes;
5. Assess potential impacts to local ecology (to be undertaken in separate studies);
6. Assess potential impacts to local culture and heritage (to be undertaken in separate studies);
7. Assess erosion protection options for road embankment;
8. Assess sand retention potential of sea pool;
9. Estimate capital and operational costs of pool; and
10. Assess likely popularity of pool, and parking capacity;

A range of assessment criteria were considered for arriving at a preferred option, and include:

- Capital costs;
- Maintenance costs;
- Safety from waves;
- Potential for natural flushing;
- Potential for sand and seagrass infill;
- Impact on beach processes;
- Engineering certainty;
- Ease of construction;
- Ease of disabled access;
- Potential for boulder/debris impacts; and
- Preservation/maintenance of water quality (including separation from external contamination).

2 Pool types

2.1 Preamble

There are three broad classes of pools which primarily use the surrounding seawater, namely:

- A netted/slatted enclosure which could be fixed or floating (Figure 2.1 to Figure 2.4);
- Tidal/wave filled pool (Figure 2.5 and Figure 2.6);
- A pump-filled pool (or pump-assisted pool) (Figure 2.7).

2.2 Netted or slatted enclosure

There are numerous netted or slatted pool enclosures around Australia. Due to their abundance, WRL is not aware of any attempt to catalogue them nationally. Examples of netted pool enclosures in South Australia include Moonta Bay, Port Lincoln, Point Sinclair, Streaky Bay, Ceduna and Wallaroo. Netted enclosures are often constructed in association with a jetty and are primarily a barrier for sharks (and/or dangerous jellyfish in tropical areas).

Slatted enclosures can also incorporate promenades, deck areas, regular dimensions and geometry, and provide for lap swimming. The amenity of most of these types of pools relies on the native sandy beach present at the site.

There is evidence of an ephemeral sandy beach at Hallett Cove, primarily as a thin veneer of sand over cobbles, and it could be possible to create or further enhance a sandy beach at Hallett Cove. However, to establish a permanent sandy beach would be complex and expensive (many times the cost of an ocean pool located at the back of a beach or headland), with an element of uncertainty. Furthermore, the storm wave climate at Hallett Cove is much larger than that of most netted or slatted pools (e.g. in Sydney Harbour). Therefore, a netted or slatted pool would need to be more heavily engineered at Hallett Cove than most existing examples.

Given that no detailed studies have yet been undertaken, without the high certainty of a sandy beach being available, WRL does not recommend that investment be made towards a netted or slatted enclosure for Hallett Cove.

Figure 2.1 Netted pool, Point Sinclair SA

Figure 2.2 Netted pool, Manly Cove NSW

Figure 2.3 Slatted pool, Little Manly NSW

Figure 2.4 Slatted and netted pool with boardwalk, Balmoral NSW

2.3 Tidal/wave filled pool

A concrete tidal/wave filled pool is potentially feasible for Hallett Cove. Most ocean pools in NSW started their life as tidal/wave filled, but many have evolved into being pump filled.

Potential limitations on a purely tidal/wave filled pool for Hallett Cove include:

- The presence of "dodge tides" (Section 7.1) means that flushing would be low at times;
- The wave climate is much lower than the open coast of NSW; and
- Wave flushing is likely to fill the pool with seagrass wrack and/or sand, and potentially litter and other marine debris.

As with many ocean pools in NSW, a combination of intermittent tidal, wave and pump filling would be feasible for Hallett Cove.

Figure 2.5 Tidal/wave filled pool, Edithburgh SA

Note: lap pool and wading pool

Figure 2.6 Tidal/wave filled pool, South Curl Curl NSW

2.4 Pump-filled pool (or pump-assisted)

A pump-filled pool (or pump-assisted) is potentially feasible for Hallett Cove.

A purely pumped pool has the following disadvantages:

- The pool will need to be higher and therefore may contain more concrete;
- Pump costs will be higher; and
- The pool will be more psychologically disconnected from the ocean.

Based on experience from other locations, an optimum position and elevation can be developed that somewhat relies on pumps, but also receives some wave and tidal flushing.

Figure 2.7 Pump-filled pool, Maccallum Pool, Cremorne, Sydney Harbour NSW

3 Background on Ocean Pools

Depending on definitions, there are approximately 70 ocean pools in NSW, with most located between Newcastle and Wollongong. Fifteen ocean pools are located on Sydney's northern beaches. Most NSW ocean pools were built from the late 1800s to early 1930s. The last new construction was at Cronulla in the 1960s, which was rebuilt in the early 1990s. However, most ocean pools in urban areas are renovated at intervals of 10 to 20 years.

The term "ocean pool" has been used in this report, however, they are also referred to as sea pool(s), rock pool(s), tidal pool(s), ocean baths, sea baths, rock baths, and (in the UK) lido.

The original pools generally had little formal engineering design, but often involved local residents and/or life savers excavating favourable portions of rock shelves, and later enhancing these with concrete walls. Some locations had existing natural pools which were used by traditional owners and/or early colonial settlers. The constructed ocean pools evolved through numerous construction iterations. They are a highly valued local asset and are now generally managed by the relevant local council.

Concrete/rock ocean pools are ubiquitous within NSW and some provinces in South Africa. There is one in Queensland (Caloundra), two in South Australia (Edithburgh and Kingscote), and small numbers of ocean pools in the UK (e.g. Bude), USA (Victoria Beach, Laguna Bay), Mediterranean and New Zealand (one at Dunedin). There are also numerous "ghost" ocean pools on many coasts, including NSW. These pools were either damaged by ocean forces, were excessively dangerous, filled with sand, or simply ceased to be repaired or maintained.

Ocean pools are highly popular with communities and complement traditional beach use. They offer the following advantages over swimming in the ocean:

- A barrier from sharks;
- No rips;
- Partial protection from large waves;
- Partial reduction in stinging jellyfish;
- A well-defined space for training and practising;
- Potentially better water quality than the ocean at certain times; and
- The potential for safer night swimming.

Ocean pools also offer the following advantages over conventional swimming pools:

- Ocean salt water is perceived as more natural and is more buoyant;
- Minimal chemicals are used for cleaning;
- No heating costs;
- Lower pumping and/or filtration costs;
- Potentially reduced costs for staffing, cleaning and maintenance; and
- They allow a close psychological connection with the ocean ("The Wild Edge" – Section 4.2).

Potential disadvantages and/or limitations for ocean pools include:

- They displace existing ecological communities;
- They require a commitment to monitoring, maintenance and future refurbishment;
- The need to manage public safety;
- A pool can change wave and sand patterns in some locations;
- Increased human visitation and congestion may concern some people;
- Liability issues have not been comprehensively tested for new pools;
- Social, political and environmental complexities; and
- There has possibly never been a Development Application for a new ocean pool in Australia.

4 Literature on ocean pools

4.1 Engineering literature

There is limited engineering literature on the design and coastal engineering of ocean pools. This is because:

- Most ocean pools were constructed without formal design; and
- Few ocean pools have been constructed in the last 50 years;

The following works have been sighted by WRL.

4.1.1 WRL Reports

WRL Ocean pool studies

Munro C H and D N Foster (1964), "Investigation of Southern Swimming Pool Cronulla Beach", Technical Report 1964/04.

Foster, D N and R C Nelson (1967), "Investigation of Proposed Baths at South Cronulla Surfing Beach", Technical Report 1967/02.

Haradasa, D K C and J E Hills (1985), "Model Tests of Proposed Swimming Pool at South Cronulla", Technical Report 1985/02.

Carley, J T, C D Drummond and G P Smith (2016), "Options for Managing Large Rocks in North Curl Curl Ocean Pool", Letter Report WRL2016073 L20160922.

AWACS Reports (A joint venture between WRL and Manly Hydraulics Laboratory; MHL)

Haradasa, D, R Jacobs and A Gordon (1990), "Model Investigation and Hydraulic Design of Southern Swimming Pool Cronulla Beach", AWACS Report 90/14.

Rock shelf processes

Shand, T D, W L Peirson, M Banner and R J Cox (2009), "Predicting Hazardous Conditions for Rock Fishing - A Physical Model Study", Research Report 234.

4.1.2 Manly Hydraulics Laboratory (MHL) Reports

MHL (1996), "A Preliminary Study on the Upgrade Options for North Curl Curl Rock Pool", Report MHL727.

4.1.3 Other engineering literature

Haradasa et al. (1993)

Haradasa, D, D Hewitt and R Jacobs (1993), "Design and Construction of an Ocean Rock Pool at Cronulla", Coastal Management Conference, Port Macquarie, NSW.

This paper reflects on the design and construction methods for the refurbished ocean pool at Cronulla.

Jayewardene et al. (2011)

Jayewardene, I F W, R Jacobs, D W Cameron and L Skountzos (2011), "Case Studies in Improving Design Criteria for Ocean Swimming Pools Utilising Physical Modelling and Other Investigative Techniques", Australasian Coasts and Ports Conference, Institution of Engineers Australia.

This paper examined issues regarding eight ocean pools in NSW, including water quality and sand ingress.

Bosman and Scholtz (1982)

Bosman, D E and D.J.P. Scholtz (1982), "A Survey of Man-Made Tidal Swimming Pools along the South African Coast", Proceedings of the International Conference on Coastal Engineering, American Society of Civil Engineers.

Bosman and Scholtz (1982) documented the coastal engineering of 80 ocean pools on the coast of South Africa, predominantly in KwaZulu-Natal and Cape Province, many of which were constructed in the 1950s following a relatively large number of shark attacks. It is the most comprehensive published work on the engineering design of ocean pools, so has been summarised here in more detail than other works. They noted that there was a need/demand for more ocean pools and that no design criteria could be found.

The stated tidal range is about 1.5 m, which is comparable to NSW. Corbella and Stretch (2012) noted that littoral drift at Durban is approximately 650,000 m^3/year to the north-east, versus approximately 40,000 to 100,000 m^3/year at Adelaide (Section 7.3.4).

They estimated that the 80 ocean pools for which they collected data accounted for about 90% of existing pools along 3,000 km of coast, that is, they estimated that there were a total of approximately 90 ocean pools in South Africa.

Noting that the paper is about 36 years old, the ocean pools at the time were filled by waves and tides, with no mention of pumps. They classified ocean pools into four types, namely (Figure 4.1):

- Pools partly enclosed by walls – usually on beaches with flatter slopes (Type a).
- Pools partly enclosed by walls, with high walls to exclude beach sand (Type d), with ramps and tapered channels to allow wave flushing.
- Pools fully enclosed by walls – usually on beaches with steeper slopes (Type b, Type c),
- Semi-detached pools (Type c) [referred to as island configurations by WRL].

They observed that pools with higher walls (Types b, c, d) located in the vicinity of sandy beaches modified the beach shape (Figure 4.1), and in particular, the sand build up surrounding Type (c) pools can eventually enter the pool.

Approximate wall crest levels relative to mean sea level (converted to MSL by WRL) are shown in Table 4.1. In Australia, Australian Height Datum (AHD) is approximately MSL (Section 7).

Wall level (m MSL)	KwaZulu-Natal (Number)	Cape Province
2.25	0	0
2.00	5	1
1.75	6	2
1.50	7	5
1.25	2	6
1.00	7	14
0.75	0	9
0.50	2	7
0.25	1	0
0.00	0	2
-0.25	0	0

Table 4-1 Crest levels of South African ocean pools

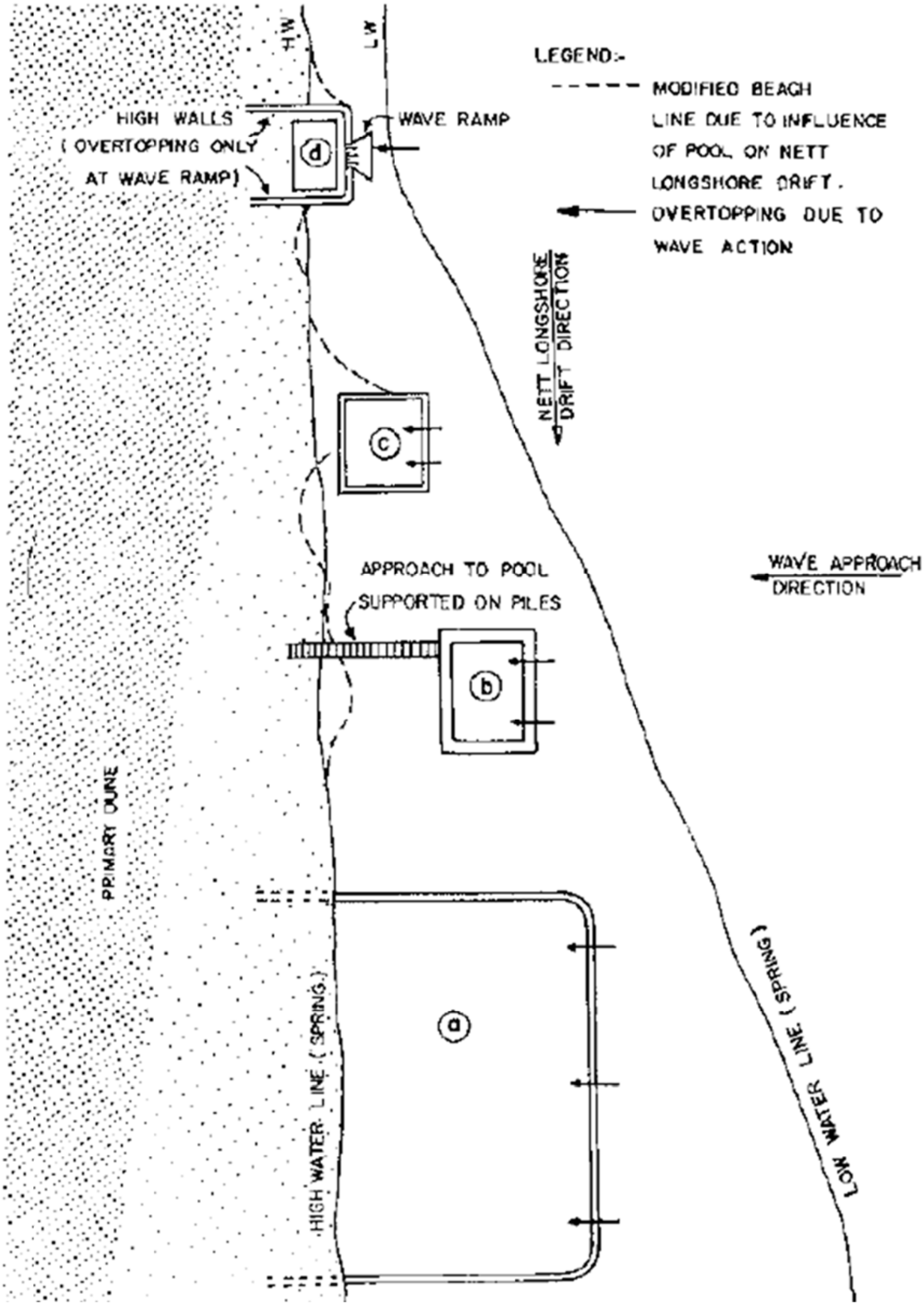


Figure 4.1 Schematisation of pools (Figure 3 of Bosman and Scholtz, 1982)

They also noted that:

> "Most pools were constructed of mass concrete founded on rock, with one pool constructed on steel sheet piles. The wall crest levels of most of the pools are above the mean high water spring tidal level with the predominance of crest levels about 0.1 m to 0.5 m above mean high water spring level.
>
> The majority of the pool walls facing the approaching waves have seaward slopes between 2:1 horizontal and vertical and crest widths between 0.4 m and 1.0 m.
>
> Pool floors consist usually of either sand or rock or combination of the two. Some pools have concrete floors.
>
> All pools are provided with drain pipes at the lowest position in the pool to allow drainage during low water spring tides."

Wave overtopping inflow rates for 13 pools were measured during high water spring tides and found to range from 20 to 650 m^3 per metre length of wall - no duration for this was given, nor the wave conditions which prevailed. On the assumption by WRL of 6 hour duration (above mean sea level), this translates to average rates of 0.9 L/s/m to 30 L/s/m.

They noted that:

> "A large number of pools are drained fortnightly to clean the pools, remove accumulated sand and to enable the rock and concrete surfaces to be washed with lime to control the growth of slippery algae. Other chemicals used to control algal growth are carbide and copper sulphate. …"
>
> "A few pools are frequently sanded up due mainly to incorrect siting. Two of these are sanded up to such an extent that they are out of use.
>
> Water replenishment at about eight of the pools is considered to be insufficient. This leads to stagnant water conditions and excessive algal growth.
>
> Some of the pools are dangerous since bathers can be washed from side or back walls out to sea.
>
> Parts of walls of three of the pools have been destroyed by waves."

Bosman and Scholtz (1982) recommended that the following design factors be considered:

> "(b) The siting of the pool: The pool should preferably be situated so that the walls can be founded on rock where possible. Where no rock foundation is present sheet piling could be considered as a foundation for the walls. Seasonal variation of the beach profile as well as longshore sediment transport in the beach zone should be considered in the siting to prevent the pool from being sanded up. Sufficient consideration should also be given to the aesthetic and ecological considerations to minimize the impact of the structure on the environment.
>
> (c) Water replenishment by wave action: Sufficient quantities of fresh sea water should enter the pool frequently enough and overflows should be situated so that adequate renewal of water throughout the pool is ensured. A general criterion for inflow would be to stipulate that inflow should occur at least during high water neap tides with dominant wave conditions. The walls should be built rather too low than too high since it will be easier to raise the walls if this is afterwards found to be necessary. The seaward slope of the wave-facing wall should be about 2 horizontally on 1 vertically or flatter since flatter slopes increase overtopping and stability.
>
> (d) Safety: The pool floor should be even and if the pool is not of uniform depth the slopes should be gentle. Situations where overwash from walls to sea can occur which could be a danger to bathers should be prevented. Intakes of drain pipes should be covered with grids. Notice boards indicating water depths should be provided.
>
> (e) Maintenance: The floor level of the pool should be above low water springs to allow drainage. It appears to be good practice to whitewash the walls with lime when the pool is cleaned as this apparently retards the growth of algae and shells and also gives the pool an attractive and tidy appearance."

4.2 Landscape design literature

The project: "The Wild Edge – A survey of coastal pools in NSW" by Nicole Larkin (2019) has collected data for 56 ocean pools in NSW by photographing and mapping their form/shape/topography with a drone (https://www.nicolelarkin.com/the-wild-edge/). The drone photography had been completed at the time of writing, with further analysis to be undertaken and extended to complete the documentation.

4.3 Sociological literature

Because of the popularity of ocean pools within the community and their integral place in society, especially before the proliferation of indoor/inland Olympic pools, there is a body of literature regarding social, cultural and heritage aspects of ocean pools. This literature is valuable in identifying the locations of ocean pools and documenting some of their characteristics.

4.3.1 McDermott (2005, 2011, 2012)

Marie-Louise McDermott (2005, 2011, 2012) wrote extensively on the origins, history, presence and culture of ocean pools in NSW and South Africa, including a 2012 PhD thesis. The PhD thesis documented 93 ocean pools in NSW, but noted that some of these were of marginal construction and/or were no longer maintained. It also documented 50 ocean pools in South Africa.

4.3.2 National Trust (2005)

The National Trust of Australia (NSW) published “Survey of Harbourside Ocean Pools of the Sydney Metropolitan Region (2005). The version viewed by WRL is dated “reprinted 2005”, however, the project brief is dated 1992-1993 and the document sheets are dated 1994. It documented 29 ocean pools and 45 “tidal (harbourside)” pools in the Sydney region, and included a description, history and status of each pool, together with sketches and photos. It contains minor descriptions of some engineering features such as balustrades and the presence of a pump enclosure, but does not provide dimensions, levels, performance or engineering details.

4.3.3 O’Connell (2015)

Mary O’Connell (2015) has compiled a series of ocean pool calendars featuring photos and information on ocean pools from Sydney. In a summary page for the 2016 calendar, she noted:

> “There were two distinct periods of construction or expansion of Sydney’s ocean rock pools. The later nineteenth century saw early forms of public private alliances as local authorities built pools and leased them to private entrepreneurs or swimming clubs. Both Bronte and Bondi ocean pools were designed by a public works civil engineer, working for the NSW Water Board. These were opened to the public in the early 1890s while Randwick Council had excavated their Coogee pools as early as 1874.

The second period of creation, particularly on the Northern Beaches, was in the 1930s - the Depression era – when councils built pools with unemployed labour gangs. Les Murray's poem, The Ocean Baths, honours them …"

4.3.4 Web sites

There are numerous web sites devoted to ocean pools. Examples include:

- Ocean pools NSW: https://oceanpoolsnsw.net.au/; and
- All into ocean pools: https://allintooceanpoolsinc.org/.

4.4 Changes since original ocean pool construction

The following factors have changed in Australia since the original construction of ocean pools from the 1890s to 1930s.

Engineering:

- Higher safety standards and duty of care for public assets;
- Advances in coastal engineering and understanding of coastal processes;
- Improvements in pump technology;
- Sea level rise and its potential acceleration; and
- Wider availability of less corroding or non-corroding reinforcement for concrete (e.g. galvanised steel, stainless steel, glass fibre, basalt fibre).

Socio-political:

- Active shark management strategies in NSW and Queensland;
- Longer life expectancy and longer retirement;
- Higher standards of surf life saving and professional lifeguards, and increased employment of professional lifeguards;
- The growth of recreational surfing;
- Increased awareness of sun safety;
- The proliferation of (inland) fresh water Olympic pools using filtered, treated water;
- Generally improved swimming ability in people raised in Australia; and
- Improvements in access for people with a disability.

5 Investigations of other ocean pools

5.1 Scope

WRL's scope involved investigating four ocean pools in detail, namely:

- Dee Why;
- North Curl Curl;
- South Curl Curl; and
- Freshwater.

Based on information provided by Yorke Peninsula Council, WRL also compiled details of Edithburgh tidal pool.

The main criteria for selecting the four Sydney pools were:

- They are well known to WRL engineers, who have long term knowledge of these pools as residents, surf life savers and swimmers;
- They cover a range of aspects, attachment to land, wave exposure, wave overtopping and safety; and
- They have different cleaning regimes and apparent water quality.

WRL engineers Ian Coghlan, Chris Drummond and James Carley completed drone (Figure 5.9 and Figure 5.22) and RTK GPS surveys (Figure 5.1) of these pools and their surrounding rock platforms. These were combined with existing published seabed surveys and seabed composition maps (Gordon and Hoffman, 1989) to develop an approach path for ocean waves into the pools.

In addition to observations and measurements by WRL engineers, interviews were undertaken with present and retired Northern Beaches Council staff involved with the management and renovation of these pools, together with regular users. Maintenance costs for ocean pools are presented in Section 16.

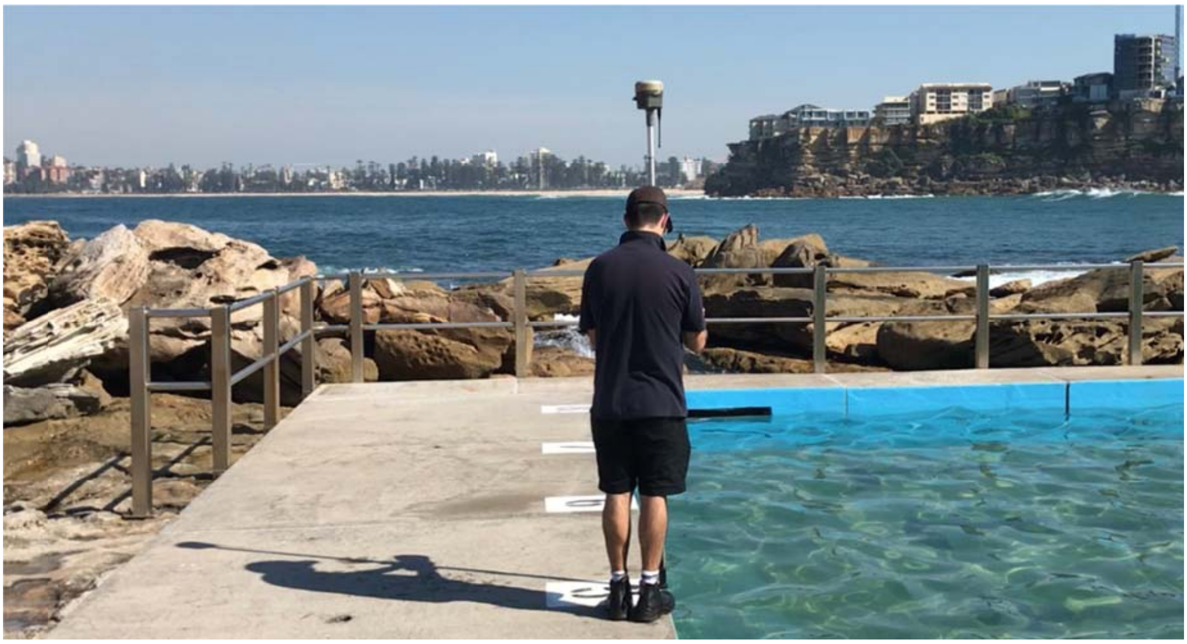


Figure 5.1 GPS surveys of Dee Why (top) and Freshwater (bottom)

5.2 Dee Why ocean pool

Dee Why ocean pool is shown in Figure 5.2. It comprises a main pool (50 m x 19 m), a children's/wading pool (21 m x 11 m) and steps/bleachers for public space (~400 m^2). The seaward wall crest is 1.8 m AHD. The main pool depth varies from 1.7 m to 0.7 m, while the wading pool varies from zero to 0.7 m. The dimensions, including depths are summarised in Section 5.7. Land based surveys undertaken by WRL were combined with the most recent seabed maps for Sydney to create transects offshore from the pool as shown in Figure 5.3, Figure 5.4 and Figure 5.5.

Figure 5.2 Dee Why ocean pool (Source: NearMap)

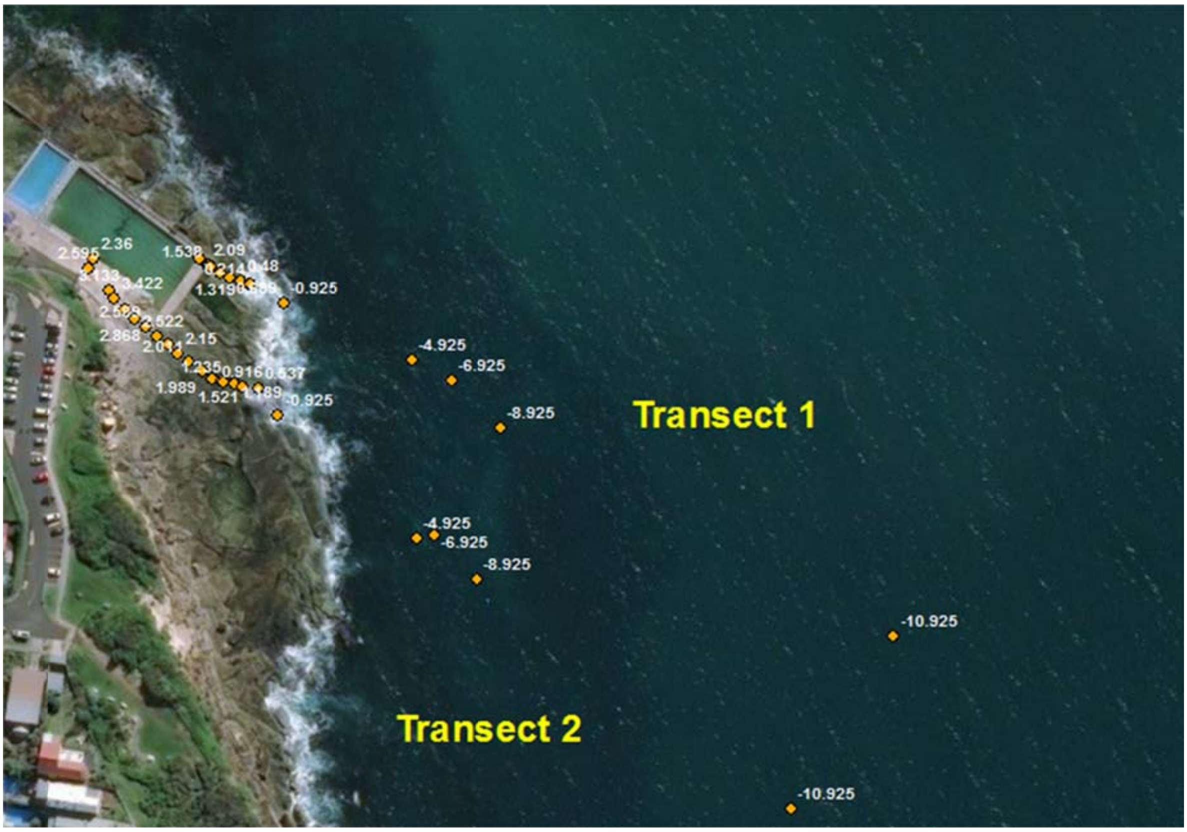


Figure 5.3 Dee Why transect locations

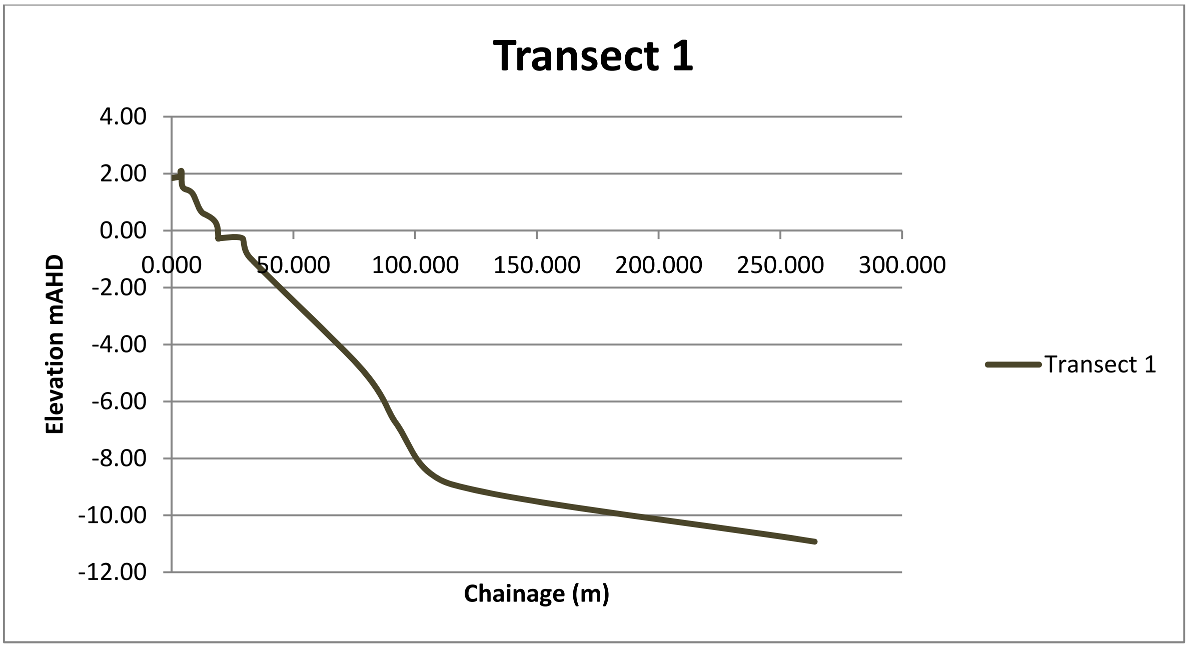


Figure 5.4 Dee Why transect 1

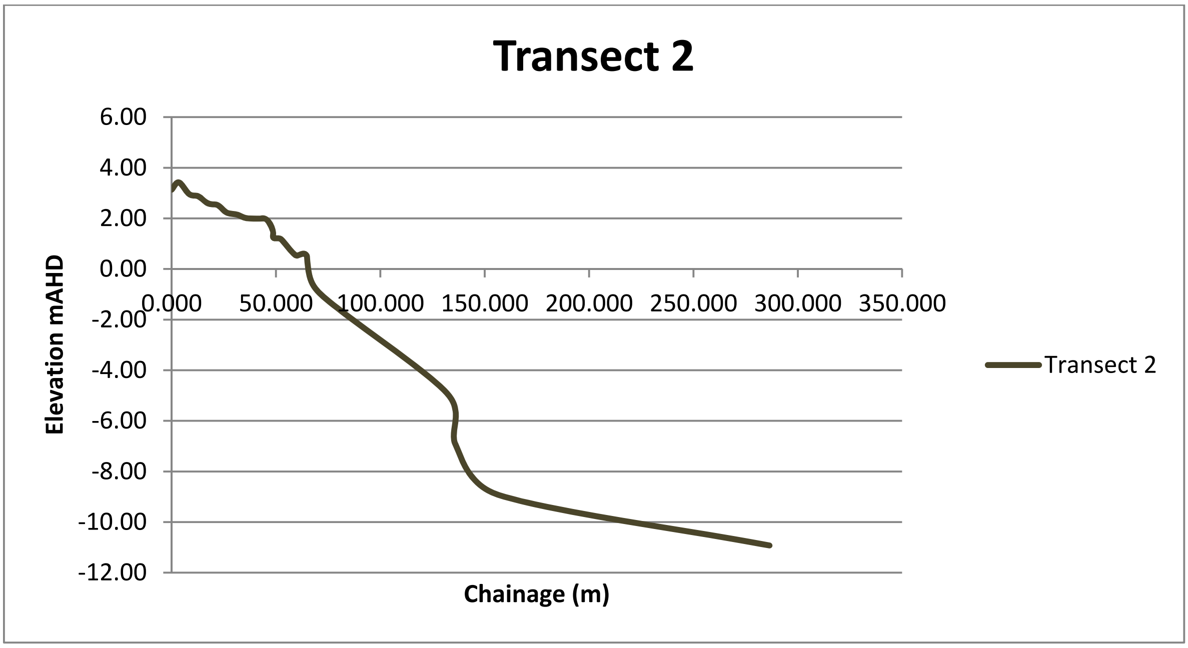


Figure 5.5 Dee Why transect 2

The walls and floor are concrete. The children's/wading pool is painted with blue chlorinated rubber paint, with a non-slip aggregate incorporated into the paint on the floor.

Under ambient conditions it receives very little wave flushing, consequently it utilises two Tsurumi pumps with the following characteristics: Model 80SFQ27.5, 80 mm bore, 3-phase, 2,000 L/minute (33 L/s), 123 kg.

Dee Why pool takes about 1 hour to drain and about 8 hours to fill.

Dee Why pool is cleaned fully once per week for most of the year and partly drained and refilled overnight in the middle of the weekly cleaning cycle. It still suffers from poor water quality during the peak of summer.

Sand ingress into the pool is minor and is able to be washed out as part of normal pool cleaning.

Boulders are transported into the pool during major storms about every 5 to 10 years.

The pool is dangerous about 1 to 6 times per year (Figure 5.6 and Figure 5.7), but the attachment to the land and stepped nature of the pool surrounds (Figure 5.6) allows for safe refuge.

The northerly aspect and cliff/bleachers on its southern side make this pool pleasant in winter.

Figure 5.6 Dee Why wave overtopping (1)

A bike rider gets 'salted' at Dee Why. Picture: Jenny Peachey

Figure 5.7 Dee Why wave overtopping (2)

5.3 North Curl Curl ocean pool

North Curl Curl ocean pool is shown in Figure 5.8. It comprises a main pool (33 m x 12 m) and a natural children's/wading pool (33 m x 11 m). There is minimal constructed public space, but substantial natural rock shelves. The seaward wall crest is 1.6 m AHD. The main pool depth is about 1.2 m, while the wading pool varies from zero to 1.2 m. The dimensions, including depths are summarised in Section 5.7. Land based surveys undertaken by WRL were combined with the most recent seabed maps for Sydney to create transects offshore from the pool as shown in Figure 5.10 and Figure 5.11

Figure 5.8 North Curl Curl ocean pool location (Source: NearMap)

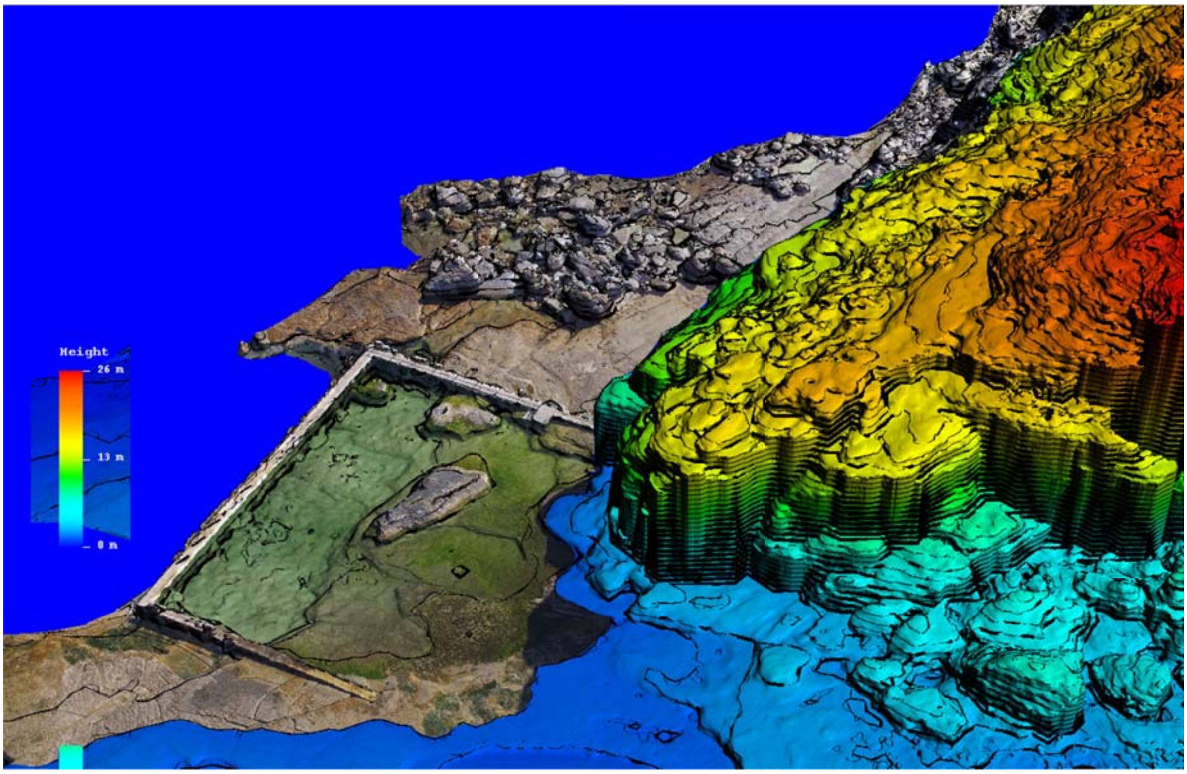


Figure 5.9 North Curl Curl ocean pool terrain

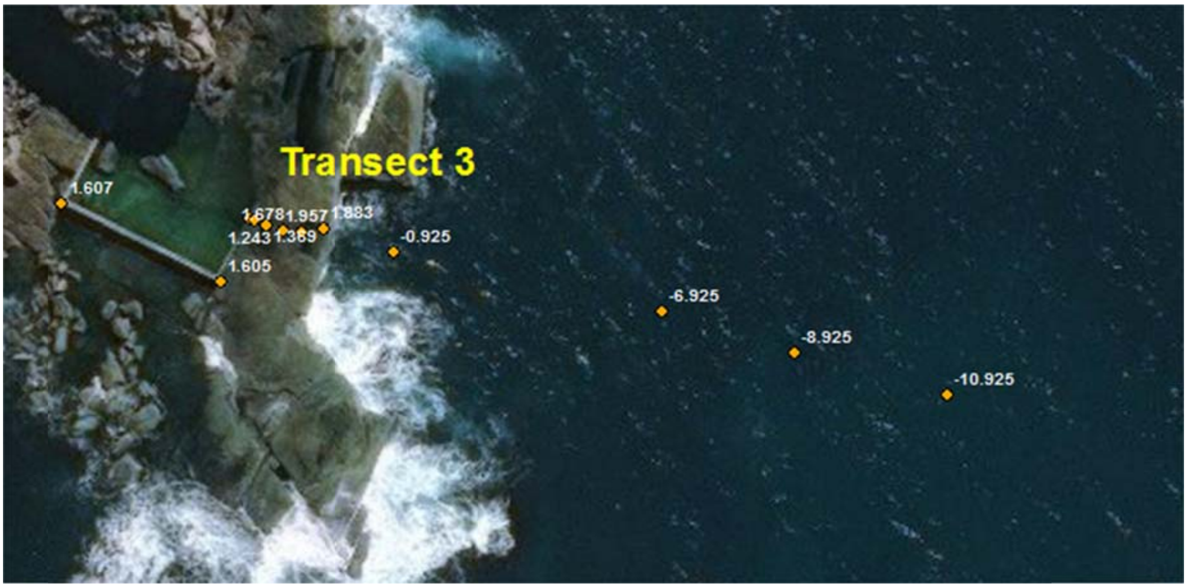


Figure 5.10 North Curl Curl transect locations

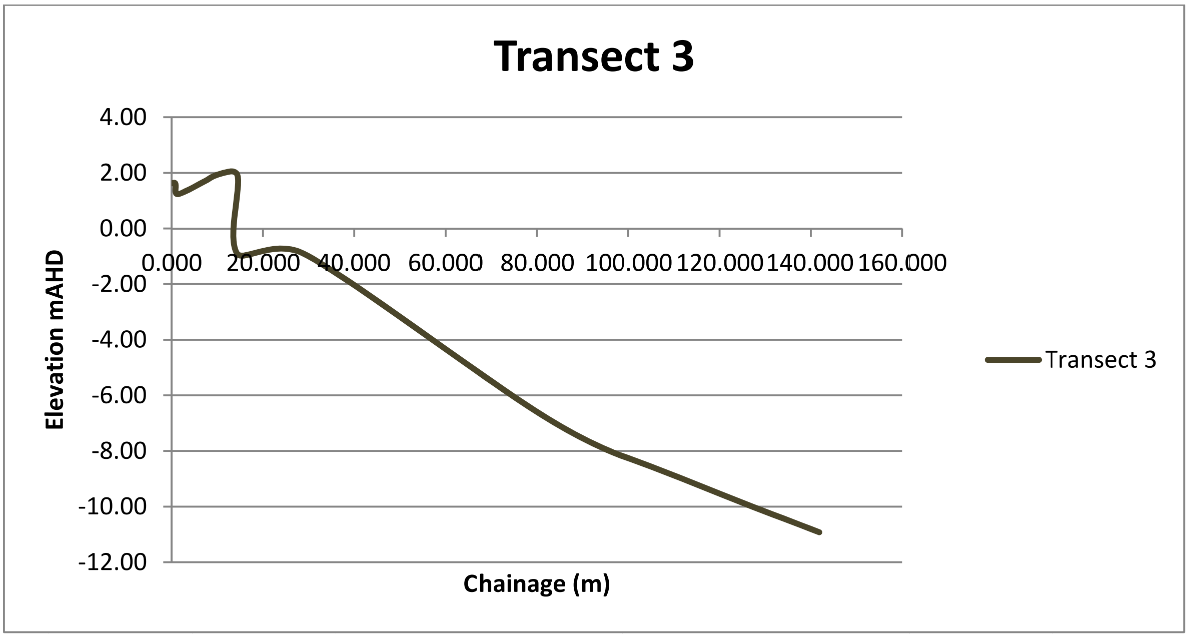


Figure 5.11 North Curl Curl ocean pool transect 3

This pool is quite remote by Sydney standards. Access can be gained around the foreshore during very low tides, or via a remote bush path and very steep steps.

The walls are concrete while the floor is a mix of rock and sand.

There is no pump.

North Curl Curl pool is cleaned about twice per year, to remove algae/slipperiness from the steps by water blasting and/or algaecide. The pool is half drained to do this.

Because of the low intervention, the pool supports its own ecosystem, however, this includes numerous sea urchins. The walls are covered in a variety of organisms, some of which are soft, but some of which are hard and sharp, which can result in cuts to the feet of swimmers if they push off the walls hard.

Due to its wave exposed location, the water quality is generally good. However, as there is no pump, during hot weather with small waves and low tides, the pool can harbour “pelican itch” – a parasite/lice carried by birds which buries into human skin and dies, causing significant itching.

Sand ingress into the pool is minor due to its remoteness from the sandy beach and seabed.

Boulders are transported into the pool during major storms about every 5 to 10 years, and sometimes damage the pool balustrade (Figure B.3).

The pool can be dangerous even in ambient conditions during high tides - about once per week to once per fortnight (Figure 5.12 to Figure 5.14). Numerous injuries due to wave overtopping have occurred at this pool. Christopher Drake died at this pool and his death was the subject of a coronial inquest in 2014 (MacMahon, 2014). The pool is close to an island type in form, with only a minor connection to the land. This accentuates its danger, as swimmers can be washed out of the leeward side of the pool into the surf and rips.

The known danger of this pool means that it is actively managed during patrol season (Figure 5.15).

Figure 5.12 North Curl Curl ocean pool overtopping (1)

Source: Pamela Pauline, australianphotography.com

Figure 5.13 North Curl Curl ocean pool overtopping (2)

Source: amandabauer.blogspot.com

Figure 5.14 North Curl Curl ocean pool overtopping (3)

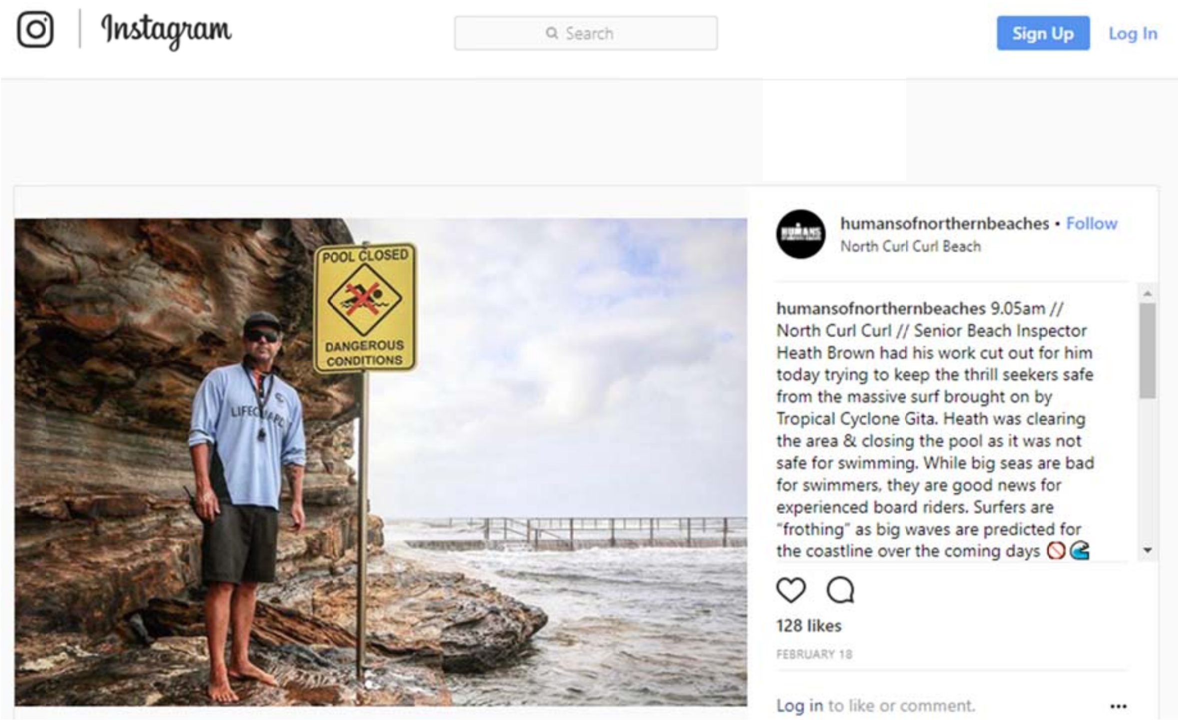


Figure 5.15 North Curl Curl ocean pool closure

5.4 South Curl Curl ocean pool

South Curl Curl ocean pool is shown in Figure 5.16. It comprises a main pool (50 m x 13 m), a children's/wading pool (30 m x 15 m) and a promenade/public space (~240 m^2). The seaward wall crest is 1.5 m AHD. The main pool depth varies from 1.6 m to 1.2 m, while the wading pool varies from zero to 0.7 m after they have been emptied of sand. The dimensions, including depths are summarised in Section 5.7.

Land based surveys undertaken by WRL were combined with the most recent seabed maps for Sydney to create transects offshore from the pool as shown in Figure 5.17 and Figure 5.18.

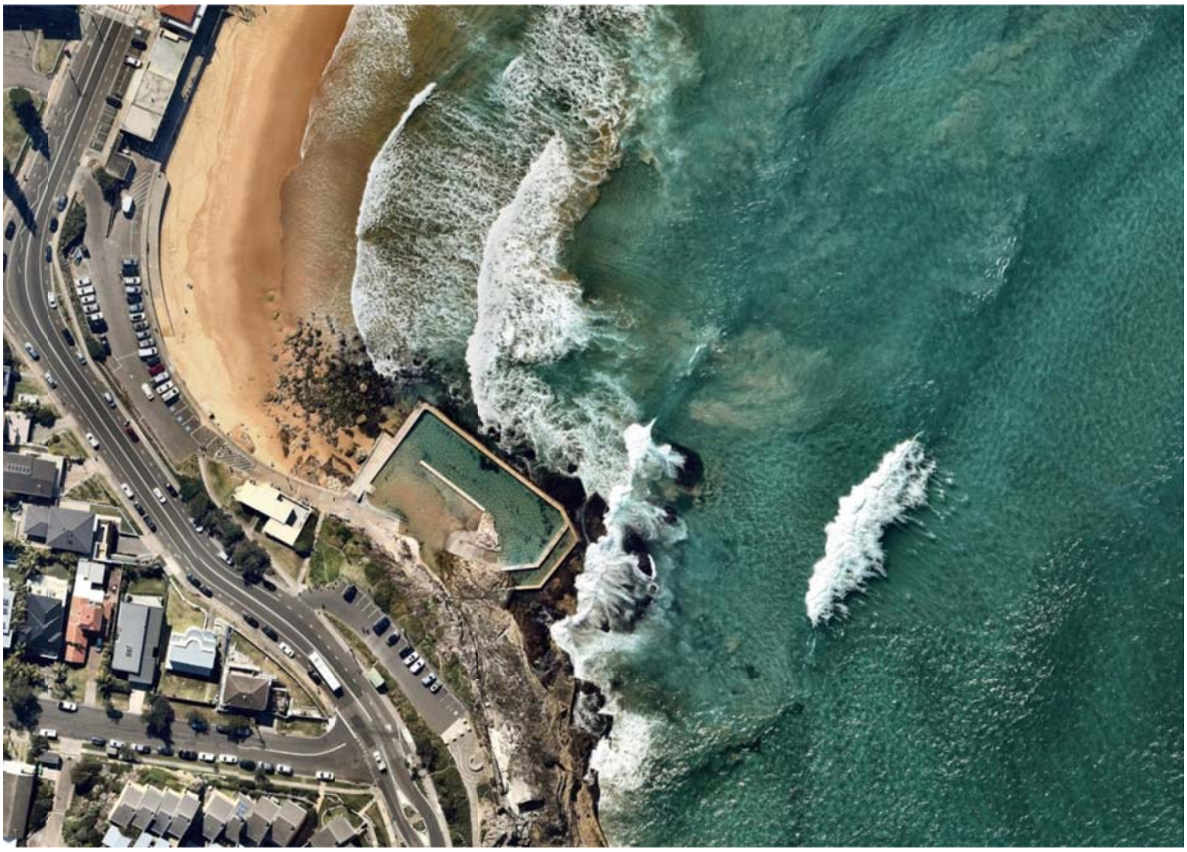


Figure 5.16 South Curl Curl ocean pool location (Source: NearMap)

Figure 5.17 South Curl Curl transect locations

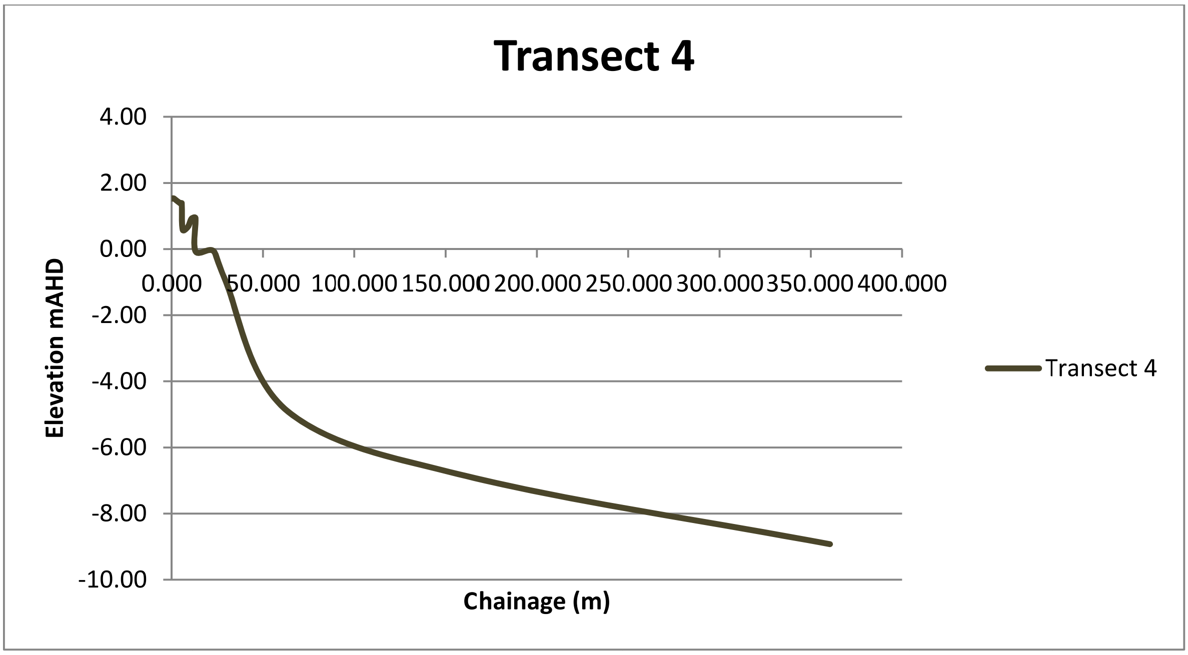


Figure 5.18 South Curl Curl ocean pool transect 4

The walls are concrete and painted with blue chlorinated rubber paint. The floor is a combination of concrete, excavated rock and sand. There is level access from an adjacent car park and a ramp into the wading pool.

Under ambient wave conditions at high tide, it receives substantial wave flushing. It is equipped with a Tsurumi pump with the following characteristics: Model 80SFQ27.5, 80 mm bore, 3-phase, 2,000 L/minute (33 L/s), 123 kg. However, due to wave flushing, the pump is only required when waves are very small.

South Curl Curl pool takes about 1 hour to drain and about 8 hours to fill.

South Curl Curl pool is cleaned once per week for most of the year. It rarely suffers from poor water quality, except during the peak of summer at the end of the weekly cleaning cycle.

Sand ingress into the pool is substantial when wave heights are moderate to large (significant wave height; Hs, above about 2 m). It is estimated that there are about five sand removal campaigns with a bobcat per year and about four with a loader excavator, that is, nine on average (Figure 5.19). This amounts to about $13,000 per year in sand removal expenses by a contractor.

The pool regularly accumulates small quantities of seaweed, and occasionally fills with more substantial quantities of it. Occasionally seaweed mixes with sand on the bed and eutrophies, forming a malodorous sludge, which needs to be removed by machine.

Boulders are transported into the pool during major storms about every 5 to 10 years.

The pool is dangerous about 6 to 12 times per year (Figure 5.20), but its attachment to the elevated surrounding land allows for safe refuge, and serious incidents are rare.

The northerly aspect and cliff/promenade on its southern side make this pool pleasant in winter.

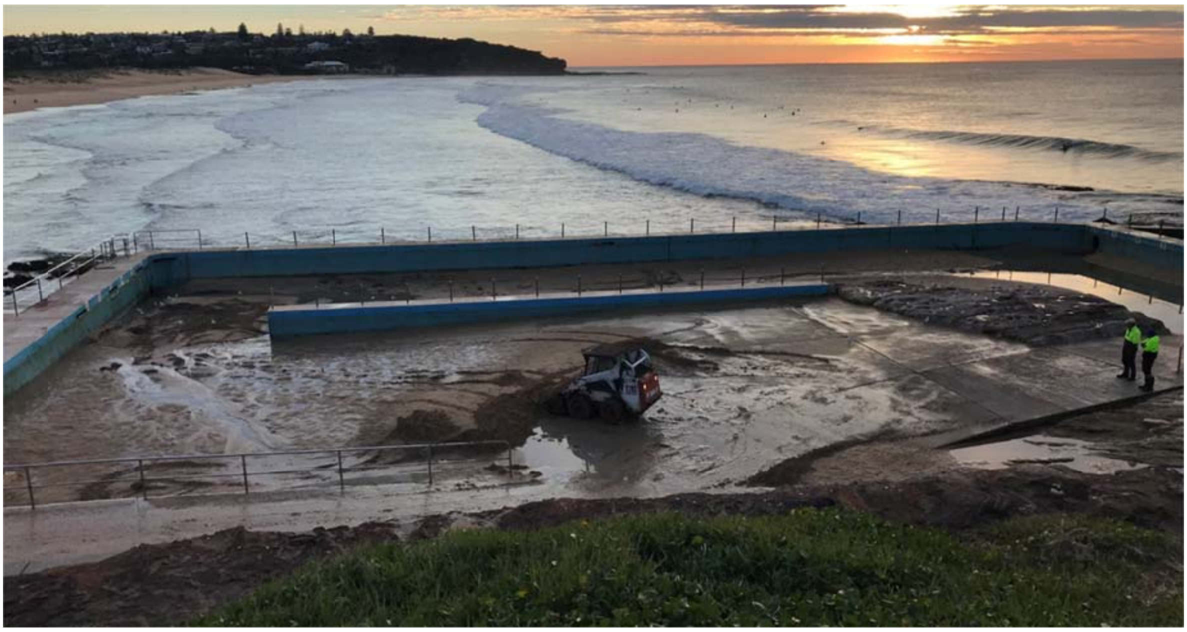


Figure 5.19 South Curl Curl ocean pool sand removal

Figure 5.20 South Curl Curl ocean pool overtopping

5.5 Freshwater ocean pool

Freshwater ocean pool is shown in Figure 5.21. It comprises a main pool (50 m x 18 m) and a promenade/public space (~420 m^2). There is no children's/wading pool, which results in occasional collisions/conflicts between users, noting that there are nearby small natural rock pools. The seaward wall crest is 1.5 m AHD. The main pool depth varies from 1.7 m to 1.2 m. The dimensions, including depths are summarised in Section 5.7. Land based surveys undertaken by WRL were combined with the most recent seabed maps for Sydney to create transects offshore from the pool, as shown in Figure 5.23 to Figure 5.25.

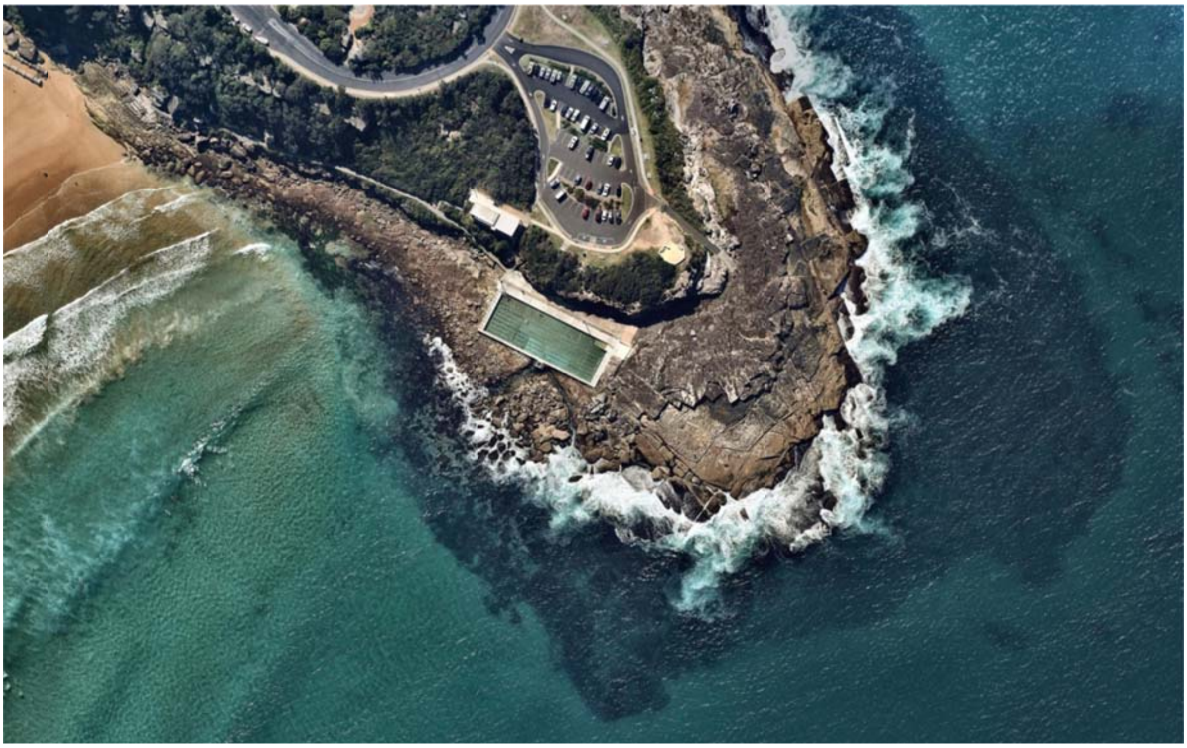


Figure 5.21 Freshwater ocean pool location (Source: NearMap)

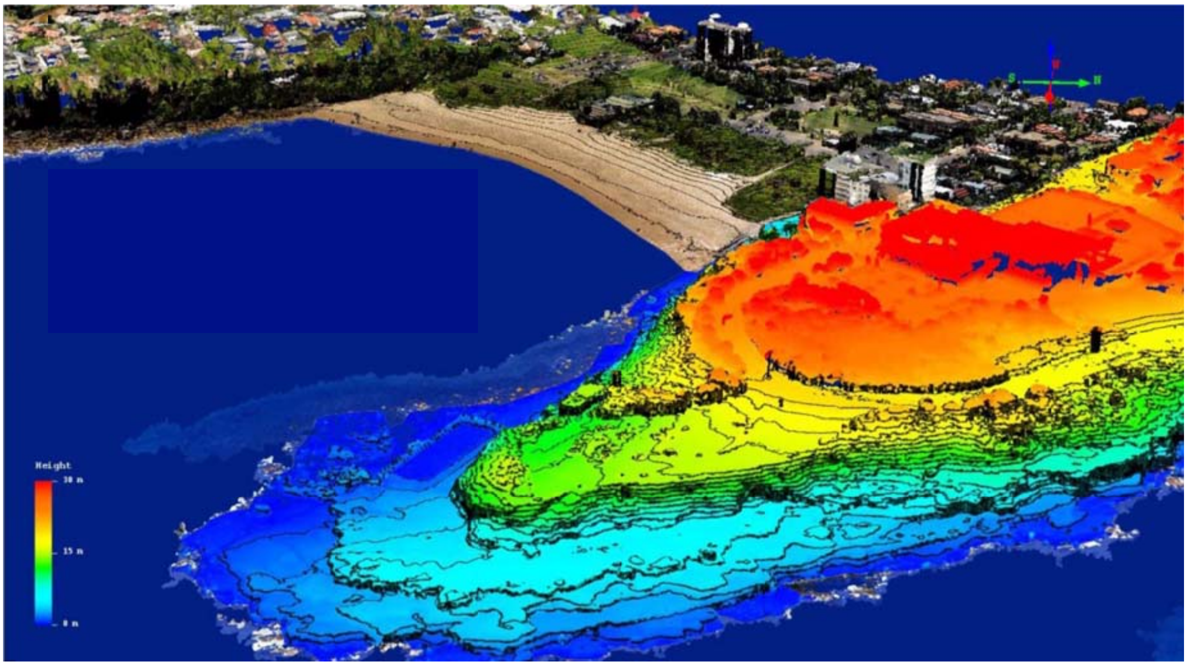


Figure 5.22 Freshwater ocean pool terrain

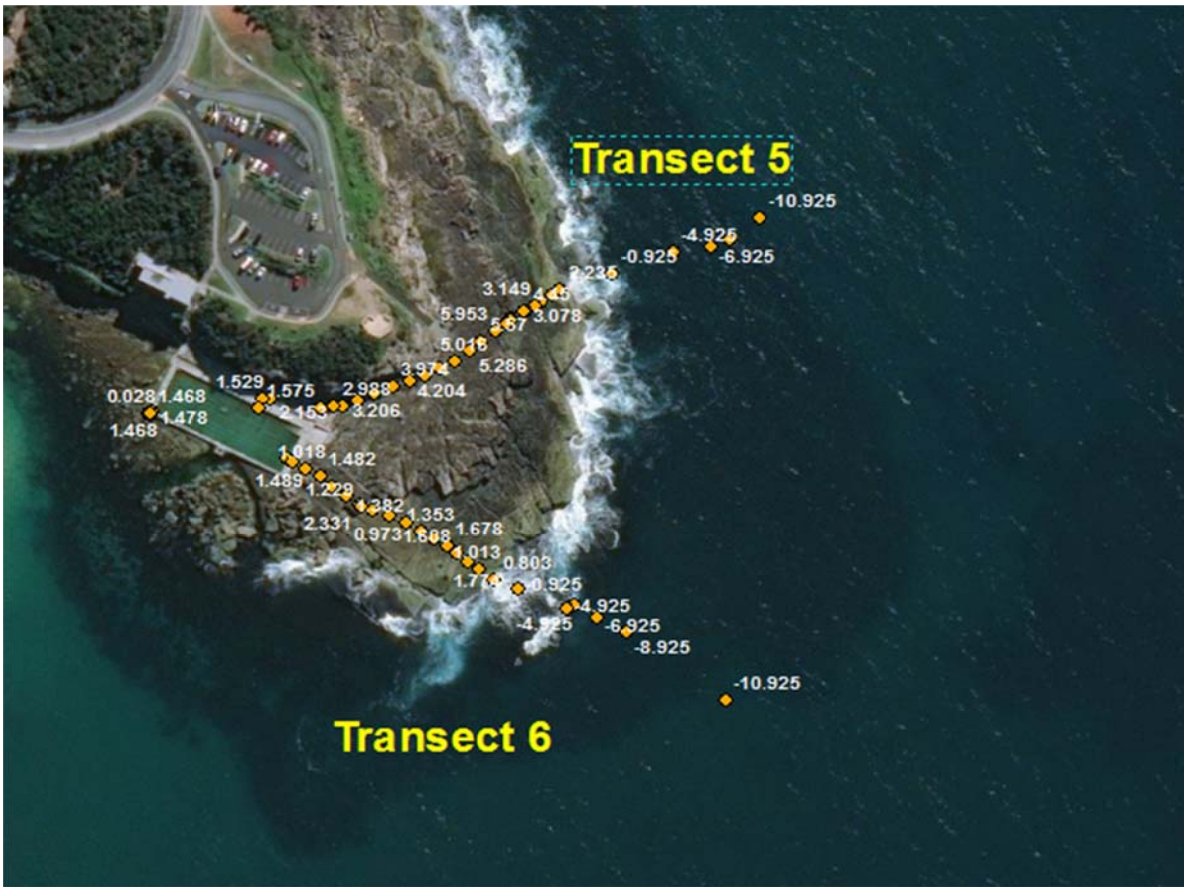


Figure 5.23 Freshwater transect locations

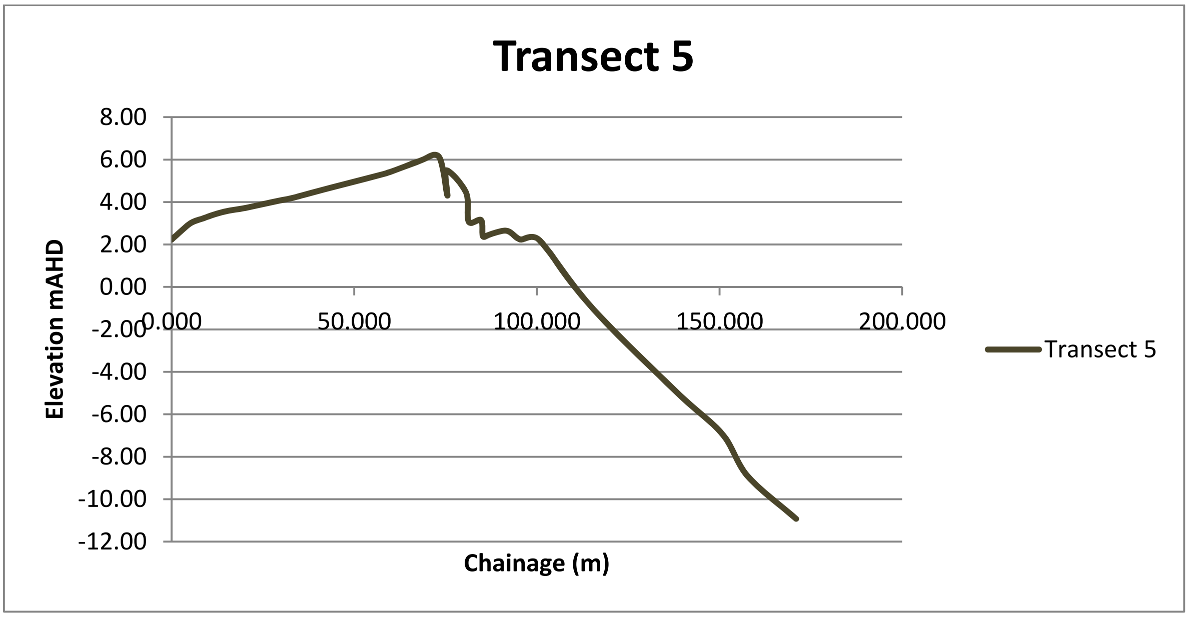


Figure 5.24 Freshwater transect 5

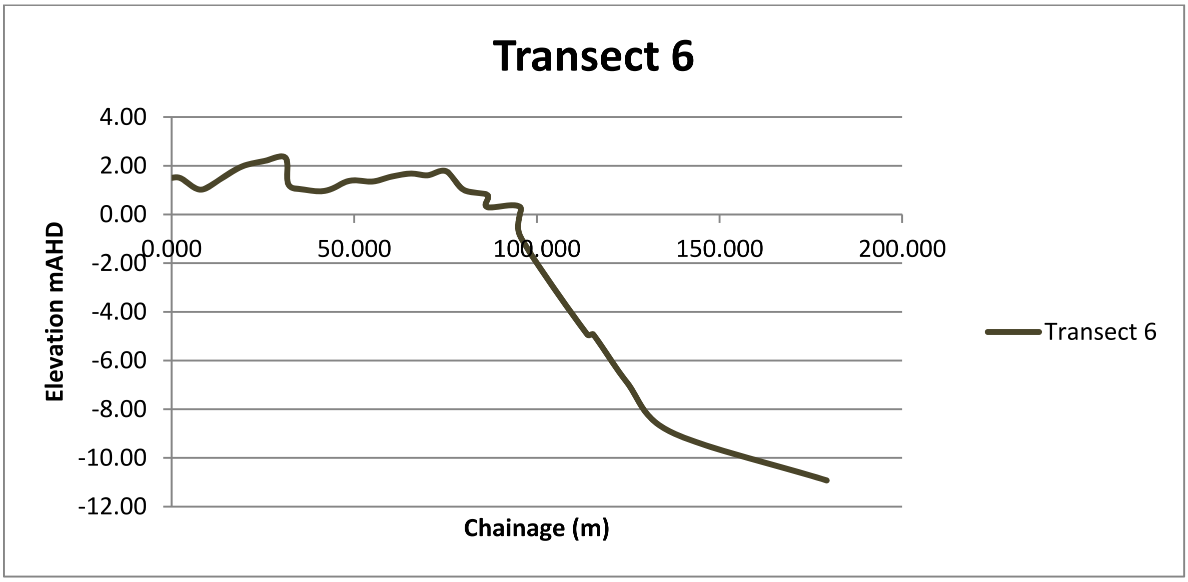


Figure 5.25 Freshwater transect 6

The walls are concrete and painted with blue chlorinated rubber paint. The floor is concrete with black painted lane lines. There is stair access from an adjacent car park, plus a pathway from the nearby beach and steep/rough ramp access for service vehicles and machines. There is a ramp with a gradient of about 1V:4H into the pool which is wide enough for service vehicles.

Except during very high tides and/or large waves, it receives minimal wave flushing. It is equipped with a Tsurumi pump with the following characteristics: Model 80SFQ27.5, 80 mm bore, 3-phase, 2,000 L/minute (33 L/s), 123 kg. This pump is run a large proportion of the time to maintain water quality.

Freshwater pool takes about 1 hour to drain and about 8 hours to fill.

Freshwater pool is cleaned fully once per week for most of the year and partly drained and refilled overnight in the middle of the weekly cleaning cycle during peak months. It still suffers from poor water quality during the peak of summer.

Sand ingress into the pool is minor and is able to be washed out as part of normal pool cleaning.

Boulders are transported into the pool during major storms about every 10 years.

The pool is dangerous about once (1) per year, but the attachment to the land and stepped nature of the pool surrounds allows for safe refuge except during extreme storms, when overtopping water approaches via Transect 5 in Figure 5.24.

The pool sometimes accumulates small quantities of seaweed which is removed as part of normal cleaning.

Its location on the southern side of a cliff means that it is colder than other locations in winter, but is well protected from summer north-east winds. Therefore, it is only lightly used in winter, but is heavily used in summer.

5.6 Edithburgh tidal pool

Details of the Edithburgh tidal pool were provided by Yorke Peninsula Council, with substantial additional details provided in the document “Edithburgh Swimming Pool” by Meridith Clifford (2008) for Edithburgh Museum Inc.

An aerial photo of the pool is shown in Figure 5.26. Historic photos are shown in Figure 5.27 to Figure 5.32.

Note: Image quality is poor in Google earth and Nearmap (Source: Nearmap)

Figure 5.26 Edithburgh tidal pool 2005

Figure 5.27 Edithburgh tidal pool 1930s (Clifford, 2008)

Figure 5.28 Edithburgh tidal pool 1930s (Clifford, 2008)

Note: Pool is empty. Leaks are common in many ocean pools

Figure 5.29 Edithburgh tidal pool 1930s -1940s (Clifford, 2008)

Figure 5.30 Edithburgh tidal pool 1940s -1950s (Clifford, 2008)

Figure 5.31 Edithburgh tidal pool 1970s (Clifford, 2008)

Figure 5.32 Edithburgh tidal pool extension 1992 (Clifford, 2008)

The pool is now about 25 m long and between 8 and 12 m wide. Survey drawings from Yorke Peninsula Council indicate the seaward wall of the pool is at 0.01 to 0.09 m AHD, that is, just above mean sea level. The pool floor is shown to be as low as -1.07 m AHD, and much shallower on the western side, giving a maximum water depth of about 1 m.

Clifford (2008) reported the following.

> "Dr Flood, a former mayor of Yorketown (1882-1883) was observed to be building a tidal pool in 1885, however, he died before it was completed and it was abandoned. Steps were constructed to separate bathing beaches for men and women.
>
> The cliff face was terraced in 1930 and the first pool constructed in 1933. The outer wall was shattered in a north-easterly gale in 1934, but was rebuilt and stood for a further 50 years. Public space (a balcony/viewing area) was also constructed. A shark net was installed outside the pool in 1981, but was discontinued due to prohibitive maintenance costs – predominantly due to vandalism.
>
> The pool was redeveloped in 1983-1984, which involved terracing, a balcony, dressing sheds, toilets and landscaping. This had a budget of $229,000, funded through a Commonwealth grant of $165,000 and a contribution from the Edithburgh Progress Association of $64,000. This was also a job creation project, employing 25 people for 20 weeks.
>
> The pool was lengthened and deepened with a grant of $10,000 in 1991-1992."

The present pool does not have pump. With a crest at about mean sea level, it is flushed by waves/tides most days. Council reports that it is drained and cleaned once or twice per year, during which sand and rocks are removed from the pool. Boulders are washed into the pool during large north to east wind wave events. Waves wash into the pool during high tides, but the landward pool surrounds are quite elevated, so people can escape readily.

5.7 Summary of pool dimensions

A summary of pool dimensions for the five ocean pools studied in detail, and a sixth pool at Collaroy in Sydney, are shown in Table 5.1, with additional information on wall and water levels in Table 5.2. As noted in the table, (most of) these pools contain the following elements:

- A main swimming (lap) pool;
- A smaller children's/wading pool; and
- Constructed public space.

Pool	Wall level (m AHD)	Length (m)	Width (m)	Deep depth (m)	Shallow depth (m)	Area (m^2)	Volume (m^3)
Main pool							
Collaroy		50	25			1,250	
Dee Why	1.8	50	19	1.7	0.7	950	1,140
North Curl Curl	1.6	33	12	1.2	1.2	396	475
South Curl Curl	1.5	50	13	1.6	1.2	650	910
Freshwater	1.5	50	18	1.65	1.2	900	1,283
Edithburgh	0.0	25	10	1.0	0.5	250	190
Children's/wading pool							
Collaroy		15[a]	15[a]		0	225	
Dee Why		21	11	0.7	0	231	81
North Curl Curl		33	11	1.2	0	363	218
South Curl Curl		30	15	0.7	0	450	158
Freshwater		n/a	n/a	n/a	n/a	n/a	n/a
Edithburgh		n/a	n/a	n/a	n/a	n/a	n/a
Constructed public space							
Collaroy		[b]	[b]			530	
Dee Why		50	8			400	
North Curl Curl		0	0			0	
South Curl Curl		40	6			240	
Freshwater		60	7			420	
Edithburgh		[c]	[c]			400 [c]	

Notes: a: Main pool is equivalent to wading pool ; b = irregular; c: 300 to 400 m^2 plus barbeque shed plus grassed area.

Table 5-1 Dimensions of six ocean pools

In addition, WRL has acquired the seaward wall levels from numerous other ocean pools from a range of sources, including direct surveys by WRL associated with other projects. While these levels are useful, the propagation of waves into a pool is also dependent on the pool's location, coastal exposure and geometry of the surrounding rock shelf and seabed, rather than just the level itself. These levels are shown in Table 5.2. It can be seen that the wall level of most NSW pools is well above the mean high water springs (MHWS) tide level, with most above the 1 year ARI water level. These pools rely on the generally moderate wave climate (and/or pumps) to achieve flushing of the pool. Complex wave propagation and overtopping processes need to be modelled to quantify this (Section 11).

Pool	Source	Seaward wall level (m AHD)	MHWS[a] or MHHW[b] (m AHD)	Median Hs[c] (m)	1 year ARI WL[d] (m AHD)
Dee Why	WRL survey	1.8	0.65	1.6	1.24
North Curl Curl	WRL survey	1.6	0.65	1.6	1.24
South Curl Curl	WRL survey	1.5	0.65	1.6	1.24
Freshwater	WRL survey	1.5	0.65	1.6	1.24
Sawtell	UNSW Aviation LiDAR	1.8	0.65	1.5	1.24
Black Head	UNSW Aviation LiDAR	2.0	0.65	1.2	1.24
Forster Pool	UNSW Aviation LiDAR	1.6	0.65	1.0	1.24
The Entrance Baths	WRL RTK-GPS	2.0	0.65	1.2	1.24
Pearl Beach	WRL RTK-GPS	0.94	0.65	1.2	1.24
Bilgola Pool	UNSW Aviation LiDAR	1.9	0.65	1.6	1.24
Mona Vale Pool	UNSW Aviation LiDAR	1.5	0.65	1.6	1.24
North Narrabeen Pool	WRL RTK-GPS	1.4	0.65	1.2	1.24
Queenscliff Pool	WRL CDD Drone	1.6	0.65	1.6	1.24
Bondi North inner	UNSW Aviation LiDAR	1.0	0.65	1.6	1.24
Bondi North outer	UNSW Aviation LiDAR	0.5	0.65	1.6	1.24
Bondi Icebergs	UNSW Aviation LiDAR	2.4	0.65	1.0	1.24
Ross Jones Coogee	UNSW Aviation LiDAR	1.0	0.65	0.8	1.24
Wylie's Baths Coogee	UNSW Aviation LiDAR	1.0	0.65	0.8	1.24
Edithburgh SA	Tonkin drawing 20161486.01A	0.0	0.9	0.5	?

a. MHWS is mean high water springs as defined by MHL tide tables and applies to NSW locations
b. MHHW is mean higher high water as defined by Australian National Tide Tables and applies to Edithburgh
c. These are estimates by WRL using coastal engineering judgement, with some values based on published measurements
d. Excludes wave setup

Table 5-2 Crest levels of ocean pool walls

6 Hallett Cove geology

6.1 Preamble

Coastal Environment (2012) reported the following with regard to Hallett Cove:

6.2 Geology introduction

“The Hallett Cove Conservation Park and the Hallett Headland Reserve showcase the unique and world-renowned geology of the area, including the high cliff line from Marino to Black Cliff, the amphitheatre and sugarloaf within the Hallett Cove Conservation Area, and the high cliffs to the south along Hallett Headland, including the Hallett Headland Reserve. The beach itself is unique, with the exposure of shingle and clay substrate originating from the present-day erosion of the cliffs and reefs and the remnant glacial till. Large isolated rocks (erratics) are exposed along the beach, and occasional thin patches of sand mask the underlying shingle. The Field River entrance across the beach and the unique riparian vegetation along the river banks offer a different experience for passive recreation.”

6.3 Geological and geomorphological background

“The geological significance of the area was first recognised by Professor Ralph Tate of the newly formed University of Adelaide who in 1877 discovered the visible signs of glaciation along the coastal cliffs (Dolling 1981). This glaciation, which was evident along approximately 2 km of the cliff shoreline, has subsequently been identified as the result of a glacier traversing the area from south to north in the Permo-Carboniferous age (Hasenohr & Corbett 1986), almost 270 million years ago. Striations in the basement rock caused by scratches from rocks embedded in the glacial ice are visible on the rock shelf at the cliff top near Black Rock at the northern end of Hallett Cove (Plate 0-6, [WRL Figure 6.1]). The Precambrian surface of these purple siltstones (believed to be some 600 million years old) was polished and scratched by the movement of the glacier. These Precambrian sandstones and siltstones of the Marinoan Series are exposed today as the cliff line reaching north from Black Cliff and as the lower level rocky shoreline platform at the base of the cliffs. They are exposed once more along the cliff line to the south of Hallett Cove (Hasenohr & Corbett 1986).”

Plate 0-6: Exposure of 600 million year old Precambrian siltstones at the top of Black Cliff, Hallett Cove. The polished surface and deep scratches caused by the passage of a glacier approximately 270 million years ago were first recognised by Professor Ralph Tate of the University of Adelaide in 1877. Photo: Coastal Environment Pty Ltd, 27 April 2011

Figure 6.1 Exposure of 600 million year old Precambrian siltstones (CE, 2012)

"The significance of these geological finds has been recognised as being of national and global importance. In 1893 an expedition to the site was organised by the Australasian Association for the Advancement of Science and included 150 local and visiting geologists and other interested persons. This expedition was described at the time as the largest scientific expedition ever undertaken in the southern hemisphere. Following the retreat of the glacier, sediments were deposited along its route, infilling an old river valley that formerly occupied Hallett Cove. The nature of these Permian sediments within the amphitheatre area (Plate 0-7 [WRL Figure 6.2]) suggests they were deposited in a lake formed by melt water trapped behind the retreating ice towards the end of the glaciation (Hasenohr & Corbett 1986). 'The soft Permian glacial deposits, overlaid by more recent clays, became in time deeply eroded, gradually carving the formation now known as the "Amphitheatre."' (Dolling 1981)."

Plate 0-7: The sugarloaf and amphitheatre within the Hallett Cove Conservation Area 2011. Photo: Coastal Environment Pty Ltd, 27 April 2011

Figure 6.2 The Sugarloaf and Amphitheatre (CE, 2012)

"The periods of glacial deposition, subsequent sedimentary deposits and then erosion by surface runoff and rising sea levels to the current still stand (about 6,000 years BP) are all reflected in the present-day shoreline of Hallett Cove. At the base of the cliffs to the north and south is a narrow wave cut rock platform, visible from the air for about 50 m width from the low water line and to an approximate depth of around 3 m below mean sea level. This bedrock presumably underlies the beach and much of the remaining sedimentary deposits in the amphitheatre and forms the modern land surface of Heron Way Reserve and the subdivisions landward of the beach to the north and south of the Field River. The depth and continuity of this rock substrate could only be confirmed by drilling or seismic survey."

"The shingle comprising much of the beach sediment is in part of glacial origin. 'Visible only at low tide is the lowest of these sediments, called by geologists a lodgement till. It is a bed which extends well out to sea with only the surface exposed at the low water mark. The sediments consist of a very fine grained, compacted grey sandy clay containing unsorted (variably sized) clasts or pebbles of rock. Most of these are angular but a small number are rounded. The majority of the pebbles consist of red siltstones or sandstone torn from the underlying Proterozoic bedrock by the advancing ice, but a small number consist of quartzite granite or rocks of volcanic origin.' (Giesecke 1999). Dating of the pollen in this sediment suggests it is of Permian age."

“The erratics have been a popular subject for amateur photographers visiting the beach over many years. In particular, there are two large stones about 50 m south of the Conservation Park boundary which are clearly visible on the earliest photos of Hallett Cove. These two large erratics (Plate 0-8 [WRL Figure 6.3]) are ‘composed of red-brown Proterozoic sandstone and siltstone. These were probably stripped from the bedrock south of Hallett Cove and carried deep in the Permian ice’ (Giesecke 1999). Close examination of these two photos and other available photographs dating back to around 1970 shows very little obvious change in the surface level of the beach at this location. There are slight fluctuations and changes in the texture (sand to gravel) at different dates. The more recent photographs of these erratics (1980s to present) all tend to show gravel or shingle rather than sand. This photographic record is consistent with the limited survey data available which suggests a fluctuation in the surveyed levels at this location on the beach of less than 0.5 m since 1975.”

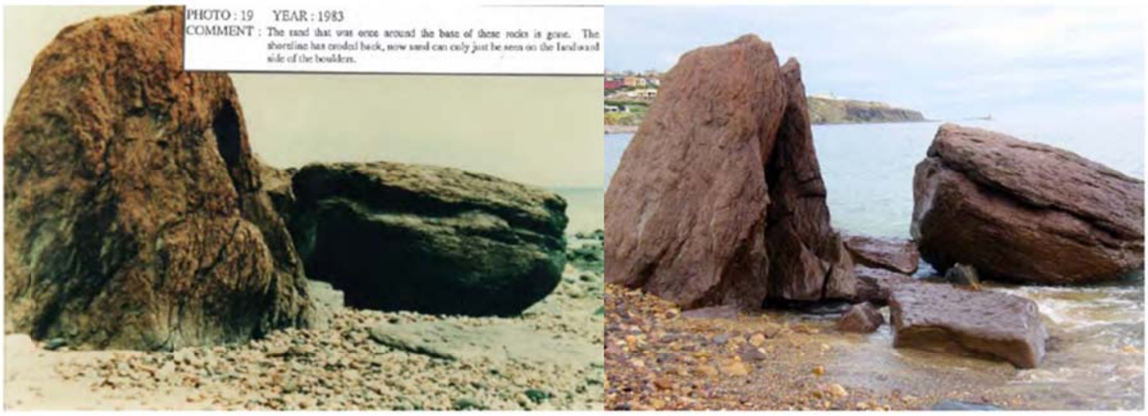


Plate 0-8: Erratics on Hallett Cove Beach. **Photo** (left) taken 1983 (Matschoss & Mayberry). **Photo** (right) taken 29 April 2011 (Coastal Environment Pty Ltd). There appears to be less than 100mm variation in the sediment level around the base of the rocks over a period of almost 30 years

Figure 6.3 The “Erratics” on Hallett Cove Beach (CE, 2012)

“Sea level was significantly lower during the last glacial period and 20,000 years ago would have been about 120 m below the present level. During that period of lower sea level, the current Hallett Cove foreshore was inland and elevated. Erosion of the hinterland to the east and the sediments infilling and seaward of the present shoreline would have been eroded, ‘forming a vast alluvial plain which in the late Pleistocene ice age extended across the present Gulf St Vincent’ (Dolling 1981). During the subsequent Holocene transgression as sea level rose, the Gulf was inundated and the current sea level was achieved approximately 6,000 years ago. Since that time the shoreline has continued to be eroded by wind and waves to form the present shoreline. This geological history is essential to understanding the current structure of Hallett Cove and the way in which it responds to the current-day coastal processes (wind, waves and currents).”

6.4 Geotechnical studies

Coffey Geotechnics (2013) undertook a geotechnical investigation entitled "Heron Way, Hallett Cove Geotechnical and Environmental Investigation" for the City of Marion. Eighteen boreholes were drilled, with all located above the embankment. The drilling machine had a maximum drilling depth of 3 m.

Coffey Geotechnics (2013) noted that "Bedrock was perceived to be encountered at borehole 16 at a depth of 0.9 m. Based on regional geological information, bedrock is expected at relatively shallow depths of less than 30 m." Most other boreholes terminated in fill comprising natural materials, generally sandy clay, clayey sand, sandy gravel, gravelly clay or sandy silt. As stated above, the boreholes were well back from the revetment, only extended a maximum depth of 3 m below ground, and therefore did not extend into the areas where an ocean pool might be located.

6.5 Synthesis of geology and geotechnical studies

The unique geology comprises the whole study area but is only well preserved at the surface to the north of the old surf club. Where areas have been developed to the east and south of the Hallett Cove Conservation area, the surface geology has been reworked, flattened, and in some areas covered with imported fill. There is a strong argument for limiting further works to that area of the foreshore south of the Conservation area only.

The existing geotechnical studies did not probe the intertidal areas where an ocean pool would likely be located. . The borehole information obtained was not designed for this purpose - the boreholes were short and did not generally go below the reworked back beach areas. They provided no additional information on the foundation conditions at potential pool sites. For the project to progress further, geotechnical studies specific to potential pool locations would be needed to allow appropriate selection/design of foundations and construction procedures.

7 Hallett Cove coastal processes

7.1 Tides and water levels

Water levels are composed of the following components:

- Astronomical tides which are forced by the sun and moon;
- Tidal anomalies or residuals which may be forced by wind (wind setup), barometric pressure and trapped waves;
- Wave setup inside the surf zone; and
- Wave runup on beaches, cliffs and structures.

These components are shown in Figure 7.1 and described below.

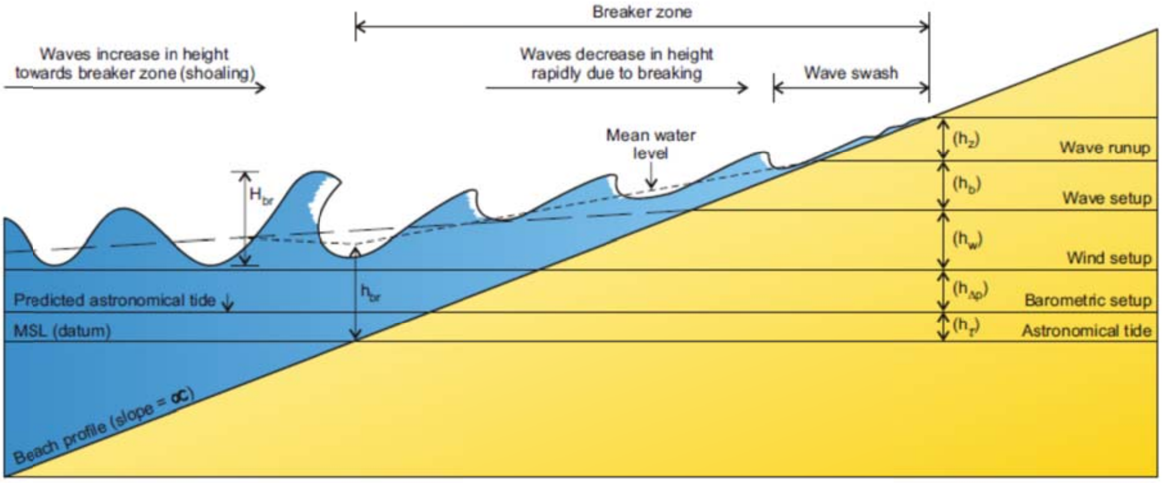


Figure 7.1 Components of elevated water levels (Adapted from NSW DECCW, 2010)

7.1.1 Tides

The main data relevant for Hallett Cove is:

- Outer Harbor Port Adelaide from 1940 to present; and
- Port Stanvac from 1992 to 2010.

Adelaide’s Living Beaches (ALB, 2005) provided the following information on Adelaide’s tides:

> “The tidal range on the Adelaide coast varies from about 2.4 m at spring tides to near zero at neap tides, although winds and atmospheric pressure gradients also cause significant changes in the sea level. Tidal currents in coastal Adelaide waters are essentially north–south alongshore, with speeds up to 0.2–0.3 metres per second (m/s).
>
> Tide levels are measured from a local chart datum (CD), which is different for each major port. By international convention, the datum is set at the calculated lowest astronomical tide (LAT). Tide predictions and measurements for Outer Harbor were converted to this datum on 1 January 2001. At Outer Harbor, LAT is 1.452 m below the AHD, which is consistent across Australia. Table 7.1 shows commonly used tide levels, as determined by Flinders Ports Pty Ltd and published in the tide tables, for Outer Harbor in both CD and AHD.
>
> **Mean high water spring tides and mean high water neap tides**
>
> Tide tables commonly refer to other levels such as mean high water springs (MHWS) and mean high water neaps (MHWN). The former is defined as the average of all twice-daily high tides at spring periods, while the latter is averaged over neap tide periods. Spring tides refer to the periods when the predicted tidal range is at its greatest – when the solar and lunar influences on the oceans work together at or soon after the new or full moon. Neap tides are the periods when the tidal range is smallest, between the new and full moon – when the lunar and solar influences are opposed and cancel each other out to some degree.
>
> **The South Australian sea**
>
> The South Australian sea has resonance periods that influence the separate components of diurnal tidal constituents in such a way that an apparently peculiar tidal behaviour occurs. The effects are different in each of the two gulfs. In Gulf St Vincent, the entrance conditions create an apparent standing oscillation that causes high tide to occur at the same time everywhere in the gulf. Both gulfs also experience an unusual situation known as ‘dodge tides’, which occur near the equinoxes and are due to tidal modifications causing water levels to remain constant the whole day. The phenomenon, which also occurs to a lesser extent on other parts of the South Australian coast, is described by Bye (1976).”

MHL (2013) provided the following commentary on the Outer Harbor Port Adelaide tide gauge:

> "The Port Adelaide (Outer) gauge digital records began in November 1943 with a Ballout chart recorder and float. This was upgraded to a Leupold and Stephens recorder in May 1982. The site was then upgraded again to an air bubbler type instrument with a Mindata/Handar recorder at the start of 1996.
>
> Older records are available at South Australian State Records, in the form of tide books with tide highs and lows, with monthly statistics. Some of these records were photographed for this study but further investigations should reveal more records. The earliest date captured for this site was March 1937-July 1941.
>
> Land subsidence has been a major issue for both of the Port Adelaide sites as the subsidence covers a substantial area of northern Adelaide. Further complicating the extraction of sea level trends at the site is the benchmarks in the region also being subject to subsidence. See Belperio (1993) for further information."

Published water levels are shown in Table 7.1 relative to tide datum (lowest astronomical tide, LAT) and Australian Height Datum (AHD), which is approximately mean sea level. The following adjustments have been made between LAT and AHD:

- Outer Harbor (CE 2012, BOM 2010a) AHD = LAT + 1.45
- Port Stanvac (BOM, 2010b) AHD = LAT +1.28 (BOM) (Note that the University of Hawaii data repository incorrectly says + 0.993)

Tidal plane	Outer Harbor Adelaide (m LAT)	Port Stanvac (m LAT)	Outer Harbor Adelaide (m AHD)	Port Stanvac (m AHD)
Highest astronomical tide	2.8	2.5	1.348	1.22
Mean high water springs	2.3	2.0	0.848	0.72
Australian Height Datum	1.45	1.28	0.000	0.00
Mean high water neaps	1.3	1.2	-0.152	-0.08
Mean sea level	1.3	1.2	-0.152	-0.08
Mean low water neaps	1.3	1.2	-0.152	-0.08
Mean low water springs	0.3	0.3	-1.152	-0.98
Lowest astronomical tide	0.00	0.0	-1.452	-1.28

(from Australian National Tide Tables, 2010 and BOM, 2010)

Table 7-1: Tidal planes for Port Adelaide

Typical tidal measurements for Port Stanvac are shown in Figure 7.2.

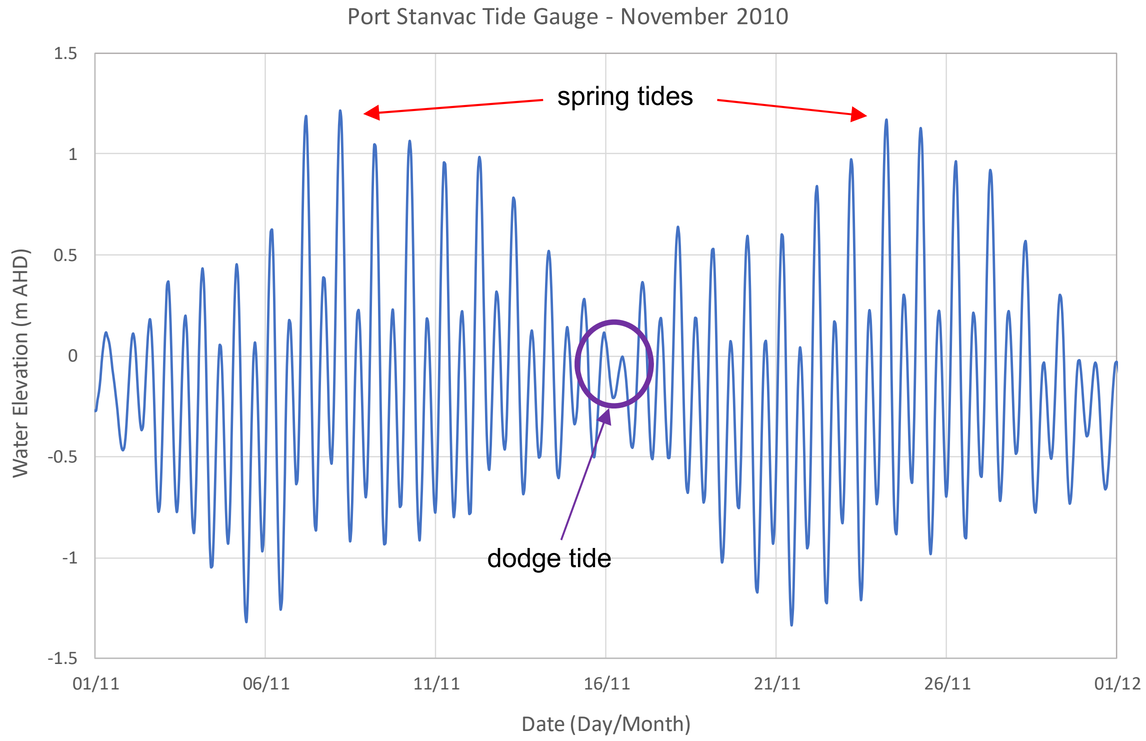


Figure 7.2: Example spring tides and dodge tides Port Stanvac – November 2010

7.1.2 Other sea level anomalies

Other sea level anomalies (often referred to as tidal anomalies) can result in differences between the actual water level and the predicted tidal water level(s). Anomalies can include a combination of short-term factors, such as variations in seasonal temperature, air pressure, wind stress, and coastal-trapped waves and longer term effects caused by variations in global atmospheric and oceanic patterns.

In addition to conventional “storm surge”, anomalies over time scales of days to months to years can be caused by:

- Ocean Density Changes;
- Coastal Trapped Waves;
- El Niño - Southern Oscillation;
- Inter-decadal Pacific Oscillation (IPO); and
- Future sea level rise.

7.1.3 Extreme water levels

Extreme water levels (excluding wave setup and runup) for Adelaide are shown in Table 7.2, based on the sources listed in the table. It is recommended that additional analysis be undertaken of the Port Stanvac tide gauge data as it geographically more relevant, noting that extreme water level conditions are relevant to the structural design of an ocean pool, but not its serviceability.

Average recurrence interval (ARI)	Port Adelaide (m AHD)		
Source	**1**	**2**	**3**
1 year	1.602	1.92	1.50
10 year	2.047	2.25	
100 year	2.325	2.51	2.35
200 year			
500 year			

Excluding wave setup and runup

Source:

1. City of Port Adelaide Enfield (2005)
2. Wynne et al (1984); Kinhill et al (1983)
3. Riedel and MacFarlane (1999) using joint probability with same ARI for waves

Table 7-2 Extreme water levels for Port Adelaide

Integrated Coasts (2018) mapped elevated water levels for Hallett Cove based on the following information:

> “DEWNR advises that current storm surge risk for Kingston Park to the north of the depicted location is 2.4m AHD storm surge, and 0.3m wave set-up, and at Port Noarlunga to the south is 2.3m storm surge and 0.4m wave set-up. In all Hallett Cove regions storm surge has been set at 2.3m and wave set-up at 0.3m. Wave run-up has been mapped at 1.0m higher and depicted by way of dotted blue line.. Coast Protection Board sea level rise policy levels are 0.3m indicatively by 2050, and a further 0.7m indicatively by 2100. [sea level rise is discussed below]”

This is broadly consistent with the 100 year ARI values shown in the table above,

7.1.4 Sea level rise

The two longest tide gauge records (Fremantle and Sydney) reveal rising sea levels prior to 1960, relatively stable sea level rise rates between 1960 and 1990, followed by an increased rate of rise from the early 1990s (White et al., 2014). White et al. (2014) reported that for the period between 1966 to 2009, (when there are observations of most sections of the Australian coastline), the average rate of relative sea level rise around Australia was 1.4 ± 0.2 mm per year, which is slightly less than the global averaged rise for the same period (CSIRO and BOM, 2015).

The Coast Protection Board policy (1992) policy is to design for an absolute sea level rise of 0.3 m for 2050 plus an allowance for subsidence depending on location (0.1 m for Port Adelaide). Engineers Australia's (NCCOE, 2017) interpretation of the most recent IPCC projections is shown in Figure 7.3.

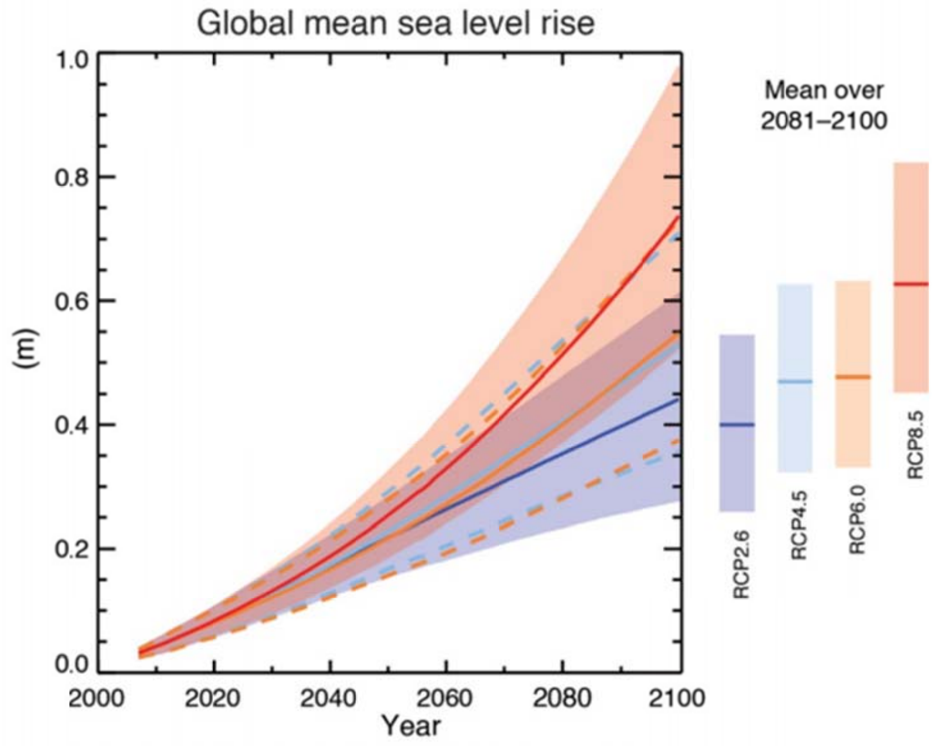


Figure 7.3 Sea level rise projections (Figure 6 from NCCOE, 2017)

As discussed above, data from high precision SEAFRAME tide gauges exists for Port Stanvac from 1992 to 2010, while data is available for Thevenard from 1966 to 2018, including a high precision SEAFRAME tide gauge from 1992. This data shows the following trends (BOM, 2011, 2019):

- Gauge movement trend relative to local benchmarks, (but not land subsidence):
  - Port Stanvac: -0.1 mm/year (subsidence);
  - Thevenard: +0.2 mm/year (uplift).

- Sea level rise after correcting for subsidence and barometric effects:
  - Port Stanvac: 4.3 mm/year (1992 to 2011, BOM, 2011);
  - Thevenard: 4.3 mm/year (1992 to 2011, BOM, 2011);
  - Thevenard: 4.1 mm year (1992 to 2019, BOM, 2019)

For an ocean pool asset life of 50 years, sea level rise scenarios of 0.3 m by 2050 have been considered in this report, with discussion of 1 m by 2100 in accordance with CPB policy. Based on IPCC and NCCOE curves (2017), these benchmarks have the rates of rise shown in Table 7.3**.**

Planning horizon	Sea level rise (m)	Rate of rise		
		Average (mm/y)	At end of planning horizon (mm/y)	At end of planning horizon (mm/decade)
Present day	0.0	4.1	4.1	41
2050	0.3	5	7	70
2100	1.0	9	16	160

Table 7-3 Sea level rise benchmarks and rates of rise

As discussed in Section 16, ocean pools are typically refurbished at intervals of 10 to 20 years. This often involves adding new pool surrounds and increasing the pool wall levels. With decadal rates of sea level rise of 40 to 160 mm, sea level rise can be managed within the expected refurbishment cycle for an ocean pool. It should be noted, however, that the wave overtopping response (Section 12.4) may not be linear, and therefore additional consideration of this needs to be undertaken at detailed design stage. It can be readily managed through refurbishment elevation (of walls and floor) or the use of wave deflector shapes for the seaward wall.

7.2 Waves

The coast at Hallett Cove is subject to ocean swells propagating from the Southern Ocean and local wind waves within the Gulf St Vincent. Coastal Engineering Solutions (CES, 2004) undertook numerical modelling separately for both these wave sources for a 10 year period (termed a hindcast) from 1/1/1993 to 31/10/2002 at 3 hour time steps with some details of the modelling presented in Figure 7.4 to Figure 7.7). Model output was extracted for 96 nearshore sites between Hallett Cove and the Outer Harbor. Thus modelling was not focussed on Hallett Cove and was not intended for the purposes of determining shoreline sediment transport rates nor design wave conditions for application at Hallett Cove. It was a portion of a broader study addressing the Adelaide metropolitan coast further north. The modelling did not incorporate detailed nearshore bathymetry and provided data at limited points in relatively deep water (20 m) at two locations offshore from Hallett Cove. Wave conditions and average sediment transport rates should therefore be applied with appropriate caution.

This remains the best/only available data relevant to Hallett Cove, but it should be noted that it is computer model output rather than measured data. The ocean storms and local winds that drive the waves within the model are model simulations of real weather events.

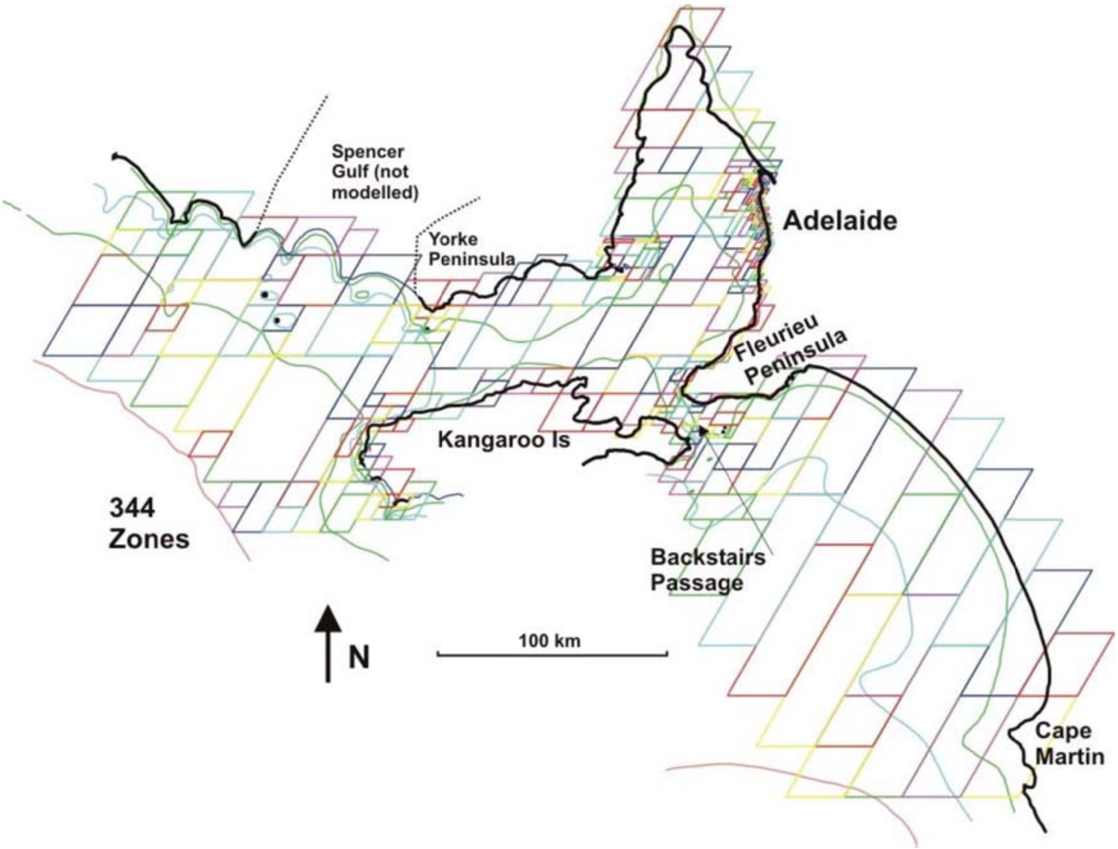


Figure 7.4: Model domain for swell waves (Figure 4.5 of CES, 2004)

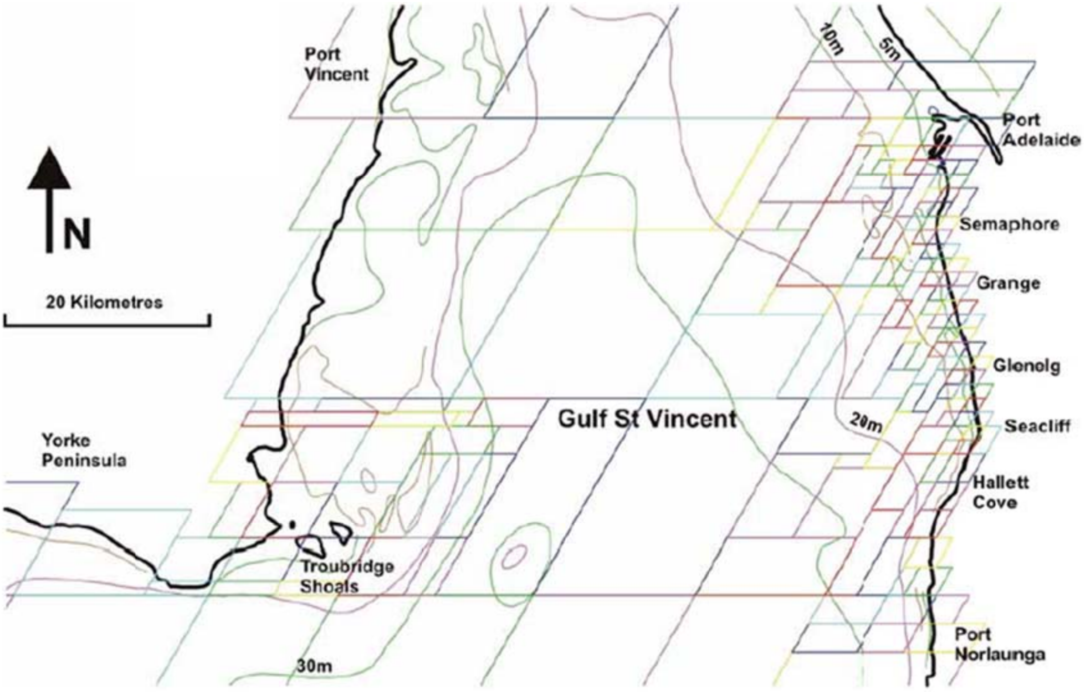


Figure 7.5: Nearshore zones for wave modelling (Figure 4.6 of CES, 2004)

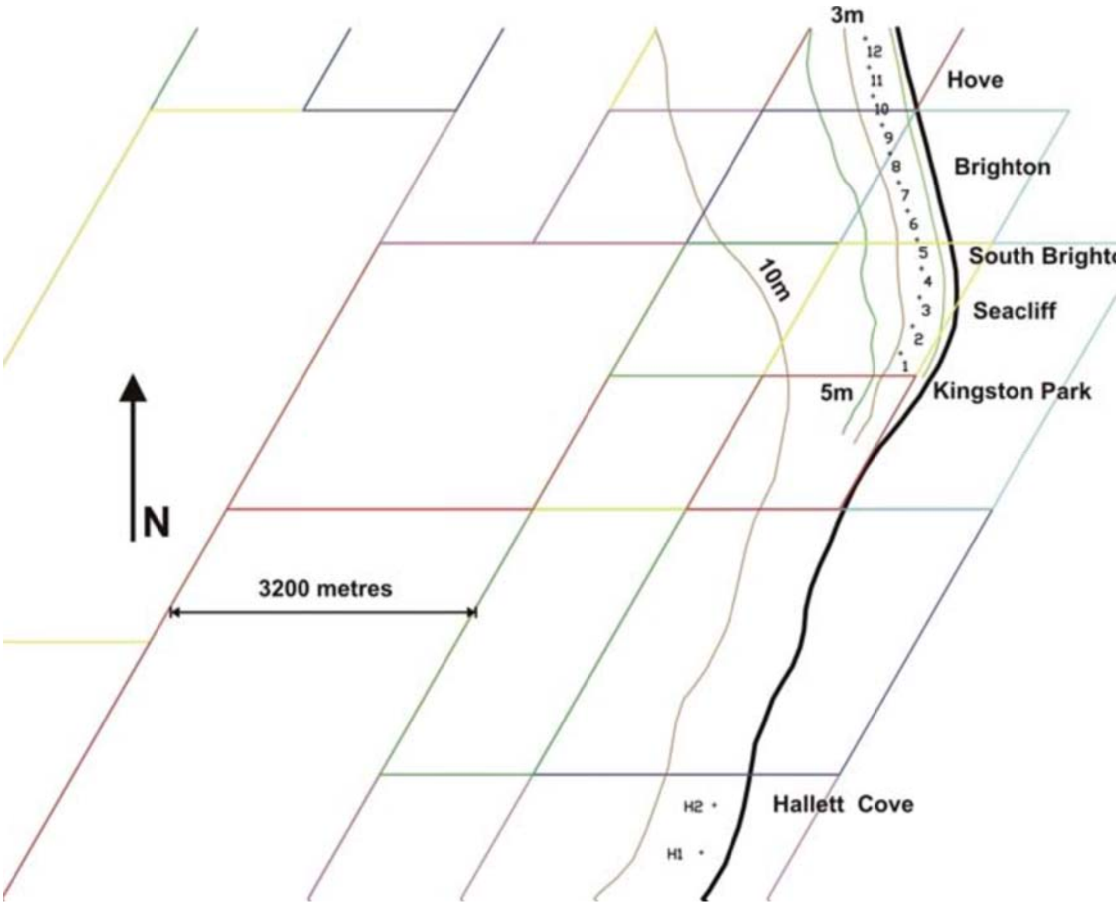


Figure 7.6:Model output near Hallett Cove (Figure 4.7 of CES, 2004)

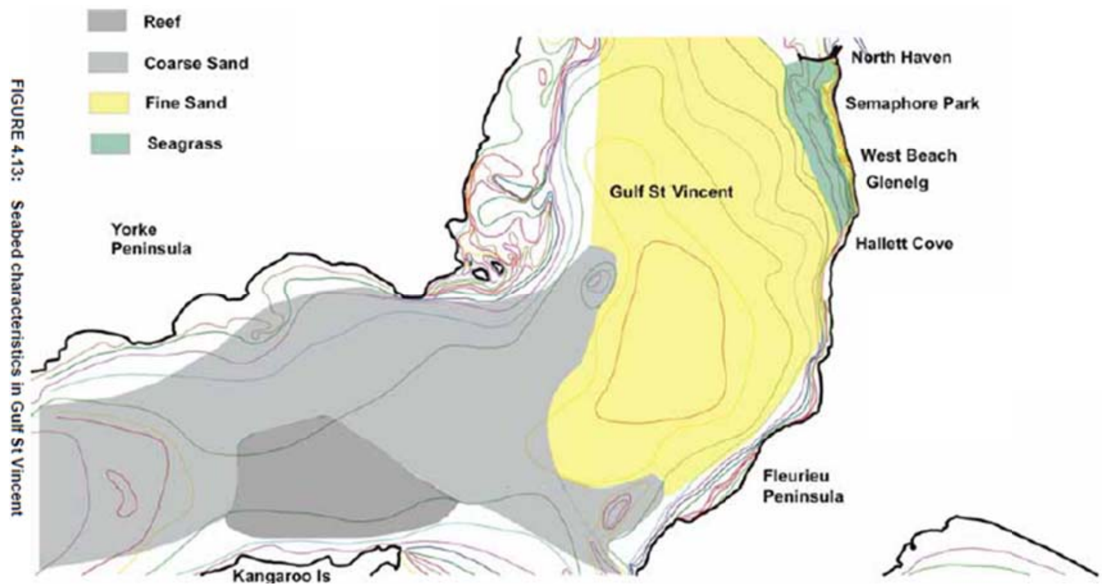


Figure 7.7 Seabed types used for wave modelling (Figure 4.13 of CES, 2004)

CES Deep Water Sea Waves (depth 20 m) at output point H1 (Hallett Cove) for the period 1/1/1993 to 31/10/2002 on 3 hourly time step are shown in Table 7.4.

Parameter	Value
Analysis period	1/1/1993-31/10/2002
Effective record length	9.8 years
Time step	3 hours
Average H_S	0.37 m
Average H_S associated T_P	3 s
H_S exceeded 10%	1.17 m
10% exceeded H_S associated T_P	5 s
H_S exceeded 1%	2.19 m
1% exceeded H_S associated T_P	7 s
1 year ARI Hs	3.45 m
1 year ARI H_S associated T_P	9 s

Source: CES (2004)

Table 7-4 Wave parameters (sea only) from Hallett Cove numerical modelling

7.3 Other coastal processes and hazards

7.3.1 River discharges and other water quality hazards

Flood flows from the Field River (Figure 7.8) have the potential to contaminate an ocean pool. Larger scale ocean contamination from rainfall or sewage also has the potential to adversely affect water quality in an ocean pool, in a similar manner to swimming in the ocean. This should be considered carefully in choosing an appropriate site and operating procedure. It can then be managed through detailed modelling, ceasing to pump into the pool, or pool closure as a last resort.

Coast and Marine, NR AMLR (2019) have advised that some species of diatoms are present in the Hallett Cove area that cause skin irritations, while others are toxic. They also referred to bacteria associated with human and dog use. Dogs are not permitted in any ocean pools known to the authors, and they are generally signposted to this effect. Detailed design of pumps and pool circulation will allow an ocean pool to maintain sufficient dilution of species introduced within a pool, but may not protect against background external ocean water species.

As per Appendix B.10, no ocean pools known to WRL use chlorine or water treatment, as this would create toxic discharges when emptying. Cleaning is via high pressure water blasting, with sparing use of algaecides on slippery horizontal surfaces which present a hazard to people.

Figure 7.8 Flood water from Field River 29/06/2010 (Coastal Environment, 2012)

7.3.2 Stormwater

Contamination from stormwater also needs to be considered for detailed design of an ocean pool. Minor diversions of existing stormwater pipes is a relatively minor cost within the overall cost of an ocean pool.

7.3.3 Seagrass wrack, litter and debris

Wave runup into an ocean pool has the potential to transport seagrass wrack into the pool. This is a common issue in many other ocean pools. Sea grass wrack can be a consistent and significant problem along the foreshores of Gulf St Vincent (e.g. West Beach boat ramp) and elsewhere on the open coast (e.g. Victor Harbour). If the issue is deemed minor to moderate, wrack removal can be undertaken as part of routine pool maintenance. Substantial wrack ingress would best be prevented through a sufficiently elevated pool incorporating pumps. Detailed design of any pump intakes would also need to consider the potential for seagrass blockage, and elevate the pool sufficiently that major ingress of wrack is confined to events of about 1 year ARI (or even less frequent).

Coast and Marine, NR AMLR (2019) have advised that Hallett Cove (and O'Sullivans and Willunga Beaches) are litter accumulation points. In site visits by the authors, the cobble shoreline at Hallett Cove was noted to trap and harbour litter. At a local level, ingress of litter and debris into an ocean pool can be managed (as per wrack) through a sufficiently elevated pool, favouring the use of a pumped system. Wrack may still accumulate against the outside of the pool structure and this should be considered in deciding design orientation and materials used. Numerous strategies external to an ocean pool could be developed to reduce the regional scale litter problem.

7.3.4 Littoral drift

CES (2004) estimated that the potential net littoral drift for Hallett Cove was 100,000 m^3/year northward, but due to the low availability of sand, the actual littoral drift was less than 10,000 m^3/year northward. The modelling showed that the potential littoral drift is higher at Hallett Cove than further north on Adelaide beaches. However the limitations on the modelling undertaken have not allowed this to be verified by measurements. Issues relating to supply of sand to the beach around the southern headland and Port Stanvac may also limit actual transport rates. The extent of transport in relatively shallow water off the base of the rock shelf has not yet been addressed.

7.3.5 Storm erosion and vertical sand movement

Two Coastal Management Branch profiles (200040 and 200041) are present at Hallett Cove for 33 surveys between 3/5/1975 and 7/2/2018 (Section 11), with surveys generally once per year. Due to the predominance of reef, boulders and cobbles, with only a thin veneer of sand, there is little short and long term change in these profiles.

Coastal Environment (2012) made the following observations for profile 200041:

- "The location of the erosion escarpment at the back of the beach has not changed over the period of record from 1975 to 2007 (i.e. has not receded);
- The maximum change in level of the beach seaward of the erosion escarpment (approximate chainage 45m) is less than 0.5 m;
- In 1975 the back of the beach for a distance of 20 m from the erosion escarpment was up to 0.5 m higher than in 2007;
- Below mean sea level (0 m AHD, approximate chainage 85) there is no discernible change in the level of the beach profiles for a distance of 65m offshore to a depth of -1.5 m AHD; and
- The total volume variation in the envelope of profiles between the erosion escarpment (approximate chainage 45) and the mean water mark (0 m AHD, approximate chainage 85) is less than 20 m^3/m."

7.3.6 Beach response to sea level rise

Coastal Environment (2012) estimated a Bruun Factor for Hallett Cove of 25. That is, as an initial approximation, the beach/embankment is expected to recede by 25 times the sea level rise.

Without protection (Section 14), for the CPB sea level rise benchmarks, the beach could recede by:

- 2050; 0.3 m sea level rise; 8 m recession;
- 2100; 1 m sea level rise; 25 m recession.

The shingle/cobble foreshore may result in recession being lower than this, particularly given that recent sea level rise has been about 4.1 to 4.3 mm/year (Section 7.1.4), with minimal recession observed.

7.3.7 Boulder debris loads

The predominance of boulders and cobbles at Hallett Cove means that the detailed design of the structure needs to consider debris impacts along with conventional water forces.

7.4 Seabed composition

Detailed maps have not been sighted, but aerial photos indicate that the seabed at Hallett Cove and offshore appears to consist of shingle/cobble with some sand. The available sand is in deficit compared with the littoral drift potential.

8 Ecological and cultural heritage studies

Council is undertaking separate ecological and cultural heritage studies regarding this project.

9 Potential usage

9.1 Existing usage of Hallett Cove beach

A detailed study of existing usage of Hallett Cove Beach has been undertaken by Mark Western of Integrated Coasts and is presented in Appendix C. Using site data collection and additional literature, it is estimated that there are about 64,000 visits per year from November to March and perhaps 75,000 total visits per year to the beach and foreshore of Hallett Cove. The veracity of these estimates could only be improved with continuous data collection over a representative year.

9.2 Beach and pool usage

9.2.1 Available data

Estimated annual beach and pool visits from a range of data sources are shown in Table 9-1, with further discussion on sources and methods below. It can be seen that heavily used ocean pools in Sydney have over 260,000 annual visits, while for remote pools, annual visits can be as low as 50,000.

Beach usage data is collected by many councils through paid lifeguards, and is also available through statistics collected by volunteer surf life savers and collated by surf life saving state and national bodies. The data spans the “patrol season” – typically the months of October to April inclusive, and patrol hours – typically 9 am to 5 pm or 6 pm. The volunteer data only covers weekends and public holidays within the patrol season. A small number of beaches have longer patrol seasons or hours, but these are not part of the ocean pool case studies.

For Sydney’s northern beaches, this data covers an entire beach precinct, including the ocean pool, and does not separate out the pool usage. The lifeguard beach usage data was upscaled by 20% to account for use outside of patrol hours. The proportion of total beach use attributed to each pool was estimated by expert opinion (also termed the Delphic Method), whereby a minimum of two opinions were sought from professional lifeguards or surf life savers familiar with that beach – usually from those who collect the statistics. The proportion of beach users estimated to use the pool ranged from 10% at more remote pools to 50% at South Curl Curl where the pool has excellent access and the beach is considered to be one of Sydney’s most dangerous.

Beach/Pool	Period	Pay or Free	Beach precinct (a) or gate data	Upscaled individual visits (b)	Pool visits % (c)	No of pool visits
Collaroy	2017-18	F	357,655	429,186	30%	128,756
Dee Why	2017-18	F	1,090,573	1,308,688	20%	261,738
North Curl Curl	2017-18	F	392,968	471,562	10%	47,156
South Curl Curl	2017-18	F	363,789	436,547	50%	218,273
Freshwater	2017-18	F	821,758	986,110	15%	147,916
Queenscliff	2017-18	F	611,264	733,517	20%	146,703
Forster ocean pool (d)	"recent"	F		100,000		100,000
Bondi Beach (e)	2014	F		3,500,000		
Bondi Icebergs (f)		P				?
Wylie's Baths Coogee (g)	2017-18	P	50,000	82,000		82,000
Dawn Fraser Baths (g, h)	2016-17	P	40,886	101,800		101,800
Greenwich Baths	2015-16	P	32,605	60,000		60,000
Illawarra aquatic facilities	2016	P				128,000
Adelaide Beaches		F		9,200,000		
Marion Outdoor Pool	2017-18	P				100,000
Australian pool visits	2016	P				106,000,000
Average per facility	2016	P				99,000

Notes:

(a) Lifeguard data from Northern Beaches Council for October 2017 to April 2018, or gate data from source

(b) Beach data upscaled by 20% to account for users outside of patrol hours/season. Pool data upscaled to account for season passes (assumed 20 visits/year) and family passes (assumed to be 4 people)

(c) Delphic method, whereby two expert local life savers were polled and the results averaged

(d) Daniel Aldridge Mid Coast Council quoted in Port Macquarie News 6/12/2018

(e) 2014 data from Bondi Park, Beach and Pavilion Plan of Management

(f) Several attempts have been made to acquire this data, but they have been unsuccessful

(g) Upscaling based on data for family tickets and season passes

(h) 2016-2017 data from C Leisure (2017)

(i) Surf Life Saving South Australia and Adelaide's Living Beaches (2014)

(j) Royal Life Saving Society (2017)

Table 9-1 Annual users of beaches and pools in various locations

The Royal Life Saving Society (RLS, 2017) has collated usage statistics for various aquatic facilities around Australia. RLS quotes the following statistics:

- Western Australian aquatic facility visits: 4.4 visits per person per year;
- Wollongong City Council public aquatic facilities: 128,000 visits per year;
- Australian public aquatic facilities: 1027; and
- Australian average visits per pool per year: 99,000.

Usage statistics were also collected from ocean, tidal or harbour pools with paying access, with the results reflecting “seasonal” and “family” passes where the data is available.

Council has advised that there are approximately 100,000 visits per year to the Marion Outdoor Pool, which is open for 6 months per year and charges entry fees.

Based on the data in Table 9.1 and consistent with Royal Life Saving Society’s (2017) average for Australian aquatic facilities, a plausible estimate for annual visits to an ocean pool at Hallett Cove is 100,000, and could feasibly range from 50,000 to 150,000.

This figure represents an annual average of about 23 people per hour during daylight hours. If the ocean pool was open year round and had free entry, given the added attraction of a “trip to the beach”, it is not unreasonable to expect higher annual visitation than the paid entry Marion Outdoor Pool, which has 100,000 visits in its 6 month season.

9.2.2 Composition of users

Pool use comprises lap swimming and “fun and splash” activities. The best ocean pools have separate areas for each, with the following observations made for Sydney ocean pools, based on the long term observations of the authors. Lap swimmers predominate before about 9 am in summer, and predominate at all times in the cooler months. Some winter swimmers purchase wetsuits, as they prefer to swim in salt water and the wetsuit cost is offset against the entry fees for inland pools. Many winter swimmers brave the cold winter water without a wetsuit and some ascribe physical and psychological health benefits to swimming in cold water.

Many ocean pools have associated swimming clubs – sometimes separate ones in summer and winter. Examples of iconic winter swimming clubs include the Bondi Icebergs and the Freshwater Frigid Frogs (South Curl Curl). The Frigid Frogs originally operated at Freshwater ocean pool, but this pool is unpleasant in winter due to its location on the southern side of a cliff. They subsequently migrated 1 km further north to South Curl Curl ocean pool - the location on the northern side of a headland is pleasant in winter.

Ocean pools are sometimes “taken over” for surf life saving activities, swim clubs or school activities. During peak times in the height of summer, lap swimmers accept that the pool will be overrun with “fun and splash” activities, and confine their lap swimming to other times.

Over an entire year, ocean pool usage is probably evenly balanced between lap swimming and “fun and splash” activities, but there is no data to support this. It is envisioned that a new ocean pool would incorporate ramp access for all in accordance with contemporary Australian standards and codes.

9.3 Economic value of beach and pool usage

The majority of work regarding beach economics in Australia has been undertaken by Dr Dave Anning of Griffith University (Anning 2012, 2016), but does not specifically relate to ocean pool use.

A range of economic criteria from Anning (2012, 2016) are presented in Table 9.2. While local resident expenditure has been estimated to be as low as $0.50 per visit, proximity to a desirable coastal location usually commands a premium in real estate values.

The Royal Life Saving Society (2017) also undertook economic modelling of aquatic facilities and developed estimates for the economic benefit per visit. Furthermore, they undertook complex analyses that demonstrated an economic health benefit through mechanisms such as reduction of lifestyle diseases. The results of these are shown in Table 9.2.

Visitor/Expenditure type	Year	Low	Mid	High	Total
Anning (2012, 2016)		$	$	$	$
Byron Bay beaches					
Domestic overnight tourist	2010-2012		74.00		
International tourist	2010-2012		28.00		
Day tripper	2010-2012		55.00		
Gold Coast and other locations					
Local resident expenditure	2008	0.50		2.30	
Tourist expenditure	2008	15.00		45.00	
Consumer surplus Fuel only	2013		6.10		
Fuel plus time @ 40% of hourly rate	2013		9.30		
Plausible beach visit value including inflation	2019		10.00		
Royal Life Saving Society (RLS, 2017)					
Economic benefit			13.83		
Health economic benefit			26.39		
Total benefit			40.22		
For 100,000 annual visits based on RLS (2017)					
Plausible economic benefit					1,400,000
Plausible health economic benefit					2,600,000
Plausible total economic benefit					4,000,000

Table 9-2 Economic value of beach/pool visit in other locations

By combining Table 9.1 with Table 9.2, the following economic benefits of an ocean pool are possible:

- Plausible visits: 100,000 per annum (range 50,000 to 150,000);
- Plausible economic value: $1.4 million per annum (range $700 thousand to $2.1 million);
- Plausible health economic value: $2.6 million per annum (range $1.3 to $3.9 million);
- Plausible total economic value: $4 million per annum (range $2 to $6 million).

The above analyses show strong economic benefits for an ocean pool, but do not indicate the distribution of costs and benefits. That is, an entity such as Council or the state government may fund construction and maintenance, while another party, such as residents from other local government areas or the commonwealth health budget may benefit from the project.

Examples of potential means utilised in other areas to acquire a share of the economic benefits of an ocean pool include:

- Grants from State or Commonwealth governments;
- Special rates levies;
- Increased rates revenue through increased property values;
- Additional development or intensification of development;
- Parking fees (often with resident and ratepayer exemptions);
- Parking fines;
- Development and leasing of associated commercial facilities (e.g. cafes or function centres); and
- Entry fees for the pool (rare for ocean pools).

9.4 Public safety

A detailed risk assessment of public safety would need to be undertaken if progress is to be made towards an ocean pool. While WRL has only examined five ocean pools in detail, it should be noted that of the 70 ocean pools in NSW, a small number (<5) are staffed with full time lifeguards, some are reasonably proximate to existing surf life saving facilities (which do not operate year round), while others are located in quite isolated areas. As most pools are popular meeting places, it is rare for there to be only one person in the vicinity, so many emergencies are first responded to by bystanders.

Examples of potential management measures for separate issues to be analysed are listed below.

Dangerous ocean conditions propagating into the pool

- Warning signs;
- A traffic light forecasting and monitoring system; and
- Closure of the pool.

Non-swimmers or poor swimmers getting into difficulty

- Volunteer or professional lifeguards;
- Fencing and/or closure of the pool after hours;
- Bystander action;
- Warning and depth signs; and
- An emergency call button.

Collisions or accidents in the pool; medical episodes in the pool

- Design the pool so as to minimise the potential to jump into it from heights;
- Warning and depth signs;
- Volunteer or professional lifeguards;
- Bystander action;
- Existing emergency callout procedures; and
- An emergency call button.

Additional discussion of fencing of ocean pools is contained in Appendix B.8. As discussed there, about five of the approximately 70 ocean pools in NSW have fencing, with most of the fenced pools charging for entry, which in turn funds paid lifeguards. All other ocean pools in NSW are unfenced, probably on the premise that they present a hazard less than the surrounding ocean.

10 Car parking demand and availability

The projected pool usage indicates that the present supply of parking may be insufficient and further consideration of parking spaces would be needed. A high level car parking study has been undert////aken by Mark Western of Integrated Coasts in Appendix D. The summary from this is reproduced below.

"If an ocean pool is to be successful at Hallett Cove Beach it must be demonstrated how traffic and parking might be managed. Conventional planning methods that attempt to meet demand within peak periods by installing larger areas of car parking will be unsuccessful. New paradigm thinking will identify ways in which car parking can be managed on larger days, and how patrons can be encouraged to utilise other forms of transport.

<u>A preliminary strategy</u>

The following strategies could be implemented to provide a viable number of car parks for an ocean pool. The reasons for each strategy have been described above.

1. Increase the number of car spaces in close proximity to the pool.
2. Install cycle storage facilities adjacent to the main pool car park and adjacent to the cafe.
3. Create a 'Drop and Go' zone along Heron Way.
4. Create more parking opportunities on Dutchman Drive.
5. Consider traffic control options and additional parking opportunities on Grand Boulevarde.
6. Overflow traffic on larger days would likely choose Arafura Street as it has two pedestrian access points to the foreshore area.
7. A cycle ride sharing scheme could be instituted at the train station (cycle garage)."

11 Wave overtopping calculations

11.1 Background

A basic model was set up using the EurOtop (2016) document to compare wave overtopping between existing ocean pools and Hallett Cove. The schematic cross section for this is shown in Figure 11.1.

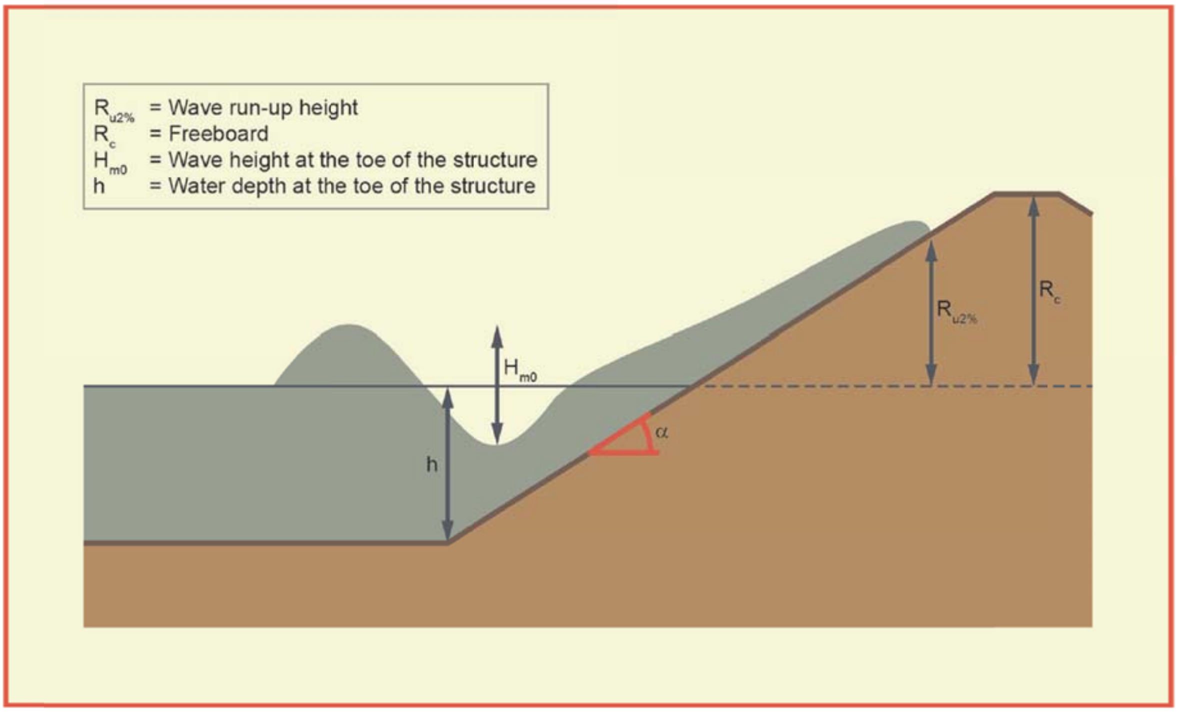


Figure 11.1 EurOtop cross section for overtopping

An example of the wave overtopping process from a WRL physical model is shown in Figure 11.2. A range of wall geometries can be adopted to reduce wave overtopping (Figure 11.3 to Figure 11.5), noting that wave overtopping has both positive and negative impacts on an ocean pool.

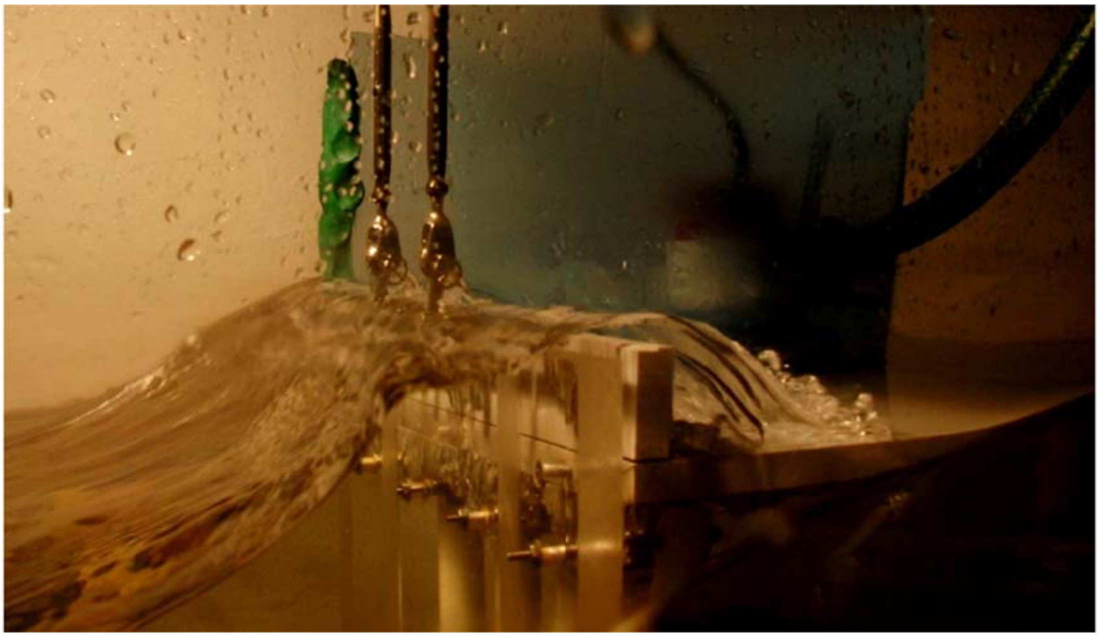


Figure 11.2 Wave overtopping physical model

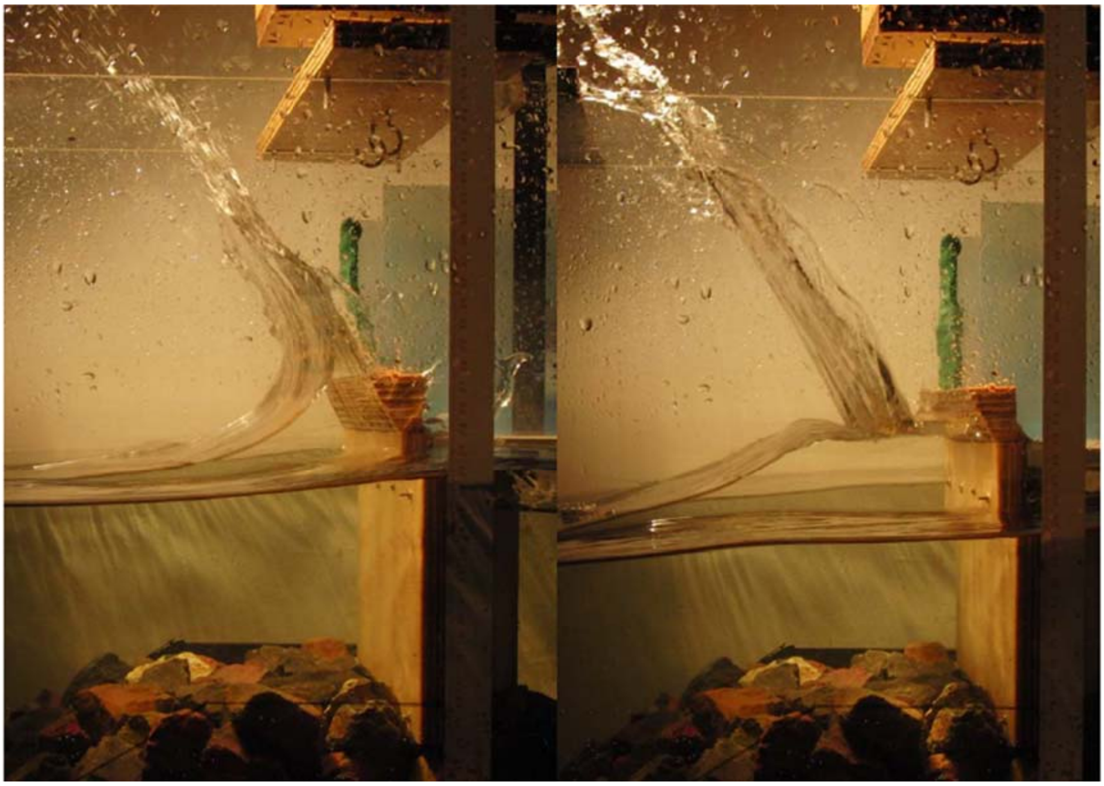


Figure 11.3 Angled wave deflector wall physical model

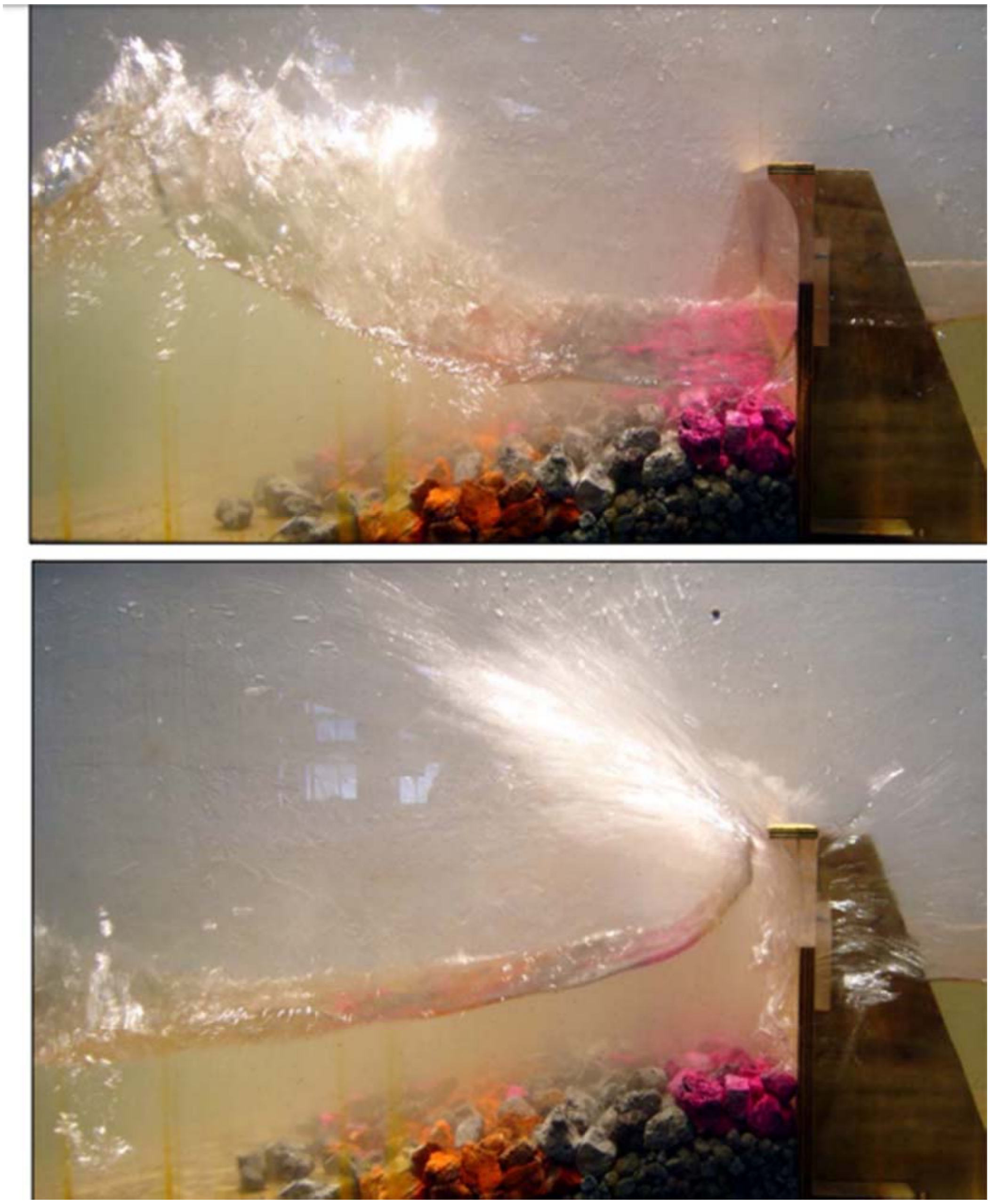
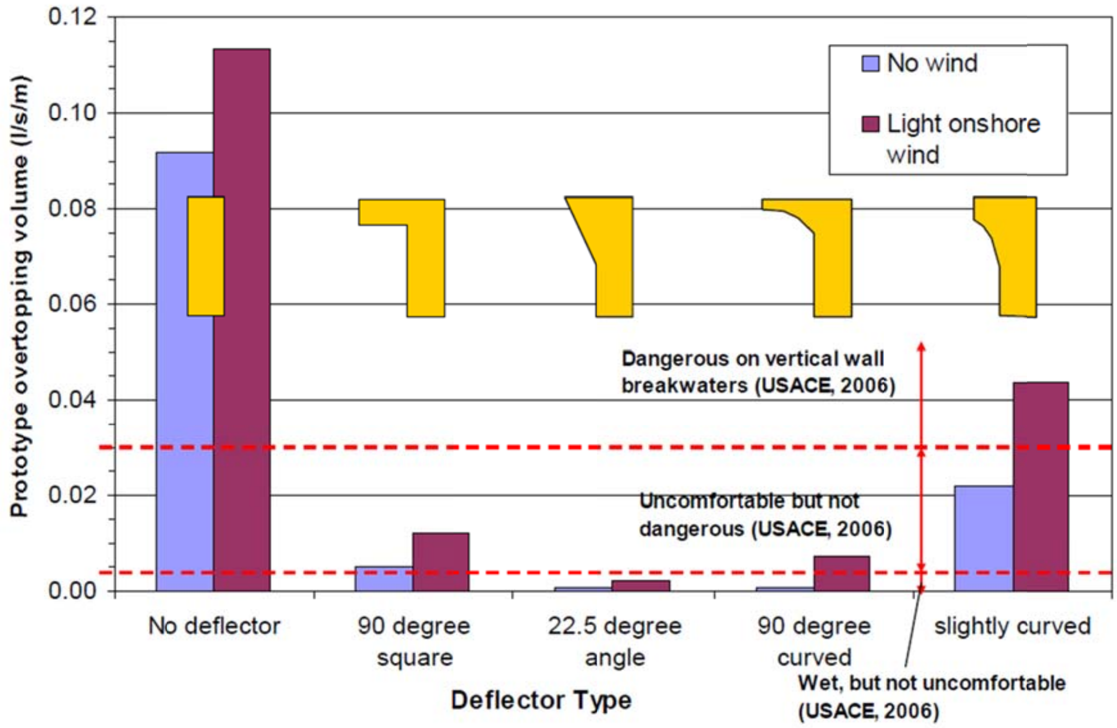


Figure 11.4 Curved wave deflector wall physical model



Note: From model tests for separate WRL project

Figure 11.5 Various wave deflector wall shapes

11.2 Overtopping calculation models

WRL set up a numerical model (Dally et al, 1984; SBEACH) for each shore normal transect for the Sydney pools and Hallett Cove to the -11 m AHD contour for each pool location. Details of the model are given in Larson and Kraus (1989) and Larson et al. (1990). The transects were derived by joining WRL's land/drone survey to the hydrographic charts (Section 7).

This was interfaced with EurOtop (2016) equations 5.12 and 5.13 [design and assessment approach] to define the overtopping at the seaward edge of the pool using depth limited Hs from SBEACH. WRL's procedure was compared to overtopping measurements and geometry for Cronulla determined in a physical model (Haradasa et al, 1990) and good agreement was found.

The overtopping model was applied with a spring tide for the following conditions:

- Ambient/median wave conditions;
- 10% exceedance wave conditions; and
- 1 year ARI wave conditions.

Note that almost all ocean pools are dangerous in conditions exceeding 1 year ARI, so wave overtopping for larger events was not modelled. Events larger than 1 year ARI will need to be considered for structural design of the pool.

11.2.1 Overtopping estimates for four Sydney pools

Overtopping estimates for four Sydney ocean pools are shown in Figure 11.6 to Figure 11.8. EurOtop (2016) recommends that its techniques be used as order of magnitude estimates only. The values found concur with the qualitative observations of WRL's engineers.

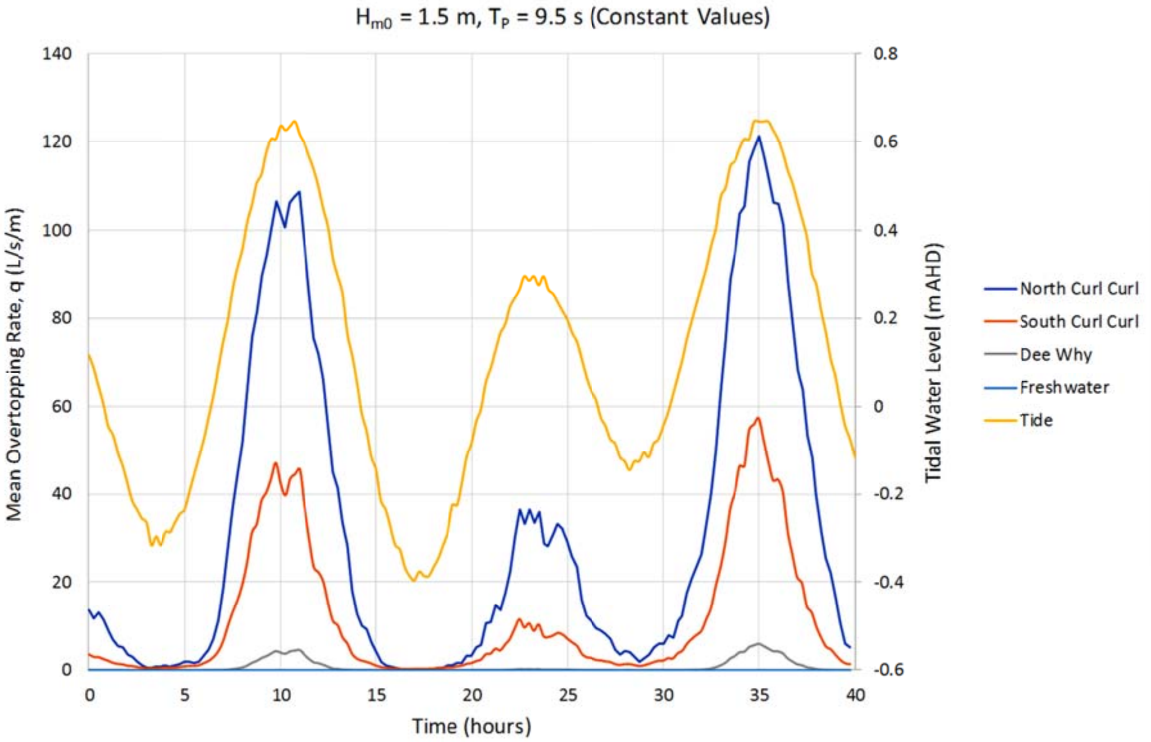


Figure 11.6 Overtopping Sydney pools ambient waves

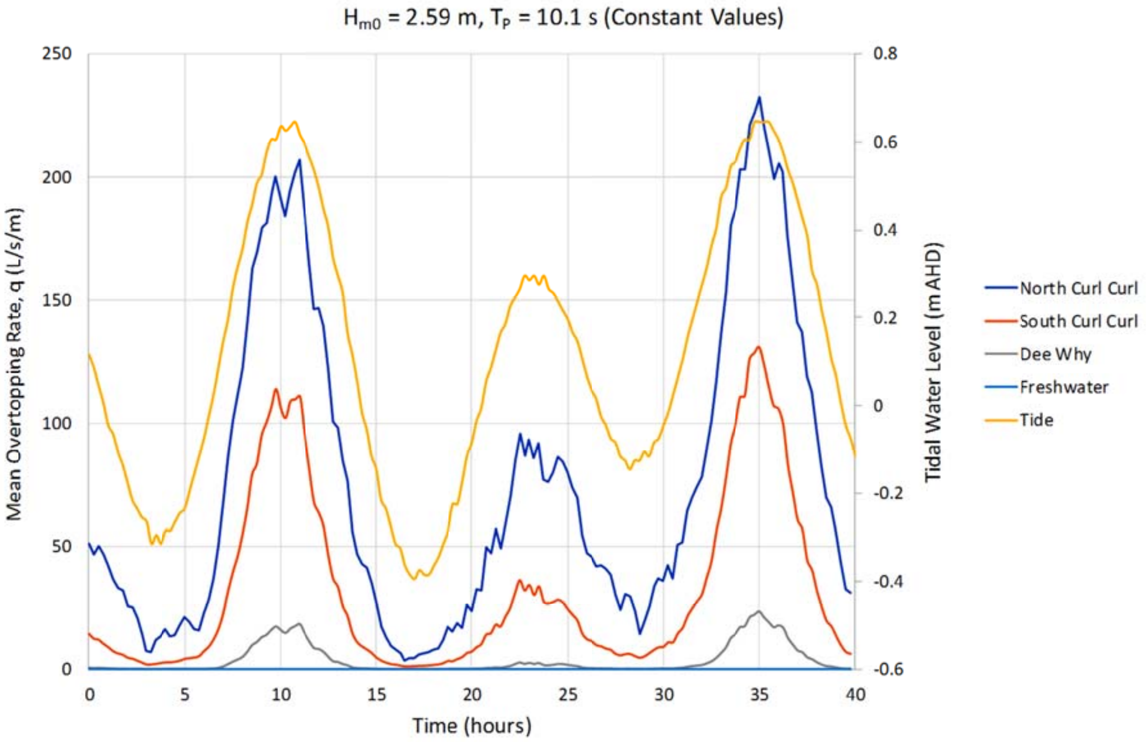


Figure 11.7 Overtopping Sydney pools 10% exceedance

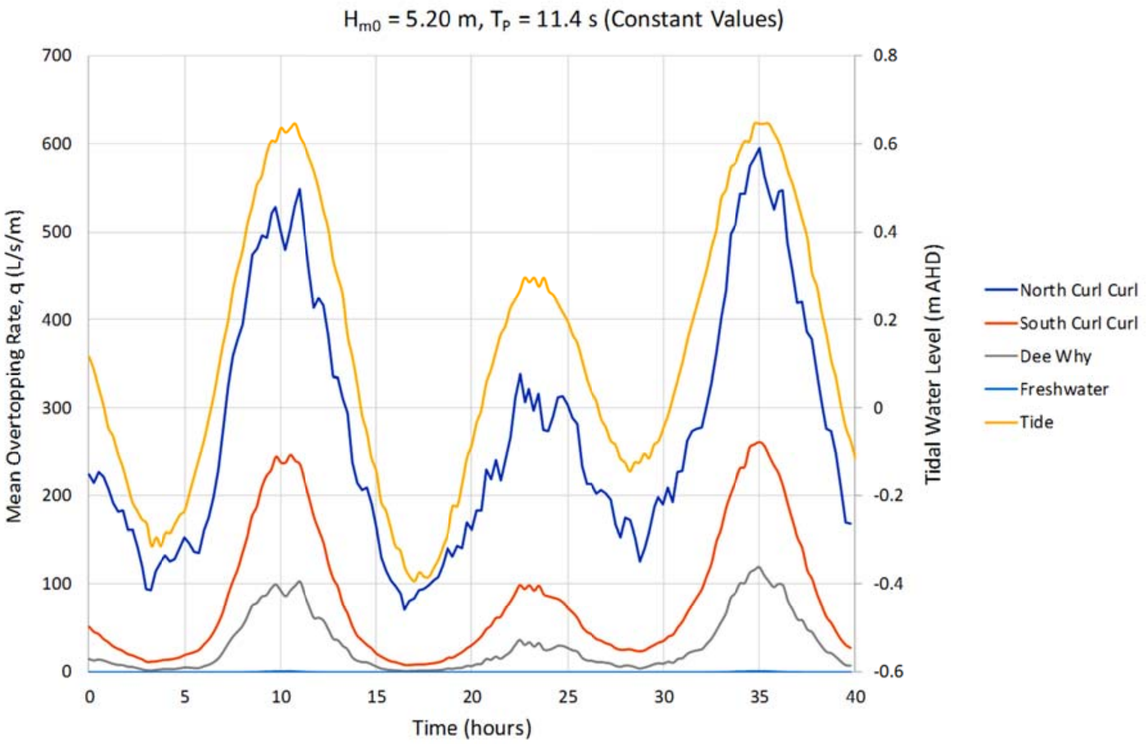


Figure 11.8 Overtopping Sydney pools 1 year ARI

12 Hallett Cove ocean pool location and wave overtopping

12.1 Land and seabed levels

The following information was used to ascertain levels:

- A recent aerial (helicopter) ground level survey undertaken by Aerometrex; and
- Coast Protection Branch profile surveys from 2018.

A typical onshore transect from the aerial survey is shown in Figure 12.1. The surveyed underwater transects are shown in Figure 12.2, which also shows two onshore profiles where an ocean pool could be considered. It can be seen that the plan positions of the profiles do not exactly coincide, however, they have been blended together to form a typical profile (Figure 12.3) for the purposes of wave overtopping modelling. More accurate profiles could only be acquired through a custom survey, but the data used is sufficiently accurate for preliminary wave overtopping modelling.

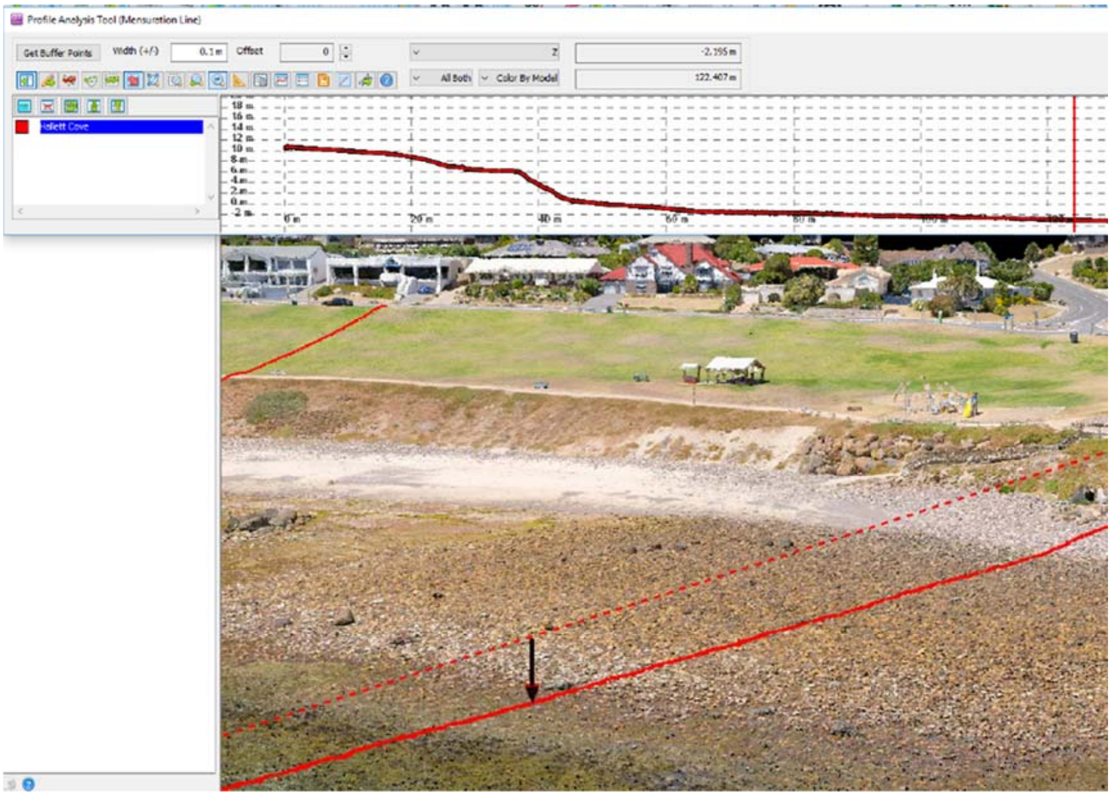


Figure 12.1 Aerometrex aerial survey and profile

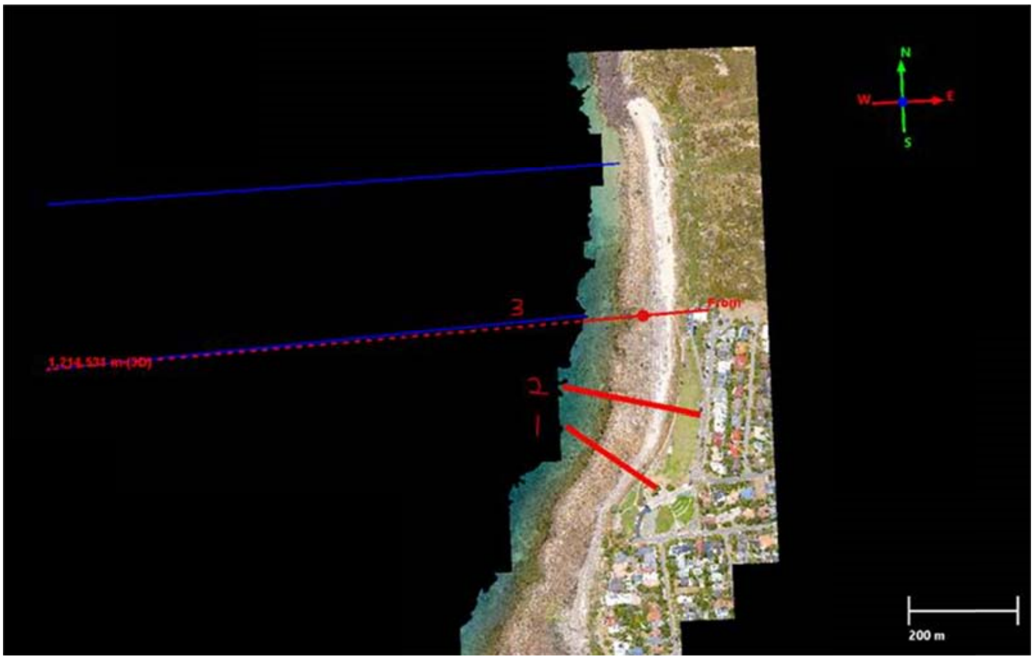


Figure 12.2 Coast Management Branch underwater survey locations

Figure 12.3 Hallett Cove Profile 1

12.2 Potential pool location

Ocean pools are best located on existing rock platforms, and should be reasonably close to the water to retain the ambience of an ocean pool. A northerly aspect and a wall/cliff/embankment to the south make them more pleasant in the cooler months. Recommended pool dimensions are outlined in Section 13. As discussed there, the only major constraint on shape is that lap swimmers prefer a 50 m length with parallel walls at the ends. Other aspects of pool shape would be best undertaken by a specialist architect or landscape architect.

An optimum pool location involves multiple criteria, many of which are subjective, social, environmental or political, and are beyond the scope of this report. Potential locations, together with a non-exhaustive list of their major advantages and limitations within the scope of this study are presented in Table 12.1. This list is confined to the vicinity of Hallett Cove. The potential to accrete sand and form a beach is discussed in Section 15.

Location	Distance from Heron Way reserve	Advantages	Limitations
Southern end of Heron Way Reserve	Southern end	Quasi headland and platform Partial northerly aspect Proximate to existing high use areas Existing parking spaces with potential for expansion Existing access and rock armouring	Bedrock platform not strongly evident Limited potential to accrete sand
Boatshed café	Northern end	Proximate to existing high use areas Existing parking spaces with potential for expansion Some potential to accrete beach	Soft dune access Not on a headland Higher potential for sand ingress Coastal impacts on Conservation Park
Northern end of beach	600 m N	Greater potential for sand accretion	Within Conservation Park No road access or parking
Field River entrance	400 to 600 m S	Partial northerly aspect	Dune area with private houses Water contamination during river flows Quiet streets with limited parking No potential to accrete sand
Southern rock platforms	1000 to 1,500 m S	Broad bedrock platforms Northerly aspect	Distant from roads and walkways Quiet streets with limited parking No potential to accrete sand

Table 12-1 Potential pool locations

12.3 Suggested Hallett Cove location

A potential pool location for a 50 x 20 m pool, wading pool and bleacher steps is shown in Figure 12.4. This location may be varied by up to 20 m cross shore or 100 m alongshore without significantly altering the assessment described below. Calculations were undertaken with the seaward edge of the pool at chainage 76 m (refer to Figure 12.3).

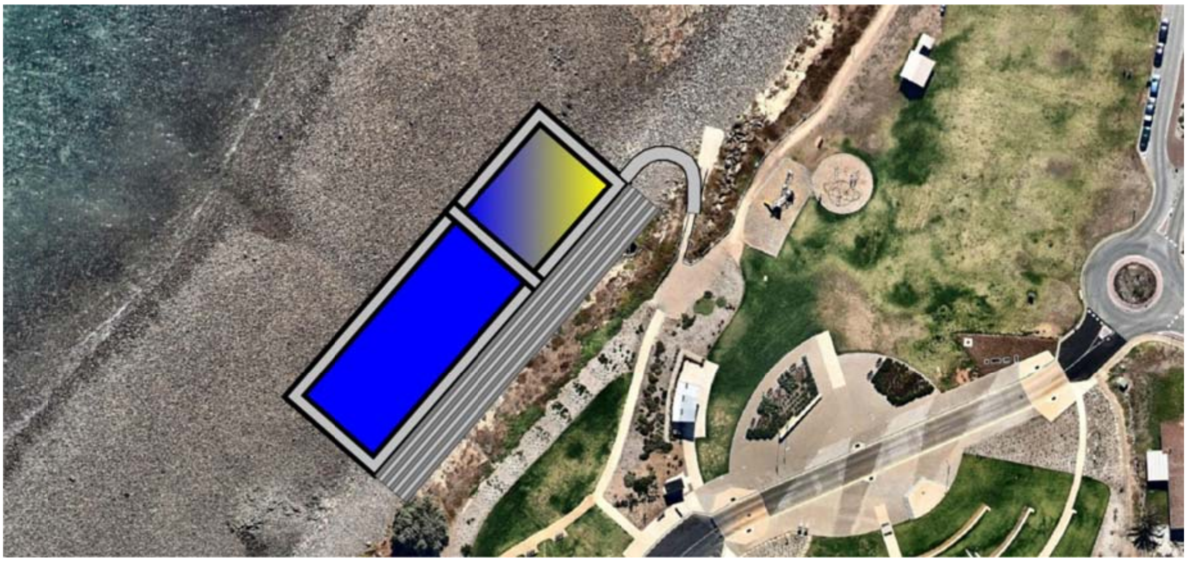


Figure 12.4 Potential pool location

While proximity to existing facilities (toilets, showers, change rooms) is desirable, the cost of facilities is relatively low compared with the cost of a new ocean pool.

In addition to the dependence on location, many criteria can be altered/managed through the elevation of the pool walls, external wall shape (Section 11), and/or the extent of excavation versus wall height.

12.4 Wave overtopping and flushing

The same procedure described in Section 11.2 (with the addition of 1% exceedance wave conditions) was applied to obtain overtopping estimates for a potential ocean pool location in Hallett Cove and are shown in Figure 12.5 to Figure 12.8. These include wall crest levels of 1.0, 1.5, 2.0 and 2.5 m AHD. EurOtop (2016) recommends that its techniques be used as order of magnitude estimates only.

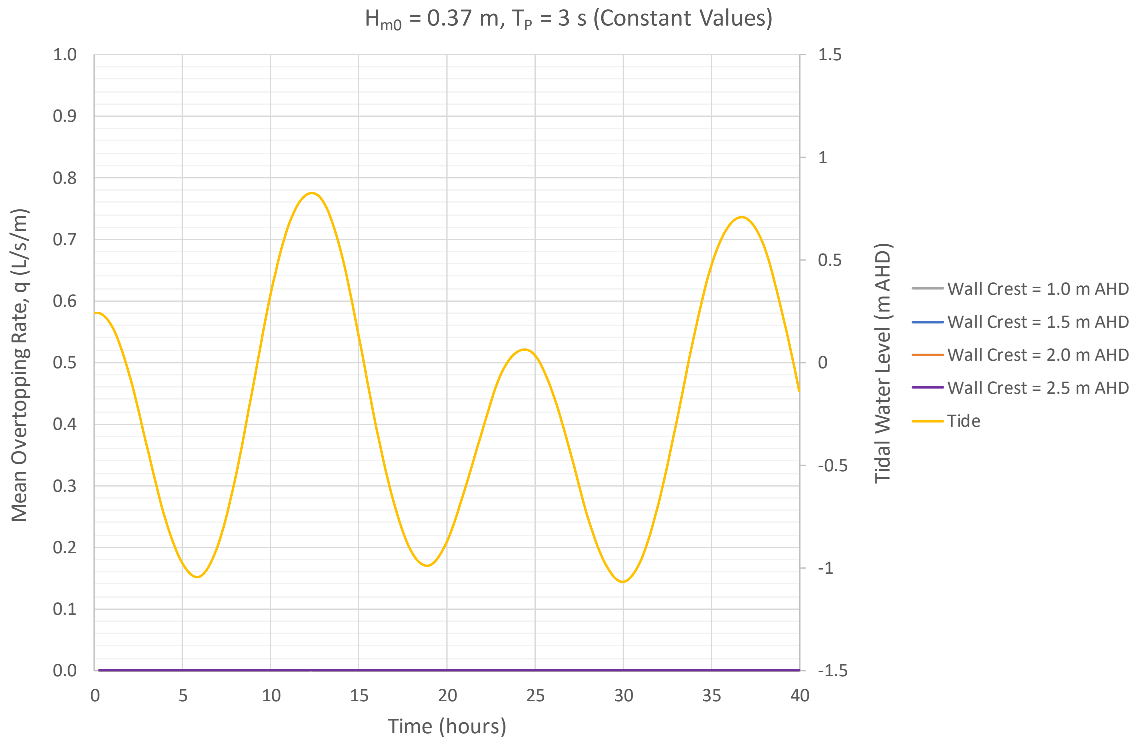


Figure 12.5 Overtopping Hallett Cove pool ambient waves

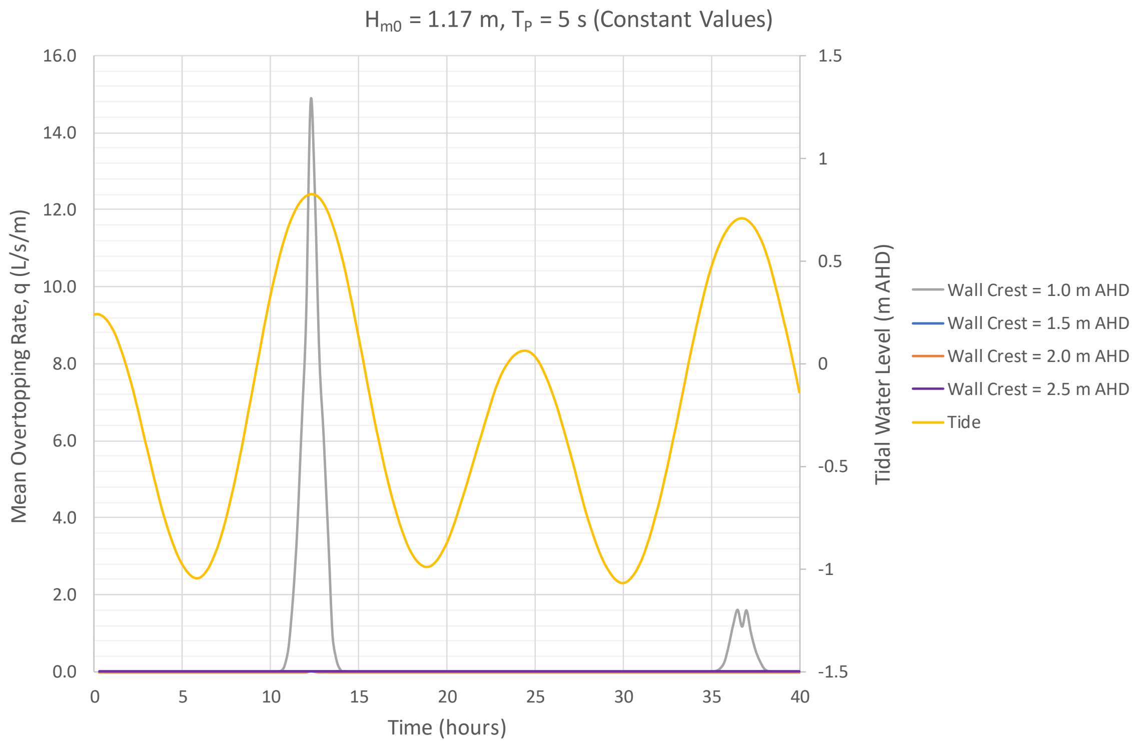


Figure 12.6 Overtopping Hallett Cove pool 10% exceedance waves

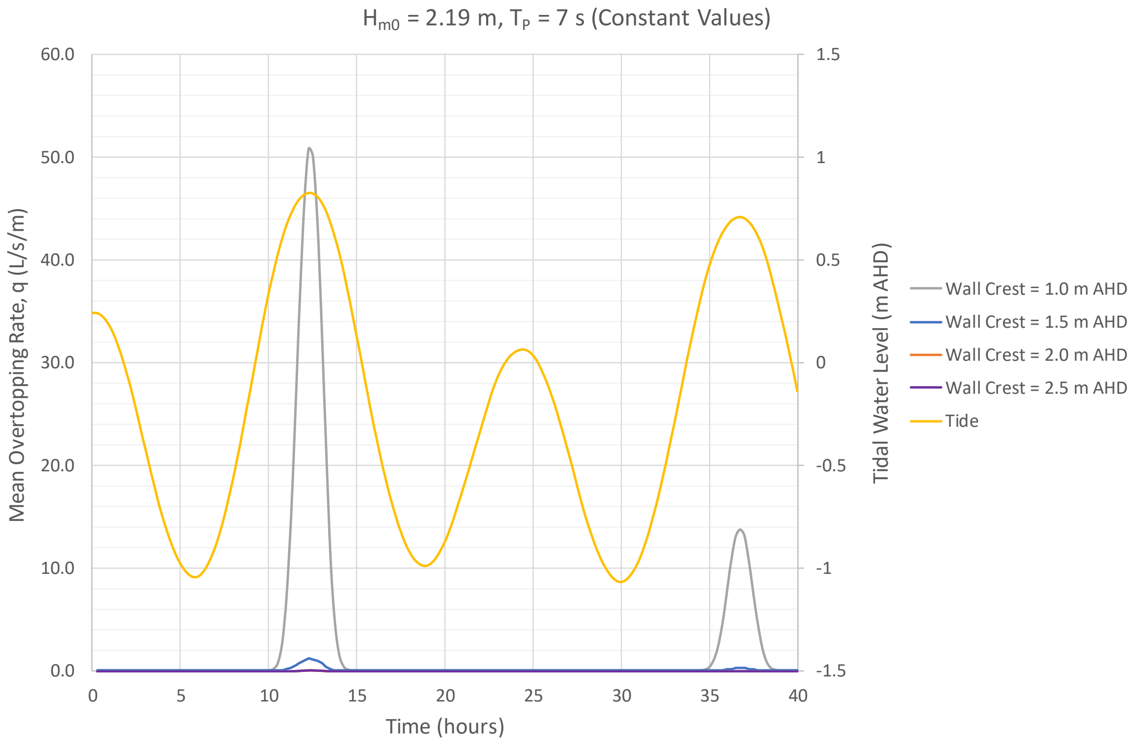


Figure 12.7 Overtopping Hallett Cove pool 1% exceedance waves

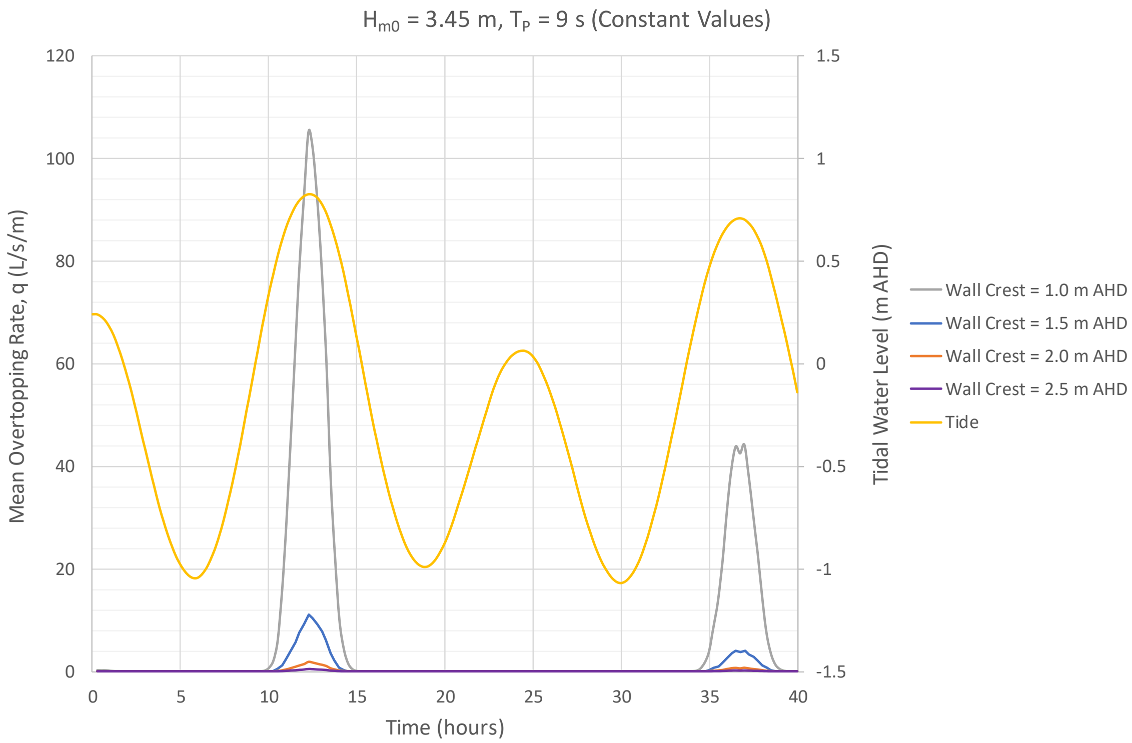


Figure 12.8 Overtopping Hallett Cove pool 1 year ARI waves

These calculations show that natural flushing for Hallett Cove comparable with well performing Sydney pools cannot be achieved under ambient conditions, while a 1 m AHD crest at Hallett Cove (lower than most Sydney pools) will still be dangerous at the peak of the tide 10% of the time. These differences primarily arise from the larger tidal range for Adelaide and smaller wave climate (wave heights and periods) relative to Sydney.

Therefore, to achieve flushing of the pool under ambient conditions and reasonable safety under 10% to 1% conditions, a wall crest of at least 1.5 m AHD would be needed in conjunction with a pump.

13 Concept design parameters

The recommended design parameters emanate from the following:

- The review of existing ocean pools (Section 5);
- Discussions with numerous pool users and experts to define a “good” or “best” practice ocean pool;
- Wave overtopping calculations; and
- Pool design standards (Appendix B).

The following design parameters are recommended for the Hallett Cove ocean pool:

- Pool dimensions:
  - Main pool: 50 m long x 20 m (8 lanes) wide (could be narrowed to 15 m (6 lanes) if required);
  - Main pool 1.2 to 1.35 m deep in shallow end; 1.6 m in deep end;
  - Children’s/wading pool: 250 to 450 m^2;
  - Children’s/wading pool: ranging from zero to 0.7 m deep;
  - Constructed public space: 250 to 450 m^2;
- Pool shape:
  - Lap swimmers prefer a 50 m length with parallel walls at the ends, but other components could be any shape;
- (Preliminary) Pool wall elevation 1.5 m AHD or preferably higher;
- Minimum elevation of lowest point in pool floor: -0.2 m AHD (higher is preferable);
- Scuppers 100 mm high, with a further 100 mm of concrete over them, that is, the pool deck is 0.2 m above the normal pool water level;
- A predominant reliance on pumping to fill and replenish the pool’s water; and
- Allowance for pram, wheelchair, machine and service vehicle access.

It is strongly recommended that the design incorporates input from a landscape architect or architect.

14 Potential to protect embankment from erosion

14.1 Embankment erosion and management

Previous work by Coastal Environment (2012) and Integrated Coasts (2018) identified that the embankment is vulnerable to present day extreme storms, and this vulnerability will increase with future sea level rise. An illustration of erosion following a storm event is shown in Figure 14.1. These studies indicated that rock armour protection of the embankment (a revetment) and/or cobbles are the most feasible options over the medium to long term. This hazard is already managed by the placement of rock armour in places, as shown in Figure 14.2.

Figure 14.1 Erosion of embankment following storm event (Coastal Environment, 2012)

Figure 14.2 Existing partial rock armour (Integrated Coasts, 2018)

The previous studies have recommended that protection of the embankment extend for a distance of up to about 400 m alongshore (Figure 14.3), but could be staged over time, with the full 400 m not presently needed. The appearance of the placed rock could be sympathetic to the Hallett Cove foreshore (Coastal Environment, 2012).

Figure 14.3 Extent of future armouring (Integrated Coasts, 2018)

14.2 Stepped concrete seawalls (landward of pool)

Many ocean pools incorporate stepped concrete bleacher seawalls as public space (Figure 14.4). These have the potential to act as seawall protection of an embankment. However, the following limitations would be present:

- A stepped concrete seawall associated with an ocean pool would be about 75 m long;
- End effect erosion/scour would occur where the wall ends, however, this would be minor and easily managed with the cheaper protection of a rock armour revetment, some of which already exists; and
- Stepped concrete seawalls are relatively expensive ($12,000 per lineal metre), and therefore probably not viable or necessary for the entire Hallett Cove embankment.

Figure 14.4 Stepped concrete seawall associated with ocean pool

14.3 Combination of stepped concrete (landward of pool) with rock armour (alongshore from pool)

Stepped concrete seawalls provide excellent public space, but are expensive. Therefore, in most situations (e.g. Manly and Kingscliff NSW), they are used for a limited extent, between sections of existing seawall or rock armour revetment. Examples of stepped seawalls are shown in Figure 14.5 and Figure 14.6, while a typical Adelaide rock armour seawall is shown in Figure 14.7. The presence of a clay and cobble at Hallett Cove means that the scour potential for coastal structures may be less than some other Adelaide locations with sandy shorelines.

Figure 14.5 Existing stepped concrete seawall (Manly NSW)

Figure 14.6 Existing stepped concrete seawall (Kingscliff NSW)

Figure 14.7 Existing rock armour seawall (Glenelg SA)

With approximately 400 m of embankment to be protected in the future, approximately 75 m of embankment protection could be landward of an ocean pool and be constructed from stepped concrete, leaving 325 m of rock rubble (located alongshore from the ocean pool), the costs for this would be:

- Stepped concrete seawall: 75 m @ $12,000 = $900,000
- Rock rubble embankment protection: 325 m @ $3,000 = $975,000 (Coastal Environment, 2012)
- Total cost for embankment protection: $1,875,000.

Assuming that the protection works will be undertaken regardless of an ocean pool, the additional cost for the stepped concrete portion would be:

- 75 m @ ($12,000 - $3,000) = $675,000.

Note that no rock rubble is recommended to be placed seaward of the proposed ocean pool, except possibly as scour protection subject to additional geotechnical investigations and detailed design.

15 Potential for sand retention

15.1 Impacts of recommended location on shoreline

Due to the predominantly cobble shoreline, and recommended location on the southern platform, shoreline impacts through interference with alongshore sand transport would be minor. There is the potential for minor sand accretion against the structure, but any desired large scale sandy beach augmentation could only be achieved with conventional coastal engineering means such as groynes, offshore breakwaters and/or nourishment.

15.2 Creating a sandy beach at Hallett Cove

Coastal Environment (2012) examined the feasibility and costs to create and maintain a sandy beach at Hallett Cove. This would likely involve a sand retention structure, such as an offshore breakwater (comparable to Semaphore Park) or groyne, initial sand nourishment of 500,000 m^3 (if compatible sand was able to be sourced), and the addition of 100,000 m^3/year of compatible sand to feed alongshore losses. Sufficient studies have not yet been undertaken to determine if this would be technically feasible for Hallett Cove. Indicative costs for this (assuming it was feasible and adjusted to 2019) would be:

- Sand retention structure: $3 million;
- Initial nourishment: $10 million
- Annual maintenance: $2 million.

This cost is multiple times that of an ocean pool. It would be technically feasible to integrate an ocean pool into a scheme to create a sandy beach, with the ocean pool acting as a groyne or being part of an offshore breakwater, however, this would introduce additional complexities, uncertainties and risks, which are detailed in the report. A more detailed understanding of sediment movement (supply and potential transport rates) would be required, should these options be contemplated. As an ocean pool could be constructed and maintained for a much lower amount than the construction and maintenance of a beach, and could be viable, independent of a beach, it is not recommended that an ocean pool be dependent on any scheme to create and maintain a beach at Hallett Cove. The construction of an ocean pool at the recommended location does not preclude further consideration of a sandy beach for Hallett Cove.

16 Capital and maintenance costs for ocean pool

16.1 Indicative capital costs

Based on discussions with ocean pool asset managers and first principles estimates by experienced engineers, the likely range of initial capital costs for a new ocean pool would be:

- Low: $2 million;
- Most likely: $3 million;
- High: $5 million.

This would cover:

- A 50 m x 20 m main pool;
- A 250 to 450 m^2 wading pool; and
- 250 to 450 m^2 of constructed public space.

As per Section 14, approximately 400 m of embankment may need to be protected in the future. Assuming that approximately 75 m of embankment protection is constructed using stepped concrete and 325 m of rock rubble, the costs for this would be:

- Stepped concrete seawall: 75 m @ $12,000 = $900,000
- Rock rubble embankment protection: 325 m @ $3,000 = $975,000
- Total cost for embankment protection: $1,875,000.

16.2 Indicative maintenance costs

Indicative annual maintenance costs have been derived from discussions with ocean pool asset managers. Some noted that most existing ocean pools are old assets and were constructed prior to many contemporary developments in engineering technology. Therefore, a new ocean pool could require less maintenance than many of these pools.

Maintenance costs have been presented as low, most likely and high values. The high values are encountered on heavily used Sydney pools (>250,000 visits per year), where the asset is aging and the wave climate is much larger than Adelaide. Pools which can be classed as low maintenance are in relatively remote locations (<50,000 visits per year), do not have a pump or lane markings, and involve minimal cleaning – relying predominantly on wave flushing.

The following tasks are covered in the indicative maintenance costs:

- Planning, asset management, supervision;
- Cleaning;
- Cleaning materials;
- Trash pump and pressure cleaner;
- Sand and wrack removal;
- Minor concrete patching;
- Balustrade repairs;
- Painting;
- Lane marking;
- Pump overhauls;
- Pump replacement;
- Rock removal;
- Lighting maintenance;
- Joint sealing (Sikaflex); and
- Service vehicle.

Indicative maintenance costs are shown in Table 16.1, which are presented as an annual amount and as a Net Present Cost based on a 7% discount rate over 20 years. This is in accordance with the central discount rate of most state treasury recommendations. Due to the relatively mild wave climate, new construction and moderate usage, maintenance for an ocean pool at Hallett Cove is likely to be less than the "most likely" category.

Range	Annual costs ($/year)			Net Present Cost 20 years @ 7% ($)		
	Council staff labour	Materials and subcontracts	Total	Council staff labour	Materials and subcontracts	Total
Low	11,000	1,000	12,000	116,000	11,000	127,000
Most likely	60,000	18,000	78,000	635,000	190,000	826,000
High	90,000	47,000	137,000	950,000	500,000	1,450,000

Table 16-1 Indicative maintenance costs

Daniel Aldridge of Mid Coast Council in NSW stated in the Port Macquarie News 6/12/2018 that annual maintenance for the Forster ocean pool was $63,250, which is comparable to the figures shown above.

16.3 Pump electricity costs

Additional studies would need to be undertaken regarding water circulation, water quality and pumping requirements. As discussed in Section 13, some form of pumping is recommended for Hallett Cove. Many ocean pools exist with no pump, whereas Dee Why ocean pool uses two pumps, but is estimated to have over 250,000 visits per year. A range of indicative electricity costs to run a pump for an ocean pool is shown in Table 16.2. These are based on 30 kW pumps (Appendix B.9.6) with an electricity supply cost of 30c per kW hour, except for the "low" value, which is for pools with no pump. Due to the mild wave climate and tidal range at Adelaide, as per Section 12.4, a pump is recommended for Hallett Cove.

Range	Annual costs ($/year)	Net Present Cost 20 years @ 7% ($)
Low	0	0
Most likely	13,000	137,000
High	38,000	395,000

Table 16-2 Indicative pump electricity costs

16.4 Indicative pool refurbishment costs

As discussed in the report, most ocean pools require upgrading at intervals of about 10 to 20 years. Funds for this are usually obtained through additional grants. Management of ocean pools is also undertaken within a local Council's normal asset portfolio management system.

Based on discussions with asset managers, indicative refurbishment costs (future value, FV and present cost, PC, discounted at 7% over 20 years) are:

- Low: $200,000 future value; $51,000 present cost;
- Most likely: $800,000 future value; $206,000 present cost;
- High: $1,500,000 future value; $388,000 present cost.

16.5 Summary of costs

A summary of costs detailed above (including in-house council labour, materials, external contracts and electricity) is provided in Table 16.3, noting that the “low” value for pump costs is for pools with no pump.

Range	Initial capital	Refurbishment at 10 to 20 years		Maintenance		Pump costs	
	$	$	Net Present	$/year	Net Present	$/year	Net Present
Low	$2,000,000	$200,000	$51,000	12,000	127,000	0	0
Most likely	$3,000,000	$800,000	$206,000	78,000	826,000	13,000	137,000
High	$5,000,000	$1,500,000	$388,000	137,000	1,450,000	38,000	395,000

Table 16-3 Summary of costs

17 Conclusions

Following a review of literature on ocean pools, site inspections of existing ocean pools, assessment of the local geology and consideration of the local coastal processes, a pumped ocean pool is considered technically feasible at Hallett Cove.

WRL has prepared a conceptual design for a “best practice” ocean pool at Hallett Cove which incorporates:

- A 50 m x 20 m main pool;
- A 250 to 450 m^2 wading pool; and
- 250 to 450 m^2 of constructed public space (including a stepped concrete seawall on the landward side of the two pools).

As part of this feasibility assessment, information associated with the proposed ocean pool (including benefits, initial and ongoing costs, potential usage, car parking availability and public safety) has been provided to assist the City of Marion in deciding whether the project can proceed to detailed design or not. Note that additional studies would be needed to progress the project towards detailed design.

If a decision is made to proceed to detailed design of an ocean pool at Hallett Cove, it is recommended that the design incorporates input from a specialist architect or landscape architect.

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Appendix A: People who assisted with this study

The following individuals were interviewed in this study and provided knowledge, experience, expertise, information and opinions regarding ocean pools. WRL acknowledges the contributions they made to assist with this study. However, the opinions in this report are those of WRL and may not represent the position of the individuals below:

- Mr Bill Andronicus;
- Associate Professor Kirsten Benkendorff;
- Associate Professor Rob Brander;
- Associate Professor Ron Cox;
- Mr Angus Gordon;
- Mr Nick Hoskin;
- Mr Russell Jenkins;
- Ms Nicole Larkin;
- Mr Levi Littlejohn;
- Mr Andy Prentice;
- Northern Beaches Council pool maintenance staff;
- Mr Rick Pybus;
- Ms Courtney Tallon; and
- Professor Bruce Thom.

Appendix B: Pool design details

B.1 Preamble

This appendix contains ocean pool design details which have evolved during the lives of many pools.

B.2 Engineering design of structure

Establishing the design working life of a maritime structure is critical for determination of subsequent design parameters. WRL has adopted a nominal design life of 50 years for this proposed ocean pool. This is a typical design life for a normal maritime structure (AS 4997, 2005). As discussed elsewhere, most heavily-used ocean pools in NSW are renovated at intervals of 10 to 20 years, with minor maintenance at more frequent intervals.

Having established the design life, an appropriate level of design risk needs to be adopted, to develop design waves and water levels. An annual probability of exceedance for significant wave height and still water level forms the design "event" or design conditions.

Australian Standard (AS) 4997 recommends design significant wave heights based on the function and design life of the structure as reproduced in Table B.1. AS 4997 recommends that the design water levels accompanying these waves should not be below Mean High Water Springs (MHWS).

Based on this guideline, selection of the 200 to 500 year ARI event may be suitable for the proposed "normal" maritime structure. However, coastal hazard assessments for local government areas typically consider the 100 year ARI as the design criteria for deriving coastal setbacks and inundation areas. As such, there is a reasonable basis for accepting some reduction in the design conditions. The guideline gives no further direction on the recommended design water level. Use of this conservative design water level indicates that selection of the reduced design significant wave height is robust for preliminary design. This could be revisited at detailed design stage.

Function Category	Structure Description	Encounter Probability (a, b)	Design Working Life (Years)			
			5 or less (temporary works)	**25** (small craft facilities)	**50** (normal maritime structures)	**100 or more** (special structures/ residential developments)
1	Structures presenting a low degree of hazard to life or property	~20%(c)	1/20	1/50	1/200	1/500
2	Normal structures	10%	1/50	1/200	1/500	1/1000
3	High property value or high risk to people	5%	1/100	1/500	1/1000	1/2000

(a) Apart from the column "Encounter Probability (calculated by WRL), the table is a direct quote from AS 4997-2005.

(b) Inferred by WRL.

(c) The encounter probability for temporary works, normal maritime structures and special structures in Function Category 1 is ~20%. However, the encounter probability for small craft facilities in Function Category 1 is 39%.

Table B.1 Design life and design event (source AS 4997-2005)

B.3 Design elements

This report is primarily focussed on coastal engineering issues, so is not an exhaustive review of applicable legislation and standards pertaining to swimming pools. Additional studies into this may need to be made.

The following design elements need to be considered for an ocean pool:

- Pool location:
  - Access;
  - Proximity to rivers, drains, groundwater and stormwater;
- Pool design:
  - Dimensions;
  - Disabled access;
  - Maintenance access;
  - Lane lines;
  - Lane rope attachments;
  - Scuppers;
  - Concrete mix;

    - Handrails, balustrades, chains;
    - Children's/wading pool;
- Pump(s):
    - Primary insitu pump(s);
    - Portable pump;
    - Pump location and type;
- Pool floor:
    - Concrete, sand or rock;
    - Slope to drain;
- Drain valve:
    - Size;
    - Location;
    - Slope and fall to drain valve;
    - Valve type;
- Lighting:
    - Night swimming;
    - Cleaning;
- Maintenance provisions:
    - Vehicle access;
    - Painting and surface finishes;
    - Cleaning protocols and triggers;
    - Storage of cleaning equipment;
    - Chemical use;
- Amenities and services:
    - Change rooms, toilets and showers;
    - Electricity;
    - Parking for cars and bicycles; and
    - Signage.

B.4 Pool location

Due to its complexity and importance to the overall project, pool location is discussed separately in Section 12.

B.5 Pool dimensions

B.5.1 FINA dimensions

While the proposed pool will not be suitable for official accredited swimming competitions due to its salt water, official FINA (Fédération internationale de natation; English: International Swimming Federation) dimensions are presented in Table B.2 for reference. Additional criteria (such as greater depth) apply for pools intended for Olympic Games and world championships, which are not realistic for an ocean pool.

Pool type	Length(m)	Width (m)	Lane width (m)	Depth with starting blocks (m)*	Depth without starting blocks (m)
50 m pool	50.000	25	2.5	1.35	1.0
25 m pool	25.000	25	2.5	1.35	1.0
Water polo (men)	30	25	n/a	1.8 to 2.0	1.8 to 2.0

* "Depth - A minimum depth of 1.35 metres, extending from 1.0 metre to at least 6.0 metres from the end wall is required for pools with starting blocks."

Table B.2 FINA pool dimensions

B.5.2 Swimming Australia depth guidelines

Swimming Australia Limited (2015) considered Standards Australia Limited Pool Depth Guidelines (2006) and the Royal Life Saving Society (SU 1.22) "Safe Water Entry For Competitions" and concluded:

> "Where the recommended pool depth sought is in relation to entry into water for competition or training with novice swimmers then there should be no concourse diving into water with a depth less than 1.35 and no platform dives into water with a depth of less than 1.8 metres. Where the recommended pool depth sought is in relation to recreational users then there should be no platform or concourse dives into water with a depth of less than 2.0 metres."

B.6 Children's/wading pool

Many successful ocean pools incorporate a swimming (lap) pool and a separate children's/wading pool. The wading pool allows children and non-swimmers to be separated from lap swimmers, and offers shallower wading depths for children and non-swimmers. As discussed above, successful children's/wading pools typically have an area of 230 to 450 m^2 and maximum depths of 0.7 m with a ramped floor.

B.7 Width of pool walls

Access for maintenance and repairs may be required on all pool walls. Wider walls make this easier and safer for workers. As a minimum, walls should be wide enough to wheel a trolley carrying heavy equipment, say 600 mm to 1 m. Vehicle or machine access (> 2.4 m wide) on some walls is advantageous.

B.8 Suggested pool dimensions

Based on the above and measurements of existing ocean pools, the following pool dimensions are suggested:

- Main pool: 50 m x 20 m (8 lanes). 1.2 m to 1.35 m deep in shallow end and 1.6 m in deepest part, with "No diving" signs;
- Children's/wading pool of 250 to 400 m^2, grading from zero depth to 0.7 m maximum depth; and
- Constructed public space of 300 to 400 m^2 would also enhance community use of the pool.

B.9 Other design elements

B.9.1 Design for access and mobility

Design for access and mobility is covered in AS 1428.1-2009 and the National Construction Code (NCC, 2019). Conventional requirements for ramps are a minimum width of 1 m, maximum gradient of 1V:14H and maximum distance of 9 m between landings (for 1V:14H gradient). This would mean a maximum vertical distance 0.64 m between landings.

The National Construction Code (NCC, 2019) is focussed on performance based design. It also presents studies regarding wheelchair stability on slopes in air (rather than those under water). Subject to a holistic analysis of the project, NCC (2019) permits a ramp to be not steeper than 1V:6H over a sloping ramp length of 6 m. In reality, much of a ramp approach into a pool will be under water, where different physical forces and stability prevail.

If a wading pool is designed for 20 m width and 0.7 m maximum depth, complying ramp access could be part of the wading pool's floor.

If an island pool location is adopted, disabled access would be more complex. This could take the form of an elevated bridge or some form of matting on the sand. The matting may be buried in sand at times and may be damaged by waves at other times.

B.9.2 Lane lines, lane ropes and attachments

Many pools with a concrete floor have lane lines painted on the bottom (Figure B.1). These allow swimmers using the middle lanes to keep in their lane and reduce collisions with other swimmers.

Lane ropes are used in many ocean pools during times of high pool use and/or while running carnivals/races. Flush mounted stainless steel attachments (Figure B.1) are preferred.

Figure B.1 Stainless steel lane rope attachment and scupper

B.9.3 Scuppers

Scuppers serve the following functions:

- Allow a pool to keep a near constant water level;
- Prevent excessive loss of water from inside the pool through splashing and waves made by swimmers; and
- Allow floating debris and surface scum to discharge from the pool.

Typical design of scuppers (Figure B.1) is a rectangle of about 1 m long by 100 mm high. Most Sydney Northern Beaches' pools have a concrete slab of about 150 mm thickness above the scupper. This allows sufficient concrete cover to the reinforcement. It means that the pool surrounds are about 250 mm above the water level of the pool.

Detailed design of a pool can consider the following with respect to scuppers:

- Locating the scuppers to assist with intended pool circulation patterns;
- Designing scuppers with different invert levels to assist with intended pool circulation patterns; and
- Locating the scuppers with reference to prevailing winds, to assist with removal of floating debris.

B.9.4 Concrete mix and reinforcement

Some areas of some pools on Sydney's northern beaches have been constructed/repaired using rounded river pebble aggregate in the concrete mix, rather than conventional angular basalt aggregate. This is to reduce the hazard of sharp aggregate injuring or being uncomfortable for wet/bare feet. This is probably most relevant on the pool surrounds and the pool floor at depths where wading can be undertaken.

Corrosion of reinforcement steel has been a major problem with concrete structures in the marine environment. Many ocean pools were constructed with mass concrete without reinforcement. Partial excavation meant that the walls did not have to be very high, and therefore had lower wave forces acting on them. Recent advances in technology and availability mean that reinforcement of stainless steel, glass fibre or basalt fibre could be used, subject to detailed design.

Some insitu concrete work will be inevitable, however, many upgrade projects have involved some use of precast concrete. For formed concrete, the recommendation has been to form and pour on the same day where possible, which precludes complex reinforcement systems being tied in place.

B.9.5 Handrails, balustrades, chains and fencing

Most ocean pools have some form of perimeter balustrade where an external fall hazard is present (generally interpreted as more than 1 m). There are two main types used:

- Two rail balustrades (Figure B.2 and Figure B.3) which comply with AS 1657-2018; and
- Post and single chain balustrades (Figure B.4).

Photo: James Carley WRL UNSW

Figure B.2 Two rail ocean pool balustrade (Freshwater)

Photo: Andy Prentice

Figure B.3 Two rail ocean pool balustrade and debris damage (North Curl Curl)

Photo: James Carley WRL UNSW

Figure B.4 Post and single chain pool balustrade

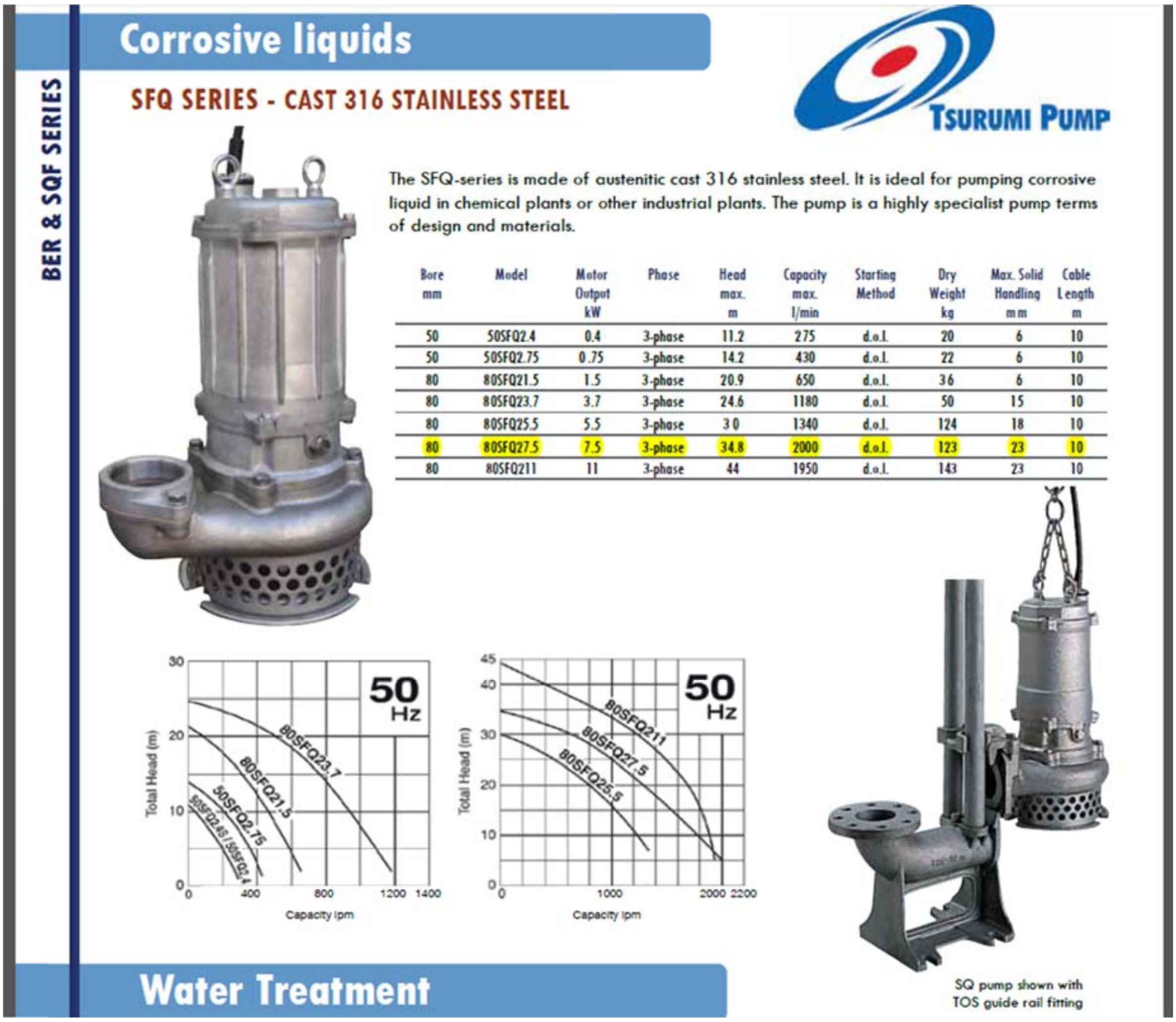
Balustrades are occasionally damaged (probably) by boulder impacts during storm events. The designs shown incorporate modular elements, so can be more easily repaired in the event of damage.

To WRL's knowledge, there are a small number of ocean pools in NSW with fencing (Bondi Icebergs, McIver's Baths, Wylie's Baths, Thirroul, Shellharbour and Ulladulla Ocean Pool), however, this is sometimes to control access for pools with paid entry. All other ocean pools in NSW are unfenced, probably on the premise that they present a hazard less than the surrounding ocean.

B.9.6 Pumps

All people with expertise in ocean pools recommended that one or more pumps should be the primary method for filling and maintaining water quality in an ocean pool. This has evolved since the early ocean pools were exclusively wave filled, and reduces the difficulty in modifying pools for future sea level rise. The use of a pump rather than wave filling allows for reduced ingress of sand in areas such as Hallett Cove.

Five ocean pools in the former NSW Warringah Council area use a cast 316 stainless steel submersible Tsurumi pump with the following characteristics: Model 80SFQ27.5, 80 mm bore, 3-phase, 2,000 L/minute (33 L/s), 123 kg (Figure B.5).


BER & SQF SERIES

Corrosive liquids

SFQ SERIES - CAST 316 STAINLESS STEEL

TSURUMI PUMP

The SFQ-series is made of austenitic cast 316 stainless steel. It is ideal for pumping corrosive liquid in chemical plants or other industrial plants. The pump is a highly specialist pump terms of design and materials.

Bore mm	Model	Motor Output kW	Phase	Head max. m	Capacity max. l/min	Starting Method	Dry Weight kg	Max. Solid Handling mm	Cable Length m
50	50SFQ2.4	0.4	3-phase	11.2	275	d.o.l.	20	6	10
50	50SFQ2.75	0.75	3-phase	14.2	430	d.o.l.	22	6	10
80	80SFQ21.5	1.5	3-phase	20.9	650	d.o.l.	36	6	10
80	80SFQ23.7	3.7	3-phase	24.6	1180	d.o.l.	50	15	10
80	80SFQ25.5	5.5	3-phase	30	1340	d.o.l.	124	18	10
80	80SFQ27.5	7.5	3-phase	34.8	2000	d.o.l.	123	23	10
80	80SFQ211	11	3-phase	44	1950	d.o.l.	143	23	10

SQ pump shown with TOS guide rail fitting

Water Treatment

Figure B.5 Tsurumi pump details

Five ocean pools in the former NSW Pittwater Council area use an equivalent submersible Grundfos pump.

Three ocean pools in the Sydney Northern Beaches Council area rely on wave filling only (Newport, Mona Vale and North Curl Curl), with the first two often filling with sand and seaweed. Northern Beaches Council also keeps a Sykes transportable pump for assistance, cleaning and as backup.

Northern Beaches Council staff report that the pools with a pump typically take 8 to 12 hours to fill. There are problems at some pools with pumps clogging with seaweed or sand. Pumps are serviced/overhauled about twice per year and last about 10 years in total.

Submersible pumps and their housing need to be below the lowest operating water level. This means they (or their housing) are exposed to wave impacts and construction and servicing is difficult.

While Northern Beaches Council pools have adopted submersible pumps, there are advantages and disadvantages with the use of NPSH (net positive suction head) pumps. NPSH pumps would require a foot valve and backup priming mechanism, but allow the pump infrastructure to be out of the wave impact zone, with only the much simpler and smaller scale inlet within the wave impact zone.

B.9.7 Pool Floor

Most ocean pools have a concrete floor which slopes towards a drain valve. Some have floors comprising sand and/or natural rock, with the rock smoothed and levelled in places.

Most people with experience in ocean pools recommended a concrete floor. In common with many design elements of ocean pools which have evolved, most heavily-used ocean pools in urban areas have a concrete floor, while more remote pools with less use sometimes have a more natural floor.

A concrete floor has the following characteristics:

- Advantages:
  - Easier to clean and remove excess sand;
  - Seaweed and other contaminants may mix with sand floors, creating odour and sludge;
  - Reduced leakage from pool;
  - Smoother underfoot for pool users;
  - Ability to paint lane lines on the bottom; and
  - Easier access for service vehicles and machines.

- Disadvantages:
  - More expensive; and
  - Less natural surface.

Sand and/or natural rock floors have the following characteristics:

- Advantages:
    - Potentially reduced cost; and
    - More natural habitat.

- Disadvantages:
    - More difficult to clean;
    - Potential for the pool to leak;
    - Potential for sludge to form in sand;
    - Lane lines cannot be marked on bottom; and
    - Potential hazard if crevices are present.

B.9.8 Drain Valve

All pools known to WRL have a drain valve. On Sydney's northern beaches, these are typically 600 mm diameter, cast iron gate valves (Figure B.6). Most Sydney pools can be drained in about 1 hour. The invert of these valves should be located no lower than the mean low water neap level, with some consideration for future sea level rise. Cast iron/stainless steel has been the preferred material due to its strength and resistance to impacts.

Reasonably safe low tide access to the drain valve is needed for workers.

Figure B.6 Gate valve for draining pool

B.10 Maintenance

B.10.1 Frequency

Most Northern Beaches Council ocean pools are cleaned once per week at low tide most of the year by a work crew of three. This involves draining the pool and cleaning as described below. The frequency is relaxed to once per fortnight during winter. Two of the most heavily used pools (Dee Why and Freshwater) do not experience substantial wave flushing, so are partly cleaned a second time most weeks during summer. This partial cleaning involves half draining and refilling without other active cleaning.

Cleaning is much easier when a vehicle carrying the cleaning equipment can be driven into the empty pool, obviating the need to unload, cart and reload. Such vehicle access may also serve as disabled access if designed appropriately.

More natural pools, such as North Curl Curl are partly drained about twice per year and the steps blasted/scrubbed to remove algae. Due to the marine habitat in this pool, there is a reluctance to fully drain it for an extended length of time.

B.10.2 Surface finishes and cleaning of surfaces

Most Sydney Northern Beaches pools use a blue coloured chlorinated rubber paint on their walls, while the floors are generally unpainted concrete. The smooth paint surface is used as it reduces the propensity for organisms to attach to walls and reduced weathering of concrete through cement erosion. Pools with a concrete floor generally have black lane lines painted on the floor. Walls are typically painted once per year, while lane lines are typically painted twice per year. Non-slip epoxy coatings have been trialled on precast pool surrounds at South Curl Curl, but they have not fully bonded to the concrete.

While more aggressive chemical cleaners have been used in the past, cleaning of surfaces for Northern Beaches Council pools is now undertaken with a high pressure water blaster. Painted horizontal surfaces and/or surfaces requiring additional treatment are cleaned with “Cyndan Algae Died B”. Cyndan (cyndan.com.au) describes this as: “a non-chlorine liquid treatment formulated to control and remove algae, mildew and bacteria. Algaecide for killing algae in pools, ponds, air conditioning cooling towers, fountains, etc.”

B.10.3 Sand removal

Water velocities required to move sand are shown in Figure B.7 (Hjulstrom, 1935). Indicative sand size for Hallett Cove is 0.2 to 0.3 mm. It should be noted though, that (based on observations from WRL engineers) due to winnowing and sorting, the sand which gets transported into ocean pools is usually finer than the surrounding beach, however, no details for this are available.

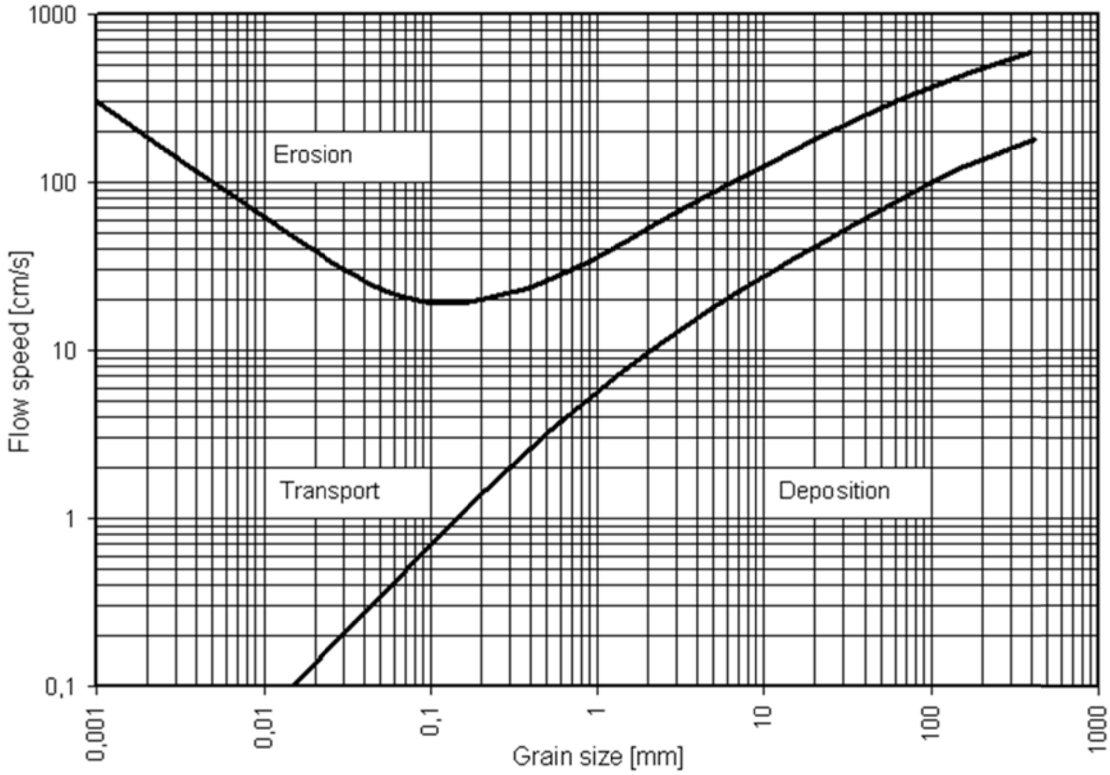


Figure B.7 Hjulstrom diagram for sand erosion

From Figure B.7, sand of 0.2 to 0.3 mm will mobilise under the following water velocities:

- Initial transport (bed load/ripples): 0.015 to 0.02 m/s; and
- Erosion/scour: 0.2 m/s.

Indicative swimming speeds are as follows:

- Victorian Police swimming test:
  - 100 m in 4 minutes = 0.42 m/s.
- Surf Life Saving Australia Surf Rescue Certificate ($\geq$ 13 years' old):
  - 200 m in 5 minutes = 0.67 m/s.
- Surf Life Saving Australia Bronze Medallion ($\geq$ 15 years' old):
  - 400 m in 9 minutes = 0.74 m/s.
- Surf Life Saving Australia Gold Medallion and professional lifeguard:
  - 800 m in 14 minutes = 0.95 m/s.
- World record:
  - 50 m in 20.91 s = 2.39 m/s.

Reconciling the above, humans can swim faster than the velocities required to erode sand, but apart from elite swimmers, not much faster, and therefore any active sand removal through velocity scour is probably not viable while swimmers are using the pool.

Thin veneers of sand are usually removed by hosing with pumped water (Figure B.8) as part of normal pool cleaning operations. Thicker sand deposits require removal with earthmoving plant (Figure 5.9). Pool design and operation also needs to plan for the scenario of earthmoving plant or vehicles breaking down inside the pool, since a rising tide with wave overtopping could result in loss or damage to plant and/or environmental contamination.

Figure B.8 Sand removal Bondi Icebergs (Source: Aquabumps)

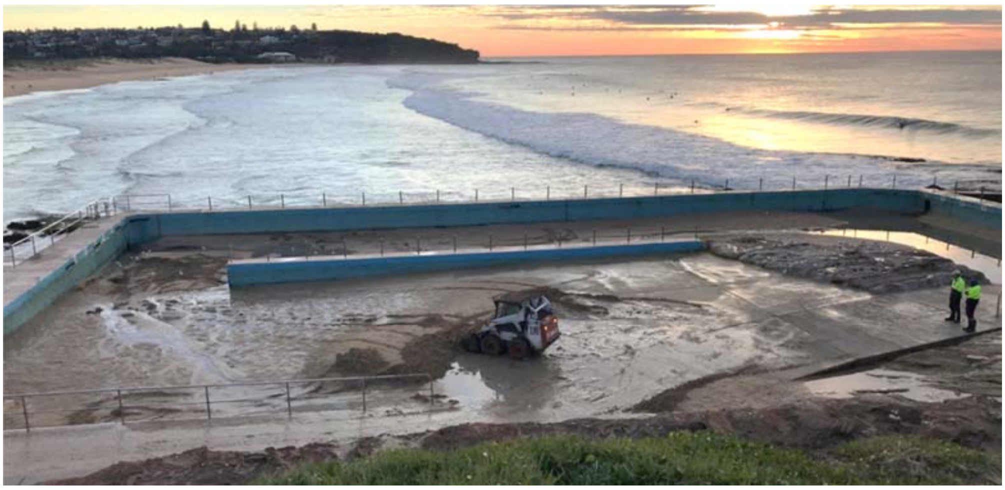


Photo: James Carley WRL UNSW

Figure B.9 Sand removal South Curl Curl

Appendix C: Potential usage (by Integrated Coasts – Mark Western)

C.1 Overview

The purpose of this section is to evaluate: the potential usage for the proposed ocean pool, the possible economic value of beach and pool usage, and the possible demand and availability of car parking for pool users.

A comprehensive and accurate estimate of existing usage of Hallett Cove Beach could be derived by deploying a network of cameras and surveying the area for an entire representative year. The resources (time and money) for this were not available for this project, so estimates relying on a reduced scope of data collection were developed.

To ascertain a profile of existing users and related car parking patterns the Hallett Cove Beach area was surveyed on the dates and times noted in Table C.1. The survey visits marked in blue represent those that involved a car parking count and people count. The purpose of the other visits was to review the beach area in the early morning for three days: Thursday, Saturday and Sunday.

	0800hrs	1100hrs	1400hrs	1700hrs	2000hrs
1st Jan 2019 – New Years		X	X	X	X
5th Jan 2019 - Saturday		X	X	X	X
31 Jan 2019 - Thursday	X	X	X	X	X
2 Feb 2019 – Saturday	X				
3 Feb 2019- Sunday	X	X	X	X	X

Table C.1 Survey visits to Hallett Cove Beach

The survey time frame of three hours was chosen for two reasons. Three hours is likely to represent the limit of time at which a visitor would stay at the beach and it was a manageable time frame in which to conduct surveys in the context of a low-cost feasibility study.

The overall purpose of the surveys was to obtain a 'snapshot' of beach, foreshore and car parking use at four times through the day for four separate day types:

- A public holiday (within school holidays);

- Saturday (within school holidays);
- Sunday (after school holidays); and
- Thursday (after school holidays).

It is also important to recognise that the surveys were conducted in the prime summer months of the year and on days of pleasant summer weather.

C.2 Beach and potential pool usage

C.2.1 Profile of existing users

Based on twenty (20) visits to the beach it was observed that people visit Hallett Cove Beach for the following venues or activities:

1. Café (normally adults, or adults with children);
2. Reserve: BBQs, picnics (Figure C.1), playground, sitting, talking;
3. Beach: fossicking, sitting, walking (but not swimming);
4. Coastal trail: walkers use Hallett Cove Beach as the parking point;
5. Morning and evening walkers, sometimes with dogs;
6. ‘Sun-setters’: on pleasant evenings people gather on foreshore until sunset; and
7. Speciality groups: for example a snorkelling group assembled on north end (2 Feb) and a playgroup was observed using the playground (31 Jan).

Figure C.1 Picnic on foreshore (Western, 2019)

Evaluating the way in which people travelled in cars also provided insight into visitor demographic:

1. Couples predominate (often meeting with other couples);
2. Parent(s) with children – usually in groups of 3-5;
3. Women in groups of 2-5 (usually café attendees, but also seen on the reserve). Women are often seen exercising on the walking trail either alone or in a pair; and
4. Larger picnic groups normally contain a larger range of visitor types.

The types of visitors that are less seen at Hallett Cove Beach include:

1. Teenagers (unless with parents, often on the walking trail). Sometimes 2-4 teenage girls were observed, but rarely any teenage boys; and
2. Groups of men (young or old). Sometimes lone men sat on foreshore area, but rarely any young adult male groups were observed.

C.2.2 Numbers of existing users

People were counted within the following areas and photographs taken:

- Café (and kiosk) area (sometimes just the kiosk is open);
- Reserve – green space, BBQ areas, playground; and
- Beach – from Grand Boulevard to Black Point (i.e. the whole beach).

Trail walkers use the car park, attend the kiosk or café, but are unable to be counted when walking on the trails. The results of the count are included in Table C.2 along with summary weather conditions.

1 January – New Year's Day holiday (1100 – 2000)

	1100	1400	1700	2000	Totals
Weather (very pleasant)	25°	29°	28°	23°	
Café (closed) kiosk (open)	14	18	13	0	45
Reserve - BBQ/playground	93	124	111	106	434
On the beach	35	46	42	34	157
Totals	**142**	**188**	**166**	**140**	**636**

5 January – Saturday (1100 – 2000)

	1100	1400	1700	2000	Totals
Weather – v. pleasant (mild)	21°	24°	24°	20°	
Café (open until 2000)	68	116	31	15	230
Reserve - BBQ/playground	64	78	51	42	235
On the beach	17	42	35	16	110
Totals	**149**	**236**	**117**	**73**	575

31 January – Thursday (1100 – 2000)

	1100	1400	1700	2000	Totals
Weather (v. pleasant – mild)	22°	26°	25°	19°	
Café (not open after 1500)	25	55	0	1	81
Reserve - BBQ/playground	43	6	7	26	82
On the beach	6	3	5	4	18
Totals	**74**	**64**	**12**	**31**	183

3 February – Sunday (1100 – 2000)

	1100	1400	1700	2000	Totals
Weather (hot, but not extreme)	31°	31°	30°	25°	
Café (open but not after 1500)	81	44	0	0	125
Reserve - BBQ/playground	24	12	28	98	162
On the beach	13	7	7	23	50
Totals	**118**	**63**	**35**	**121**	**337**

Table C.2 Existing usage counts

The last survey day of 3 February 2019 provides an ideal case study for visitor behaviour at Hallett Cove Beach when the weather becomes hotter:

- From 1100 to 1700, 91 people were observed on the beach or reserve; and
- At 1400 (2pm), 19 people were on the beach or reserve.

In comparison, nearby Moana Beach at 1.15pm (Figure C.2) on the same day is likely to have had ~300 cars parked on and off the beach, and therefore likely to have 700-800 visitors to the beach and foreshore areas.

Figure C.2 Visitors to Moana Beach (3 February 2019, 1:15, Western)

Moana Beach is one of the smaller southern beaches and is about 15 minutes' drive south of Hallett Cove Beach. Beaches further south at Port Willunga, Aldinga Beach and Sellicks Beach are likely to have had much greater beach populations on this day.

In all the surveys conducted at Hallett Cove Beach no one was observed swimming until the 19th visit on 3 February at 1700 when three teenage girls, and one older male (unrelated) had a short swim.

Based on this survey day, and common knowledge about beach visitors, it can be safely concluded that in hotter weather, people do not patronise the Hallett Cove Beach but either stay indoors or visit other beaches. This factor is well summarised by one of the contributors on *change.org* for the petition *'Let's build a sea-pool in Hallett Cove':*

> **Amanda G**
> Feb 13, 2018
> We live in Hallett Cove and currently when we go to the beach on a hot day, it's not the one at our doorstep because we can't swim [there].

C.2.3 Duration of beach visit

WRL have provided the following information. There are some data sources for instantaneous and/or daily totals of beach users in other jurisdictions, and instantaneous data has been collected and presented above for Hallett Cove at 3 hourly intervals. However, there is very limited data available for the typical duration of a beach visit, which is necessary to upscale the collected Hallett Cove data into daily and annual totals.

The only data known to WRL is contained in Anning (2012) and the City & County of Honolulu (2018). Anning undertook specific on-site and online surveys for users of Manly Ocean Beach (Sydney) and Collaroy-Narrabeen Beach (Sydney). The City & County of Honolulu (2018) undertook user surveys associated with upgrading a derelict ocean pool in the vicinity of Sans Souci Beach, Waikiki, Hawaii.

The following durations were estimated:

- Manly Ocean Beach:
  - Average: 2.5 hours
  - ± Standard deviation: 1 hour to 4 hours
- Collaroy-Narrabeen Beach:
  - Average: 2 hours
  - ± Standard deviation: 0.5 hour to 3.5 hours
- Sans Souci Beach, Waikiki:
  - Average: 3.9 hours

The figures for Collaroy-Narrabeen Beach are probably most representative for Hallett Cove, as they are predominantly suburban residential areas, whereas the other locations have a substantial tourist industry. That is, the best available data indicates that typical beach (or future pool) visit at Hallett Cove would last for 2 hours and could typically range from 0.5 to 3.5 hours.

C.2.4 Baseline calculation of Hallett Cove Beach visitors (November to March)

The fact that Hallett Cove Beach has less visits by what we might call the 'traditional beach goer' is an advantage in this study because the introduction of a pool will likely introduce a totally new type of visitor. Therefore deriving an estimate of existing visitor numbers to Hallett Cove Beach may provide a useful baseline from which to assess the impact of new users that a swimming pool is likely to attract. It is recognised that the surveys were not designed specifically to calculate the number of visitors per day to Hallett Cove Beach. However, deriving some estimate may assist in determining what might be a realistic number of 'pool goers' to add to that baseline. The calculation may also give a perspective on what increase in the number of visitors that Hallett Cove could realistically handle.

This baseline study utilises visitor numbers from Saturday 5 January and Sunday 3 February as representative of weekend attendance, and Thursday 31 January attendance multiplied by 5 to represent weekday attendance at the beach. These were further adjusted for a typical duration of 2 hours to account for the 3 hourly sampling and for visitation before 11 am, that is, from 4 x 3 hourly data (but assuming a 2 hour duration of visit) to 7 x 2 hourly data (Table C.3). Previous estimates by WRL have assumed that beach use in quieter months is about 20% of the summer values.

This indicates that existing plausible beach usage for Hallett Cove beach is:

- 3,197 individual visits per week in summer;
- 63,945 individual visits for 20 weeks per year; and
- 76,734 individual visits per year (based on 20%) upscaling.

Day/Date	Recorded visits 3 hourly data spanning 0930-2130	Upscaled data 2 hourly visits from 0700-2100	Estimate for week	Estimate for 20 weeks/year
Saturday 5 January	575	1,006		
Sunday 3 February	337	590		
Thursday 31 January (x5)	183	320		
Totals – per week			**3,197**	**63,945**

Table C.3 Estimate of individual beach visits

When considering the possible influx for new pool users, the question needs to be asked as to how many new users might be generated, and how would Hallett Cove Beach manage the increase. Could an influx of 80,000 to 100,000 visitors be managed in the context when 64,000 to 75,000 visits are currently made (and a very optimistic estimate)?

C.3 Potential usage of pool

C.3.1 Profile of potential users

The impetus for the funding of this study was the endorsement of 4,957 petitioners on ***change.org*** to 'build a sea-pool at Hallett Cove'. Before this petition was closed 507 people also added a comment as to why they supported the concept of an ocean pool. 218 of these people gave generic support with comments such as, 'great idea', 'good idea', 'yay', and similar. Many of these also indicated that they would actively patronise the pool. 16 people left comments that were obscure or meaningless. This left a data set of 273 comments from people that gave reasons for their support of the ocean pool. This data set (Table B.4) proved to be a useful resource to conduct a qualitative assessment of reasons that people desired a pool, and also provided an insight into the likely user. It is important to note that some people made multiple observations and therefore the number of comments exceeds the number of participants.

Reason	Number	%
Perceived community need (in particular where the person identified as a 'local')	76	24%
Tourism, the desire for increased visitors to the area (the State needs this, the South needs this)	58	18%
The desire for a swimmable beach (rocky beach comments). These were locals and non-locals	47	15%
Safe swimming opportunity (mostly sharks and drownings)	48	15%
Kids and families (is a twin with item above)	20	6%
Healthy, exercise opportunity (some mention chlorine). Many mentions of the boardwalk.	19	6%
People who had swum in other pools – interstate, Edithburgh	37	12%
Economy and property values	4	1%
Request for access for those with disabilities	3	1%
Expressed some concern about impact on the environment	4	1%

Table C.4 Qualitative assessment of petitioner comments

In the following pages, sample quotes are provided with accompanying qualitative assessment where applicable. The comments have not been edited for spelling and grammar, nor upper/lower cases for listed names, but the surnames have been reduced to a single letter.

Local needs / community needs (76 comments)

It was expected that there would be strong local support for the pool. The following are a sample of the 76 comments received.

- Rebecca B
  1 year ago
  Im a local and this would be an excellent idea for the community

- Emeel H
  1 year ago
  I am local and would love a swimming area at Hallett cove

- Amanda G
  Feb 13, 2018
  What an amazing idea! We live in Hallett cove and currently when we go to the beach on a hot day, it's not the one at our doorstep because we can't swim [there].

- Glenice F
  Feb 13, 2018
  I live at Hallett Cove and would love to be able to swim there

- Julie T
  1 year ago
  Have lived in Hallett Cove for 30years would love to swim there

People in neighbouring suburbs also indicated that they would use the pool.

- Roya F
  1 year ago
  I'm living in Sheidow Park but can't get my kids to the closest beach to us for a swim. It would be fantastic to be able to go for a swim at Hallett Cove.

- adam R
  1 year ago
  I live at trott park would definitely use it with my kids

- Sarah W
  1 year ago
  My children and I regularly visit this area to see friends and we would love to go to beach near their house instead of driving kms away to Christies Beach

A boost to visitor numbers and tourism more broadly (58 comments)
A large percentage of respondents saw the pool proposal as a boost to visitors to the area. Some of the locals seemed to feel that Hallett Cove was undervalued and would welcome more visitors to an iconic pool.

- Jess W
  Feb 13, 2018
  This would be amazing and draw more people to the area!

- Liz h
  1 year ago
  Great idea, will bring a lot of visitors to the area.

- Tash s
  1 year ago
  I'm a local and this would be awesome for tourism

- candice k
  May 30, 2018
  I used to live near Hallet Cove and the area could use a boost, something like this would be fantastic!

Others took a broader view and saw the proposal as good for tourism in Adelaide or the State.

- bria p
  1 year ago
  This would be awesome for SA
- Mel P
  Feb 15, 2018
  Hallet cove would attract visitors from all over. Would be a lovely family outing that isn't found anywhere else in adelaide.

- Fiona H (typing in a rush)
  1 year ago
  Halett cove has so much more to offer this would be adduch a grwat investment foe tourism in our state. Walk the board walk play on the reserve and swim in the rock pool. Perfect!

- Christina M
  Feb 14, 2018
  As a Hallett Cove resident this would bring further tourism to the local area and allow more and more Adelaidians the chance to see what's on offer in their own backyard. Safe from sharks is added bonus.

Swimmable Beach/ Rocky Beach (47 comments)

The nature of the beach was another common theme from both locals and visitors alike.

- Brooke H
  1 year ago
  I'd love to be able to swim at Hallett cove rather than cut myself on the rocks :)

- Brigitte K
  1 year ago
  It would be great to take the kids down too and not cut themselves. Such a great idea for the area

- fiona w
  1 year ago
  Hallett cove has so much to offer but not a beach that people can enjoy. Swim pool is a great start to make this beach desirable. At the moment its an ankle breaker

- Aimi C
  1 year ago
  It's a great idea. It would be a reason for us to go to the beach at Hallett Cove, otherwise we would not go there when there is so many better swimming beaches nearby.

- andy c
  Jun 17, 2018
  There's no sandy beaches from Kingston to o Sullivan's so this is a great idea!

- Tracey M
  1 year ago
  Its an awesome idea. Hallett Cove is a fantastic beach but hardly anyone tends to swim there because its so rocky.

- Kendall M
  Feb 14, 2018
  We love this area and a swim pool would be fantastic for families of the area. Its currently too dangerous to take the kids to actually spend quality time there'.

Safe swimming beach (48 comments)

The desire for a safe swimming beach was not normally related to the rocky nature of the beach (and these comments were assigned in the category above). A section of the respondents expressed that they were fearful of swimming in the ocean because of sharks, drownings and rips. People expressed the desire for an option for salt water swimming that was safe. These respondents may represent a new beach user that may not be utilising other beaches.

The following quotes are a sample of responses:

- Sasha J
  Feb 13, 2018
  This is a great idea to create a safe environment for families to swim at the beach.

- Tracey D
  1 year ago
  I want somewhere safe for my kids to swim.

- Jodie K
  Feb 14, 2018
  Safe from sharks and turning a rarely used beach spot into a more lively hub!

- Nickolas G
  Feb 13, 2018
  I love swimming shark free.

- Nick R
  1 year ago
  Great community facility ideal for poms who are scared of sharks

- Amelia P
  1 year ago
  With the amount of beach drownings recently I think these opportunities need to be welcomed.

- Melissa M
  1 year ago
  This is a brilliant idea, to create a safe swimming area as the beach at Hallett Cove is really dangerous for anyone who attempts to swim there.

- Sharyn E
  1 year ago
  Sea pools at beaches along the coast of Adelaide would be beneficial for a number of reasons. Not all swimmers have the skills or knowledge of tides and currents to negotiate the surf.

Comparisons with experiences interstate or at rural SA pools (37 comments)

A substantial number of respondents drew on their experience interstate or at Edithburgh or Kangaroo Island pools within the State. Most of the respondents had lived/stayed in Sydney and recognised the value of these pools to the community.

- Nigel S
  Feb 12, 2018
  It's a great idea, will bring tourists to the area, great for kids. Having lived in Sydney, these pools are really well patronised and would be great for the Adelaide coastline

- Jacqueline N
  Mar 28, 2018
  It's a great idea. There is one in Edithburg. It's a safe place for people too swim

- Danielle C
  1 year ago
  It's a great idea, I went in one as a child in Sydney and have never forgotten the experience

- Kelli H
  1 year ago
  I grew up in Sydney, where sea-pools are quite common, they are wonderful for families, and those afraid of our toothie ocean dwelling friends.

- Johanna K
  Feb 12, 2018
  Yes! I grew up swimming in Sydney's sea pools. I've always wished we had them here in Adelaide.

There were also several comments expressing frustration that ocean pools had not yet been implemented in Adelaide. One is included here:

- James M
  Feb 12, 2018
  It's about time Adelaide had a decent rock / tidal pool. Hopefully this will be the first, but not the last one in metro SA.

Health and fitness (19 comments)

Nineteen respondents specifically mentioned the ocean pool as an opportunity for health and fitness activities.

- lisa d
  Apr 20, 2018
  Would be wonderful to bring kids n families to the beach and for fitness..

- Susan A
  Feb 12, 2018
  I'm signing because outdoor activity is important for everyone. This is a great idea.

- michelle r
  Feb 12, 2018
  swimming is so good for you..the more the better
- Letitia L
  Feb 13, 2018
  We need this pool for safety reasons & we will use it. My husband needs daily excersize & out doors is the best way.

Some respondents singled out the health benefits of swimming in salt water versus chlorinated water. This may indicate that there would be a niche of swimmers who would visit this pool but not visit chlorinated pools.

- Sue G
  Mar 13, 2018
  We shouldn't have to go to nsw to enjoy this experience!! Swimming in toxic chlorine can be avoided! !
- Steve B
  1 year ago
  Swimming safely in salt water is healthier than swimming in pool chlorinated water.

- Carol L
  Feb 14, 2018
  Every time I go to Sydney I'm reminded of what a great idea this is. I like swimming laps but hate chlorine.

A connection drawn between the boardwalk and the pool (~ 6 comments)

A number of respondents saw a connection between the provision of the boardwalk and the destination of a swim in a pool at the end of a walk. This concept is likely to have some tourist value as well and could be a source of promotion for the conservation park and Hallett Cove.

- Michelle S
  Feb 6, 2018
  What a great idea . You can use the boardwalk and then have a swim in a safe environment. Good excercise for everyone. Bring it on

- Louise G
  1 year ago
  The conservation park is so amazing. However after a hot 1.5 hour walk we had to drive to another beach to cool down. A sea pool would be a perfect addition to the beautiful and stunning SA coast.

- anita B
  1 year ago
  Thats a at brilliant idea, what an asset, to jump into the sea pool after walking the boardwalk, that would be a wow !

Economy and property values (4 comments)

Views about the economy and property values were not strongly represented. However, it could be speculated that many who expressed support for the pool in other ways, also would see an ocean pool as benefitting house values and the broader economy as well.

- Aneta S
  1 year ago
  Such a great solution to making HCB a swimming beach! It would raise the property value in the area for sure.

- Rebecca W
  1 year ago
  It’s a mighty great idea. Not only would it help boost the patronage at the local quiet often empty shopping centre. But it’s would be great for both the cafe on the beachfront and possibly help bring people to see the fantastic natural structures of the conservation park.

Disability perspective (3 comments overall)

A few respondents requested that the pool be designed to cater for those with disabilities.

- Tammy K
  Feb 13, 2018
  It's a great idea especially if it was designed so that it was disability and wheelchair friendly to get into the water…

Environmental perspective (4 comments overall)

Environmental concerns were in the minority of respondents.

- Amity L
  Jul 15, 2018
  Yes this is an awesome idea as long as it it built with the surrounding environment in mind I'm all for it! Yay

- RITA B
  1 year ago
  as long as it does not have environmental impact, it would be great for the community

One person had questions about the nature of the pool water.

- Natalie P
  Feb 12, 2018
  I would like to see a seaside swimming pool because it would give the beach goers somewhere safe to swim and not have to worry about getting attacked by sharks or getting dragged out in rough rips or drowning etc. It would be a good idea but I was just thinking about the water coming from the ocean into the pool and what it contains.

A few people from further away indicated that they would travel periodically to visit the pool

- Leanne S
  1 year ago
  Athough I live in the Barossa it'd make a fantastic family day out!

- Elizabeth
  Nov 17,2018
  I would drive from the other side of Adelaide to swim in a sea pool

One younger person summed up his hopes for the pool:

- Kobi A
  1 year ago
  It's our only chance of hopefully catching some bodacious mermaids.

Various summary comments:

Several people summarised the issues and likely demand more descriptively:

- Linda P
  Feb 13, 2018
  [The] view is sensational, lawns, swings for families to picnic as well as a lovely boardwalk for those wanting fitness, but not a good place to swim as very rocky. A sea pool would be a great addition for families to spend a day here.

- Fae H
  1 year ago
  We already have an upgraded cafe and take-away on the beachfront, and the pavillion and playground bring in the families. The only element missing is somewhere safe to bathe. The sea pool in Edithburgh is a fabulous facility, so let's have the hat trick by bringing swimming to the Cove.

C.3.2 Caveats regarding stated preferences

A qualitative study such as this is based on declarations on what people intend to do, or think they will do. Further surveys and study would quantify more fully the likely level of pool patronage.

It is worth noting that expectations of a pool were stimulated by the picture (Figure B.3) included on the petitioning website[1]. The proposed design for the Hallett Cove sea-pool will be necessarily different because of the differing coastal environment.

Figure C.3 Photograph of Bronte pool in NSW

[1] www.change.org/p/lets-build-a-sea-pool-in-hallett-cove-south-australia

C.4 Profile of new pool user

Based on the comments provided by 273 petitioners the profile of the pool user is likely to be:

1. Local and regular – it is very likely that the pool will be heavily patronised by local swimmers. These swimmers would also include large numbers of teenagers who are at present vastly under represented at the beach and would use the pool after school and on weekends. Local includes the surrounding suburbs of Trott Park, Sheidow Park. It is likely that Hallett Cove would come alive on hot weekends, rather than becoming dormant due to lack of swimming facilities.

2. Families with children – it appears from the comments that families would patronage the pool from further afield because it offers safe swimming for small children. Combined with the playground facilities, Hallett Cove would be attractive to families with children.

3. Exercisers (health) – although only four people specifically mentioned 'lap swimming', pool use is likely to be generated by those looking for an opportunity to exercise. This may be more formal exercise such as lap swimming or aqua aerobics, but is likely to include those who choose to swim/bathe in salt water to promote good health.

4. Periodic visitors – it is very evident that there is strong interest in attending the pool from outside Hallett Cove. These visitors are more likely to put it on the 'family calendar' and perhaps attend once or twice a season.

5. The pool would likely attract many more young adults (18-25) to the beach. At the moment this demographic is represented very poorly (especially males).

6. The opportunity exists to promote the walking trail and the ocean pool together. It is likely that groups (including youth groups and clubs) may schedule this as an activity. As a tourist promotion for the trail, park, reserve and beach it is likely to be a resounding success.

7. The pool is likely to present opportunities for specialist users. Aqua aerobics, swimming lessons, snorkelling instruction, life saving may be activities that specialist personnel would like to run.

C.5 Number of potential users

The number of potential users is difficult to quantify. There are no other ocean pools within Greater Metropolitan Adelaide upon which to draw comparative data. In this study two data sources are utilised:

- Data of patronage of Sydney ocean pools; and
- Data from Marion Swimming Centre (outdoor swimming centre).

Data from these are contained in the main body of WRL's report.

C.6 Economic value of beach and pool usage

Data regarding the economic value of beach and pool usage is contained in the main body of WRL's report.

Appendix D: Car parking demand and availability (by Integrated Coasts – Mark Western)

D.1 Overview

The projected pool usage indicates that the present supply of parking may be insufficient and further consideration of parking spaces would be needed. A high level car parking study has been undertaken by Mark Western of Integrated Coasts. The purpose of this section of work is to evaluate the existing car parking capacity in the vicinity of the proposed pool and to evaluate how an increased number of vehicles might be managed. The context of this work should be viewed as a preliminary feasibility study that is likely to require further assessment of a more detailed nature. Apart from a general overview of the transport network of the area, no evaluation has been conducted as to the impact of the pool users on traffic movements in the area.

D.2 Transport network

D.2.1 Road access to the pool site

There are three ways in which external visitors can travel by road to Hallett Cove Beach from Lonsdale Highway (Figure D.1):

- The main access route is to use The Cove Road and then Dutchman Drive.
- For those coming from the south along the Lonsdale Highway, Gretel Crescent – Grand Central is more likely to be used.
- Another access way from the south is to utilise Myer Road, a slower road that eventually arrives into Hallett Cove Beach area via Marine Pde.

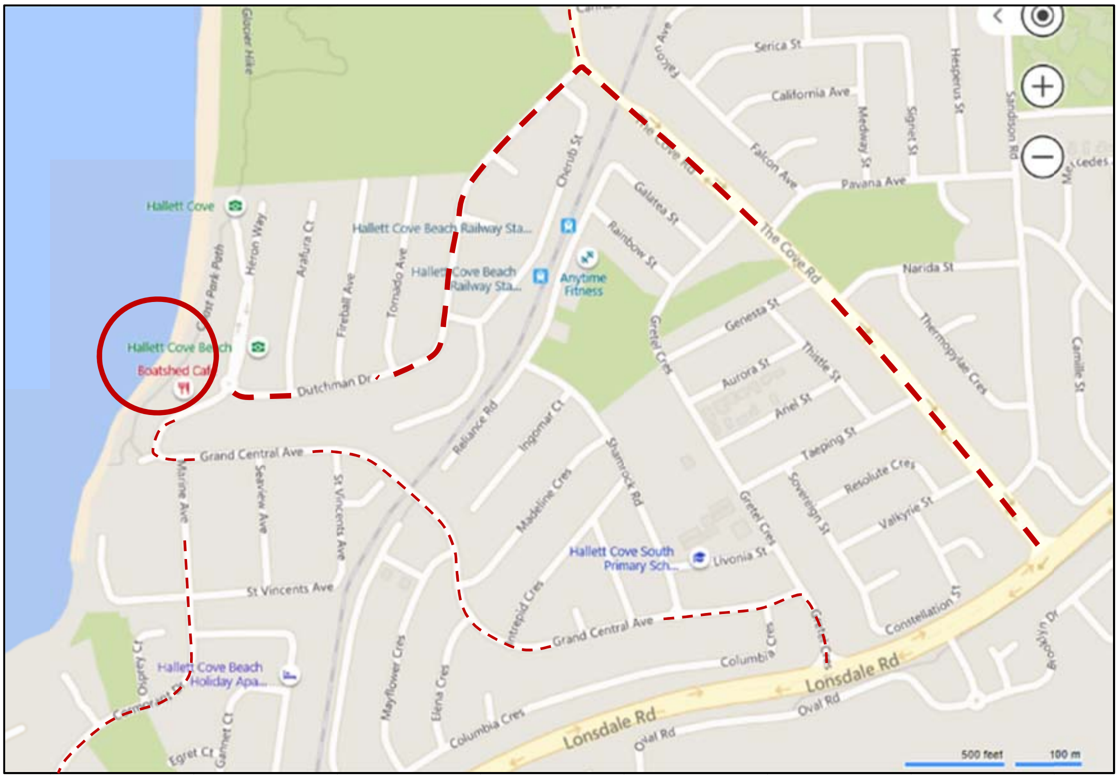


Figure D.1 Road access to Hallett Cove Beach

The Cove Road is classified as a 'secondary road' and also forms the road spine for the northern sections of Hallett Cove. This road would be utilised by residents from the northern sections of Hallett Cove, and likely also to be used by Marino and Seacliff residents.

D.2.2 Public transport availability

The Hallett Cove Beach train station is situated about 800 m from the pool site (Figure D.2). This is the outside limit in which people may walk to access the beach, especially in hot weather. Bus service 683 connects the train station to bus stop 59 at Hallett Cove Beach with a service that runs approximately every hour. Local residents living to the south of Hallett Cove would also be able to utilise the bus service from bus stops 60-65[2].

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[2] https://adelaidemetro.com.au/content/download/751/57336/file/681-682-683_ttable_routemap_27-01-19.pdf

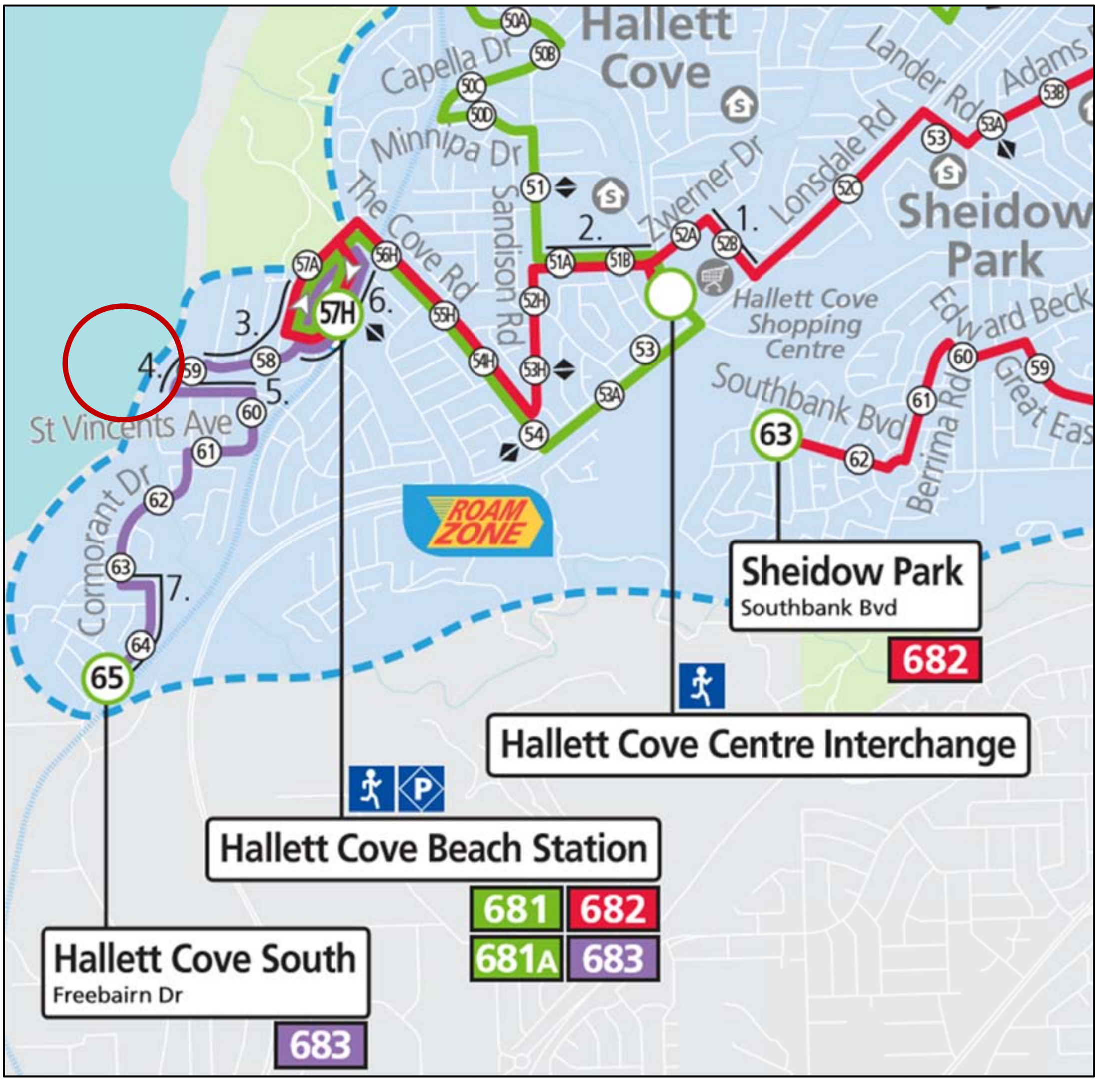

Figure D.2 Public transport access to Hallett Cove Beach

D.2.3 Cycling and walking access

Bicycle lanes have been installed to The Cove Road from Lonsdale Highway but cease at the bridge over the train line. A small walking path between Dutchman Drive and Heron Way is also often used as cycling track (Figure D.3). However the path does not extend further up Dutchman Drive.

Footpaths have been installed on both sides of Dutchman Drive and only one side of other access roads.

No facilities have been installed at Hallett Cove Beach to cater for cycle storage.

Figure D.3 Potential cycle and walking track to Hallett Cove Beach

D.3 Development Plan Review

The current land-use zoning is depicted in Figure D.4. The predominant land-use is 'Residential'. Heron Way Reserve is zoned 'Coastal Open Space' and the foreshore region is zoned 'Coastal Conservation Zone'. Principles of Development Control (PDC) in relation to vehicle movement and parking is limited to one principle in the Coastal Conservation Zone:

(b) minimise vehicle access points to the area that is the subject of the development.

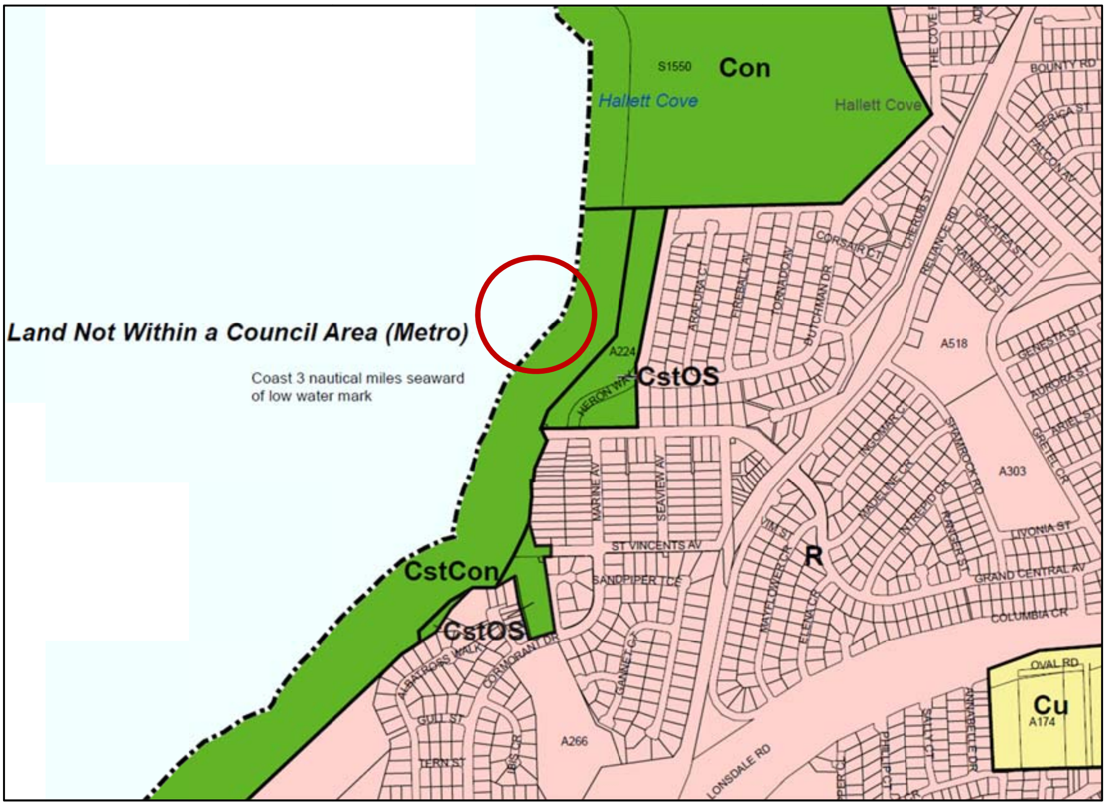

Figure D.4 Portion of Zone Map Mar/15, City of Marion Development Plan

D.3.1 General principles from the Development Plan

Development should be integrated with existing transport networks, particularly major rail, road and public transport corridors as shown on Location Maps and Overlay Maps – Transport (Figure D.5), and designed to minimise its potential impact on the functional performance of the transport network (PDC 2).

Development generating high levels of traffic, such as schools, shopping centres and other retail areas, and entertainment and sporting facilities should incorporate passenger pick-up and set-down areas. The design of such areas should minimise interference to existing traffic and give priority to pedestrians, cyclists and public and community transport users (PDC 6).

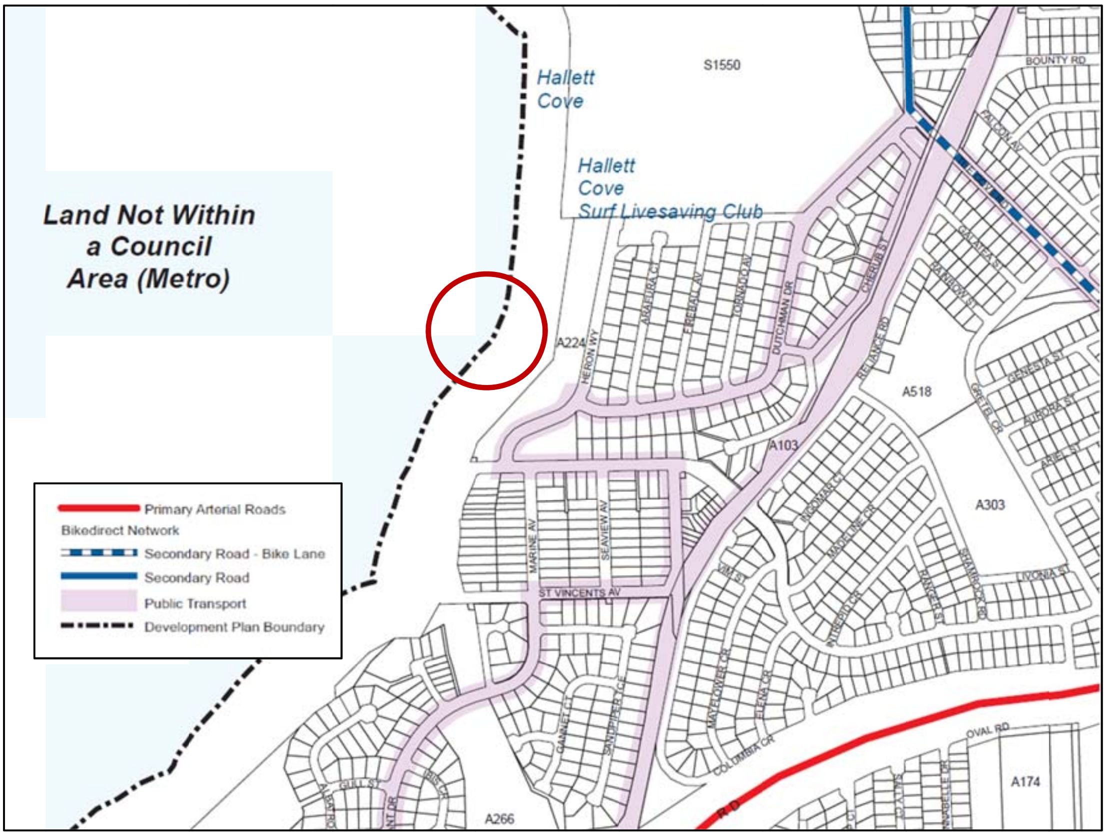

Figure D.5 Portion of Transport Map Mar/15, City of Marion Development Plan

D.3.2 Vehicle Parking Controls

Development should provide off-street vehicle parking and specifically marked accessible car parking spaces to meet anticipated demand in accordance with *Table Mar/2 – Off-street Vehicle Parking Requirements* (PDC 34). However, Table Mar/2 gives no parking requirements for pools.

General principles of development control relating to car parking are contained at PDC 36 and 38:

> Vehicle parking areas should be sited and designed to: (a) facilitate safe and convenient pedestrian linkages to the development and areas of significant activity or interest in the vicinity of the development (b) include safe pedestrian and bicycle linkages that complement the overall pedestrian and cycling network (c) not inhibit safe and convenient traffic circulation (f) minimise the number of vehicle access points onto public roads (h) where practical, provide the opportunity for shared use of car parking and integration of car parking areas with adjoining development to reduce the total extent of vehicle parking areas and the requirement for access points (i) not dominate the character and appearance of a site when viewed from public roads and spaces (Portion PDC 36)

Vehicle parking areas that are likely to be used during non-daylight hours should provide floodlit entry and exit points and site lighting directed and shaded in a manner that will not cause nuisance to adjacent properties or users of the parking area (PDC 38)

D.4 Parking Demand Assessment

The recent report by Victoria Transport Policy Institute, *Parking Management: strategies, evaluation and planning*[3] provides an insight into old and new paradigms when dealing with car parking assessments that are likely to be relevant when considering car parking demand for an ocean pool[4].

D.4.1 Conventional car park demand assessment

The report notes that conventional parking demand assessments usually:

- Assume that parking should be abundant and free at most destinations;
- Assume that parking lots should almost never fill;
- That every destination should satisfy its own parking needs; and
- Operates on a predict and provide planning which planners then try to satisfy.

Conventional planning determines how much parking to provide at a particular site based on recommended minimum parking standards published by various professional organisations. These parking standards are usually predicated on the likely generation of car parking usage in accordance with land-use type[5]. Furthermore, car parking demand studies identify the characteristics of peak usage, and then base car parking needs based on 85th percentile demand curves. In practice this means that the aim is to produce a car parking design that would have 15 out of 100 sites vacant even during peak periods.

In the context of the proposed ocean pool, the conventional approach would be to ascertain usage based on land type from published sources, and then apply data from comparative examples as to confirm the likely car park demand. In regard to the former, there is no published data on how many car parks an ocean pool would be likely to generate. In regard to the latter, there are no comparative examples within South Australia upon which to base a study to determine how many people may patronage the pool, and what likelihood of car parking generation.

3 Litman, T 2016 *Parking Management: Strategies, Evaluation and Planning*, Victoria Transport Policy Institute

4 Additional reports are included in the reference section.

5 A comprehensive example of this planning approach is contained within *Guide to traffic generating developments,* Roads and Traffic Authority (NSW), October 2002

Three published sources were identified in relation to pools generally:

- Canberra - 5 car spaces per 100 m^2 of pool area[6];
- Victoria - 5.6 x 100 m^2 of the site[7]; and
- Gold Coast - 15 spaces, plus one (1) space per 100 m^2 of Total Use Area[8].

The current pool proposal gives an upper and lower range of pool and public space areas in Table D.1.

Public Space Area	Upper Area (m^2)	Lower Area (m^2)
Main pool	1,000	750
Wading pool	450	250
Public space	450	250

Table D.1 Upper and lower range of proposed pool and public space areas

Applying the design criteria from each of the sources listed above to the proposed pool design delivers the following car park requirements in the Table D.2 below.

Location for Car Spaces to Pool Area Ratio	Upper Area (no. parks)	Lower Area (no. parks)
Canberra	70	50
Victoria	106	70
Gold Coast	34	28

Table D.2 Upper and lower range of proposed car park requirements

It is acknowledged that these latter two calculations are low because the site area of the proposal is low, and public space is likely to be higher than 450 m^2 in final design. It is also important to remember that these criteria are related to conventional pools, not ocean pools. A formal car parking demand assessment would then seek to identify from a comparative example what the likely patronage and car parking may be for the site.

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[6] ACT Planning and Land Authority 2018, *Parking and Vehicular Access: General Code*
[7] Victorian Government 2018, *Municipal Planning Strategy and Planning Policy Framework*, Table 1: Car parking requirement.
[8] Gold Coast City Council, ND, Gold Coast Planning Scheme, *Car parking, Access and Transport Integration.*

D.4.2 New paradigm car park demand assessment

The Victorian Transport Policy Institute report also explains what is meant by 'new paradigm' car parking demand assessment. New paradigm car parking design:

- Considers too much supply as harmful as too little;
- Strives to use parking facilities efficiently;
- Considers full lots to be acceptable provided that spill over parking is available nearby;
- Emphasizes sharing of parking facilities between different destinations; and
- Emphasizes innovation that encourages other modes of transport.

Because it is not possible to predict exact parking demand and management program effectiveness, efficiency-based standards rely on *contingency-based planning*, which means that planners identify solutions that can be deployed if needed in the future. Management solutions tend to reduce most problems, providing a greater range of benefits and so are supported by more comprehensive planning[9].

D.4.3 Car park demand assessment design

Because data is not readily available for ocean pools, assessment is framed around the following questions:

- What is available capacity?
- What is the current demand and parking pattern?
- How many people arrive per vehicle?
- What is the possible number of additional patrons that could currently be parked ?
- Where could new spaces be sourced?
- What strategies could be employed to manage parking demand?

The scope of the study was set at two levels: ~250 m walk from the pool site and ~400 m walk from the pool site (Figure D.6). As the café area is an integral part of the reserve it was included in the study of the smaller radius. To create a more easily assessable study area, the full length of roads were included, even though some areas of these may be in excess of 400 m walk. It was also noted that pedestrian access is available to the reserve area from the northern ends of Arafura Court and Fireball Avenue via a concrete walking path.

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[9] Similar trends exist in car parking management in South Australia. Refer report: *Parking Spaces for Urban Places: Car Parking Study Technical Report*, *Aurecon, 2013,* and *What we have heard: Metropolitan Adelaide Car Parking Review, DPTI, 2018.*

Figure D.6 The scope of the car parking assessment

The site was inspected on four different days: 1st January (public holiday), 5th January (Saturday), 31st January (Thursday), and 3rd February (Sunday). The site was inspected at 1100, 1400, 1700, and 2000 hours on each day. A video was recorded from the car of the subject area, photographs were taken of the café area, beach and reserve and the car park pattern recorded on to a map (see example in Figure D.7).

Figure D.7 Example of survey method

What is the available car parking capacity?

- Availability of car spaces adjacent Heron Way Reserve: 102, 4 accessible car spaces;
- Within 250 m from the pool site: 168 car spaces, 4 accessible car spaces; and
- Within 250-400 m from the pool site: 103 car spaces.

What is current demand and parking pattern?

Car parking survey ‘snapshots’ were taken on the following days and time noted in Tables D.2 and D.3.

		1st Jan	5th Jan	31st Jan	3rd Feb
1100	Filled	76	130	93	103
hours	Vacant	92	38	75	65
1400	Filled	101	127	80	49
hours	Vacant	67	41	88	119
1700	Filled	78	87	23	29
hours	Vacant	90	81	145	139
2000	Filled	72	60	30	68
hours	Vacant	96	108	138	100

Table D.2 Car parking survey ‘snapshots’ within 250 m from the pool site

		1st Jan	5th Jan	31st Jan	3rd Feb
1100	Filled	7	12	10	14
hours	Vacant	96	91	93	89
1400	Filled	9	13	8	13
hours	Vacant	94	90	95	90
1700	Filled	15	13	10	14
hours	Vacant	88	90	93	89
2000	Filled	9	10	12	12
hours	Vacant	94	93	91	91

Table D.3 Car parking survey ‘snapshots’ within 250 m from the pool site

General observations:

- Car parking filled from the north to the south in the morning due to café and trail usage.
- Car parking filled from the south to the north in the evening (when café closed).
- Even on busy days car parking was in ample supply after 1700 hours.
- Accessibility parks were usually available at both sites (check 31 Jan).
- Car parking within 250 m exceeded or approached 100 three times at 1100 hrs. The only time it did not was when the café was closed on New Year's Day.
- When car parking exceeded 100, car parking moved to Dutchman Drive.
- The only cars observed in the 250-400 m range were residents or resident's visitor's cars.

What are the characteristics of vehicle occupancy?

Three studies were carried out on Sunday 3rd February at 1100, 1400, and 2000 hours.

Study 1: 1100 hours

One hundred cars were observed either arriving or departing from any car space adjacent to Heron Bay or within the café car parking area (Table D.4). Care was made to ensure that short stay cars were not counted twice. 'Drive throughs' were not counted.

Occupants	Number of vehicles	Number of people
1	23	23
2	51	102
3	15	45
4	7	28
5	4	20
Total	100	218

Table D.4 Car parking survey – occupants per vehicle (11:00 3 February 2019)

Findings: 2.18 people per vehicle.

Study 2: 1400 hours

The constituency of various parties were observed on the reserve and at lunch. Most parties were observed leaving. This was a smaller data set of 56 people.

Survey results: 56 people left in 25 vehicles
Findings: 2.24 people per vehicle.

Study 3: 2000 hours

Fifty cars left at the end of the evening with the following number of occupants in Table D.5.

Occupants	Number of vehicles	Number of people
1	10	10
2	51	102
3	8	24
4-5	6	27
Total	75	163

Table D.5 Car parking survey – occupants per vehicle (20:00 3 February 2019)

Findings: 3.26 per vehicle (using 4.5 for latter category).

Observations:

Single occupancy vehicles were mostly female and either meeting friends at the café or accessing the walking trail. Some single males were also observed who were either sitting on the reserve or in their cars.

Users of the reserve and beach tended to arrive in pairs or above. Families with children were often in a group of 3-5. This observation tends to be supported by the higher occupancy rate within vehicles at the end of the day (i.e. 3.26 per vehicle).

Conclusion:

An appropriate vehicle occupancy rate for pool users is 2.5 people per vehicle.

What number of additional visitors could be accommodated within the existing car parking supply?

To take a more conservative approach, only 85% of available parks were allocated to the study. One of the main reasons for taking this approach is that when seeking to park vehicles within a network of roads, it is likely that finding parks may be more difficult. The purpose of this study is to ascertain how many pool users could have been accommodated on the two days with the highest number of visitors to Hallett Cove Beach (Tables D.5 and D.6). It also allows for a greater number of residents cars to parked on the street.

1st January	Parks within 250 m of pool					Parks within 250-400 m of pool					
	Spaces	85 %	FILLED	VACANT	2.5 vehicle	Spaces	85%	FILLED	VACANT	2.5 vehicle	Total extra
1100	168	143	76	67	167	103	88	7	81	201	368
1400	168	143	101	42	105	103	88	9	79	196	301
1700	168	143	78	65	162	103	88	15	73	181	343
2000	168	143	72	71	177	103	88	9	79	196	373

Table D.5 Car parking survey results (1 January 2019)

5th January	Parks within 250 m of pool					Parks within 250-400 m of pool					
	Spaces	85%	FILLED	VACANT	2.5 vehicle	Spaces	85%	FILLED	VACANT	2.5 vehicle	Extra people
1100	168	143	130	13	33	103	88	12	76	189	221
1400	168	143	127	16	40	103	88	13	75	186	226
1700	168	143	87	56	140	103	88	13	75	186	326
2000	168	143	60	83	208	103	88	10	78	194	401

Table D.6 Car parking survey results (5 January 2019)

Based on this study, the car parking within 250 m radius of the pool site would have come under pressure within the mornings until mid-afternoon. It is important to recognise that these days were optimum summer days and were in peak New Year season. In theory, the area 250-400 m from the pool site would have had ample car parking opportunities.

Overall a doubling of the existing number of users to Hallett Cove Beach is reasonable, assuming that people are willing to park in neighbouring streets and walk to the pool.

Where could additional car parking spaces be sourced?

Any proposed changes are subject to community engagement, funding and engineering investigation.

The issue of proximity

While in theory there would normally be ample parks in the broader network of streets there exists only nine (9) parks in close proximity to the pool. Increasing the number of parks in this area is likely to be essential to create enough parks for normal usage on normal weekends or weekdays. This would be important for those with children, those with disabilities, and for those who want to visit the pool for exercise early in the morning or later in the afternoon/ evening.

Five (5) new parking spaces could be created by changing the angle of car parking on Heron Way (Figure D.8).

Figure D.8 New car spaces created by change of angle

Alternatively, It is probably more desirable that a greater number of car spaces are created in the vicinity of the pool as drawn conceptually in Figure D.9.

Figure D.9 New car spaces created by installation of additional car park.

D.5 What traffic management strategies could be employed?

Parking management refers to policies and programs that result in more efficient use of parking resources. Parking management includes several specific strategies. When appropriately applied parking management can significantly reduce the number of parking spaces required in a particular situation, providing a variety of economic, social and environmental benefits. When all impacts are considered, improved management is often the best solution to parking problems.

The items listed below are not intended as an exhaustive list. They are intended to illustrate how parking demand might be managed, especially on larger demand days.

Employee car parks

The number of workers in the café and kiosk was observed to be in the range of 5-8.

Specialist groups

A snorkelling group was observed assembling on the northern end of Heron Way on 2nd February (Saturday morning). The estimated number of participants was 20, arriving in approximately 15 cars, plus the two car spots taken up by the car and trailer (Figure D.10). Groups such as these could be advised to park in Arafura Street and meet in the cul-de-sac just 60 m up the rise. A snorkelling group is likely to be undertaking their activity for at least 2-3 hours. Saturdays and Sunday mornings are the highest demand times for car parking in this vicinity. If Council was able to communicate directions to the leaders of these groups who in turn would communicate with their constituents, then impact on the car parking could be more easily managed.

Figure D.10 Specialists groups could be encouraged to manage their own parking.

Shuttle bus from the Train Station to Heron Way

97 parks are available at the Park and Go on Cherub Street within 800 m of the pool site. On very large days (such as weekends and public holidays) people could be encouraged to park in the Park and Ride at Hallett Cove Beach. Portable signage on Dutchman Drive could alert travellers that Hallett Cove Beach is 'full' and that parking is available in the Park and Ride. A shuttle bus between the two locations could ferry people to and from the Heron Way Reserve. This may be a strategy used in the future to allow for the growth of numbers at the pool.

Encourage cycling

Currently there are no cycle parking facilities at Hallett Cove Beach. Installing these near the pool and adjacent to the café would encourage people to ride to the beach. Installing a wide footpath on the west side of Dutchman Drive from the upper roundabout, and installing a wider path from Dutchman Drive to the café area is likely to encourage riders to access Hallett Cove Beach from the northern sections of Hallett Cove. This pathway would also connect Tornado Ave, Fireball Ave and Heron Way on the northern end (Figure D.11). To compensate for the loss of planting on Dutchman Drive the cycle way/walking corridor could be planted with various suitable species of trees.

Installing cycle sharing facilities at the Park and Go at Hallett Cove Station would encourage people to utilise the train service, and then cycle to the pool.

Figure D.11 Installing a cycle and walkway will provide a link for northern and eastern Hallett Cove residents

<u>Provide 'Drop and Go' facilities in Heron Way</u>

A 'Drop and Go' area (Figure D.12) may encourage people to use ride sharing services (such as Uber). Additionally, on days that are very busy, drivers can drop their passengers at the pool and drive further away to find a park.

Figure D.12 Drop and Go facilities will allow people to park further away

D.6 Car parking summary and conclusions

The projected pool usage indicates that the present supply of parking may be insufficient and further consideration of parking spaces would be needed.

If an ocean pool is to be successful at Hallett Cove Beach it must be demonstrated how traffic and parking might be managed. Conventional planning methods that attempt to meet demand within peak periods by installing larger areas of car parking will be unsuccessful. New paradigm thinking will identify ways in which car parking can be managed on larger days, and how patrons can be encouraged to utilise other forms of transport.

<u>A preliminary strategy</u>

The following strategies could be implemented to provide a viable number of car parks for an ocean pool. The reasons for each strategy have been described above.

1. Increase the number of car spaces in close proximity to the pool.
2. Install cycle storage facilities adjacent the main pool car park and adjacent to the cafe.
3. Create a 'Drop and Go' zone along Heron Way.
4. Create more parking opportunities on Dutchman Drive.
5. Consider traffic control options and additional parking opportunities on Grand Boulevarde.
6. Overflow traffic on larger days would likely choose Arafura Street as it has two pedestrian access points to the foreshore area.
7. A cycle ride sharing scheme could be instituted at the train station (cycle garage)."

Figure D.13 Car parking strategy

This strategy would allow for approximately 200 car spaces primarily within 250 m walk of the pool site. Allowing for a range of vehicle occupancy numbers generates a range of visitor numbers that could be accommodated by vehicle (Table D.7). Adding a percentage of visitors that would walk, use public transport or cycle provides an overall potential visitor number.

Occupancy rates	Vehicle	Non-vehicle	Total visitors
2.0	440	125	565
2.25	495	125	620
2.5	550	125	675

Table D.7 Potential visitor capacity for Hallett Cove Beach

As a contrast, the peak number of visitors observed in the vicinity of Heron Way Reserve was 236 people on 5th January at 1400 hours.

In Appendix C, it was calculated that approximately 64,000 people visit Hallett Cove Beach reserve area between months of November to March (20 weeks). The car parking and visitor strategy outlined above would indicate that 2-3 times that number of people could be accommodated at Hallett Cove Beach.

Additional car parking strategies

To allow for growth, and contingency planning, other strategies may need to be employed.

The Park and Go adjacent the train station contains an additional 97 spaces. On anticipated larger days, a shuttle bus could run continuously between the Park and Go and the Drop and Go for peak hours (probably only 4-5 hours). Signage on Dutchman Drive would alert visitors of the service. This strategy would create the potential for an additional 225 people to travel by car and visit Hallett Cove Beach every 2-3 hours (depending on the length of stay).

However, this strategy would also increase the patronage on the train if visitors knew that on public holidays or on weekends that the shuttle bus was in operation. A small fee would likely offset the cost of the bus.