FROM SEA WALL TO SEA LIFE: IMPLEMENTING SEAWALLS THAT SUPPORT INTERTIDAL BIODIVERSITY

C Covich[1], P Makim[2]
[1]Mosman Council, Sydney, NSW
[2]Mosman Council, Sydney, NSW

Abstract

In the last decade, Mosman Council through its Community Environmental Contract (CEC) has embarked upon improving the ecological value of its seawalls. Principally this has involved the transformation of hard vertical concrete walls to boulder walls and other structures that would attract and support marine life.

More than 50% of Sydney's foreshore has been replaced by seawalls (Chapman, 2003). In Mosman, there are approximately 3.5 km of seawalls with the foreshore being a highly valued location for recreational, commercial and residential development. Many of these walls were traditionally solid vertical walls providing minimal or no habitat for sea creatures. Research also indicates that hard structured seawalls can actually encourage the establishment of invasive species. Most of Mosman's seawalls have heritage significance as well as being required for land protection and therefore full restoration of the natural shoreline was not an option.

In an attempt to increase biodiversity, various approaches have been trialed on Mosman seawalls including the establishment of Saltmarsh, sandstone boulder fields and rock pools in front of seawalls.

The main focus of this work was a vertical 1970's concrete seawall in Pearl Bay, west of the Spit Bridge in Sydney Harbour. At this location, Council constructed an 800 metre long sandstone boulder field along the base of the wall at a slope of 35 degrees. The non-uniform surface, crevices and slope of the wall created a habitat that was non-existent on the old concrete wall. At the same location, Saltmarsh beds were established. Saltmarsh is an endangered ecological community and is important for biodiversity, erosion control, water quality improvement and the aquatic food chain.

It was evident that within a week of the construction there was an increase in biodiversity and this has continued to improve ever since. However the Saltmarsh did not prosper as well as expected due to its elevation and the fact that the planting area served as a rubbish trap for gross pollutants.

In addition to the large scale seawall works an alternate measure of small rock pools were tested. Rock pools were constructed at Pearl Bay West and Musgrave Street Wharf and involved the creation of an intertidal habitat. As with the seawall work, marine growth increased fish and other sea life which was evident quickly after construction. Whilst this approach was less labour intensive and costly the overall improvement was not considered as significant as that observed along the Pearl Bay Seawall.

Of note, the measure of success of this work was not just the increased biodiversity on the seawall but the “life” and transformation the work brought to a degrading area. The seawall works were paired with other improvements including interpretive signage, a new jetty, landscaping, outdoor seating, a playground, sand nourishment to the beach areas and walking and bicycle paths. The positive recreational improvements and educational elements elevated the project from simple asset management to something that invited exploration

and involvement. The project could truly be described as a transformation from seawall to sea life.

Introduction

Mosman Council is located on the northern shores of Sydney Harbour, NSW and manages approximately $11 million of marine structures including 3.5km of seawalls. The structures are managed to ensure safe, efficient and effective land protection as well as conserving heritage values and improving environmental value.

From 2005 to 2015, Mosman ratepayers, through the Community Environmental Contract (CEC) funded a comprehensive program of works related to the environment. The works included the installation of Stormwater Quality Improvement Devices (SQIDs), the rehabilitation of bushland and natural creek lines and the renewal of seawalls with enhanced ecological value. The contract funded through a 5% rate levy, was Council's guarantee to residents that all money raised through the levy would be spent on specific budgeted environmental projects.

As a result of the CEC program, Council has collected over 1860 tonnes of pollutants from the stormwater network, improved the condition of over 35 hectares of bushland, restored 150 meters of natural creek lines and renewed approximately 1.5 km of seawalls.

Many of the seawalls have heritage significance and are required for protection of recreational areas. As a result the goal was to sensitively renovate the walls in order to provide habitat for intertidal creatures similar to what would be found on natural rocky shores.

The seawall works were packaged as an integrated project. It was important to add value to single issue works by achieving a multitude of sustainability objectives to ensure that the community felt their dollars were well spent. The works also included heritage and structural restoration, landscaping, pedestrian and bicycle paths, a viewing deck and community education programs including an information breakfast, rock pool tours and signage. Whilst these additional works increased the cost of the project, it did revitalise the area and transform it into a recreational destination.

The three seawall projects detailed in this paper are situated at Pearl Bay, Pearl Bay West and Musgrave Street Wharf.

Figure 1 and 2: Locations of seawall works, Pearl Bay, Pearl Bay West and Musgrave Street Wharf shown in red (Apple Maps, 2015)

History of the Seawalls

Pearl Bay Seawalls

Pearl Bay is adjacent to Spit West Reserve which is land that was reclaimed in the 1920s, shortly before the first Spit Bridge was built in 1925.

The bay separates a residential area to the west as seen in the background of Figure 3 and a traffic corridor to the east connecting the Northern Beaches to the North Shore.

The site east of Pearl Bay was predominately used as tip for Mosman Council from the 1920's with the refuse forming the base for the reclamation material. Large residential homes were constructed on the western slopes and the foreshore was protected by many small sandstone walls.

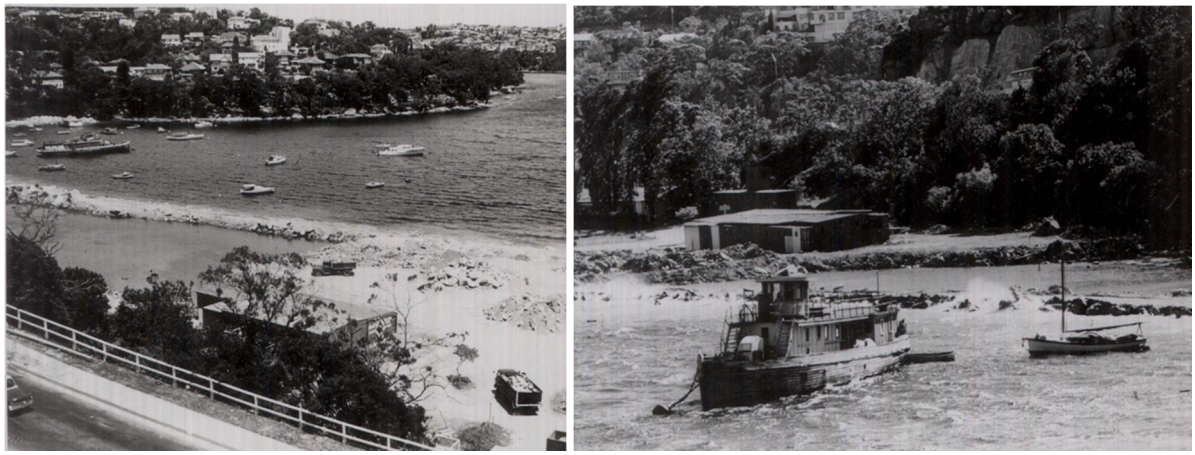

Figure 3 & 4: Historical photos of Pearl Bay reclamation noting the residential developments (Mosman Library)

Figure 5 & 6: Historical photos of Pearl Bay reclamation noting tip refuse as fill material (Mosman Library)

The area to the east of Pearl Bay has always suffered from large swells given its exposure to westerly winds. This is evident from the over topping on the poorly constructed seawall during the reclamation shown in Figure 9. To alleviate the constant erosion in the 1970's a decision was made to construct a new seawall to replace this ineffective seawall.

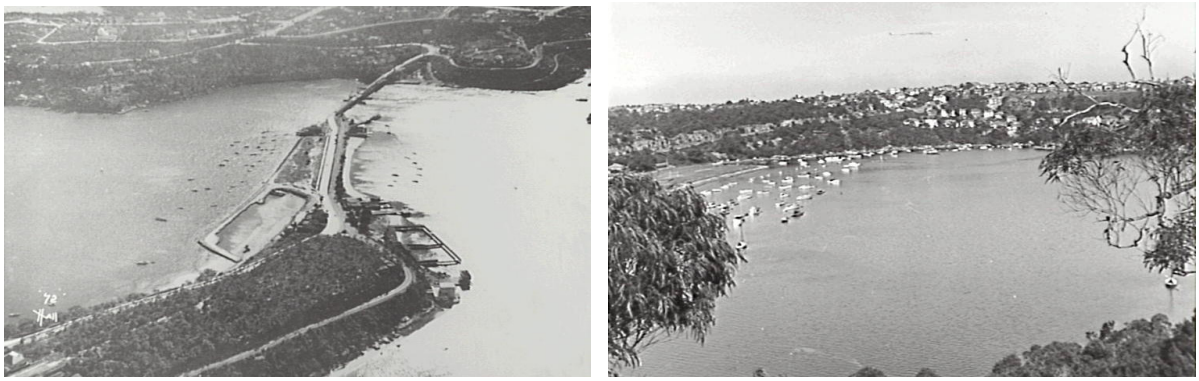

Figure 7 & 8: Historical photos of Pearl Bay (Mosman Library)

Figure 9 & 10: Historical photos of Pearl Bay, large swells and the 1970's seawall (Mosman Library)

The result was an almost vertical solid concrete seawall seen in Figure 10. This wall and the vertical sandstone block wall in Pearl Bay west provided very little intertidal habitat and by 2010 were in declining condition.

Musgrave Street Seawall

The Musgrave Street seawall is located within Mosman Bay on what also appears to be reclaimed land. Estimated at approximately 100 years old, it comprised of sandstone block construction at a vertical profile. The wall had similar ecological and intertidal habitat problems seen at Pearl Bay and being close to a ferry wharf suffered significant wash erosion.

Figure 11 & 12 Historical Photos of Musgrave Street Wharf (Mosman Library)

Works at Pearl Bay Seawall

Little thought was given to the biodiversity during the construction of the Pearl Bay Seawall in the 1970's. The vertical nature of the hard engineered wall did little to increase biodiversity and also resulted in "dead zone" where turf could not establish due to wash from waves which was exacerbated by the angle of the wall. It was considered that a more sensitive design was required at this location. Vertical seawalls provide fewer habitats and this generally results in less variety of flora and fauna. The slope of the wall has also been shown to have a strong influence on the intertidal species with vertical walls supporting different species to other types of walls (Wiecek, 2008).

The works at Pearl Bay Seawall involved repairing the concrete wall then placing a shallow sloping sandstone boulder field on a geotextile filter fabric along the wall.

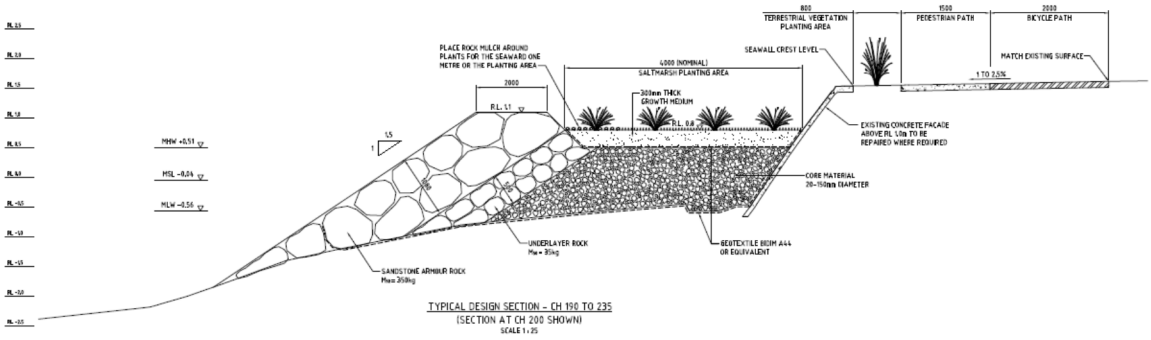

Figure 13: Seawall Works at Pearl Bay (Worley Parsons, 2008)

The rocks were median size of 100kg and were randomly placed. The benefits of this construction included:

- structural protection for the wall
- increase total habitat area and complexity
- dissipation of wave energy
- Sandstone boulders fields attract species that will not live on concrete walls (Chapman, 2011)


Figure 14 & 15: Pearl Bay, before and after seawall construction

The construction at Pearl Bay cost approximately $1900/m. It also included a flat saltmarsh planting area, 4m wide, off the seawall which was surrounded by a rock berm to allow for tidal inundation. Six species of salt marsh were used in the planting area, Sarcocornia quinqueflora, Triglochin striata, Salmolous repens, Sporobulus virginicus, Cotula coronopifolia and Suaeda australis. Saltmarsh is an endangered community in NSW and less abundant than mangroves. There is evidence that mangroves are spreading in Sydney Harbour and little evidence to substantiate that they provide habitat for juvenile fish in the harbour (Chapman 2008).

A viewing deck was installed over the saltmarsh planting area along with educational signage. Sand nourishment was undertaken on a beach area along with a pedestrian and bicycle path, seating and landscaping.


Figure 16 & 17: Pearl Bay, before and after beach reclamation

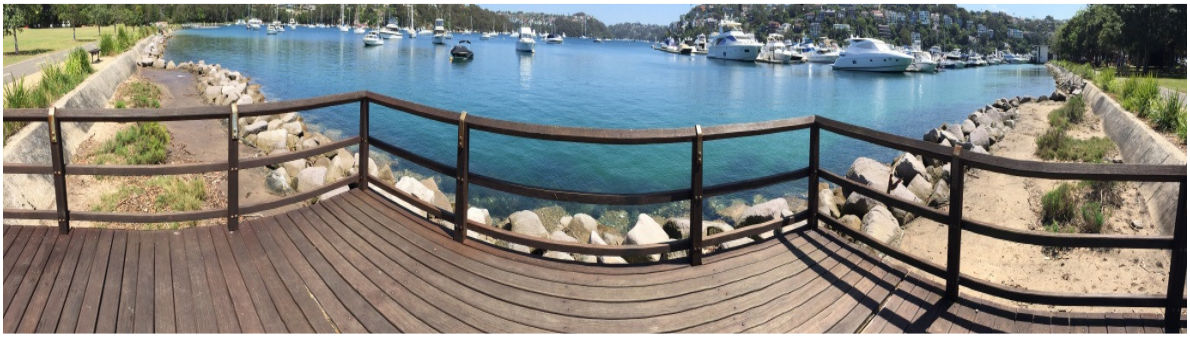

Figure 18: Viewing Deck at Pearl Bay

Works at Pearl Bay West Seawall

Works at this location involved structural repairs to the wall followed by the construction of a tidal pool. The tidal pool was created by installing a low wall then placing a layer of sandstone cobbles and boulders in the pool to introduce habitat complexity. The pool is approximately 500mm deep. Advice from Gee Chapman of Ecological Impacts of Coast Cities (EICC) indicated that the pool depth did not necessarily need to be at 500mm, it was more important to have tidal flushing and regular rubbish removal. As a result, the location of the pool relative to the tide was critical as was a cleaning regime. The construction cost approximately $1100/m.

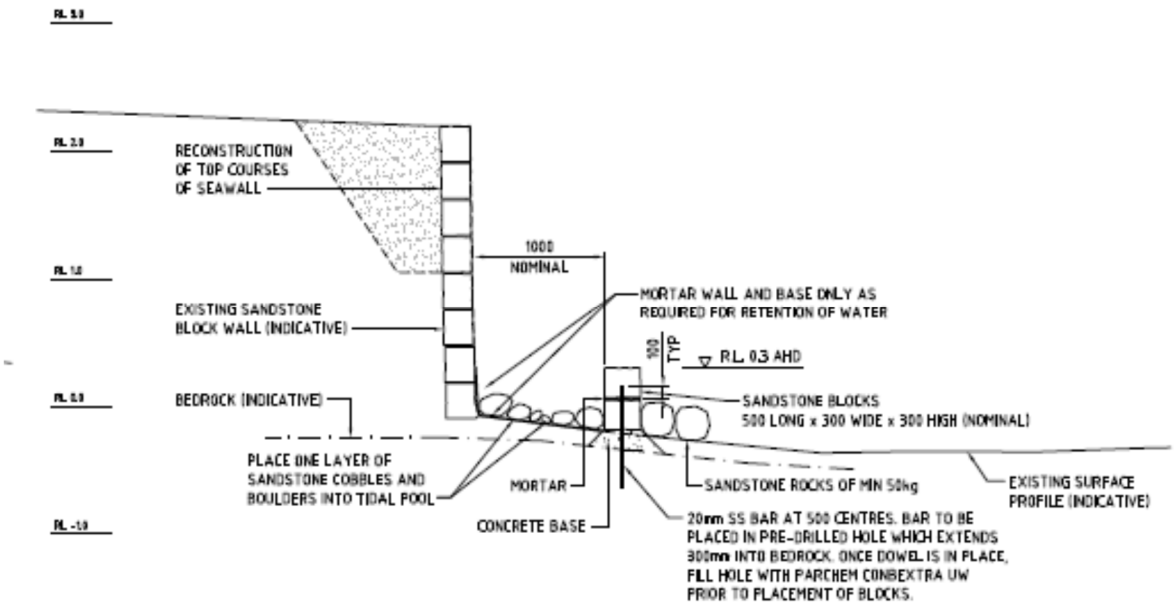

Figure 19: Seawall Works at Pearl Bay West (Worley Parsons, 2008)

Figure 20: Tidal Pool at Pearl Bay West

Works at Musgrave Street Seawall

The works at Musgrave Street Seawall were similar to Pearl Bay West and involved repairing the existing wall and construction of a tidal pool. The pool included a layer of sandstone boulders and cobbles. As this site is adjacent to a ferry wharf this location was subject to frequent swells and wash. The objective at this location was to offer the flora and fauna increased protection using the same concepts that were successfully implemented at McMahons Point, Sydney (Chapman, 2008). The construction at this location cost approximately $900/m.

Figure 21: Tidal Pool Musgrave Street

Results and Discussion

In a short period after the works, there was a noticeable increase in the flora and fauna within the sites. Initially the salt marsh also prospered in the planting area.

Figure 22 & 23: Marine life, Pearl Bay & Musgrave Street

However at Pearl Bay it was observed that the flat areas in the harbour, tidal pools and planting platform, quickly became rubbish traps.

Whilst 90% of Mosman's stormwater network is treated by stormwater quality improvement devices (SQIDs) that collect gross pollutants, westerly winds transport floating debris and waste from neighbouring Council areas. Unfortunately these Councils did not have the same waste removal coverage for their catchments. The extent of the debris is seen in Figures 24 and 26.

Figure 24, 25, 26 & 27: Rubbish on the planting platform before and after, Pearl Bay

Analysis indicated that within six months of construction, the salt marsh had reduced by approximately 50% in coverage area. In an attempt to improve the growing conditions, Council implemented a reactive cleaning program at the site. The coverage of the saltmarsh was observed to stabilise however the site still suffered from gross pollutant build up. To address this, Council implemented a weekly cleaning program and included this site in its general cleaning contract.

This cleaning approach did allow the saltmarsh to recover somewhat but it has not prospered in this location. After a review and further observations, the following were considered contributing factors to the reduction in salt marsh:

- The elevation of the planting area resulted in too much tidal inundation and not enough protection from wave energy - the marina adjacent to the platform and its recent expansion created a higher frequency and larger amplitude wave pattern than expected
- The exposure to westerly winds resulted in constant build-up of gross pollutants and other floating debris which inhibited the ability of the saltmarsh to develop
- The species of saltmarsh selected may not have been as resilient in this location as thought. Whilst six species were selected, further research on species selection may have resulted in a superior outcome
- The platform has created an perfect area for fisherman to stand on, trampling the salt marsh - there was regular evidence of footprints and discarded fishing material

Whilst the intertidal area and saltmarsh had mixed results, biodiversity on the seawall flourished. Unlike the vertical seawall, the rock boulders provided a habitat for seaweed, shellfish, molluscs and crustaceans. This in turn resulted in increased observance of smaller and larger species of fish and cephalopods. A habitat and aquatic survey was undertaken prior to project but a follow up survey has yet to be completed.

In addition to the increased activity within the marine and intertidal area, the works also resulted in an increased usage by local residents. As seen in Figures 14 and 16 the shoreline was rarely used as a destination given its limited amenity and the salt water preventing the establishment of plants. The re-engineering of the wall transformed not only the life dynamic but the aesthetic nature of the area. The integration of a viewing deck along with items such as a footpath and cycleway, increased planting and sand nourishment provided a destination for people to enjoy the newly created environment. Council counts of pedestrian and cyclists show a substantial increase in visitors to the area.

However the increased popularity of the site has also increased required maintenance. Cleaning and maintenance at the site - which was previously non-existent - now includes sand raking, gross pollutant waste removal, bin waste collection, furniture and footpath repairs and landscaping. In addition the newly installed items such as furniture and the viewing deck have reduced life due to the proximity to the marine environment.

The cost of cleaning the salt marsh platform is approximately $12,500 a year and recovers around 400kg of rubbish a week. Although the tidal pools and seawall have seen increased marine life in the intertidal area it was more prolific along the seawall when compared with the rock pools.

Conclusion

While ecological engineered seawalls can increase marine life, the integration of projects can provide wider benefits. However integrated projects come with increased capital,

maintenance and lifecycle costs which should be considered and budgeted for when preparing a project.

The seawall works showed a greater benefit than intertidal pools probably due to the gross increase in habitat surface area. However tidal pools are still a cost effective method to increase biodiversity if there is limited budget. They can quickly become rubbish traps if they are not well thought through and accompanied by regular cleaning. Species of saltmarsh should be carefully considered prior to planting and their location should not only consider nature's implications, but the harsh realities of the human environment.

Overall the project at Mosman has shown that packaging environmental works with recreational improvements provides a greater exposure and appreciation for its benefits. Without added facilities making sites more accessible and attractive, the biodiversity achievements may go unnoticed.

References

Apple, 2015 'Apple Maps' Accessed 18 October 2015 https://mapsconnect.apple.com/

Chapman, G and Underwood, A 2011 'Evaluation of ecological engineering of “armoured” shorelines to improve their value as habitat' Journal of Experimental Marine Biology and Ecology 400: 302-313

Chapman, G and Bulleri, F 2003 'Intertidal seawalls–new features of landscape in intertidal environments' Landscape and Urban Planning, 62: 159-172

Chapman, G 2008 'Commentary on the proposals for habitat enhancement for the Mosman Seawall and Coastal Engineering Projects' Report provided to Mosman Council from University of Sydney (EICC)

Chapman, G and Blockley D, 2009 'Engineering novel habitats on urban infrastructure to increase intertidal biodiversity' Oecologia 161(3): 625-635.

Heath

Mosman Council 2011 'The Spit Reserves Plan of Management' Accessed 29 September 2015 http://www.lpma.nsw.gov.au/__data/assets/pdf_file/0011/176465/The_Spit_Reserves_Plan_of_Management.pdf

Mosman Council, 2008 'Community environmental contract annual report' Accessed 29 September 2015 http://www.mosman.nsw.gov.au/file_download/1217/CEC_Annual_Report_2007-2008.pdf

Wiecek, D, 2008 'Management guidelines for improving the environmental value of seawalls and seawall lined estuary foreshores' Coastal Conference 2008, accessed 29 September 2015 http://www.coastalconference.com/2008/papers2008/Wiecek,%20Danny%206C.pdf