

Wattle Range Council

# BEACHPORT BOAT RAMP

REVIEW OF MAINTENANCE REQUIREMENTS

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# XECUTIVE SUMMARY

The current boat ramp facility in Beachport was constructed in 2004. In 2014, significant modifications were completed to the breakwater with a larger marina basin created and an extra boat ramp lane added. Maintenance of the boat ramp has been an ongoing problem due to excessive build-up of sand, and the demand has generally exceeded the design allowances. This has challenged maintenance budgets available for the facility, and Wattle Range Council have sought advice from WGA (Wallbridge Gilbert Aztec) to investigate options for reducing the cost of future maintenance activities.

Following a successful trial using a 'Dragflow' dredge pump suspended from a 130t mobile crane, WGA have assessed the current and future demands of the facility with the available information from existing sources. A number of recommendations have resulted, with the following options suggested as having the strongest likelihood of yielding measurable improvements to the operation and maintenance of the boat ramp facility:

# a) Metocean data

Collect wave and current data for future modelling

=> Budget = \$30k

(\$50k if council purchase equipment for increased data acquisition)

### b) Sieve analysis

Procure test equipment to allow collection of sand particle size data to allow mapping of distribution

=> Budget = \$5k

# c) Numerical modelling

Appoint consultant to develop a base numerical model to assess the behaviour of the existing facility

=> Budget = \$25-30k

(\$40-50k if additional options assessed for modifications, including groynes)

## d) Geotechnical investigation to determine extent of rock

Initially limited to test pits with excavator to assess potential for larger central reservoir / pit to assist dredging

=> Budget = \$5k-10k

# e) Consider optimisation of breakwater arrangement

Modelling only in the first instance, included with 'c' above

=> Budget = \$5k-15k

# f) Permanent dredge pipe infrastructure

Facilitate easier setup for dredging and more efficient operation, utilise for second dredge trial to further assess viability of dredge maintenance vs excavators

=> Budget = \$10k

# g) Further trial of Dragflow dredge pump

Implement learnings from the first trial to minimise downtime and maximise efficiency. Consider land based pipe with longer flexible lay-flat hose, and longer working hours.

=> Budget = \$35k

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# PROJECT BACKGROUND

Prior to about 2004, Beachport did not really have a boat ramp. The original concrete slab on the beach approximately half way between Corigliano Street and Blacketer Street (Beach 6) was more of a vehicle access across the beach rather than a boat ramp, and the slab extent finished well above the low tide mark on the beach. The arrangement fell a long way short of industry standard requirements (non-compliant with AS3962-2001: Guidelines for the design of marinas, Section 7.2 – Boat launching ramps), and it was generally necessary to reverse vehicles into the water a considerable distance to allow launch and retrieval from boat trailers. The arrangement was especially challenging for larger vessels, where tractors were required and some planning around tides was often necessary. The commercial fishermen (mainly crayfish, or Southern Rock Lobster) typically used the beach ramp only at the beginning and end of the crayfishing season, leaving there dinghies tied to the jetty through the summer fishing months. This meant that the ramp was generally only used by recreational fishermen.

A new boat ramp facility was constructed in 2004 and improved the functionality and operability of the boat ramp considerably. The development was not without controversy though, and led to significant divisions between the townspeople due to the broader changes to the adjacent beaches. Specifically, the challenge of trying to maintain deep water for small boats to access the boat ramp facility was at odds with beach users who previously swam from the beach at the end of Corigliano Street (Beach 6), and those who used the beach between the 'Harbourmaster's Residence' and the jetty. Figure 1.1 below shows an aerial view of the Beachport foreshore prior to construction of the 2004 boat ramp.



Figure 1.1 – Aerial view of the original beach ramp, taken while the 'trial' geotextile breakwater (Groyne 5) is under construction. (Source: Google Earth, November 2003)

From a technical viewpoint, the main ongoing challenge with the boat ramp facility since 2004 has been maintenance – it has proven very difficult to keep the boat ramp operational (particularly through the winter months), and frequent dredging campaigns with excavators and trucks have been necessary to maintain a functional water depth. The costs and effectiveness of these various maintenance campaigns have not been considered as part of this assessment. Further commentary is provided on the 2004 boat ramp development and associated design in later sections of this report.

A number of minor changes were made over the years following the original construction in 2004 to improve the functionality of the boat ramp arrangement, with various alterations to the offshore breakwater and the shore protection structures. This is described in further detail in Section 3 of this report.

Further major changes were made to the boat ramp facility in late 2013 / early 2014 to form a larger marina basin by extending the protective groyne by approximately 100m in length to the North (parallel to the rock revetment armouring the shore). Figure 1.2 below shows the breakwater extension under construction.



Figure 1.2 – Aerial view of the '2004 boat ramp' under construction in late 2003, with extended breakwater. (Source: Google Earth, November 2003)

This new arrangement provides additional protection to users of the boat ramp, and has certainly been successful on this basis. Based on the work undertaken since construction, it is reasonable to suggest that the new arrangement has not achieved the desired level of ongoing maintenance in terms of budget.

# 2 SCOPE OF WORK

The initial scope of work for this review was to look at options to reduce long term costs (ongoing maintenance) for the Beachport Boat Ramp. Based on more detailed discussions between Wallbridge Gilbert Aztec (WGA) and the Director of Engineering Services for Wattle Range Council (WRC), the review was to also consider possible amendments to the current design that may reduce maintenance requirements, and was also to consider more efficient maintenance techniques including dredging technologies. It was also decided that the scope of work should include the trial dredge activities that had been considered by WRC for some time. This was to ensure that key variables for future pumped dredge options were adequately understood, and so that a proper assessment of future opportunities could be described in more detail.

In all instances with this project, WGA has been represented by Luke Campbell (the author of this report). WRC was initially represented by Peter Halton (Director Engineering Services), though later project support has been provided by Lauren Oxlade (Manager Environmental Services), particularly for the trial dredge that was undertaken in March 2017, and for subsequent discussions.

It is important to note that this report will not attempt to specifically address any non-technical issues that have been identified by the various stakeholders, such as amenity and access, as it is a summary document addressing ongoing maintenance concerns only. However, where it is relevant to do so (i.e. when comparing various technical solutions), both positive and negative impacts on these various user groups will be considered.

This report will consider options for reducing the ongoing maintenance costs of the Beachport Boat Ramp facility. The report will consider potential amendments to the current boat ramp arrangement (described in more detail in later sections of this report) that might further optimise the design in a way that will reduce the maintenance requirements, and will also consider alternate management techniques for moving sand build up within the marina basin in a more efficient manner.

The report will first describe the project background, followed by a description of the key processes that drive the ongoing maintenance requirements. The existing boat ramp facility will be considered with regards to both operational requirements and maintenance provisions, and previous maintenance activities will be described including the most recent trial dredge using a hydraulic Dragflow pump suspended from a 130t mobile crane positioned adjacent to the boat ramp carpark.

The ongoing maintenance demands are not known with any accuracy, but the sand management requirements will be described in as much detail as possible without further modelling for the purpose of assessing future requirements. Further investigations and modelling of the current arrangement is suggested to improve the understanding of maintenance demands, and is described in Section 7 of this Report. Potential amendments to the current boat ramp / marina basin arrangement will then be considered, along with discussion of future maintenance options, resulting in a description of suggested recommendations for consideration by Wattle Range Council, also described in Section 7 of this report.



Figure 2.1 – Groyne and beach identifiers along the Beachport foreshore, as used by WRC (Source: Worley Parsons 2015 report).

# 3

# SITE DESCRIPTION

Beachport is a small coastal town in the South East of South Australia, just under 400km south-east of Adelaide. It is located in the Wattle Range Council district, part of the 'Limestone Coast' region of South Australia. The town of Beachport has always been true to its name – it is a small port without any major protection from the Southern Ocean, and commercial fishing vessels live on swing moorings within Rivoli Bay. The town was originally a whaling station, but developed primarily as a town supporting pastoralism and providing export facilities for wool. This was the driver for the distinctive jetty with a length in excess of 700m. This jetty now acts as important infrastructure for both of Beachport's main economic drivers – commercial fishing and tourism. Beachport supports one of South Australia's largest cray fishing fleets (Southern Rock Lobster), and swells from a relatively small population of less than 900 permanent residents to many thousands through the summer months due to a large influx of tourists.

## 3.1 Previous Coastal Protection Structures

A number of coastal protection structures have been built over the past 80 years or so, accounting for coastal erosion and generally intending to resist erosion of the foreshore.

The coastline within Rivoli Bay is quite active and has been since Beachport was first settled approximately 150 years ago. There are photos of the foreshore in Beachport from almost a century back showing large amounts of erosion beyond the upper beach. The original timber seawall structure basically extended out to the Surf Beach to protect the former railway (situated just over the foredune) from ongoing erosion effects. WGA understand that the seawall commenced construction in approximately 1932 after significant storm erosion.

The beach in the immediate township was largely tamed by a series of perpendicular rock groynes that were developed by the local council from approximately 1962, and through trial and error, a reasonably stable outcome was achieved, albeit with regular maintenance requirements. It should be noted that the while the original groynes have generally not meet any regarded design rules from coastal design literature, both in length and spacing, and have typically been bypassed in by sediment transport actions, this has been somewhat addressed with more recent upgrades, particularly at the groynes immediately South of the boat ramp.

# 3.2 Coastal Processes

The general coastal processes within Rivoli Bay and at Beachport have been fairly well documented by previous work, ranging from the 1980 study by Short and Hesp through to the most recent assessment of Rivoli Bay completed by Worley Parsons in 2015 for the Wattle Range Council (refer to Reference section of this report for full details). WGA consider that these works address most general coastal engineering issues in appropriate detail, and this report seeks only to provide brief summaries where appropriate to allow more detailed discussion about ongoing maintenance issues. Additional attention will be given to issues that relate more specifically to the boat ramp area, and other secondary sediment transport mechanisms that may have been overlooked previously.

# 3.2.1 Oceanographic Conditions

The entire South East coast is generally aligned to a normal of about 240 degrees and is fully exposed to the dominant South-West waves and swell from the Southern Ocean. The approaching deep-water wave energy, is typically high, and rarely dissipates altogether.

### 3.2.2 Wave Climate

Waves along the South-East coast can originate from West, South-West, South and South-East quadrants, but the dominant and prevailing swell waves arrive from South-West directions. The moderate to high swell waves are relatively persistent throughout the year, but additional storm wave effects are superimposed during the passage of low-pressure cyclones particularly through the winter season. The Beachport Boat Ramp is located in the lee of Cape Martin, and is therefore offered considerable direct protection from the wave climate that is further dissipated through shoaling and refraction effects by the relatively shallow bathymetry within Rivoli Bay.

# 3.2.3 Sediment Transport from Swell Waves

The prevailing action for sediment transport along the Beachport foreshore is longshore drift due to wave action, clearly outlined below in the summary figure from the Worley Parsons Rivoli Bay report (refer Figure 3.1). However, longshore transport along the coast to the North is not the only coastal process that causes sedimentation, especially at the boat ramp location where a number of other secondary effects combine to exacerbate the problem.

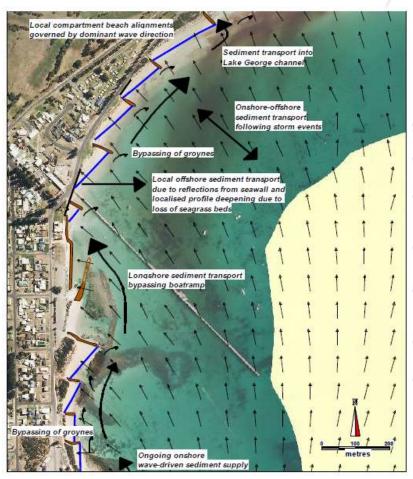


Figure 3.1 – Summary of the main sediment transport mechanisms that occur along the Beachport foreshore (Source: Worley Parsons 2015 report).

Based on a cursory inspection of the site, it is reasonable to conclude that sediment transport exists in a net northerly direction due to the main weather direction from the south, with prevailing waves coming largely from the SE quadrant by the time incident swell waves have transformed via refraction and diffraction as the propagate around Penguin Island and then Glenn Point.

But net sediment transport is not the only condition that needs to be considered and addressed for maintenance. In other locations, particularly throughout South Australia (and especially within the gulf environments), this mechanism is dominant and reasonable estimates for maintenance requirements can be determined with a fair degree of confidence without too much concern regarding other modes of transport. That is, for the Adelaide metropolitan beaches at least, sand generally moves from South to North due to the prevailing wind and wave directions, with only relatively minor reversals when there are significant northerly winds and finer grained sediment and seagrass wrack is pushed back to the South. Beachport is very different, and the other modes of sediment transport can be significant to the overall picture.

# 3.2.4 Other Transport Mechanisms

Other transport mechanisms in Beachport (specifically at the boat ramp site) include:

- Wind driven sand blowing over the groyne to the immediate south of the original outer breakwater shore connection, noting that in recent years this beach cell has typically been overfilled relative to historical levels;
- 2. Wave action pushing sand in over the top of the outer breakwater;
- Waves pushing sand around the end of the breakwater after being refracted slightly south of west as they transform around the end of the outer submerged breakwater;
- 4. Sand carried in under suspension due to anti-clockwise currents that can form within Rivoli Bay (refer Photograph 3.1);
- 5. Sand driven through the permeable breakwater extension.

These last mechanisms are particularly relevant during heavy swell conditions within Rivoli Bay, when the high sediment load is very visible as the water turns from 'blue' to 'green'. The heavy swell mobilises sediment to be carried by currents into quieter water where it then settles out, noting that finer grained (lighter) sediment is carried much further and easier than larger (heavier) coarse grained sediment. One can readily see that the grading curves for sand within the boat ramp basin (inside the boat ramp) is generally finer grained compared to the baseline sources outside of the boat ramp.

Limited investigations have been undertaken to further consider sand particle size, but further work is required to better understand the distribution of various sand gradings throughout the Beachport foreshore area. Further investigations considering the mobility of various particle sizes under the wave and current conditions at this specific site will also greatly improve the general understanding of sediment transport. Both of these suggestions are described further in the Section 7 recommendations.

With the information currently available for assessment, the importance of sand carried in suspension to the total maintenance demand is indeterminate. This mechanism, along with the anti-clockwise shore currents that are suggested contributors by local townspeople suggested as a means to shift sand from North to South, require further supporting data and modelling before they can be considered as more significant factors for the overall sedimentation problem within the boat ramp basin.

Based on the author's most recent observations, a further consideration that warrants additional investigation as a potential source of North – South sediment transport into the boat ramp marina basin is a reflected long-period wave from the surf beaches across Rivoli Bay. This is only speculation at this early stage of assessment, but observed fluctuations in water levels and associated changes in current direction over a 30 second to one minute interval are supportive of the existence of long waves.



Photograph 3.1 – View to the South from the Lake George outlet drain showing dark coloured fresh water draining from inland. It can be clearly seen that there is a current taking the 'dirty' water to the South via the anti-clockwise currents setup in Rivoli Bay at the time. (Source: Author, October 2016)

# 3.3 Other Coastal Features relating to the Boat Ramp

The following adjacent structures are within the zone of influence for sediment supply relating to maintenance of the boat ramp marina basin.

# 3.3.1 Geotextile Bag 'Trial' Breakwater

The introduction of the breakwater outside of the current boat ramp was largely to protect the last remaining seagrass environments left in this part of the bay. The seagrass banks previously provided a certain amount of wave protection to the foreshore in the region of the boat ramp. While there has been significant loss of seagrass habitat since construction of this breakwater, the main seagrass bank previously offering protection was steadily diminishing in size in the years prior in any case (this feature has been monitored in some detail by the Coastal Management Branch of the Department of Environment, Water and Natural Resources – DEWNR throughout the entire period), and would have almost certainly continued to degrade. Given the loss of protection from the natural seagrass, it could be argued that the breakwater has been successful in offering an alternate means of protection for this foreshore area.

The boat ramp was intended to take advantage of the protected environment in the lee of this breakwater, with the additional rock spur structure to protect the shoulder of the ramp from prevailing conditions.

# 3.3.2 Jetty Vertical Seawall

The other factor that has changed significantly relates to the seawall at the abutment end of the jetty. The original timber seawall is still behind the newer wall that was built by Maritime Constructions about 10 years ago (refer Photographs 3.2 and 3.3 below).



Photograph 3.2 – View to the North of the renewal / replacement of the vertical seawall adjacent to the jetty. (Source: Author, November 2006)



Photograph 3.3 – View to the South (from the Jetty) of the vertical seawall construction. (Source: Author, November 2006)

This seawall reconstruction was necessary to address the advanced deterioration of the original timber seawall (left in place behind the newer wall). The reflected wave that forms as waves drive into the seawall creates a perfect condition for mobilising sediment, and right at a bad location in terms of offering fresh sediment to the mouth of the new, extended boat ramp basin. Refer to Figure 3.4 for a view of a large reflected wave forming at the seawall location adjacent to the jetty (note very large swell conditions).



Photograph 3.4 – View of a reflected wave forming at the timber seawall adjacent to the jetty during large swell conditions, Beach 8 (Source: Author, May 2007)

# 3.4 Original Beach Ramp

The original beach ramp consisted of a basic concrete slab on the beach approximately half way between Corigliano Street and Blacketer Street on Beach 6. It served more as a vehicle access to and across the beach rather than a boat ramp, generally effective only in reducing the number of vehicles that would get bogged in soft sand by providing a more competent footing down to the firmer beach within the tidal range. An aerial view of the Beachport foreshore with the basic beach ramp access is shown below in Figure 3.2. The previous ramp location is within the marked yellow circle.



Figure 3.2 – Aerial photo of the Beachport foreshore with the original beach ramp. (Source: Barbara Cameron, Circa early to mid-1980's, summer)

The author is very familiar with the environment at the location of the original beach ramp, as he was a resident in Beachport up until this point in time and launched (and retrieved) many boats from the beach.

### 3.4.1 General Arrangement

The beach access slab (ramp) was approximately 2 lane widths across, and extended only to about mid to low tide (it certainly finished well above the low tide mark on the beach). Small boats and dinghies were generally launched across this beach, though most users at this time tended to launch boats from the beach either side of the ramp rather than from the concrete ramp itself due to better water depth being found on each side. Other users also chose to use the 'boatyard' beach to the south of Glenn Point at this time.



Figure 3.3 – Aerial photo of the Beachport foreshore with the original beach ramp. (Source: Author, Circa early 1990's, summer)

# 3.4.2 Design Considerations

The beach ramp was largely stable, mostly due to the fact that its slope matched that of the beach, and the beach was generally in a state of equilibrium, with only relatively minor fluctuations through winter / summer seasonal changes. A similar arrangement still exists at the commercial boat ramp facing out towards Penguin Island, albeit on a larger scale, supporting the crayfishing industry (boats are removed to the hardstand for maintenance during winter months).

It is likely that very little (if any) coastal engineer design was implemented with the original beach ramp, and only some minor structural input for the concrete slab design would have been included. The ramp itself was in fair condition when the original ramp was taken out of service in late 2003, with expected damage to the concrete due to chloride attack.

# 3.4.3 Functionality and Effectiveness

The former ramp did not meet any recommended requirements in terms of depth or gradient, and was particularly challenging with an onshore breeze or with any significant swell. The arrangement fell a long way short of industry standard requirements (non-compliant with AS3962-2001: Guidelines for the design of marinas, Section 7.2 – Boat launching ramps), and it was generally necessary to reverse vehicles into the water a considerable distance to allow launch and retrieval from boat trailers. The arrangement was especially challenging for larger vessels, where tractors were required and some planning around tides was often necessary.

The commercial fishermen (mainly crayfish, or Southern Rock Lobster) typically used the beach ramp only at the beginning and end of the crayfishing season, leaving there dinghies tied to the jetty through the summer fishing months. This meant that the ramp was generally only used by recreational fishermen. Figure 3.3, above, is an aerial photograph taken at least 5 – 10 years after the photograph from Figure 3.2, and it can be seen that relatively little change has occurred to the various beach compartments. Similarly, Figure 3.4 below is from just prior to construction of the trial breakwater and 3-lane boat ramp and very little change is evident along the beach compartments.



Figure 3.4 – Aerial photo of the Beachport foreshore with the original beach ramp. (Source: Author, Circa mid to late 1990's, summer)

The original beach ramp was only accessible in relatively benign weather conditions and was only used safely by fit and experienced users if any more than very minor waves were present. The ramp was inaccessible to anything more than small dinghies at low tides unless users were willing to drive vehicles into the sea a considerable distance.

# 3.4.4 Maintenance Requirements

WGA do not know of any ongoing maintenance that was undertaken as part of the operation of the original beach ramp, though it is likely that at least minor reactive maintenance activities were completed by the local council at the time. Given that the ramp did not interrupt the longshore sediment transport along the beach, there was a general equilibrium at play. The ramp was positioned approximately mid-way between the Blacketer St and Corigliano St rock groynes, and was offered protection only by the shallow limestone reef and seagrass beds present immediately offshore.

Given that there were no major impediments to the net northerly movement of sediment (also accommodating north to south movement when active), longshore drift was able to supply sand to beaches further to the North of the boat ramp and beyond the jetty with no human input (sand bypassing, etc.) WGA understand that there were some instances where reactive measures were necessary to address localised erosion at the 'Harbourmasters' Cottage' at the end of Railway Terrace, but no details are currently available for inclusion in this assessment.

### 3.4.5 Other Considerations

Given the relatively minor obstruction caused by the previous beach ramp (it was possible to simply walk up and over the ramp), the foreshore beaches at the time could be walked at low tide from the jetty all the way to Glenn Point. This was still possible at higher tides, but it was necessary to climb up and over the rock groynes in many locations.

Photograph 3.5 below shows a view of the beach where the former beach ramp was located, with the reef structures visible at low tide. The ramp itself is not visible in this photograph as it is obstructed by the Blacketer St rock groyne (Groyne 6). It can be seen that continuous access along the Beachport foreshore was only interrupted by the original groynes themselves, and these were easily walked around at low tides.



Photograph 3.5 – Photograph of beachgoers, view to the North, Beachport foreshore and former beach ramp location beyond. (Source: Barbara Cameron, Circa early to mid-1990's, summer)

Photograph 3.6 below shows beach users set up at the current boat ramp location, with the former beach ramp in operation in the background. Note that this mixed use would be considered a significant safety risk for the design of any modern boat ramp facility, where it is highly desirable to separate pedestrians and other beach users from vehicle traffic.



Photograph 3.6 – Photograph of beachgoers at the current boat ramp location, view to the North-East, Beachport foreshore and former beach ramp in the background. (Source: Barbara Cameron, 1988, summer)

### 3.5 2004 Boat Ramp Development

A new boat ramp facility was constructed in 2004 and improved the functionality and operability of the boat ramp considerably. The development was not without controversy, and led to significant divisions between the townspeople due to the broader changes to the adjacent beaches. Specifically, the challenge of trying to maintain deep water for small boats to access the boat ramp facility was at odds with beach users who previously swam from the beach at the end of Corigliano Street, and those who used the beach between the 'Harbourmaster's Residence' and the jetty (Beach 7). The new structure also prevented beachgoers from walking uninterrupted between the jetty beaches and Glenn Point, and took away some of the better protected deep water swimming from the foreshore area. The arrangement (minus the pontoons, removed at the time for maintenance) is shown below in Photograph 3.7.



Photograph 3.7 – View to the North-East of the previous 2004 Boat Ramp arrangement. (Source: Author, November 2006)

# 3.5.1 General Arrangement

This project immediately followed the construction of a new 'trial' breakwater built with sand filled geotextile bags approximately 100m from the beach. At this time, the groyne at the end of Blacketer Street (Groyne 6) was also amended significantly and reoriented towards the NNE to provide protection to the boat ramp from the prevailing South-Easterly winds that occur for much of the summer period. An aerial view of the entire development is shown below in Figure 3.5.



Figure 3.5 – Aerial view of the previous (post 2004) boat ramp, taken during summer months with the facility operational (a number of boat trailers are visible in the carpark). (Source: Google Earth, February 2010)

As part of this development, there was also a revetment wall constructed between the new boat ramp location at the Blacketer Street rock groyne (Groyne 6 – heavily modified as part of the project) and the former boat ramp access location, eventually extending down to the 'Harbourmasters' Residence' towards the jetty (refer Figure 3.8 below).



Photograph 3.8 – View to the South of the previous Boat Ramp arrangement showing initial gabion basket revetment wall with additional rock protection. (Source: Author, November 2006)

This revetment wall was originally constructed using rock filled gabion baskets, but additional rock protection was necessary to stabilise the wall after deterioration.

### 3.5.2 Design Considerations

WGA understand that some initial modelling of the geotextile breakwater arrangement was undertaken by the University of Adelaide Coastal Engineering department to assess the impact on local coastal processes prior to the initial construction. This work has not been considered in any detail as part of this assessment; WGA understand that the modelled scenario was only representative of an earlier concept design and was completed mostly as a training exercise for undergraduate students.

Most notably, based on discussions with University of Adelaide and DEWNR personnel, WGA understand that the sandbag breakwater was not originally intended to be permanently connected to the beach, and the access groyne was meant to be removed at the end of the construction to allow continued flow of water from South to North. WGA have only limited understanding of the decision-making process to retain / reinstate this shore connection after the original construction, and understand from DEWNR comments that suggestions from local users regarding currents and heights for protective structures were the main drivers.

WGA understand that no additional coastal modelling (physical or numerical) has been undertaken for the boat ramp and associated marina basin. Most modifications and amendments have been done in smaller iterations to reactively address adverse effects.

# 3.5.3 Functionality and Effectiveness

The boat ramp constructed in 2004 was a much more successful boat launching facility. While operational, the facility met all industry standard requirements (compliant with AS3962-2001: Guidelines for the design of marinas, Section 7.2 – Boat launching ramps), though the wave protection offered was often inadequate during heavier swell conditions.

For most boat ramp users, the new facility was received very favourably due to the improved access windows and ease of launching in periods of increased wave height. Negative comments generally only related to the amount of down time throughout the year that occurred due to sedimentation events. Maintenance requirements exceeded expectations and the facility was not typically able to be kept operational through the winter months. Photograph 3.9 below shows the boat ramp facility with pontoons removed and sand build up visible in the shallow water.



Photograph 3.9 – View to the North of the previous Boat Ramp arrangement showing the relatively steep armoured revetment wall. (Source: Author, November 2006)

### 3.5.4 Maintenance Requirements

The 2004 boat ramp development was found to require more maintenance than initially anticipated, and budget allowances were consistently challenged by more frequent dredging activities using land based earthmoving plant (typically excavators, often required to operate with tracks in the water). The cost of moving sand (reported to be in the order of \$10/m³ by WRC personnel) was not particularly expensive relative to other dredging options, as access to the immediate area was generally straightforward for excavators and trucks, at least during summer months with lower tides and fewer storms.

The amount of time between dredging activities could vary considerably, largely a function of storm events, but even extended periods of relatively mild conditions could create sedimentation to levels that prevented users from launching and retrieving vessels, particularly those with deeper drafts. It was generally possible to maintain functionality of the facility through busier summer months, but it was found necessary to remove the floating pontoons through winter periods to prevent damage.

For this arrangement, land based excavators and trucks were found to be the most reliable method for keeping the facility operational while trying to optimise the maintenance activities and minimise disruption to the ramp.

The rock groyne protection for the 2004 boat ramp was approximately equal in length to the floating pontoons, extending only about 30m out from shore. Waves refracting and diffracting around the end of the submerged geotextile breakwater outflanked the end of the protective groyne, introducing relatively large amounts of wave energy into the marina basin during heavier swell conditions. These conditions allowed considerable sediment to be driven directly into the boat ramp area, including sediment load carried in by currents and settling into the quieter water at the toe of the ramp. The wave pattern described is easily visible in the 2012 aerial photograph below in Figure 3.6.



Figure 3.6 – Aerial view of the previous (post 2004) boat ramp showing waves transforming around the geotextile bag breakwater. (Source: Google Earth, October 2012)

The previous seagrass bank would have generated a similar diffracted wave pattern, though the effect was perhaps less pronounced before the addition of the shore connection that interrupted the general south to north wave driven sediment transport / littoral drift across the boat ramp beach.

Photographs 3.10 and 3.11 below show extensive sand build up at the boat ramp after winter storms. During times like this, only small dinghies could be launched across the sand, similar to the arrangement with the previous beach ramp, but with less water depth available due to shoaling.



Photograph 3.10 – View to North-East of the previous Boat Ramp during winter months showing the large build-up of sand on the beach. Note that the ramp is entirely ineffective and floating pontoons have been removed. (Source: Author, August 2010)



Photograph 3.11 – Another view to the North of the previous Boat Ramp during winter months showing the large build-up of sand on the beach. (Source: Author, August 2010)

### 3.5.5 Other Considerations

The offshore geotextile breakwater constructed prior to the 2004 boat ramp development has possibly contributed to other issues along the adjacent Beachport foreshore, potentially including increased levels of erosion to the North in front of the 'Harbourmasters' Residence'. This could be due to the modified wave environment due to the geotextile bag breakwater refocusing and concentrating wave energy to this location. Photograph 3.12 below shows the beach immediately north of the boat ramp basin (Beach 7) with reduced beach width and erosion at the revetment wall. These suggestions require further consideration and analysis (modelling) and form part of the recommendations suggested in Section 7 of this report. In any case, these issues were supportive of the need for some modification to the breakwater arrangement and/or adjacent groyne protection to address the changed wave conditions.



Photograph 3.12 – View to South of Boat Ramp and Rock Revetment Structure (Source: Author, December 2006)

The vertical seawall adjacent to the jetty is also considered to be an important feature of the overall system, particularly due to the increased wave energy because of reflective waves forming at the seawall with increased force due to the greater water depths (see Photograph 3.13 below). This reflected wave energy is particularly effective at mobilising sediment into the water column, which is potentially transported back towards the boat ramp area when anti-clockwise currents exist in the Beachport end of Rivoli Bay.



Photograph 3.13 – View to North of Jetty and Timber Seawall (Source: Author, December 2006)

4

# CURRENT BOAT RAMP AND MARINA BASIN

# 4.1 General Arrangement

The current boat ramp facility was constructed in late 2013 / early 2014 to form a larger marina basin by extending the protective groyne by approximately 100m in length to the North (parallel to the rock revetment armouring the shore. Based on discussions with the designers and DEWNR personnel in September 2013, WGA understand that the intention of these modifications was to improve the protection to boat ramp users, and to reduce overall maintenance requirements. The current arrangement is shown below in Figure 4.1.



Figure 4.1 – Aerial view of the current boat ramp and marina basin arrangement. The central sand bar can be seen in the middle of the basin (Source: Google Earth, March 2016)

Design drawings for this boat ramp breakwater extension project were completed by Magryn Engineering Consultants; a part of the drawing showing the plan is included in Figure 4.2 below. The detailed drawings are included with Appendix A of this report.

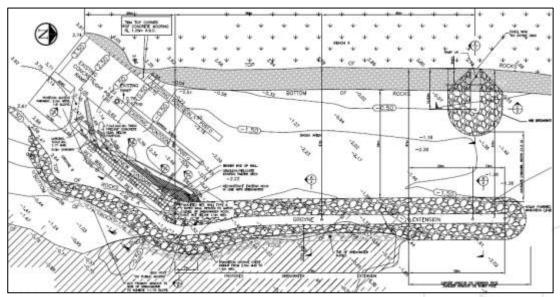


Figure 4.2 – Part engineering plan for Beachport Boat Ramp – Breakwater Extension (Source: Magryn & Associates, September 2013)

# 4.2 Design Considerations

Based on discussions with the designers and DEWNR personnel in 2013, and based on a review of the design documents for the new breakwater extension, it was suggested that maintenance would be more straightforward with the longer breakwater due primarily to improved access, but this would have required a more permanent roadway arrangement on top of the breakwater, and this doesn't go together with the permeable structure that was designed to encourage water flow through the breakwater to encourage flushing and scour. You generally cannot drive trucks on a permeable breakwater, and any attempt to make it trafficable basically just introduces future rocks and sand to be pushed back into the basin when overtopping scenarios in play, as they are here for the breakwater extension. Figure 4.3 below shows these engineering concepts on the original design drawings.

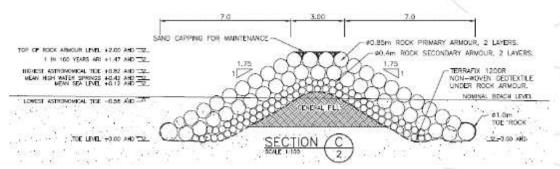


Figure 4.3 – Part engineering section for Beachport Boat Ramp – Breakwater Extension (Source: Magryn & Associates, September 2013)

WGA also understand (from discussions with the designers and DEWNR personnel in 2013) that the main premise of this design is that a current would scour out the basin, formed by water building up within the basin (through the permeable breakwater), and would then exit out through the basin entrance. It seems that the current does indeed happen in numerous instances, as water pushes over the top of the low breakwater, it increases the volume of water within the basin which runs out to the open ocean (to the North) forming a current. Unfortunately, it appears that the water that comes in typically has a much higher sediment load than the water that runs out. Outside, there are waves forcing the sand into suspension. Within the immediate boat ramp basin, there is nothing to mobilise the sediment to an equivalent extent, and the channel induced by scour alone is relatively narrow and not typically suitable for navigation purposes alone.

# 4.3 Functionality and Effectiveness

When not adversely affected by sedimentation, the new boat ramp arrangement with the extended breakwater is a high quality facility offering great conditions for launching and retrieving vessels in almost any weather for tourists and local residents alike. The ramp itself has only minor changes, most notably the vertical concrete wall on the outer (east) side, and an additional set of pontoons to create a 4<sup>th</sup> working ramp. The traffic of boats in busy periods seems to continually grow year by year, and the additional ramp seems to have helped somewhat with congestion (refer Photograph 5.1 below).



Photograph 5.1 – Boat ramp and concrete retaining wall. The additional set of floating pontoons creates a 4<sup>th</sup> lane for vehicle access. (Source: Author, March 2017)

# 4.4 Maintenance Requirements

The maintenance demands of the new facility with the extended breakwater have fallen short of the design objectives, with significant sedimentation still occurring within the basin. The ability to maintain this basin has not been adequately catered for in the design of the breakwaters and access points, and double (and even triple) handling of material has been necessary when digging out with excavators.

WGA understand that the permeability and overtopping potential of the breakwater (particularly at elevated water levels) was intended as a feature that would assist in keeping the basin open, but it is difficult to see that the net benefit is there. It is true that the current is often present to assist with flushing the basin, but it does not seem to extend far enough (and have enough energy) to make any noticeable impact on the siltation. When there is any swell present, it seems that more sand seems to come through the wall than could be possibly scoured out, suggesting that the net effect of the permeability could indeed be negative. This suggestion is untested and requires confirmation via either numerical or physical modelling (or both) to allow further consideration.

Based on inspections on site in late 2016 and early 2017, it appears that a sand spit forms at the entrance of the marina basin in a typical bar formation, and this further migrates into the boat ramp area. This may be somewhat different during winter months and requires further investigation to confirm. There is some evidence from the recent winter of 2017 that the desired behaviour of formation of a natural channel has occurred, albeit at a relatively narrow width compared to the design channel parameters.

There is excess sand build-up in both beach compartments 4 and 5, each to the south of the boat ramp location and groyne 6. This sand from the outer (south) side of the breakwater extension provides a supply of sediment to be driven through the wall, over the wall (in suspension), or pushed around the end of the breakwater extension under wave action. It is difficult to fully quantify without more detailed survey data, but it appears that there is between 5,000 and 10,000 m³ of sand sitting in Beach 4 that requires relocation / bypassing before it enters the boat ramp basin area under longshore transport mechanisms, though any potential maintenance benefit associated with maintenance dredging / carting from the beach itself requires further modelling to assess the true cost benefit relative to simply removing sand directly from the marina basin.



5

# TRIAL DREDGE, MARCH 2017

Wattle Range Council has recently investigated options for dredging the boat ramp marina basin using a small cutter suction dredge. These mini-dredge units have been used in similar applications with mixed results, generally falling short of expectations through reduced reliability, increased maintenance requirements, and reduced production rates relative to the numbers suggested in manufacturer's specifications. As part of WRC's tender process, a trial dredge was nominated as an essential component of the potential procurement for any dredge, but this was difficult to achieve in practice due to the relatively high mobilisation costs from various plant supply locations around the world. Without this trial, it was considered too risky to proceed further with this tender. WGA consider that sound judgement has been employed here, and that there are many concerns with mini-dredges to be resolved before considering this as the ongoing maintenance option.

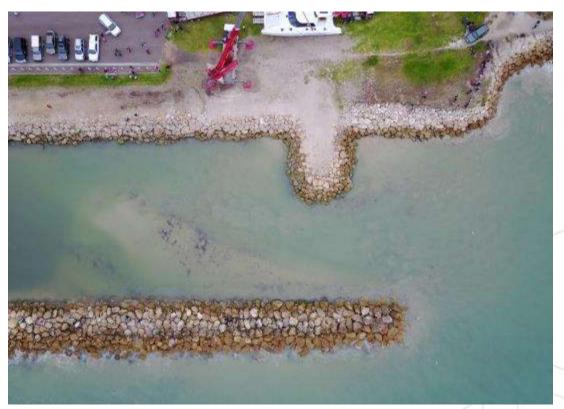
Based on previous similar projects that WGA has been involved with, albeit generally in more commercial port areas, WGA suggested that an alternate trial could be arranged without too much difficulty using plant and equipment that is available either locally or nearby (and easily transported by road). The premise of the proposed trial was to use a Dragflow dredge pump, owned and operated by Maritime Constructions (a marine contractor with considerable dredging experience). A locally sourced 130t mobile crane (Sharp Cranes) was the other key piece of plant utilised for the trial.

# 5.1 Trial Dredge Objectives

The trial dredge had the following key objectives:

- 1. Assess operability, efficiency and production rates of the Dragflow dredge pump
- 2. Assess operability and efficiency of the 130t mobile crane
- 3. Assess pipe handling requirements including install and removal, and consideration of anchoring requirements (in water and on land)
- 4. Consider beach impacts from various dredge disposal pipe discharge locations
- 5. Consider noise and smell impacts from handling dredged sand
- 6. Assess costs, including mobilisation / demobilisation and production costs
- Determine potential for over excavation within the marina basin to provide additional buffer between separate dredging operations
- 8. Restore functionality to the boat ramp and marina basin
- 9. Remove sand build up areas not readily accessed with excavators

The boat ramp marina basin approximately 2 weeks prior to the trial dredge can be clearly seen in the aerial photograph taken by a drone while a new catamaran vessel was being installed using the same 130t mobile crane (refer Photograph 5.1).



Photograph 5.1 – Drone view of the boat ramp marina basin prior to the dredge trial (Source: Maritime Constructions, February 2017)

# 5.2 Methodology

The dredge trial was planned by WGA and WRC personnel with close collaboration by Maritime Constructions and Sharp Cranes personnel. The trial was planned for 5 days, allowing for 2 days for mobilisation and setup, then 3 days of dredging operations before one day of demobilisation. Engineering drawings showing the trial dredge arrangement are shown in Appendix C of this report. The Dragflow pump (HY85/160B model with 2 cutters) was suspended from the hook of the 130t mobile crane, which had full reach over the entire marina basin with only 2 different crane setup locations. The working weight of the Dragflow pump on the crane hook was typically about 2t, slightly more with more dredge pipe suspended with concentrated sand slurry.



Figure 5.1 – Part of WGA set out drawing showing trial dredge, refer Appendix C for further details. (Source: WGA, March 2017)

# 5.2.1 Key Activities

Mobilise / demobilise dredge plant and support infrastructure:

- One semi-trailer load of 250mm OD pipe (ex Adelaide)
- Dragflow and hydraulic power pack with sufficient hydraulic hose (ex Adelaide)
- Sharp Cranes 130t Liebherr mobile crane (ex Millicent)

## Operations (3 days):

- Install 250mm OD HD poly pipe
- Dragflow dredge pump operated from 130t mobile crane
- 2 x crane setup locations

# 5.2.2 Trial Dredge Program

### Mon 6/3/2017

Semi Load 1; Dragflow / hydraulic powerpack transported to site, Semi load 2; 250mm Dredge pipe;

### Tues 7/3/2017

Complete construction of pipeline, Make all connections on Dragflow (hydraulic and discharge), 130t Crane set-up by midday;

# Wed 8/3/2017

Pre-start meeting and SWMS preparation with Sharp Cranes, Commence trial dredging;

# • Thurs 9/3/2017

Continue trial dredging, Relocate 130t mobile crane to 2<sup>nd</sup> location;

# • Fri 10/3/2017

Continue trial dredging in 2<sup>nd</sup> location, Break down pipe and Dragflow spread, Load all to transport and demobilise.

# 5.2.3 Trial Conditions

The weather during the trial was close to perfect. Moderate temperatures, light winds and relatively low swell (other than day 2 where some difficulties were encountered with handling the dredge disposal pipe). Photographs 5.2 to 5.5 show the dredge trial from a number of different viewpoints.

While conditions were ideal for undertaking the dredging activities, the lack of challenging weather meant that the resilience of the methodology (land based access with a crane) was not sufficiently tested. However, based on the trial activities, it is thought that the operational constraints of the crane itself would be the limiting factor, particularly if a permanent (or semi-permanent) dredge disposal pipe were installed along the top of the rock revetment, thereby removing the need for handling the floating pipe outside of the protected marina basin. Favourable weather conditions also resulted in high numbers of boats being launched and retrieved during the trial. This was managed with only minor disruptions to boat ramp users, but the total effect was not an insignificant delay to the overall project.



Photograph 5.2 – View to North-East showing dredge trial underway (Source: Author, March 2017)



Photograph 5.3 - View to South-East showing dredge trial underway (Source: Author, March 2017)



Photograph 5.4 – Drone view of dredge trial underway (Source: Maritime Constructions, March 2017)

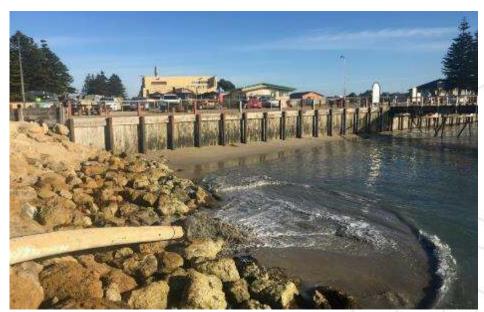


Photograph 5.5 – View to South of dredge trial underway, taken from the jetty at the seawall (Source: Author, March 2017)

# 5.2.4 Disposal of Dredged Material / Beach Nourishment

The dredged sand was generally placed on the beach immediately adjacent to the jetty. Three specific locations were trialled:

1. Direct placement on the lee of the rock groyne, with the HDPE discharge pipe placed over the groyne and slurry dissipated on the rocks. Refer to Photographs 5.6 and 5.7 for details.



Photograph 5.6 – Sand slurry pumped onto the rock groyne adjacent to the jetty beach (Source: Author, March 2017)



Photograph 5.7 – Sand slurry pumped onto the rock groyne adjacent to the jetty beach, with the build-up of sand evident along the length of the groyne (Source: Author, March 2017)

2. Sand placed onto the lower beach on the southern side of the same rock groyne, adjacent to the main swimming beach. Refer to Photographs 5.8 and 5.9 for details.



Photograph 5.8 – Dredge pipe placing sand slurry on the lower beach, with only minor local scour and no significant erosion (Source: Author, March 2017)



Photograph 5.9 – Dredge pipe placing sand slurry on the lower beach. The beach was almost immediately restored after pumping was ceased in this location (Source: Author, March 2017)

3. Sand slurry placed on the jetty beach, in this case with the HDPE pipe coming directly ashore perpendicular to the beach alignment. The 250mm OD pipe was tethered to the steel piles on the vertical seawall in this instance to maintain the position of the diffuser end on the rocks of the groyne. Refer to Photograph 5.10 for further details.



Photograph 5.10 – Sand slurry discharged onto the jetty beach with the HDPE pipe tethered to the vertical seawall using a bridle arrangement (Source: Author, March 2017)

All dredge disposal options that were trialled were found to be feasible, and locations were moved only for the purpose of assessing other options.

# 5.3 Dredge Trial Results

The results of the trial were favourable in almost all instances in meeting the objectives, with the outcomes for disposal of dredged material exceeding the most optimistic scenarios that were considered, (beach scour far less than anticipated even when pumping only water, and build-up of sand in front of the vertical seawall was more effective than hoped). The amounts of material moved were slightly less than hoped, but still proved to be effective in restoring functionality to the facility. The most negative outcome from the trial was that additional depth beyond approximately -1.5m chart datum (approx. -2m to -2.5m AHD) was not readily achieved. It seems that a particularly hard substrate (possibly cap rock or calcrete) exists at about this level and the Dragflow pump is not suitable for this material.

# 5.3.1 Dredge Volumes – Calculated Production Rates

Production rates for the trial dredge were quite variable throughout the 2 ½ days of operation. There was significant downtime through handling the disposal pipe, particularly when it was necessary to move the dredge more than 5-10m at a time. This was improved once more hose was floating, and additional flexible hose at the dredge end would have assisted further.

Accounting for times when the dredge pump was not operating, due to relocation of pipes, crane setup, waiting for vessels using the ramp, etc., approximately 14 hours of dredge operation were achieved over the operational part of the trial (approx. 4 hrs Wednesday, 6 hours Thursday, 4 hours Friday). The sediment load in the slurry coming from the dredge disposal pipe was also variable, which is always a feature of operations using a Dragflow dredge arrangement as the pump is 'tea-bagged' around to find new sediment for excavation.

The following approximate production rates were achieved based on observations at the dredge disposal pipe discharge point:

- 0% solids (seawater), 20% of pump operation time
- 0-10% solids, 25% of pump operation time
- 10-20% solids, 25% of pump operation time
- 20-30% solids, 20% of pump operation time
- >30% solids, 10% of pump operation time

The HY85/160B Dragflow pump used for the trial is generally able to pump between 300m<sup>3</sup> and 500m<sup>3</sup> of water per hour in a configuration similar to that used in Beachport. Based on the above production rates, and allowing for reduced pump efficiency while handling slurry material, the estimated quantity of material moved is in the range of about 600 to 900m<sup>3</sup>. Using a weighted average suggests a value of 700m<sup>3</sup>.

#### 5.3.2 Dredge Volumes - Measured Soundings

The following dredge volumes were measured based on the soundings of the boat ramp marina basin provided by local fishermen:

Pre-Dredge (26 Feb 2017) Volume of water from  $0m = 1627m^3$ Post Dredge (11 Mar 2017) Volume of water from  $0m = 2227m^3$ Volume of water from  $0m = 2227m^3$ Volume of water from  $0m = 1830m^3$ 

Based on these measurements, the following outcomes are suggested:

- 600m³ of sand removed between 26th Feb and 11th March 2017. It is likely that this
  is a conservative number, as sand would have remobilised from areas immediately
  adjacent to the areas dredged, filling local depressions relatively quickly from
  outside sources. A value of closer to 700m³ of sand, consistent with calculations
  based on production rates, is suggested as the best estimate of sand dredged
  during the trial.
- 400m³ of sand build up from 11<sup>th</sup> March to 20<sup>th</sup> April, suggesting that 2/3 of the material moved back into the boat ramp marina basin in less than 6 weeks of relatively mild summer weather.

# 5.3.3 Pre-Dredge (26 February 2017)

The existing surface survey completed on 26 February 2017 was assessed prior to the dredge trial works to form a control surface profile. Figure 5.2 illustrates the depth profile and Figure 5.3 specifies the depth ranges corresponding to each colour. The colours represent depth ranges in 200mm intervals, blue being shallow, and yellow/orange being deeper areas.

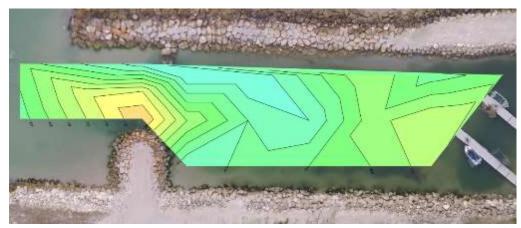


Figure 5.2 – Depth Profile (26 Feb 2017)

ELEVATIONS TABLE					
MINIMUM ELEVATION	MAXIMUM ELEVATION	COLOUR	-0.40	-0.60	
1.00	0.80		-0.60	-0.80	
0.80	0.60		-0.80	-1.00	
0.60	0.40		-1.00	-1.20	
0.40	4.20		-1.20	-1.40	
0.20	0.00		-1.40	-1.60	
0.00	-0.20		-1.60	-1.80	
-0.20	-0.40		-1.80	-2.00	

Figure 5.3 – Depth Range Data

# 5.3.4 Post Dredge (11 March 2017)

The dredge trial completed on 11 March resulted in approximately 600-700m³ of sand being removed from the boat ramp area over the course of about 2.5 days. Figure 5.4 illustrates the depth profile post dredge on 11 March 2017.

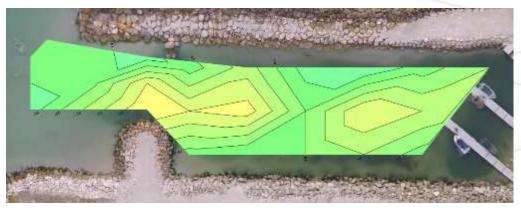


Figure 5.4 – Depth Profile (11 Mar 2017)

#### 5.3.5 Post Dredge (20 April 2017)

Over the following weeks after the dredge trial, the natural current and wave action has resulted in approximately 66% (397m³) of sediment naturally returning to the boat ramp area. As presented in Figure 5.5, the majority of the returning sediment has deposited in the narrowest section at the mouth of the boat ramp entrance.

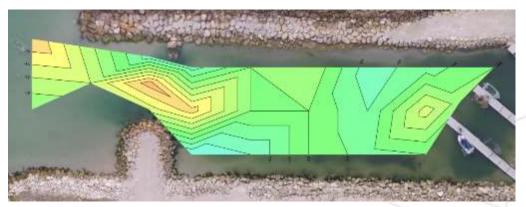


Figure 5.5 - Depth Profile (20 Apr 2017)

### 5.3.6 Dragflow dredge pump

The Dragflow dredge pump arrangement is ideally suited to maintenance dredging activities where sands and silts are encountered. The rotating agitators on the end of the pump allow for sand to be mobilised into the water column with relative ease, and this proved successful in the trial. The efficiency of the arrangement will never be as good as a cutter suction dredge (with appropriate cutting capability), but the quantities to be moved in Beachport are relatively small so production rate isn't everything. Given the number of annual events likely required to maintain access, optimisation of mobilisation and setup costs are just as important.

Some difficulties were encountered with the pump setup, mostly due to difficulties with handling the relatively heavy hydraulic hoses that drive the unit, and from minor blockages from seaweed build-up that had to be cleared periodically, as shown below in Photograph 5.11.



Photograph 5.11 – Dragflow pump being cleared of seaweed from the intake screen (Source: Author, March 2017)

#### 5.3.7 130t Liebherr mobile crane

The 130t Liebherr crane supplied and operated by Sharp Cranes performed faultlessly. Prior to the trial, it was not considered that this crane would be a feasible option going forward due to the relatively high operating cost – the cost of the crane hire alone was more than half of the trial budget cost. But the efficiency of the operation could be improved dramatically with better organisation and planning, reducing the downtime for the crane and increasing the overall productivity. The crane is available locally, and the setup location above the revetment wall proved to be ideal. The fact that this system is isolated from the ocean wave / swell environment altogether is particularly beneficial, though wasn't tested in the trial dredge. The crane had full coverage of the marina basin from only two setup locations. It is thought that with more flexible dredge pipe leading to a permanent HDPE dredge disposal pipe on land, it might be possible to improve the dredge productivity by more than double.

#### 5.3.8 Dredge discharge pipe

The dredge pipe was one of the major demands during the trial in terms of setup time. The original plan was to create a large 's-bend' in the floating pipe offshore from the beach to allow for easy movement of the crane and Dragflow. This plan was altered slightly after moderate swell conditions experienced during pipe placement and install whereby the pipe was beached on the dry sand overnight. This wasn't a problem in itself, but meant that moving the pipe later on the first day after finishing working the first area was more challenging and a front end loader was required to assist (refer Photograph 5.12 below).



Photograph 5.12 – Relocation of the dredge discharge pipe using the crane and a front end loader on the beach (Source: Author, March 2017)

A longer flexible hose from the Dragflow pump and a permanent HDPE land based pipe would offer significant improvements to the dredge arrangement if similar plant and equipment (including other types of dredge) were used on a more regular basis going forward. The wear rates for moving the small quantities involved are very low, so even second hand pipe could be considered to help keep costs down.

#### 5.3.9 Beach impacts at discharge locations

As discussed earlier in this report section, there were no detrimental effects on the beach or rock groynes at the point of discharge. The outcomes assessed for placement of sand exceeded the best case scenarios predicted before the trial in every way. The amount of beach that was able to be built up at the jetty beach was noticeable, and lasted for many days before dissipating. The amenity in this area and reduced demand on the seawall was a favourable outcome, and was done in a less disruptive manner than trucking.

It is generally easier to assess the outcomes at the discharge end of the dredge pipe rather than the dredge end, as photographs allow for comparison. See Photograph 5.13 and 5.14 below for a comparison of before / after at the discharge location near the jetty.



Photograph 5.13 – Jetty beach and vertical seawall approximately 2 weeks before trial (Source: Author, February 2017)



Photograph 5.14 – Jetty beach after dredge trial (Source: Author, March 2017)

#### 5.3.10 Noise and smell impacts

Significant amounts of community consultation was undertaken by WGA and WRC personnel during the trial. There were no complaints noted with regards to smells or noise, or anything else for that matter. Many residents commented on the success of the arrangement and their preference for the Dragflow setup over trucking campaigns.

#### 5.3.11 Dredging costs

The costs of the dredge trial came in on budget, even after a half day extension was applied to both the crane and dredge hire to fully utilise the plant and equipment for the week. This allowed for the second crane setup location to be trialled in more detail.

The unit costs of the sand movement look relatively expensive when compared to previous costs for dredging with excavators and trucks. Based on the calculated quantities from the trial, unit cost for dredging and placement is in the order of \$50/m³, which is more than double the rate that has typically been achieved with digging out using excavators. However, if the downtime allowances for dredge pipe movements and other one-off trial components of the operating time is accounted for, it is reasonable to think that the unit cost could be improved by a factor of 2 or more. It is also quite possible that the calculated volumes represent a lower bound estimate for the dredged quantity. More accurate survey would be necessary to provide a more reliable result. Further efficiencies that might be introduced with permanent pipe infrastructure could bring costs down again, quite probably to levels that are in line with the previous rates, and with greater certainty due to the fewer constraints (weather, wave conditions, etc.).

In any case, it is likely that the measured quantities are not directly comparable to trucked campaigns, where the amount of sand measured as removed is based on the number of trucks loaded, and bulking factors and saturation are potentially important variables to be accounted for if comparing sand volumes.

The frequency for dredging has proved to be considerably less than by excavators. The Dragflow trial was completed in March 2017 and has enabled a satisfactory service standard for boat launching throughout the winter months.

#### 5.3.12 Determine potential for over excavation within the marina basin

This was one of the more negative outcomes from the dredge trial. It was hoped that the Dragflow trial might allow for over-excavation within the centre of the marina basin to allow for a buffer against future sedimentation. In a perfect scenario, it would only be necessary to dig a series of deep holes in the centre of the basin to great depths, with angle of repose leading back up to the edges of the basin.

A hard substrate was encountered in most areas, and this prevented the Dragflow from advancing further than a depth of about -1.5m CD (1.5m below lowest astronomical tide), or between about -2m and -2.5m AHD. It appears that large earthmoving equipment or larger dredge plant (such as a cutter suction dredge with an overhead cutting wheel) would be required to dig through the harder layer, noting that it would only be necessary once and then only mobile sediment would need to be removed thereafter in maintenance campaigns.

#### 5.3.13 Restoration of boat ramp functionality

The main sandbank within the boat ramp marina basin was removed during the trial dredge and full operability of the channel was restored. Some areas closer to the foot of the ramp were not able to be dredged due to time constraints, noting also that these areas were quite bound up with rotting seaweed at the time. Another 1-2 days could have been spent removing further sediment from the marina basin, but time and budget did not allow for this. If greater efficiencies discussed previously to reduce downtime were introduced, it is reasonable to think that 3 days operation would generally be sufficient to clear out the entire basin using this approach, possibly even 2 full days if setup the day prior and demobilised the day afterwards.

The ability of the crane and Dragflow to work around the vessel traffic was another positive outcome of the trial dredge. Given the good weather, the trial proved to be a relatively busy time on the boat ramp, and the ramp was not required to be closed at any time. There were a few instances where boats had to wait up to 5-10 minutes if the Dragflow was operating at a particular choke point, but these instances were minimal and did not cause concern for users.

#### 5.3.14 Removal of sand build up from inaccessible areas

Prior to the trial dredge, there were a number of areas that had proven to be all but impossible to reach using excavators, including the centre of the main basin, and the entrance of the boat ramp basin toward the outer part of the rock breakwater extension. Given the reach of the crane (48m working radius with a 3t load on the hook), this proved to be no problem for the crane with the Dragflow pump, and is another favourable outcome of the trial.

6

# **FUTURE BOAT RAMP OPPORTUNITIES**

The overwhelming message regarding the way forward with a boat ramp in this location (or any location for that matter at Beachport) is that it will require regular maintenance. The options as I see them are:

- 1. Look at ways to optimise the maintenance itself. Consider a small dredge, reduce the unit cost of moving material, and potentially just manage this facility as sharply as possible.
- 2. Look at ways to reduce maintenance requirements (they will not be eliminated!). This could include fixing up peripheral issues such as installation of the much discussed northern groyne and trying to control disposal of sand that is moved by machine (i.e. dump coarse grained material near the Harbourmasters' residence, but fine grained right out towards the outlet drain).
- 3. Consider longer term options is an alternate location worth considering further? Do you manage it like various other local areas where you have a flatter ramp and semi-retired farmer with a tractor pushing people in for a small fee? This works in some instances, but is difficult to accommodate where 4 lanes of ramps are currently in operation.
- 4. Consider opportunities for more research and actual modelling / design. It is certainly an inexact science, but there are scale model approaches and numerical modelling techniques that can shed a lot of light on improvements before you spend the money on construction. For example, it would have cost about \$50k to get appropriate modelling for the breakwater extension, which seems expensive at first consideration, but might have led to a very different outcome.

#### 6.1 Current Sediment Management Demand

WGA understand that the latest estimates put the annual sand movement somewhere between 10,000m³ and 20,000m³. This in itself is not a large number, and there are many locations around Australia that deal with much larger quantities of sand on an annual basis. Importantly though, it is also known that the sand will need to be moved in more than one campaign, quite possibly more like 3-4 smaller campaigns through the year if Council wishes to maintain year-round access. Depending on the desired service standards for the boat ramp, based on the trial dredge, it might be considered that additional campaigns could be necessary to maintain year-round access (depending on the number and severity of storms), largely because it is not possible to create a sufficiently large buffer. The optimum balance between the number of campaigns and the size of individual campaigns can only be determined once mobilisation and operating costs for the various options under consideration are understood better.

To put these quantities into perspective, the basin is up to 40m wide at water level and about 100-120m long. Accounting for rock revetments and for some additional areas immediately outside of the basin that might also require periodic attention (maintenance dredging), we can assume an area of approximately 30m x 100m = 3,000m<sup>2</sup> conservatively. The target depth is to achieve depths of up to 3m (assuming AHD based on trial dredge info), or -2.5m CD (below low tide, LAT). Given recent siltation, and assuming that we'd like to ensure that a depth of (say) 1.5m below LAT is achieved for most of the time, it is reasonable to consider that each campaign would remove between say 0.5m and 1.5m of material across the basin, possibly averaging between 0.5m and 1m in dredge depth. This works out to between about 1,500m3 and 3,000m3 of material to be targeted in each campaign, possibly closer to 4,000m3 after a particularly adverse set of weather events. This checks out reasonably well with the rough estimate of 6 to 8 campaigns to manage up to 20,000m<sup>3</sup> of material annually. The good news here is that these are not large quantities for the technologies that we will consider, and the quantities required to be moved are not necessarily the dominant variable in the cost equation (whereas it is much more relevant for other land based technologies). These quantities also align favourably with the results of the dredge trial.

Since the trial dredge, it has been observed that a natural channel forms along the Beach Road side of the basin, which is utilised when the sand bar forms in the centre of the basin. This channel has remained through the winter months and is accessible from the shore by long reach excavator, allowing maintenance at minimal cost when the sand bar builds up in the centre of the basin to excessive levels (overly restricting access).

### 6.2 Maintenance History

Sand has historically been moved with earthmoving equipment (excavators and trucks), with costs varying considerably. Material that is relatively easy to access has been moved for as little as about \$10/m³, while the cost can be more than 3 times for material that is more difficult to access and double (or even triple) handling can be necessary.

#### 6.3 Ongoing Maintenance Considerations

The current marina basin arrangement is such that maintenance will always be a necessary requirement in order to keep the boat ramp functioning. There may be ways to optimise this arrangement, but it would be unrealistic to think that the problem could be even halved in magnitude without considerable modifications and redesign. Without modelling, redesign carries no guarantees of reduced maintenance. Importantly, even if the maintenance were halved, it is still a significant exercise and needs to be done in as efficient a manner as is possible. Alternative maintenance options are either dredging with marine based plant, other pumped dredge solutions, or improving access for excavators to remove double handling.

A dredge solution could potentially allow better protection of beaches immediately to the north. Sand removed from the boat ramp has historically been placed either immediately in front of the Harbourmaster's Residence, or has been removed further to the beaches north of the jetty. Hydraulic placement with a dredge can be placed more closely to the boat ramp with less concern about it coming back into the boat ramp basin, due mostly to the fact that this sand is less likely to be immediately raised into suspension through wave attack when compared to 'dry piles' on the upper beach. It is also relevant that the unit costs of moving additional sand by running the dredge for longer should not be a significant additional cost to the overall working budget.

# 6.3.1 Dredging with Marine Based Plant

The costs that we need to consider to assess the ongoing viability of dredge options include:

- Capital cost of purchasing a dredge unit and associated equipment (i.e. power packs for pumps, separate barge if necessary)
- Annual maintenance costs for the dredge plant and equipment
- Mob/demob costs for getting the dredge operational on site
- Running costs including labour
- Additional costs for moving sand with excavators, noting that we are unlikely to remove all requirements for excavators (but would hopefully reduce this quantity dramatically)

The following attributes are considered important for the boat ramp location in Beachport:

- 1. Must be road transportable. Ideally, would fit on one standard semi or low loader.
- 2. Must be relatively easy to mobilise over a short distance (i.e. from within Beachport, possibly from the commercial boat yard). Ideally, could be launched down a ramp (possibly the recreational boat ramp, otherwise the commercial boat ramp.
- 3. Must be self-propelled, most likely powered by an outboard motor.
- 4. Minimal operators required. Ideally only 2 (I think one would be a stretch in this location with potential for swell, etc.)
- 5. Must be able to pump material at least about 300m to allow disposal options both north and south of the jetty (potential for permanent pipe infrastructure)

Possibly the most obvious solution to pursue would be a small cutter suction dredge, most likely on its own custom pontoon arrangement. There are many of these available on the market 'off-the shelf', but many are really targeted at mining / tailings dam operations where conditions can be quite different. In particular, the auger dredges are often more suited to softer and less consolidated silts or soft muds/clays, and may struggle to make decent headway in more consolidated sands that you'll encounter in the Beachport boat ramp basin. Even if this option was considered favourable, it is still questionable if it makes sense for council to own this plant in its own right.

# 6.3.2 Other Pumped Dredging Options

The other option that warrants investigation for this site is a Dragflow pump arrangement similar to what was utilised in the trial. A Dragflow pump is basically a submersible slurry pump with agitators (to mobilise the sediment). The agitators are generally water jets or rotating diggers that assist to get the material into suspension. These pumps are mostly driven by hydraulics, but there are also electric versions available, particularly when looking at the smaller sized units. This might be an important thing to consider for this site, both for ease of use, maintenance (you're effectively talking about a medium sized gen set), but also for noise considerations.

There are many ways to use a Dragflow (or similar) pump. Maritime Constructions use a relatively large customised vessels with davit cranes and Hiab cranes to adjust and manoeuvre the unit, but you basically drop the unit down to the seabed and dredge a hole, forming an ever larger conical excavation as you dredge deeper. In Portland, they are able to go very deep without adversely affecting any nearby infrastructure, and effectively create a 'sink' for nearby sand to collect in, which all contributes to extending the duration between maintenance dredging campaigns. In the more constrained Beachport boat ramp basin, we are more limited with the size of holes, and would need to relocate the dredge plant more often and at closer centres. Based on the trial information, it would be necessary to utilise other techniques to first get to greater depth before being able to use a Dragflow or similar to greater depths because of the cap rock material encountered.

An option worth investigating at Beachport would be to use a Dragflow (or similar) submersible pump with just a simple A-frame type gantry support at the front of a small barge / pontoon arrangement, which would simply lower and raise the dredge pump to the seabed with a simple winch arrangement. The method described is often referred to as 'teabagging', for obvious reasons. The unit would most likely be powered by a diesel generator mounted on the back of the barge / pontoon, and would also act as counterweight. Fairly typical (and readily available) anchor handling barges would require only minor modifications to be suited to the task. These vessels are self-propelled, typically about 3m wide x 10m long, and handle anchors up to 1.5t to 2t with a single electric powered winch. They are used to handle / relocate the anchors with large cutter suction dredges.

What is most attractive about this option is that it could potentially be trialled with relatively minor costs, and is really an extension of the trial that has already been completed. It is conceivable that you would find a suitable submersible pump to hire for a short period. Similarly, it is realistic that we might find an anchor handling barge available with suitable specs, albeit it may be necessary to mount some spud pile supports or temporary winches, and a power pack or generator can be easily hired.

The dredging rates (volumes) for this type of plant are typically not quite as great as what you might achieve with a cutter suction dredge (depending on respective sizes of course), but this isn't such an issue given the relatively small quantities that we are talking about here. It is far more important that we bias simplicity to minimise ongoing maintenance costs – the less moving parts and more straightforward the arrangement, the better.

# 6.3.3 Other Regional Maintenance Dredging Requirements

There are a number of nearby locations that have similar maintenance dredging requirements, including at Kingston, Cape Jaffa and Robe. WGA understand that WRC have been involved in discussions with representatives from these nearby councils to investigate potential synergies for ongoing maintenance dredging. This does not form part of the current scope of work for this report, but may become increasingly relevant looking forward.

# 6.4 Other Boat Ramp Design Options

There are many other ways to design and construct boat ramps where sedimentation is a concern. There are several examples that come to mind where minimisation of maintenance costs has been the primary concern, and very different outcomes have resulted. Two examples are boat ramps at Exmouth in North-West Western Australia, and Esperance in South-East Western Australia.

# 6.4.1 Exmouth

The ramp at Exmouth is on Exmouth Gulf and is a single lane ramp. There is no specific protection for this ramp, as there is no major swell that comes in to the gulf in normal conditions, and there are only wind driven (short fetch) waves. This is an important distinction relative to the requirements of a ramp at Beachport. Refer to Photographs 6.1 to 6.4 for further details of this ramp arrangement.



Photograph 6.1 – Exmouth Boat Ramp (Source: Author, May 2015)



Photograph 6.2 – Exmouth Boat Ramp (Source: Author, May 2015)



Photograph 6.3 – Exmouth Boat Ramp (Source: Author, May 2015)



Photograph 6.4 – Exmouth Boat Ramp (Source: Author, May 2015)

# 6.4.2 Esperance

Another ramp built over the active beach profile to find deeper water is at Esperance. This is also a single ramp structure, and is in a more protected bay than Beachport, though conditions can be relatively demanding in certain weather events. Refer to Photographs 6.5 to 6.7 for further details regarding this ramp design.



Photograph 6.5 – Esperance Boat Ramp (Source: Author, February 2017)



Photograph 6.6 – Esperance Boat Ramp (Source: Author, February 2017)



Photograph 6.7 - Esperance Boat Ramp (Source: Author, February 2017)

It would be possible to design a similar type of boat ramp structure for Beachport, and it could certainly be done with a great reduction in the overall maintenance requirements, but there would be a significant reduction in protection offered against swell. Additionally, there would be numerous challenges to provide a 4 lane ramp that could cater for the same amount of ramp traffic as currently occurs.

This structure type is not affected by sedimentation because the typical coastal processes for the site are not interrupted. Greater width to the ramp, and any offshore protection such as a breakwater, modifies the coastal processes and generally tends towards more benign conditions and typically a flatter beach with more build-up of sand. It is therefore a balancing act between providing protection and comfort with ramp width, versus ongoing maintenance requirements. Given that expectations in Beachport from tourists and local users alike are that a facility with similar functionality to the current arrangement will be provided, it might be a very difficult process to take people back to something that is much more paired back.

RECOMMENDATIONS

#### 7.1 Introduction

These recommendations have been developed following the review of the current boat ramp arrangement in Beachport. It is sufficient to say that this study is driven largely by the disparity between community expectations relating to boat ramp maintenance costs.

The appetite of the local community for maintenance costs from council revenue streams appears to be at a ceiling at about \$100k, though expectations from many users are that a higher standard of operability should be achieved. It is likely that the cost of maintaining the boat ramp basin within the limits stipulated by the Sand Management Plan is closer to \$250k, which is a considerable difference and suggestive that more than minor changes to the current arrangement (either the basin itself or the maintenance budgets) will be required to close the gap between the tolerance of the community for spending vs the performance expectations of others.

The intention of this recommendations memo is to provide a scope for Wattle Range Council (WRC) personnel for forecasting future works and associated budgets, and to describe the input data that might be expected and/or required to properly consider more extensive modifications to the maintenance regime or capital works associated with more significant alterations to the current arrangement of breakwaters surrounding the boat ramp basin. Specifically, these recommendations respond to the two key focus areas nominated by WRC:

- 1. Operational factors that will increase the efficiency of maintenance
- 2. Improvements to the existing infrastructure that will reduce maintenance requirements

The recommendations of this assessment are broadly separated into data collection / acquisition, modelling / analysis, maintenance, and capital works. WGA will present a range of options under these categories and associated cost estimates where appropriate.

#### 7.2 Data Acquisition

The existing boat ramp and basin arrangements have been developed primarily based on site observations and previous performance of the original and adjacent coastal structures. There is a good amount of historical survey data and aerial photography, along with survey transects across the beaches (including adjacent to the boat ramp) that have been collected by DEWNR (Department of Environment, Water and Natural Resources) personnel. However, there are limited data sets suitable for modelling the existing arrangement either numerically or physically, particularly with regards to metocean conditions.

Any detailed consideration of improvements with regards to maintenance, and any substantial capital works campaigns to significantly modify the existing arrangement should first be modelled to determine if the intended outcomes are realistic, and to determine if any other unintended (and potentially detrimental) effects might be possible. The specific suggestions for modelling will be outlined in a later section, but the required data is similar for all considerations, including metocean, bathymetry, geotechnical and sand particle size distribution).

#### a) Metocean

There is no existing metocean data for the site at Beachport. Both current and directional wave information is necessary to facilitate future modelling of the boat ramp site, and for any further consideration of the groyne field extent. Previous works have been undertaken with qualitative assessments only, based predominantly on site observations.

Collection of the following metocean data is proposed:

#### **Nearshore Current Transects**

Vessel mounted, Acoustic Doppler Current Profile (ADCP) transects will be undertaken over a one day period in the nearshore environment of Rivoli Bay to enable current velocities and directions to be measured in the vicinity of the Beachport breakwater. This data gathering period can be extended if budget permits, but is adequate to generate an initial model of current velocity through the tidal range to facilitate further analysis.

#### **Rivoli Bay Currents and Waves**

A seabed mounted ADCP will be deployed for a period of two months at a location approximately 300m offshore within Rivoli Bay. The ADCP will collect current profiles, water levels and wave conditions at this location. The ADCP will be configured to capture mixed spectra of both sea and swell waves.

Wavelength Consulting have been approached to provide a quote for this data collection. The quoted fee for the above scope is \$29k + GST, noting that this figure assumes that a small workboat can be provided at no cost. Given the volunteer commitments from local professional fishermen, WGA consider that this assumption is realistic. A detailed breakdown of this proposal from Wavelength is included in Appendix C.

The nominated period for metocean data collection should be sufficient for future analysis, but the quality of the data set is somewhat dependent on weather systems that occur while the instruments are deployed, and multiple data collection campaigns could be beneficial. Additionally, WRC have other projects within Rivoli Bay that might also benefit from metocean data collection including assessment of the Southend foreshore. As such, WRC have also requested that pricing be provided for purchase of the data collection equipment. Wavelength Consulting confirm that the proposed equipment could be purchased for \$42.5k + GST, which would offset approximately \$15k of the quoted \$29k fee.

It is recommended that WRC procure at least the minimum metocean data campaign nominated above at the earliest possibility to facilitate future modelling of maintenance options and to assess the existing arrangement for potential modifications that might reduce the ongoing maintenance task. A larger data set is obviously desirable to hopefully provide the most representative site information possible for future decision making, but budget constraints are such that this may not be achievable. The minimum campaign suggested will be sufficient to allow further extrapolation of conditions from numerical modelling. The numerical models can generate useful information provided that there is adequate baseline data for sufficient calibration.

#### b) Bathymetry

There is some existing bathymetry information for various parts of Rivoli Bay, including marine hydrographic charts. Marine charts are developed with navigation in mind, and as such, focus on local high points on the seafloor that could be a risk for vessels. This is not always a good representation of the actual bed profile, and can lead to reasonable errors for models where depth is quite variable, as occurs in Rivoli Bay.

Regular soundings are taken within the boat ramp basin by local volunteers, and while this data is very useful for assessing sedimentation, this technique is not appropriate for more extensive collection of bathymetry outside of the breakwaters.

More detailed bathymetry, particularly for the areas immediately offshore from the Beachport boat ramp marina basin, would improve the accuracy of any future modelling of coastal processes, and would be especially important if any physical modelling was intended.

Additional bathymetry should be considered opportunistically by WRC if other campaigns are being procured nearby. A considerable proportion of the cost of obtaining bathymetric data has historically been mobilisation, though this has decreased somewhat in recent years as more mobile equipment has developed, reducing from somewhere in the order of \$5k to \$10k to less than \$3k. This benefit can be fully realised if local vessels are available to setup the mobile equipment, which is expected to be the case in Beachport due to local volunteers from the professional fishermen.

It is recommended that existing information only be used in the short term for modelling, but that WRC should consider all future opportunities where other stakeholders are mobilising hydrographic equipment, such as the South-Eastern Water Conservation & Drainage Board or the DPTI (Department of Planning, Transport and Infrastructure) Marine Facilities Group.

#### c) Geotechnical

There is limited understanding of the underlying geotechnical profile below the boat ramp basin. Anecdotal reports from earthmoving contractor operators involved in the construction of the existing boat ramp breakwaters suggest that there is a bedrock or 'sheet' rock layer at the base of the excavated depth. The design toe level for the rock breakwater is -3.0m AHD, or -2.4m CD. In the absence of further information, this is considered to be the lowest excavated level within the boat ramp basin, and is the lowest level achieved during the recent dredge trial.

The sand level within the boat ramp basin is intended to be maintained between -0.9 CD (-1.5m AHD) and -1.9m CD (-2.5m AHD), though this has not often been achieved due to sedimentation of the basin.

A better understanding of the geotechnical profile is important for considering future maintenance options, as this is a potentially limiting factor for over dredging to create a larger buffer for sedimentation to extend the time between clean-up campaigns. This information would drive the feasibility assessment of excavating a central 'sink' within the basin to allow removal of larger quantities of sand less often, which is attractive for maintenance methodologies with larger mobilisation / setup costs.

Traditionally, a geotechnical profile would be determined using borehole drilling. Most studies in Beachport are for residential projects where push tube tests or shallow test pits are adequate. These techniques are not appropriate if there is a layer of rock at the base of the existing basin. It is unlikely that larger drilling equipment would be in Beachport for other reasons, and it is likely to be prohibitively expensive to mobilise this equipment just for the boat ramp site. It is more likely that mobilising a larger excavator to try to dig below the -2.4m basin level will be more cost effective. In the absence of other opportunities, this should be attempted the next time that excavators are mobilised for a maintenance campaign to remove sedimentation.

It is recommended that a better understanding of the geotechnical profile be determined for the site, particularly with regards to rock layers. This might be determined from analysis of contractor site data from the more recent boat ramp upgrade, but it is likely to be necessary to undertake a dedicated investigation using a large excavator. This can be procured from local contractors, and is expected to cost in the order of \$5k.

Another technique that could be utilised to map rock layers is seismic refraction, where speed of sound through various materials is used as a guide to map out strata. Mobilisation is reasonably cost effective with this technology, though accurate calibration of results typically requires borehole data to be effective. Limestone rock types are also notoriously unreliable due to the variable nature of rock formations over even relatively minor distances (particularly at coastlines). For these reasons, seismic refraction (and other geophysical techniques) are not considered to be a viable method for further investigation in this instance.

#### d) Particle Size

Sand particle size is important for modelling to assess the mobility of sand sources under the action of coastal processes. The distribution of sand with various particle size parameters can also be a good indicator of the origin of sedimentation. Particle size is determined via sieve analysis, which is a relatively cost-effective method and can be completed by personnel with limited training. There are existing accredited companies in Mount Gambier who are able to undertake sieve analysis, but accreditation is not considered to be overly important in this instance.

It is recommended that WRC procure sieve analysis equipment for the purpose of regular sampling both in-situ at the beaches either side of the boat ramp basin, and from within the basin itself. Additionally, sand samples should be analysed before, during and after maintenance campaigns so that results can be correlated to see if any discernible patterns or sorting processes are at play. This could be useful in determining the relative quantities of sand that migrate into the boat ramp basin under various forcing conditions that occur. Sieve analysis equipment can be purchased reasonably cheaply, though some additional costs might be incurred through training of personnel (may be in house WRC staff, or contractor representatives).

# 7.3 Modelling and Analysis

The existing boat ramp basin arrangement has not been modelled as part of prior design campaigns. The original geotextile (trial) breakwater was partially assessed with a crude physical model back in the early 2000's by final year engineering students under the direction of Associate Professor David Walker, but recent discussions with Assoc. Prof. Walker reveal that all of this work was done in a fairly qualitative manner and that the final built form was not particularly representative of the model. No field wave data was available for this research project, and no calibration or verification was undertaken. There are no published results available from this work.

Modelling has the advantage that complex coastal engineering scenarios like those found in Rivoli Bay can be tested and trialled without the expense of major capital works, and the inevitable rework and maintenance if found to be less successful than desired. Both numerical and physical modelling techniques have a time and place in such coastal engineering investigations.

#### a) Numerical Modelling

There are many competing software packages available that are able to assess coastal processes and model effects that coastal structures might have on adjacent beaches. Increasing computing power allows for far more scenarios to be considered, which in many cases can reduce the amount of data that is required as more substantial sensitivity analyses can be performed to compensate. An advantage of numerical modelling is that the initial effort used to develop the base model, including setting up the model bathymetry and sediment parameters, assessing coastal processes and sediment transport models is always retained and can be refined and expanded on over various iterations of studies.

In this case at Beachport, the initial base model would attempt to capture the sedimentation effects and rates that have been observed in the field, which could assist in predicting future maintenance requirements. But more importantly, once this model has been developed, it then becomes relatively straightforward to assess whether proposed changes to the basin arrangement are likely to have positive or negative effects on sedimentation rates, and under various seasonal weather conditions. For example, the length, height, permeability and width of the existing breakwater wall could be varied to assess whether optimising this extent could favourably reduce the amount of maintenance dredging that is currently required.

An initial budget of \$25k to \$30k is considered appropriate for this initial modelling phase. This budget has been determined in discussions with Baird Australia. A more detailed proposal will be developed if WRC decide to proceed further with a numerical modelling approach. It is worthwhile noting that the same numerical model would only require minor additional input data to allow detailed assessment of the existing groyne field and consideration of potential changes to groyne length, height and extent throughout the Beachport town beaches. A budget of more like \$40k to \$50k would be more appropriate if trying to incorporate the groynes of the town beaches in the first modelling pass.

It is recommended that at least the base numerical modelling be initiated by WRC in the short term as this model is expected to be a valuable resource in testing many ideas proposed for the boat ramp basin without the excessive expense associated with trialling changes in a full scale in-situ environment.

One recent observation from the last site visit on 4th June 2017 that requires confirmation relates to the potential for long period waves at the boat ramp basin. Long waves can be formed from many sources including surf-beat on heavy swell beaches, and have the ability to travel vast distances without significant loss of energy. They have a period in excess of 30 seconds or even 1 minute, and have a high propensity to reflect (even on fairly flat beaches). WGA have been involved in investigations into long-wave effects in larger port environments in Portland (VIC), Esperance (WA), and Geraldton (WA), and there are many similarities to Beachport in these instances.

There is potential for a long wave to be reflected from surf beaches of Rivoli bay back towards the south and into the entrance of the boat ramp basin. There were signs of this happening on the day of the 4th June 2017, visible as a slow rise and fall in water levels within the basin surging up and down the boat ramp. Importantly, long period waves also cause relatively high water velocities and associated sediment transport through bed scour, which could be a significant contributor to transmission of sand from the 'bar' at the basin entrance further into the centre of the basin. This is something that has not been described in any prior studies on Beachport and should be considered with any future modelling.

### b) Physical Modelling

Physical modelling of coastal structures utilises scale models of the coastal structure or feature in question to assess the performance under conditions expected to occur on site. Successful physical modelling requires relatively accurate data, and is typically associated with larger infrastructure projects due to the relatively high setup costs for the models.

In Australia, physical modelling for coastal engineering applications is primarily undertaken at Water Research Laboratory of UNSW and Manly Hydraulics Laboratory (part of NSW Government). These facilities are each able to conduct 2D and 3D models, though 2D modelling is not likely to be of much use for the Beachport boat-ramp due to the relatively complex geometry of the basin (typically more useful if assessing the stability of breakwater profiles under relatively consistent wave directions).

A 3D model for a location like the Beachport boat ramp would cost in the order of \$30k to \$50k to construct and assess. It is much more time consuming to consider multiple scenarios with physical modelling techniques, so it is important to have a clearer and more concise objective for study.

A 3D physical model is not considered necessary or cost effective at this point in time, though may be worth considering prior to any substantial modifications to the overall arrangement of the boat ramp basin, and would be certainly worthwhile if ever considering any major redevelopment such as an alternate site, noting that the cost associated with modelling these more expansive changes could be closer to \$75k to \$100k. This may seem quite expensive at first consideration, but could still be cost effective due to the potential to find significant cost savings in ongoing maintenance through optimisation of the structures, particularly at the breakwater entrances.

# 7.4 Maintenance Options

Maintenance of the boat ramp basin has generally been done with excavators and trucks. The 'Sand Management Plan at Town Beaches, Beachport for Wattle Range Council' (19 December 2013) describes sand clearance from the boat ramp basin and mouth as being performed with either an excavator or long-reach excavator. The Sand Management Plan also allows for the use of a dredge. The trigger for maintenance to be performed is nominated as being -1.5m AHD (-0.9m CD), though it is understood that excessive sedimentation has meant that bed levels have often been much higher than this by the time maintenance activities have been able to be commenced.

More recently, the trial dredge exercise (described above) was completed using a Dragflow dredge pump suspended from a 130t mobile crane. It can generally be said that the trial was successful in most areas of investigation, with only the dredged depth being of concern (the Dragflow pump continually refused at a bed level approximately -1.5m CD to -2m CD, possibly on a rock stratum).

Looking forward, options for refining maintenance activities and reducing ongoing maintenance costs include the following:

# Investigate purchasing fixed infrastructure for dredging activities to reduce downtime

The methodology used for the trial is dependent on having a large crane or floating pontoon with a small gantry to allow operation of a Dragflow pump (or similar). A second trial using similar plant and equipment, but with the dredge disposal pipe already set up and installed along the top of the rock revetment (rather than handled in water) would demonstrate how much efficiency could be improved still using equipment hired in on a case by case basis.

Ideally, the dredge contractor would only need to arrive with the Dragflow pump (or similar), the hydraulic power pack (or electrical gen-set), and flexible hose to plug into the boat ramp end of the permanent HDPE pipe.

A 250mm O.D. pipe (226mm I.D.) is an appropriate size to accommodate the Dragflow pump, and would also be suitable for a small cutter suction dredge if alternative dredge methodologies were to be utilised in the future. It would also be possible to accommodate pipe sizes slightly larger and smaller in diameter (up/down one pipe size, diameter), but this should be considered in more detail prior to procurement. Given the relatively small quantities of sand to be moved on an annual basis, WRC would be able to procure a second-hand pipe string (wear rates are not overly significant).

#### 2) Purchase and operate a small cutter suction dredge

WRC has previously sought expressions of interest for the purchase of a small dredge that they might own and operate. There are some options on the market, including 'off-the-shelf' and custom designed / built, but few dredges of this size are considered to be proven in the field, particularly for consolidated / denser sands that are found in a boat ramp scenario like Beachport (many successful operations have been in tailings dams or other looser sediments where auger type actions are more appropriate).

Given the small quantities of sand to be moved (relative to other dredge applications), it is difficult to justify WRC owning, operating and maintaining their own dredge. It would be non-standard relative to other plant and equipment typically owned by a council. Significantly reducing mobilisation costs from the cost structure is the main benefit that would be realised with this approach, along with having ready access to this plant when required.

These benefits are not considered to outweigh the considerable financial investment required up-front for the purchase of this equipment, along with the relatively fixed ongoing annual maintenance costs incurred for running this plant for only short periods of time. This might be improved somewhat if other work could also be found with nearby councils (Robe, Kingston), but it might be difficult for a council to compete on price with other more experienced contractors.

Should Council wish to further consider the purchase of a dredge, consideration should be given to:

- Capital cost of purchasing a dredge unit and associated equipment (i.e. power packs for pumps, separate barge if necessary)
- Annual maintenance costs for the dredge plant and equipment
- Mob/demob costs for getting the dredge operational on site

- Running costs including labour
- Additional costs for moving sand with excavators, noting that we are unlikely to remove all requirements for excavators (but would hopefully reduce this quantity dramatically)

The following attributes are considered important for the boat ramp location in Beachport:

- a. Must be road transportable. Ideally, would fit on one standard semi or low loader.
- b. Must be relatively easy to mobilise over a short distance (i.e. from within Beachport, possibly from the commercial boat yard). Ideally, could be launched down a ramp, possibly the recreational boat ramp, otherwise the commercial boat ramp And it must be able to be safely transported to the basin.
- c. Must be self-propelled, most likely powered by an outboard motor.
- d. Minimal operators required. Ideally only 2 (I think one would be a stretch in this location with potential for swell, etc.)
- e. Must be able to pump material at least about 300m to allow disposal options both north and south of the jetty (potential for permanent pipe infrastructure)

# 3) Purchase and operate a Dragflow dredge pump

The other option that warrants investigation for this site is a Dragflow pump arrangement similar to what was utilised in the trial. These pumps are mostly driven by hydraulics, but there are also electric versions available, particularly when looking at the smaller sized units. This might be an important thing to consider for this site, both for ease of use, maintenance (you're effectively talking about a medium sized gen set), but also for noise considerations.

An option worth investigating at Beachport would be to use a Dragflow (or similar) submersible pump with just a simple A-frame type gantry support at the front of a small barge / pontoon arrangement, which would simply lower and raise the dredge pump to the seabed with a simple winch arrangement. The method described is often referred to as 'teabagging', for obvious reasons. The unit would most likely be powered by a diesel generator mounted on the back of the barge / pontoon, and would also act as counterweight. Fairly typical (and readily available) anchor handling barges would require only minor modifications to be suited to the task. These vessels are self-propelled, typically about 3m wide x 10m long, and handle anchors up to 1.5t to 2t with a single electric powered winch. They are used to handle / relocate the anchors with large cutter suction dredges.

What is most attractive about this option is that it could potentially be trialled with relatively minor costs, and is really an extension of the trial that has already been completed. It is conceivable that you would find a suitable submersible pump to hire for a short period. Similarly, an anchor handling barge may be available with suitable specs, albeit it may be necessary to mount some spud pile supports or temporary winches, and a power pack or generator can be easily hired.

The dredging rates (volumes) for this type of plant are typically not quite as great as what you might achieve with a cutter suction dredge (depending on respective sizes of course), but this isn't such an issue given the relatively small quantities that we are talking about here. It is far more important that we bias simplicity to minimise ongoing maintenance costs – the less moving parts and more straightforward the arrangement, the better.

Even if this option was considered favourable, it is still questionable if it makes sense for Council to own this plant in its own right.

#### 4) Investigate pros / cons for council owned vs contractor owned plant and equipment

This has been partially considered above with discussions about a small cutter suction or Dragflow dredge, but can be applied more generally to all maintenance options available to WRC. An assessment of the pros and cons of contracting services vs Council owned should be undertaken prior to any purchase of a dredge or Dragflow pump.

Nearby councils have similar challenges in Robe, Cape Jaffa and Kingston and there have been some discussions around combining dredge requirements into a larger package of work that could either justify one (or more) councils owning and operating dredge plant or could allow for the development of a larger ongoing service contract for a dredging contractor so that mobilisation and operating costs could be minimised to provide best value.

A joint project is considered to be an option worth pursuing further, but has the obvious pitfalls that the various council requirements and budgets are likely to change over time in unequal amounts, and that changes in personnel may inevitably lead to changes in approach for maintenance at the various facilities.

#### Consider a hybrid approach for removal of sand (excavators and dredge plant)

This is basically the current approach taken by Council. Under this approach, it may be optimal to do several clean-ups at the edges of the marina basin using excavators, with perhaps a couple of larger dredge activities where the centre area can be better accessed to remove excess build-up. This would potentially reduce the more costly dredge mobilisations.

#### 7.5 Capital Works Modifications

There are many options for further modifications that could be considered for the current breakwater arrangement, but it would be a mistake to undertake any further capital works activities without first attempting to better understand the behaviour of the existing arrangement. The Beachport boat ramp basin is subject to a variety of competing actions, the balance of which changes significantly with variations in seasonal weather and metocean conditions. It is very important that any potential future modifications be first tested with modelling techniques to allow for proper risk based and cost / benefit decision making processes to be completed. To do this, we first need to collect data and build a base model for the existing arrangement, as described previously in this report.

Capital works modifications have been separated into two main categories: Those that might optimise the existing arrangement, and those that are separate altogether from the current facility (i.e. alternate boat ramp sites and alternate designs).

#### a) Optimisations of the Existing Facility

The following options for capital works modifications have been considered as potential changes that might reduce the ongoing maintenance costs of the existing boat ramp facility:

#### 1) Make the breakwater shorter

- Could be an attractive option if the goal were to simply reduce overall quantities of sand requiring removal after sedimentation
- Relatively easy to do
- Relatively inexpensive
- Requires modelling to prove that worthwhile

- Not necessarily beneficial if dredge technologies utilised more going forward (unit cost of moving m3 of sand reduces)
- Reduces the safe launching space and potentially reduces the service standards for the facility when boats are unable to launch due to ocean conditions

#### 2) Make the boat ramp basin narrower

- The basin is wider than necessary for the vessel sizes
- Could be incorporated with modifications to improve excavator access
- More significant investment mass retaining walls required, some risk of scour/undermining
- Requires modelling to assess whether sedimentation rates likely to increase or decrease
- May reduce the service standards for the facility during heavy traffic periods

#### 3) Raise the height of the breakwater

- Relatively easy to assess once base model built for exiting facility (still definitely requires modelling)
- Could reduce overtopping (particularly relevant if sand in overtopping waves is found to be a significant part of the overall sedimentation issue)
- Relatively inexpensive, though likely that the breakwater would also need to be wider to allow for a trafficable crest
- Could be taken further to have a crest able to take trucks to improve maintenance of the basin with excavators, though a vertical retaining element on the inner side would be required to allow excavators to be close enough to the wall

# 4) Change the permeability of the breakwater

- Existing breakwater has geotextile within rock matrix, but no core
- Geotextile in variable condition, several large penetrations
- Large rock allows passage of wave energy through the wall, along with sand particles (likely to be a considerable source of sedimentation)
- Reconstruction of core or installation of a cut-off wall could significantly reduce the passage of wave energy through the wall
- Relatively expensive to modify, reconstruction of the breakwater required
- Requires more detailed modelling and assessment

#### 5) Create a deeper 'pit' in the middle of basin

- Requires confirmation of geotechnical profile beforehand to assess broader feasibility
- May be necessary to excavate through rock
- Would allow less frequent dredge operations with a deeper reservoir for collection of sand infill
- More efficient dredge operation if deeper central location, less movements for the dredge setup
- Modelling results would be interesting, but not as essential (more dependent on geotech and constructability for excavation)
- Cost dependent on constructability (could be cheaper to do as part of a major redig after a significant sedimentation event)

- 6) Create better access for excavators to work both sides of the boat ramp basin
  - This would require capital works improvements to implement, generally in the form of a lower plateau with suitable retaining structures to maximise the reach potential of locally available excavators.
  - A first pass assessment of this options suggests that the cost of this
    arrangement would be in excess of \$300k, which is considered to be
    prohibitively expensive at this stage for the benefit that would be derived.
     WGA consider that this option does not warrant further investigation.
- 7) Modify existing groyne field to reduce sediment transport into basin
  - Existing arrangement was generally optimised prior to the addition of breakwaters
  - Some minor adjustments to length and alignments is likely to yield improvements to the stability of foreshore beaches
  - Modelling possible to test alternate scenarios, relatively inexpensive after base model constructed
  - Existing maintenance budgets could be utilised to make minor improvements over a number of years if supported by modelling
  - There will always be significant sand movement within Rivoli Bay
- 8) Construct an additional groyne on the northern side of the jetty
  - Seawall at jetty under far more direct wave attack than historically
  - Reflective wave conditions cause scour and put sand in suspension
  - A potential source of fine sediment near the entrance of the boat ramp basin
  - Easily assessed with numerical modelling techniques, but benefits easily noticed from aerial photographs alone
  - Increased amenity at popular swimming beaches
  - Approval of concept exists with DPTI, but no budget
  - Previous design for rock groyne structure seemed excessively expensive
  - Alternate geotextile bag option could be much cheaper (potential for local volunteer contributions)
  - The scope of this is really outside of the Council remit and is the responsibility of the Department of Planning Transport and Infrastructure (DPTI within SA Government). Accordingly, this will not be considered further under this scope of work.

There are several options here that might yield measurable reductions in sedimentation and thereby reduce maintenance costs for the boat ramp facility. Various combinations of these different options could be tested with numerical modelling to assess opportunities for further investment in the community facility, but clearly this only makes sense to do so if there is a measurable payoff available where the capital cost of modifications would be directly subsidised by future reductions in necessary maintenance. Without this payoff, it is clear that any money would be better spent elsewhere.

Prior to further consideration of any items suggested above, and certainly prior to implementation of any nominated plans, it is suggested that appropriate consultation with DEWNR Coastal Management Branch personnel is undertaken to ensure that their resources and site knowledge are fully utilised. This process has not been completed at this stage of the maintenance assessment.

#### b) Alternate Boat Ramp Facility Locations

Alternate locations for the boat ramp facility at Beachport have not been considered in any detail as part of this investigation. Other sites such as Glenn Point and the back 'boatyard' beach have been suggested at various times over the years, but are not considered viable at this point in time due to budget constraints alone.

Based on experience with other similar port and coastal infrastructure projects throughout Australia, the following cost estimates are suggested:

- Demolition of the existing breakwaters and boat ramp facility would cost more than \$1m. This figure would be closer to \$2m with comprehensive restoration of the local environment, including reinstatement of the foredune and upper beach.
- To build a similar facility at another location in Beachport would cost between \$3-4m. This is more than other stages of the current boat ramp arrangement, as any other facility would be starting from a lower baseline. This includes any facility at Glenn Point, where excavation costs would be significant.
- An additional \$1-1.5m would be required for a suitably sized carpark and other associated infrastructure necessary for a boat ramp facility (toilets, lights, water services, etc.)

The estimate for a facility at an alternate site comes to a total of \$5m to \$7m for full replacement of the facility, which clearly pays for a lot of maintenance at the existing site. It is important to consider that any other facility would also require at least some maintenance too. It is extremely unlikely that a funding source could ever be secured from state and local government sources that could support the construction of an alternate boat ramp facility in Beachport, and all efforts should be focused on reducing ongoing costs associated with running the existing facility, while continuing to find other ways to improve the amenity of the adjacent beaches at the Beachport foreshore.

#### 7.6 Other Considerations

The following additional considerations are also relevant as part of this assessment of the boat ramp facility:

- Sand bypassing at Beach 4
  - The main source of sand (supply) for future infiltration / sedimentation of the boat ramp basin
  - There may be a potential cost benefit to control sand from this beach rather than
    waiting for it to enter the boat ramp basin, but requires further modelling to confirm
    viability (noting that previous attempts for this approach do not seem to have
    yielded favourable outcomes)
  - This approach would require a significant and sustained campaign to prevent bypassing around groyne 4 and may result in handling of larger volumes of sand
- Consider / analyse the ongoing stability of the rock revetment walls forming the western edge of the boat ramp basin
- Improve access to and amenity of other adjacent beaches
  - Particularly relevant for beaches 3 and 4
  - Improve access for pedestrians (make more obvious)
  - Consider small grassed areas
  - May benefit from landscape architecture and urban design
  - Prevent trailer parking at this end of the general carpark area

These beaches have generally improved as swimming beaches since the boat ramp basin has been developed, but are not heavily used. Some of the negative aspects for beach users might be mitigated by making more of these other beaches, including improved signage and general awareness for both tourists and local townspeople alike.

#### 7.7 Summary

Of the many potential recommendations summarised in this technical memo, the following activities are considered most appropriate in the short to medium term, with the strongest likelihood of yielding measurable improvements to the operation and maintenance of the boat ramp facility:

#### a) Metocean data

Collect wave and current data for future modelling

=> Budget = \$30k

(\$50k if council purchase equipment for increased data acquisition)

#### b) Sieve analysis

Procure test equipment to allow collection of sand particle size data to allow mapping of distribution

=> Budget = \$5k

#### c) Numerical modelling

Appoint consultant to develop a base numerical model to assess the behaviour of the existing facility

=> Budget = \$25-30k

(\$40-50k if additional options assessed for modifications, including groynes)

#### d) Geotechnical investigation to determine extent of rock

Initially limited to test pits with excavator to assess potential for larger central reservoir / pit to assist dredging

=> Budget = \$5k-10k

# e) Consider optimisation of breakwater arrangement

Modelling only in the first instance, included with 'c' above

=> Budget = \$5k-15k

# f) Permanent dredge pipe infrastructure

Facilitate easier setup for dredging and more efficient operation, utilise for second dredge trial to further assess viability of dredge maintenance vs excavators

=> Budget = \$10k

#### g) Further trial of Dragflow dredge pump

Implement learnings from the first trial to minimise downtime and maximise efficiency. Consider land based pipe with longer flexible lay-flat hose, and longer working hours.

=> Budget = \$35k

# 8

# **REFERENCES**

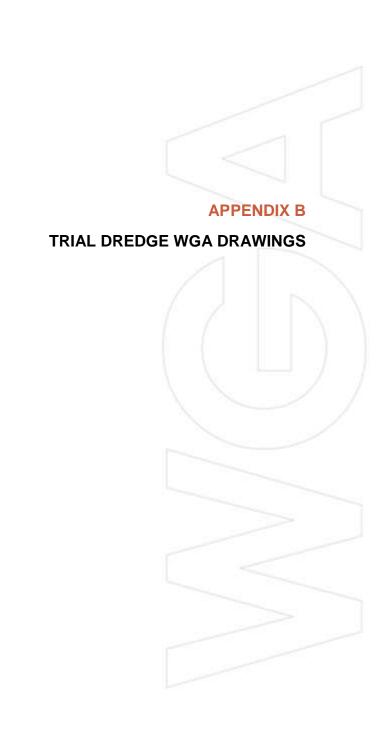
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# **APPENDIX A**

BREAKWATER EXTENSION – BOAT RAMP FACILITY, BEACHPORT SA MAGRYN ENGINEERING CONSULTANTS DRAWING





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