Summary of Investigations: Port Stanvac offshore sand deposits

Securing the future of our coastline

SOUTH AUSTRALIA

Government of South Australia
Department for Environment and Water

Background

The state government has committed $48.4 million to the *Securing the future of our coastline* project. The project will:

- Construct a sand recycling pipeline from Semaphore to West Beach to move sand from beaches where it builds up.
- Deliver a large quantity of sand (500,000 cubic metres) to West Beach from outside of Adelaide's beach system.
- Restore sand dunes using best practice techniques and native plants in partnership with local councils and coastal community groups.

The project has been informed by research completed in 2018 by external consultants the Danish Hydraulics Institute (DHI) on behalf of the Department for Environment and Water, the Coast Protection Board, the City of Charles Sturt and West Beach Parks.

This report relates to the delivery of a large quantity of sand (500,000m^3) to West Beach from outside of Adelaide's beach system.

Options for sand sources include offshore sand deposits and land-based (quarry) sand. This report provides a summary of investigations undertaken at Port Stanvac between February and December 2020 to seek suitable deposits of offshore sand to be dredged and relocated to replenish West Beach.

Why is 'external sand' needed?

Sand from outside of Adelaide's metropolitan beach system – or 'external sand' is needed because there is a limited amount of sand in Adelaide's beach system. This is because sand has been 'locked up' by building on top of the natural dune systems.

Adding sand to Adelaide's beach system is needed to raise the beach levels and boost sand dune buffers at West Beach and Henley Beach South. It will replace sand that has been eroded from West Beach over recent decades and help to address the impacts of rising sea levels.

Offshore sand deposits at Port Stanvac

The last large importation of sand into Adelaide's beach system was in the 1990s when more than a million cubic metres of sand was dredged from deposits offshore of Port Stanvac and delivered to Brighton and Seacliff beaches. Together with a sand recycling pipeline constructed from Glenelg to Kingston Park, this external sand formed and stabilised the dunes and in turn helped to stabilise the beach.

These major dredging campaigns exhausted the accessible sand deposits at Port Stanvac, however the Adelaide Living Beaches: A Strategy for 2005 - 2025 Technical Report (Department for Environment and Water 2005) identified that additional dredging of the Port Stanvac site may be viable following closure of Port Stanvac in 2004, which allowed access to a previously restricted area of the sand deposits.

Given the success of the earlier dredging campaigns at Port Stanvac, the previously restricted area was identified for investigation as a potential source of external sand for the replenishment of West Beach.

Investigations

Preliminary investigations into the potential sand source at Port Stanvac began in February 2020. The area was hydrographically surveyed to produce fine-scale bathymetry data and habitat maps. It was also surveyed using sonar to estimate the depth of sediments down to the bedrock below. Expert interpretation of the mapping defined two broad sediment categories within the survey area as complex sands and simple sands.

Thirty two sediment cores were taken across the site with equal numbers in each sand category (Figure 1). The cores were logged, photographed and sampled for contaminant testing and analysis of physical characteristics such as particle size and settling velocity. The samples were sent to a National Association of Testing Authorities (NATA) accredited laboratory to be tested as per the National Australian Dredging Guidelines (Department for the Environment, Agriculture, Heritage and the Arts 2009).

A further ten cores were taken in those locations identified as the most promising, six in the south and four in the north, to determine if the sediment was the same across the area and to define the boundaries of the potential sand sources. Samples from the extra 10 cores were only tested for particle size and settling velocity because the previous results showed no contamination of the sediments above the National Australian Dredging Guidelines screening levels.

The results from those samples were used to further define the sand source boundaries and to make estimates of sand volume at each location. The results were also used to inform turbidity plume modelling based on a potential dredging regime and the average particle size across the sampling site.

The technical reports generated by these investigations can be found here.

Results

The Port Stanvac offshore sediment deposits are variable and can generally be divided into categories of either simple (relatively homogenous) or complex (materials varying spatially and by depth). Some sediment cores contained multiple layers of different materials including layers of sand, clay, coarse gravel/pebbles, crushed shell fragments (shell hash) and seagrass fibres, whilst others contained uniform sand along the length of the core.

Cores varied also in the length of sediment recovered, with some being refused at the sediment surface and others over 2m long. In general, longer cores were recovered from areas of loosely layered shell hash and gravel whilst shorter cores were recovered in the areas of more uniform sand described by the marine geologist as fine to very fine silty grey sands (Rice 2020). In many of those cores, there was no obvious reason for the core to have stopped penetrating the seabed, such as a shell stuck in the core catcher or signs on the core barrel that it had hit rock. A possible explanation for this is the sediment in those locations was very fine in particle size and so tightly packed such that the coring machinery was unable penetrate any further.

Expert interpretation of the core sample results and the sediment depth data excluded a large area of the Port Stanvac seabed from further investigation due to the presence of clay, gravel, crushed shells, or rock. The area of investigation was thereby reduced to two main locations, one north and west of the jetty pylons and the other in the south east corner in the area that had previously been dredged in the 1990s.

Sand quantity

Estimates of the sand volume at Port Stanvac were made by combining core descriptions and recovery depths with sub bottom profiling data (Bergeson 2020). In cases where core recovery was not as deep as the sonar signal suggested it could be, the depth of the signal was used rather than core recovery depth.

The results have found the total volume of the potential sand source at Port Stanvac is approximately 400,000m^3, which is less than required for the replenishment of West Beach as part of the *Securing the future of our coastline* project. The total volume is divided between the northern and southern prospects, with approximately 100,000m^3 in the north and 300,000m^3 in the south.

The greater volume in the south covers a larger area and is more homogenous, which makes it simpler to dredge in terms of accessibility. The size of the northern prospect and its proximity to rocky and more complex sediments would make it difficult to dredge with the equipment typically used to perform this type of dredging (trailing suction hopper dredges). This means it is likely that only the larger prospect of 300,000m^3 is likely to be feasible for dredging.

Sand quality

All core samples were analysed at the laboratory for a range of physical and chemical properties. The sand samples were not contaminated with any hydrocarbons, heavy metals, pesticides or PFAS (Environmental Projects, 2020). Sediment particle size (including the percentage of fines) is an important parameter for beach replenishment because it strongly influences the way it will behave during dredging and deposition, as well as how well it will control beach erosion.

Average sediment particle size (D50) ranged from 0.031mm to 0.734mm across all samples, which places it across all categories between medium silt to coarse sand on the Wentworth (1922) scale. The most common (median value) for D50 was 0.184mm, which is fine sand on the Wentworth scale.

Fine particle size is not optimal for beach replenishment because it can be moved more quickly by the natural processes of littoral drift. A unit volume of fine sand will not achieve the same degree of beach stabilisation as an equal volume of coarser sand due to this higher mobility. A technical parameter called "overfill ratio" is used to describe how much more fine sand would need to be placed on the beach to have the same coastal protection results as a coarser sand. An overfill ratio of two means that twice as much of the finer sand would be required.

Overfill ratios were calculated for a selection of samples from the southern prospect and they ranged from values of 1.4 to 5. This means that between 750,000 and 2.5 million cubic metres of Port Stanvac sand would be required for the replenishment of West Beach. Finer sand is also more prone to wind erosion and can cause wind-blown sand issues for infrastructure and properties adjoining the coast.

Sands with a high silt content are likely to cause larger and longer lasting sediment plumes during dredging which block light to seagrass and temporarily smother intertidal and subtidal reefs (for periods of up to several months). Seagrasses are known to survive periodic increased levels of natural turbidity due to storms during winter but have been shown to need breaks of clearer water to continue photosynthesising and maintain canopy health (Wu et al 2017). Sustained sedimentation on intertidal and subtidal reefs blocks light for photosynthesising marine algae resulting in loss of the canopy and a permanent transition to a less diverse and less productive ecosystem (Cheshire 2000). Further, after the majority of the sediment plume settles in the short term, the fine fractions can become trapped in the nearshore for many years and resuspension will affect local light conditions for decades (Cronin and van Gils 2019).

The long-term impacts on the marine habitats at Port Stanvac and West Beach would be dependent on the concentrations of suspended sediments in the water column and the length of time it remains there. The percentage of fines (silt or clay particles measuring less than 63.246 microns) ranged from 0% to 62.41% with an average of 11% in the simpler sands of the southern prospect. Historically, sediments with less than 5% fines have been prioritised for beach replenishment, and the Environment Protection Agency's Dredge Guideline (EPA 2020) classifies the dredging of sediments with greater than 10% fines as High Risk to water quality.

Turbidity modelling was conducted in October 2020 to assess potential dredging plumes and to inform the placement of water quality loggers at control and impact sites at both Port Stanvac and West Beach (Deltares 2020). The model used a hypothetical, but likely dredging plan to predict concentrations of suspended sediment at the sea surface and the seabed over 70 days of operation. The results showed significant concentrations of suspended sediments, particularly close to shore, along the entire coastline between the dredge site at Port Stanvac and the placement site at West Beach. The results not only made it very difficult to choose monitoring sites because the whole coast is impacted, but showed that dredging of the Port Stanvac sand deposits would represent a high risk to marine habitats along a significant section of the metropolitan coastline.

Conclusion

Following the completion of the technical investigations at Port Stanvac, the specialist investigators attended a symposium convened by the department to discuss the results of their investigations, the quality and quantity of sand in the offshore sand deposits at Port Stanvac, and the potential risks associated with dredging the sand and pumping it ashore at West Beach.

Based on this analysis of potential dredging risks and the properties of the sand that could be delivered to West Beach, the department has concluded that the Port Stanvac sediments are not suitable or adequate for replenishment at West Beach.

References

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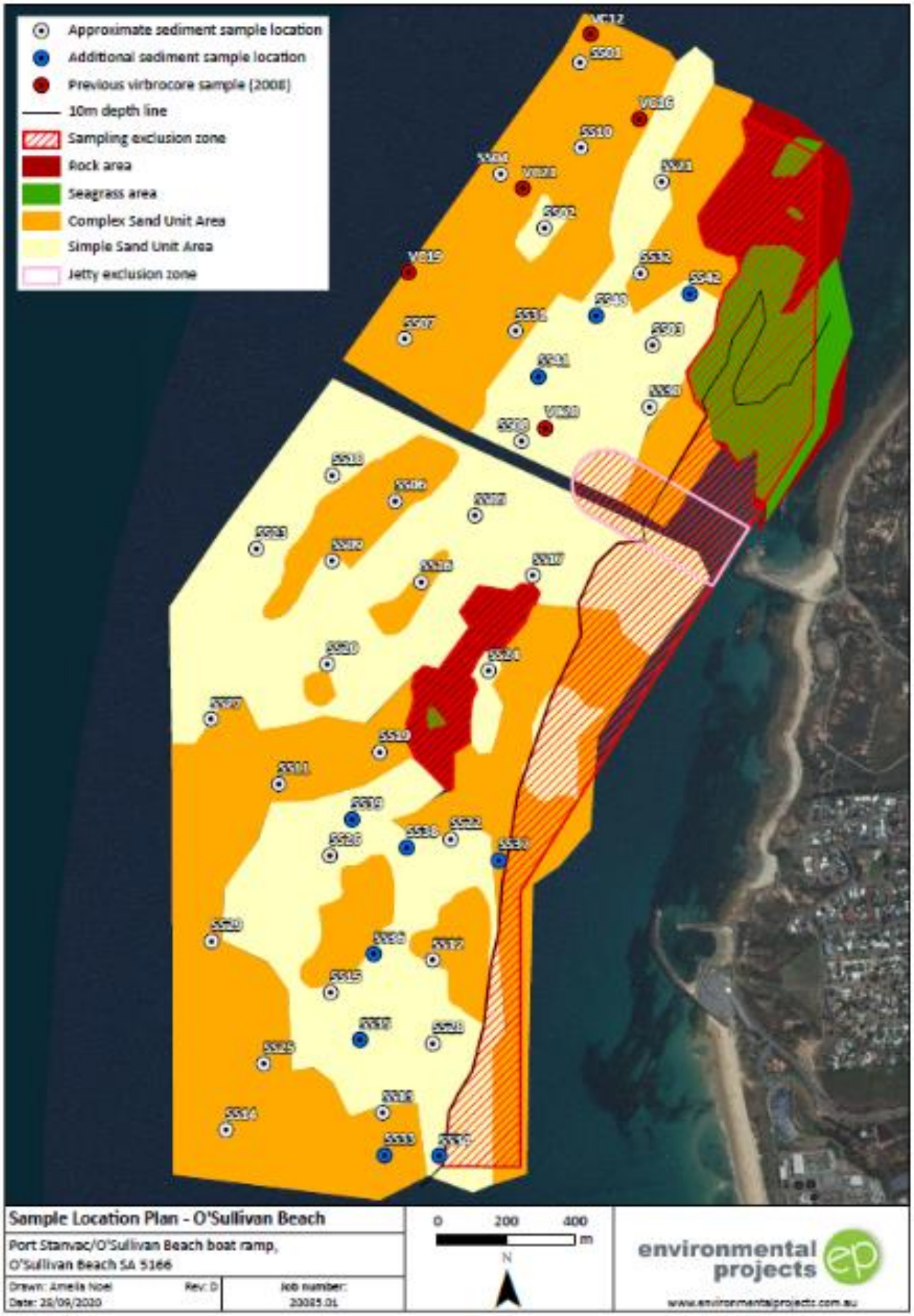
Figure 1


Approximate sediment sample location
Additional sediment sample location
Previous virbrocore sample (2008)
10m depth line
Sampling exclusion zone
Rock area
Seagrass area
Complex Sand Unit Area
Simple Sand Unit Area
Jetty exclusion zone
Sample Location Plan - O'Sullivan Beach
Port Stanvac/O'Sullivan Beach boat ramp,
O'Sullivan Beach SA 5166
Drawn: Amelia Noel
Date: 28/09/2020
Rev: D
Job number:
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