COASTAL ENGINEERING SOLUTIONS

# PORT FAIRY

# SAND SOURCING STUDY

May 2013

for
Moyne Shire Council

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## Background

- East Beach and its seawall are under stress from an on-going erosion threat that is likely to be exacerbated by sea level rise associated with future climate change. Moyne Shire Council has commissioned Coastal Engineering Solutions to investigate a number of issues relating to the appropriate management of the East Beach foreshore. An important strategy currently under consideration is supplementary beach nourishment.

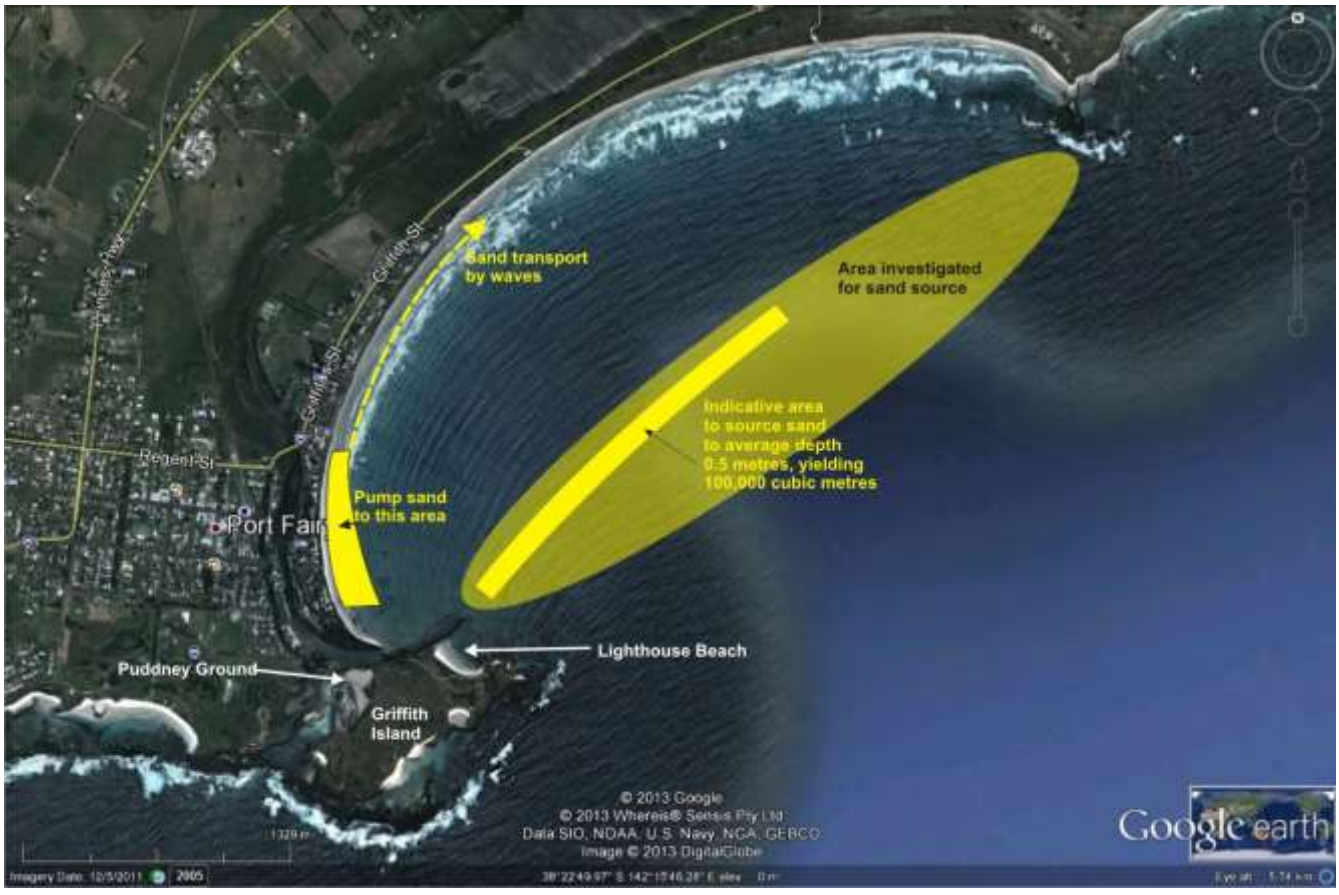
- It has been recommended by previous studies that the stability of East Beach would be enhanced if the beach could be "topped up" with approximately 100,000 cubic metres of sand – whilst still maintaining annual sand bypassing associated with the clearance dredging of the Moyne River Entrance. Potential sources to supply this sand have been investigated and assessed. These include sand from:
    - from an offshore source near East Beach, if suitable sand can be identified and extracted.
    - Lady Bay at Warrnambool where there is a continuing accumulation of sand on the foreshore, estimated to be about 10,000 cubic metres per year;
    - from onshore resources to the south of the Moyne River Entrance;
    - the Glenelg River where there are deposits of sand which the local Catchment Management Authority (CMA) would like to have removed; and
    - offshore of the Hopkins River entrance near Warrnambool where there are possibly deposits of quite coarse sand.

- This report presents the findings of investigations into sand sourcing for the supplementary beach nourishment of East Beach.

## Sand from offshore of East Beach

- Fieldwork undertaken for this study identified that sand of a similar size and characteristics to that on East Beach occurs offshore of the beach in water depths of 6 to 10 metres.
- In order to extract 100,000 cubic metres of sand for beach nourishment purposes from this source, the dredged area would likely be some 2 kilometres long, 100 metres wide and 0.5 metres deep. This shallow extraction arrangement is not expected to have any adverse impacts on the wave climate further inshore or on the stability of East Beach.

- Since the sand is effectively identical to the sand presently in the active beach system, it should be placed at the southern end of East Beach (just to the north of the semi-submerged offshore breakwater). From that location, wave and current action would transport the sand along the beach in an easterly direction along the beach as part of the prevailing littoral processes. There would nevertheless still be a need to annually by-pass sand that is trapped in the harbour and navigation channel at Port Fairy in order to maintain a stable foreshore along East Beach. The arrangement is shown conceptually in the figure below.




- Whilst beach nourishment at the southern end of East Beach would provide a supply of sand to the beaches in front of the developed foreshore, there would be a delayed benefit to East Beach north of the seawall because of the time needed for sand to naturally migrate along the foreshore. If the beach beyond the seawall is to be stabilised within a shorter timeframe, then sand nourishment wouldalso need to be undertaken along at-risk sections of this foreshore.

- A small trailing hopper dredge (such as the *Pelican*, a dredge frequently used in Victorian waters) could extract sand from offshore of East Beach and place it on the foreshore. Operating on 24 hour shifts, the dredge could achieve an extraction/delivery rate of approximately 25,000 $m^3$ per week.

- The estimated cost of this option for extracting 100,000 cubic metres of sand and placing it on East Beach is $1,770,000. This includes all running costs for the entire *Pelican* spread, including a mooring pontoon, sand delivery pipelines and incidental land based equipment. It also includes site overheads, head office overheads and profit; but does not include any contingencies or any fees for project design or contract management.

- The *Pelican* is based in New Zealand, so the cost of mobilisation is based on mobilisation from New Zealand. Nevertheless the *Pelican* is regularly working in Australia (for example once every one or two years it undertakes work at Lakes Entrance) and a substantial saving could be made/negotiated on the cost of mobilisation if the dredging in Port Fairy could be coordinated with another contract in Australia.

### Sand from Lady Bay at Warrnambool

- Sand has been accumulating in Lady Bay near Warrnambool at approximately 10,000 cubic metres per year ever since the initial construction of the breakwater at Warrnambool Harbour in 1890. This process of sand accumulation is continuing; and reputedly the City of Warrnambool wishes to have about 140,000 cubic metres of this sand removed. It has a similar grading to that presently on East Beach.

- From a beach nourishment perspective, this sand would perform in a similar manner as sand derived from the seabed offshore of East Beach. It is therefore suitable for beach nourishment of East Beach. The haulage distance from Lady Bay to East Beach is approximately 30 kilometres.

- The sand is directly accessible from the foreshore. Consequently excavation would be by land-based earthmoving equipment with delivery to East Beach in trucks. The costs therefore relate to:
  - Any royalties that are applied by government agencies;
  - Sand extraction from the beach and placement into on-road trucks;
  - Road haulage to beach access locations along East Beach;

- Spreading of the sand at East Beach from the dump location into the foreshore area being nourished.

- The estimated cost of supplying 100,000 cubic metres of sand from Lady Bay to East Beach is $2,250,000. Any royalties that may be charged need to be added to this cost.

## Sand from South of the Moyne River Training Walls

- This sand has effectively the same characteristics as the in-situ sand on East Beach and that immediately offshore. Therefore it is as equally suitable for beach nourishment purposes as the sand source offshore of East Beach.

- Although some 500,000 cubic metres of sand has either naturally accumulated or been placed in this area to the south of the Moyne River entrance, only a limited amount of the sand could be extracted because much of the land is now vegetated and colonised by shearwaters. Most of the area is classified as a Shearwater Reserve.

- The primary issue regarding the viability of this sand source at this point is therefore whether there is sufficient sand available to warrant establishing the systems and methodology to extract it and place it on East Beach.

- The actual extent of possible sand reserves from south of the Moyne river entrance would need to be investigated in detail before committing to this sand sourcing strategy. It is assumed that 40,000$m^3$ would be available from this source and the balance (of 60,000$m^3$) would be obtained from either dredging offshore of East Beach or supplied from Lady Bay, Warrnambool. It is anticipated a double handling system would be required for the locally derived sand as indicated in the figure below.

- Sand would need to be excavated from the available areas on the south of the river and placed in the river. The Port Fairy based Cutter Suction Dredger Cormorant would then dredge this placed sand and pump it onto the beach north of the river (as occurs under existing sand by-passing practices).

- The estimated cost of supplying 40,000 cubic metres of sand from the area south of the Moyne River entrance, supplemented by 60,000 cubic metres from Lady Bay at Warrnambool is $1,870 ,000. Any royalties that may be charged for Lady Bay sand need to be added to this cost.


## Sand from the Glenelg River System

- Sand from commercial extraction operations within the Glenelg River system is suitable for beach nourishment purposes on East Beach. The sand from these various sources is typically coarser than the native sand on East Beach.

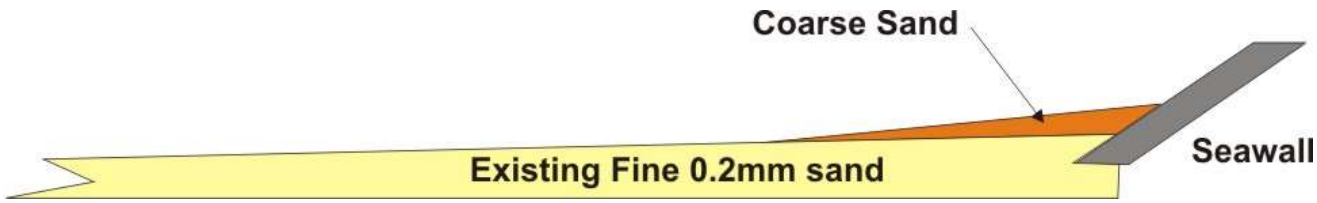
- Testing of samples taken from Glenelg River sources, suggest that sand having a $D_{50}$ of 0.8mm would be available - provided sufficient notice is provided to the supplier in order to extract and stockpile the required volume.
- Placing 40,000 cubic metres of coarse sand from the Glenelg River system onto East Beach would provide a benefit at least equal to that provided by re-nourishing with 100,000 cubic metres of finer sand more closely matching that currently on East Beach.

- The advantages of using a coarser sand for nourishment of East Beach are:
  - The rate of sand movement along the beach is likely to be at least 20% less than for the natural fine sand.

- Coarse sand tends not to move offshore during storms; in fact sand with a $D_{50}$ of 0.8mm or greater is likely to move up the beach to create storm berms rather than move offshore into sand bars.
- Even for a medium coarse sand with $D_{50}$ of 0.5mm, it is estimated that the extent of beach erosion due to offshore transport during a storm is only around 20% of that moved offshore for a finer 0.2mm sand.
- Coarse sand moving landward during a storm means that there would be a reduced tendency for scour at the toe of the existing seawall along East Beach.

- Disadvantages relate to the changed visual appearance of the beach. The beach will tend to have a hybrid slope with the existing sand located on the seaward side of the beach at the existing gentle slope of approximately 1 : 40 whilst the coarse sand will tend to be located on the upper beach with a slope of about 1 : 10 - as shown conceptually below.

- The estimated cost of supplying 40,000 cubic metres of coarse sand from commercial operations within the Glenelg River system is $3,400 ,000.




## Coarse Sand Sourced from Offshore of Hopkins River, Warrnambool

- This potential source was only identified whilst conducting this sand sourcing study. Consequently the following observations need to be qualified by noting that this sand source has not been investigated in sufficient detail to confirm its feasibility with regard to the size of any available sand - nor the quantity of sand that might be available for extraction.

- Previous studies in the Warrnambool region identified that the eastern end of Lady Bay near the Hopkins River entrance has a coarser sand than that at the western end. Previous investigations also identified that coarse sand may be quite prevalent in offshore areas. Such deposits are likely to relate to sediment deposition from the Hopkins River during earlier geological times having lower sea levels. However, the extent or depth of any deposits of coarse sand have not been investigated.

- Should a sufficient quantity of coarse sand exist in water depths of 6 to 12 metres offshore of the Hopkins River, then such sand may be a cost effective option for beach nourishment at East Beach. As shown below, the steaming distance for a dredge delivering sand from offshore of the Hopkins River Entrance to East Beach is only about 20 kilometres.


- For the purpose of this exercise it is assumed that a sufficient quantity of sand with a $D_{50}$ sizing in the range of 0.5mm to 0.8mm is available. Being coarse sand, the nominal quantity required for nourishment of East Beach is 40,000 cubic metres.

- A small trailing hopper dredge (trailer) such as the *Pelican* could dredge the coarse sand from offshore of Hopkins River at Warrnambool, then sail to Port Fairy and place that sand on the beach. A rate of approximately 13,000 $m^3$ per week over a 24 hours operating day would typically be achieved.

- The estimated cost of this option for extracting 40,000 cubic metres of coarse sand and placing it on East Beach is $1,730,000. This includes all running costs for the entire *Pelican* spread, including a mooring pontoon, sand delivery pipelines and incidental land based equipment. It also includes site overheads, head office overheads and

profit; but does not include any contingencies or any fees for project design or contract management. A substantial saving could be made/negotiated on the cost of mobilisation if the dredging in Port Fairy could be coordinated with another contract in Australia.

## Summary of Estimated Costs for Sand Sourcing Options

- The table below presents a summary of the estimated costs of using the various potential sources of sand for beach nourishment of East Beach.

| Potential Sand Source | Sand Type | Quantity | Estimated Cost |
|---|---|---|---|
| Offshore of East Beach | similar to East Beach | 100,000 $m^3$ | $1,770,000 |
| Lady Bay at Warrnambool | similar to East Beach | 100,000 $m^3$ | $2,250,000 |
| South of Moyne River Entrance [1] | similar to East Beach | 100,000 $m^3$ | $1,870,000 |
| Glenelg River System [2] | coarse sand | 40,000 $m^3$ | $3,400,000 |
| Offshore of Hopkins River [2] | coarse sand | 40,000 $m^3$ | $1,730,000 |

Notes :

1. Assumed that 40,000$m^3$ is available from this source; but the balance of 60,000$m^3$ is sourced from Lady Bay at Warrnambool.
2. Due to the sand being much coarser than the native sand on East Beach, only 40,000 $m^3$ is needed to provide a benefit commensurate with that achieved by using 100,000 $m^3$ of the finer sand from other sources.

## Environmental Aspects and Approvals

- Irrespective of the source of sand, environmental approval under the *Victorian Coastal Management Act 1995* would be required for the placement of sand on East Beach. It is also possible that a Planning Permit would need to be obtained from Moyne Shire Council.

- Whilst the *Victorian Coastal Strategy (2008)* provides generic guidance as to protecting natural and cultural values along the Victorian coastline, it does not give specific information about the values of East Beach or its surrounds.

- East Beach is part of a dynamic coastal system and has received renourishment operations in the past. It is unlikely that further placement of sand would have significant deleterious environmental impacts on the beach area habitat itself. While is possible that the physical action of placement could disturb sea birds roosting or feeding on the beach, such disturbance would be short-lived and is not considered likely to significantly adversely affect these birds.

*Sand sourced from offshore of East Beach*

- Because the material is to be placed on the beach generally above the low water mark (but still within the nearshore dynamic coastal system), it is unlikely that a Sea Dumping Permit under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* would be required. However, it is recommended that this opinion be confirmed by formal enquiry of the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC).

- At the State level, this option would require approval under the Victorian *Coastal Management Act 1995.* Environmental aspects to be considered under this approval would include the natural and cultural values of the dredge area, together with the physical and chemical properties of the material to be dredged. Applications for Coastal Management Act consent are required to document what public consultation has taken place. The Community Updates about East Beach already issued by Moyne Shire Council and the establishment of the inter-agency Port Fairy Working Group demonstrate an awareness of the need to keep citizens fully informed about plans and issues.

- It is likely that the dearth of detailed information presently available about the natural values of the seabed to be dredged may prompt regulators to require a marine ecological survey of the area concerned. It is recommended that such an investigation be undertaken should this sand sourcing option be preferred.

- The presence of historic wreck(s) in Port Fairy Bay are relevant in terms of local cultural values. The proposed dredging area would need to be defined in consultation with Heritage Victoria to avoid disturbing any identified wreck sites.

- Under the State Dredging Guidelines (EPA 2001), it is necessary to categorise the physical and chemical nature of the material to be dredged. For a project of the proposed size (dredging 100,000 cubic metres), typically 3 to 6 locations should be

taken. Insofar as the dredging would only remove an average a depth of 0.5 metres, a single core sample at each of these locations should suffice. It is recommended that should sediment sampling be proposed, a Sampling and Analysis Plan (SAP) be prepared and discussed with the Department of Environment and Primary Industries (DPEI) and EPA Victoria to confirm its acceptability before proceeding.

- The Commonwealth EPBC Act requires that any action that may affect matters of National Environmental Significance must be referred to DSEWPAC. As already indicated above, there is limited information available about the marine ecosystem at and around the proposed dredge area in Port Fairy Bay. The marine ecological survey already recommended would provide the necessary data to make an informed decision about whether a referral to the Commonwealth would be warranted.

*Sand sourced from Lady Bay, Warrnambool*

- Reputedly Warrnambool City Council would like to have the excess sand that has accumulated on the beach of Lady Bay removed. Consent under the *Coastal Management Act* would normally be required for this proposed removal.

*Sand sourced from south of the Moyne River entrance*

- Consent under the *Coastal Management Act* would be required for this sand sourcing option. Since the areas from which sand would be extracted are directly alongside the Shearwater colony on Griffith Island, it is likely that a detailed examination of potential ecological impacts of the proposed operations would be required.

- The status of Griffith Island as a Coastal Conservation Zone signals its recognised natural values - which regulators would wish to protect should any sand extraction operation be contemplated.

- Under the proposed double handling operation, material would need to be placed in the river and then dredged for placement on East Beach. The potential impacts of the temporary placement of material on the river bed would also need to be ascertained. Possible impacts could include direct smothering of habitat in the river, creation of turbidity by the dumping process, and potentially disrupting the movement of fish and/or other aquatic fauna up or down the river.

- As dredging would be involved, compliance with the requirements of the State Dredging Guidelines would be obligatory. Discussion with DPEI and EPA Victoria is recommended to establish the scope of what sediment quality investigation may be required.

- The result of these various investigations, namely the potential impact of the land excavation of the material and the impact of the temporary dumping of material on the river bed, would be required in order to make an informed decision about whether a referral to the Commonwealth under the EPBC Act would be warranted.

- Depending upon the Town Planning Scheme, a Municipal Planning Permit may also be needed.

*Sand sourced from the Glenelg River system*

- Discussion with the commercial operator of sand extraction activities indicated that in the short- or even medium-term, existing areas of sand extraction (which have the necessary permissions) are unlikely be able to reliably provide a sufficient volume of sand for beach nourishment of East Beach. Accordingly, this sand sourcing option may require new extraction areas to be established within the Glenelg River system.

- In Victoria, areas around waterways are designated as being of cultural heritage sensitivity, and the *Aboriginal Heritage Regulations 2007* under the *Aboriginal Heritage Act 2006* require that a Cultural Heritage Management Plan (CHMP) be prepared for any high impact activity within such an area. Sand extraction activities would be considered a high impact activity.

- Other permits and permissions which would need to be obtained for a new sand extraction operation could include:
  - A Municipal Planning Permit
  - Permission from the land owner
  - A work authority from the waterway manager (Catchment Management Authority).
  - Extraction licence

- It is also possible that some testing of material at a new site may be required to confirm its acid sulfate status and “fill material” status.

- As with the other sand source options, whether or not a referral under the Commonwealth EPBC Act would be necessary could only be determined on a case by case basis. Such determinations would need to consider potential threats to the natural values of the area in question. Ecological surveys could be necessary in order to make an informed decision in this respect.

*Coarse sand sourced from offshore of the Hopkins River entrance*

- Since the method for extraction and placement of this sand would be similar to that outlined for offshore extraction at East Beach, the environmental approvals and issues pertaining to that potential sand source would also apply to this option.

# 1 INTRODUCTION

## 1.1 Background

East Beach at Port Fairy is located on the northern side of the Moyne River entrance. This is a man-made entrance that intercepts the natural south to north flow of sand along the shoreline. Historically the Moyne River entrance and East Beach have been managed by:

- Dredging of the entrance channel and harbour area to maintain a functional port. For many years sand that was extracted from the channel and harbour to facilitate safe navigation was placed on Griffiths Island. This removal of sand from the active littoral system resulted in the subsequent erosion of East Beach. Within the last 20 years or so, extracted sand has instead been placed back into the East Beach littoral system - with the dredge pumping extracted sand to the northern side of the Moyne training walls, from where the prevailing coastal processes can transport it along East Beach.
- Prior to the incorporation of this sand bypassing strategy into dredging operations, various engineering works were carried out in an attempt to prevent erosion and to stabilise East Beach. The most significant of these works was the construction of a rock-armoured seawall for almost the entire length of East Beach. The seawall offers protection to subdivided land along the dune system between the shoreline and Griffiths Street. Some timber groynes were also constructed as beach stabilisation works, but these had negligible effect on beach stability.

East Beach and its seawall are under stress from an on-going erosion threat that is likely to be exacerbated by sea level rise associated with future climate change. Moyne Shire Council has commissioned Coastal Engineering Solutions (CES) to investigate a number of issues relating to the appropriate management of the East Beach foreshore.

Specific aspects being addressed by CES are:

- *Seawall Assessment and Design Concepts*. To investigate the condition and structural integrity of the existing seawall (apart from a short section recently upgraded and extended at its northern-most end), and where appropriate produce concept designs that also accommodate future climate change. The results are presented in a separate report.

- *Dredging Operations*. To investigate and determine the capacity of the dredging equipment currently in operation at Port Fairy - along with an evaluation of possible upgrading options; and consideration of alternative methods of bypassing the extracted sand. This aspect has also been addressed in a separate report.
- *Sand Sourcing for Supplementary Beach Nourishment*. It has been recommended in previous studies that the stability of East Beach would be enhanced if the beach could be "topped up" with approximately 100,000 cubic metres of sand – whilst still maintaining the annual sand bypassing commitment. Potential sand sources are to be investigated and assessed. These include sand from:
    - from an offshore source near East Beach, if suitable sand can be identified and extracted.
    - Lady Bay at Warrnambool where there is a continuing accumulation of sand on the foreshore, estimated to be about 10,000 cubic metres per year;
    - from onshore resources to the south of the Moyne River Entrance;
    - the Glenelg River where there are deposits of sand which the local Catchment Management Authority (CMA) would like to have removed; and
    - offshore of the Hopkins River entrance near Warrnambool where there are possibly deposits of quite coarse sand.

This report presents the findings of investigations into sand sourcing for the supplementary beach nourishment of East Beach.

When undertaking the investigations, CES has utilised the specialist services of John Kowarsky & Associates for advice regarding the necessary permits and approvals for sand extraction and placement. In addition, Heini Evers has provided specialist advice regarding aspects of dredging pertaining to sand extraction and placement.

There are two potential sources of sand for nourishment which are somewhat distant from East Beach (refer to Figure 1.1), namely:

- sand deposits in the Glenelg River and its tributaries; and
- Lady Bay at Warrnambool.

There are also potential sand sources nearby (refer to Figure 1.2):

- An offshore area in 8 to 10 metres water depth;
- Puddney Ground - between Griffith Island and the Moyne River;
- Lighthouse Beach; and
- Griffith Island environs.

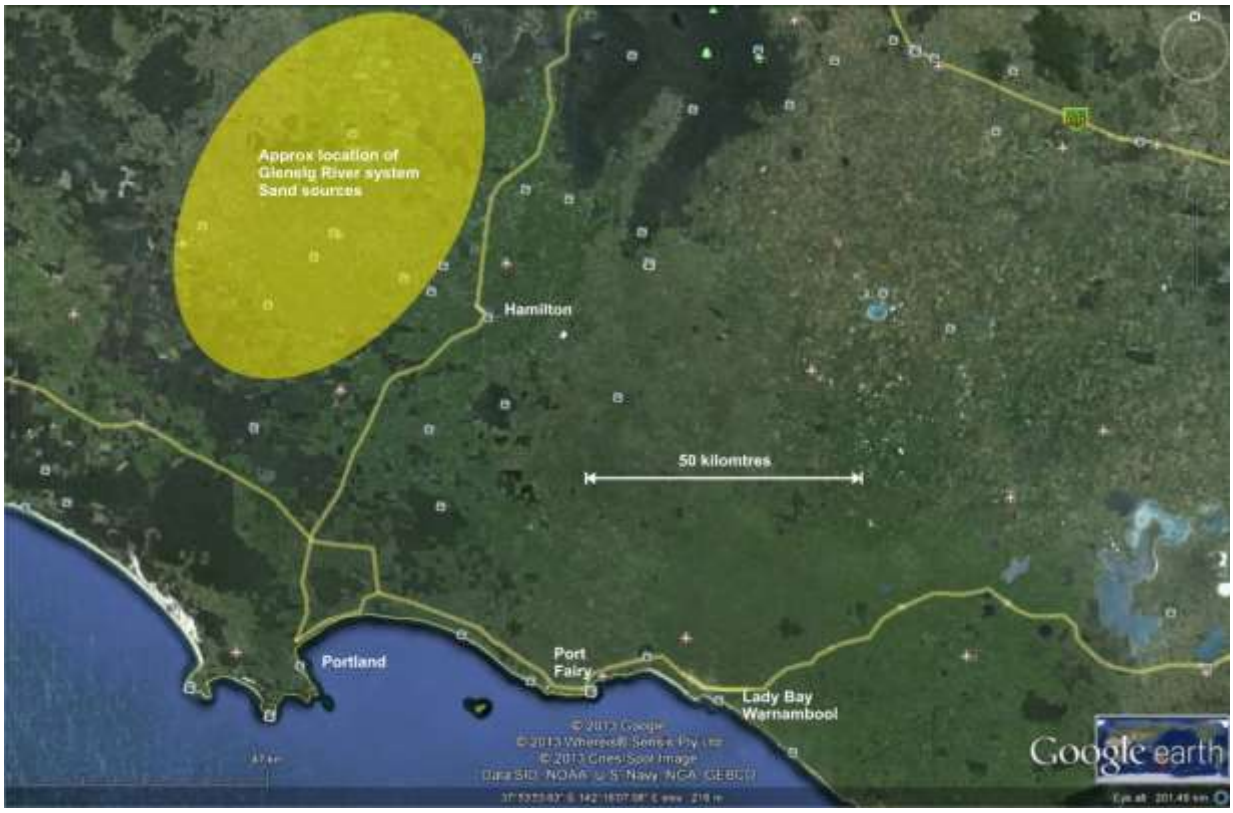



Figure 1.1 : Potential Distant Sand sources


Figure 1.2 : Potential Nearby Sand Sources

## 1.2 Report Structure

This report on sand sourcing for the supplementary beach nourishment of East Beach is structured in the following way:

- This Section 1, which consists of an introduction and provides some background regarding the commissioned work.
- Section 2 presents a discussion of the natural processes by which sand moves along the foreshores of East Beach; including how the beach responds to the prevailing coastal processes of the Port Fairy region.
- Section 3 provides a discussion of the various sand sources nominated in Moyne Shire Council's Study Brief, including a description of the types of sand and their physical characteristics. An alternative sand source is also presented.
- In Section 4 these various sand sources are evaluated in terms of their potential for supplementary beach nourishment at East Beach - along with cost estimates for their utilisation.
- Section 5 provides an overview of the environmental aspects and approval processes associated with the various sand sources.
- Section 6 lists technical references used in discussions throughout this report.
- Appendices which support the technical content of the report are then included.

# 2 SAND MOVEMENT AND BEACH RESPONSE AT EAST BEACH

## 2.1 Natural Sand Transport Processes

Sand movement within a beach system results primarily from wind and wave action. Winds blowing across the open ocean fetches generate waves - which then propagate onto foreshores where they initiate sand movement. Winds also directly affect local beach systems by blowing sand along or across the beach, resulting in the formation and ongoing shaping of foreshore dunes.

Waves reaching East Beach are generated from a number of deepwater sources and each results in wave fields that independently propagate into shallow water. The sources of waves reaching East Beach are:

- Long period ocean swells that are generated from the south-west out of the Southern Ocean and the Great Australian Bight;
- Shorter period ocean swells that are generated from the south across the fetches of the Southern Ocean to the west of Tasmania;
- Residual (and minor) ocean swell that has been generated in the Pacific Ocean and the Tasman Sea which has either propagated through Bass Strait or diffracted around the south of Tasmania;
- Locally generated waves (in the form of long period seas) that have been generated within Bass Strait, predominantly by east to south-easterly winds; and
- Locally generated sea waves which result predominantly from the sea breeze.

Each of these wave sources will be modified as they move away from their generation area towards the shoreline of East Beach. The effect that transformation processes have on the local wave climate of East Beach depends upon the wave heights, wave periods and wave directions that are prevailing at the time - as well as the nature of the seabed over which the incoming waves must pass.

- Waves from each of these various sources will tend to propagate somewhat independently of each other - maintaining their individual direction of propagation rather than amalgamating into a single wave train with a single direction of approach.

- Since prevailing wind/wave patterns are seasonal in nature, the movement of sand (due to both winds and waves) is also seasonal, differing in summer and winter. When referring to sand movement, sand can be transported along the beach and/or perpendicular to the beach.
- The direction of sand moving along the beach depends on the angle at which incoming waves break along the beach, as illustrated in Figure 2.1. If waves arrive so that their crests are parallel with the beach there will be no sand transport along the beach.

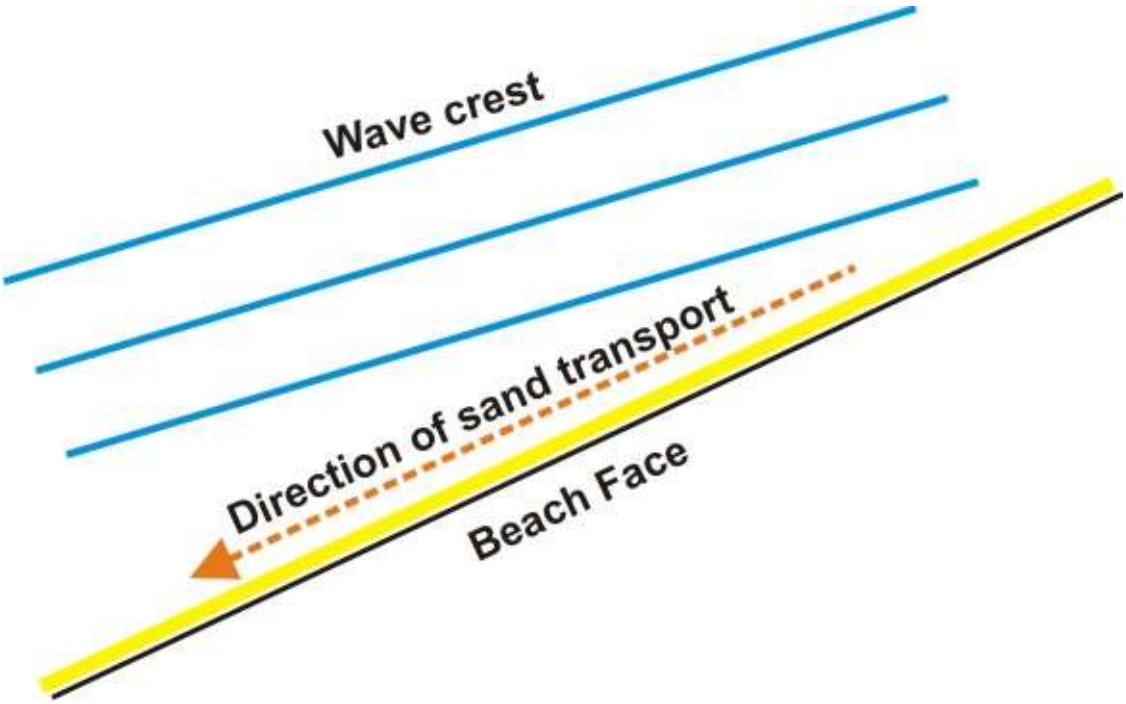



Figure 2.1 : Sand transport along a beach

- At East Beach there is frequently at least two different wave systems arriving on the shoreline: a swell (long period waves) which typically moves sand from south to north; and a locally generated sea that typically moves sand from north to south.
- Sand transport occurs perpendicular to the beach and this process is primarily influenced by the height and period of the incoming waves. Typically storm conditions move sand offshore, whilst subsequent milder wave conditions (usually in the form of swell waves) tends to move sand back onshore.

## 2.2 Sand Transport at East Beach

The natural processes causing sand transport at East Beach are seasonal. Whilst there are quite distinct wind, wave and sediment transport patterns evident during summer and winter, there can nevertheless be significant variations in their strength from year to year - which will therefore influence the response of the beach from year to year. Beach response is also affected by sand availability/supply at the northern side of the Moyne River entrance.

### *2.2.1 Summer Pattern*

During summer, the volume of sand on the beach/dune system tends to increase, particularly at the southern end fronting the subdivided foreshore. This accretion of the beach is due to:

- Mild swell wave conditions which tend to transport sand in nearshore waters onto the beach;
- Local summer wind and sea breeze patterns tend to be from the east-south-east. This means that waves generated by these winds transport sand along the beach from north to south. These same winds also dry out the sand; and blow it onshore.
- The typical mild swell conditions also move sand alongshore in the opposing direction (ie. from south to north) but this is more than offset by the previous two factors.
- Dredging (and subsequent sand delivery to the beach) is typically undertaken prior to summer to ensure that the river can be safely navigable during the summer months. This provides a supply of sand for any south to north sand movement induced by the mild swell wave conditions.

This phenomena of beach growth was very evident during a field trip undertaken in early February 2013 as part of the assessment of the East Beach seawall. There was a strong east to south-easterly wind prevailing at the time. Over the four day duration of the field trip, the beach level against the bottom of the seawall generally increased by 200mm to 300mm. This beach growth is responsible for the formation of incipient (temporary) dunes against the seawall. This is evident in Figure 2.2 where it can be seen that the seawall rock has almost been covered by wind-blown sand.

Whilst beach/dune recovery along the seawall frontage has typically occurred during summer months, the extent of recovery of the beach dune system to the north-east of this particular foreshore during summer has been limited in recent years. Instead there appears to have been a permanent removal of the incipient/foredune area, resulting in exposure of old disused rubbish/refuse disposal areas that were previously behind stable dunes.

Figure 2.2 : Dune build up at East Beach to south of the SLSC

This erosion process is illustrated by the comparison of this dune system presented in Figure 2.3. There is a well defined incipient/foredune evident in the photograph taken in June 2006, when there would have been some winter beach/dune erosion. There is no evidence of any foredune in the more recent photograph of November 2012. Rubbish from the exposed tip area can be seen strewn across the beach and at the toe of the eroded dune escarpment.

*(a) Incipient dune in June 2006* *(b) No incipient dune November 2012*

Figure 2.3 : Comparison of beach / dune system at the northern end of East Beach

### 2.2.2 Winter Pattern

During winter, the pattern of sand movement is controlled by:

- A shortfall of sand supply to the northern side of the Moyne River training wall. This is because weather favourable for dredging activities and the associated sand placement on the beach only occurs after winter;
- South-westerly swell waves typically dominate, mostly as a consequence of storms which:
    - result in the waves being consistently angled to the shoreline, so that south to north sediment transport dominates;
    - results in offshore sand movement during storms. Sand moved offshore moves back onshore during milder periods of swell from the south-west - but it tends to come ashore further north due to longshore sand transport processes.
- There are significantly reduced periods of locally generated winds and waves from the east to south-east, so the dune system tends not to build up naturally. This natural build up is also adversely affected by the wetter weather which limits the extent of wind-blown sand available for dune formation.

The overall effect is that the beach tends to erode during winter. Figure 2.4 illustrates this summer and winter trend at the northern-most set of stairs across the seawall. The summer beach level (February 2013) is about 1 metre higher than the level in winter (June 2006).

*(a) Summer 2013* *(b) Winter 2006*

Figure 2.4 : Comparison of beach conditions during summer and winter

## 2.3 Summary of Historical East Beach Sand Transport

The natural state of the East Beach foreshore has been considerably modified since European settlement of the Port Fairy region. The most significant alterations have been the construction of training works at the Moyne River entrance - so that its confluence with the ocean is now to the north of Griffith Island; and its historical south-west entrance has been closed. This training of the river entrance altered the natural sand supply to East Beach.

Historically the dune system at East Beach was located further seaward than it is at present. This can be surmised from:

- There is a designated road easement along parts of the foreshore that can no longer be utilised. The presence of an earlier road at the southern end of the beach, as seen in the GoogleEarth image presented in Figure 2.5.
- The rock-armoured seawall being completed in the early 1960's to protect the entire length of the developed foreshore;
- The estimate by BMT WBM (2007) that approximately 500,000 cubic metres of sand has been prevented from moving northward along East Beach due to the construction of the trained river entrance (started in 1870). This has been exacerbated by the subsequent placement of extracted sand to the south-west of the river entrance, thereby isolating this sand from natural littoral processes. This implies an average annual sand loss of about 5,000 cubic metres until sand by-passing during dredging campaigns was commenced about 25 years ago.


Figure 2.5 : Aerial photograph showing road seaward of existing shoreline

Whilst the rate of sand trapped to the south of the Moyne River training walls is inferred as 5,000 $m^3$/year, Coastal Engineering Solutions (2006) estimated that the net sand movement further to the north along East Beach is of the order of 20,000 $m^3$/year.

Prior to the construction of the Moyne River training walls and removal of dredged sand from the active littoral system by its placement at Griffith Island; it has been determined that the beach system at East Beach was relatively stable (Gill, 1984 and BMT WBM, 2007). The implication is that 15,000$m^3$/year of sand either by-passed the end of the training walls, or was brought onshore by mild swell wave conditions to feed the East Beach sand system. It is apparent that after the initial erosion of the beach that the beach/dune system to the east of the long East Beach seawall was relatively stable between 1960 and 2006 (Coastal Engineering Solutions, 2006).

Over the last 25 years or so, the rate of dredging from the Moyne River and its entrance has been estimated at an average of 10,000 $m^3$/year.

However, in the last seven years the extent and rate of dune erosion to the east of the seawall has increased quite dramatically. This has occurred despite there being little change in annual seasonal patterns, and only limited erosion and accretion along the section of foreshore in front of the seawall. The reason for this beach behaviour cannot be clearly defined and is beyond the scope of this study. Nevertheless, possibilities include:

- Changed wave conditions (particularly with regard to incident wave direction) which could be related to the La Nina – El Nino cycles which result in a relocation of high pressure weather systems in the north/south direction. Such movements affect the regional wind climate - and hence wave direction both offshore and in nearshore waters.
- A depletion of the offshore sand source in deeper water from where swell can be moving sand onshore.
- A reduction in sand supply by longshore movement from the west.

The emerging risk is that the eroding sand dunes are exposing historical rubbish/refuse deposits; and that the existing seawall may gradually become undermined due to a lack of sand to supply longshore and cross-shore transport processes. This situation can be remedied by placing additional sand into the beach/dune system. If this strategy of supplementary sand nourishment is not implemented and the erosion trend continues as expected, then it may be necessary to extend the existing seawall further along East Beach.

# 3 POTENTIAL SOURCES OF SAND

Moyne Shire Council requires the following potential sand sources for the supplementary nourishment of East Beach to be assessed:

- Seabed offshore of East Beach
- Sand deposits in the Glenelg River System
- Sand accumulating at Lady Bay, Warrnambool
- Sand accumulated to the south of the Moyne River.

This section of the report provides comment on these potential sources; as well as a possible source of coarse sand seaward of the Hopkins River near Warrnambool and a possible terrestrial sand source located between Port Fairy and Portland.

## 3.1 Seabed Offshore of East Beach

East Beach is composed of fine calcareous sand. It has been speculated that similar sand could be found offshore and would therefore be a suitable source for beach nourishment purposes. Council has nominated a sand nourishment volume of 100,000 cubic metres. This is a relatively small quantity in terms of a dredging project; and implies that a small dredge having only a limited depth of operation would therefore be utilised. Consequently the investigations for suitable offshore sand was limited to water depths of 12 metres or less.

Extracting sand from offshore of a beach must be carefully engineered so that it does not adversely affect nearby sandy foreshores - including the beach that is being re-nourished. If a deep "hole" is simply dredged in the seabed, it will alter the direction and height of waves passing over it. Given that the height and direction of waves reaching a beach are the primary factors determining the rate and direction of sand movement along the beach, the impact of such a hole becomes significant in shallow water. Consequently, a minimum depth of 6 metres (to low water datum) was nominally selected for consideration of possible offshore sand sources.

Fieldwork was therefore undertaken to determine seabed sand properties in offshore areas between 6 metres and 12 metres depth of water. The method of identifying offshore sand characteristics was to take samples of the surface of the seabed from a survey vessel which provided both location and depth information. The sampling was undertaken by Coastal Engineering Solutions on 5$^{th}$ March 2013.

Figure 3.1 shows the seabed contours offshore of East Beach, along with the locations from which sand samples were extracted. The survey base map used for the fieldwork had been prepared in 2006 for another project.

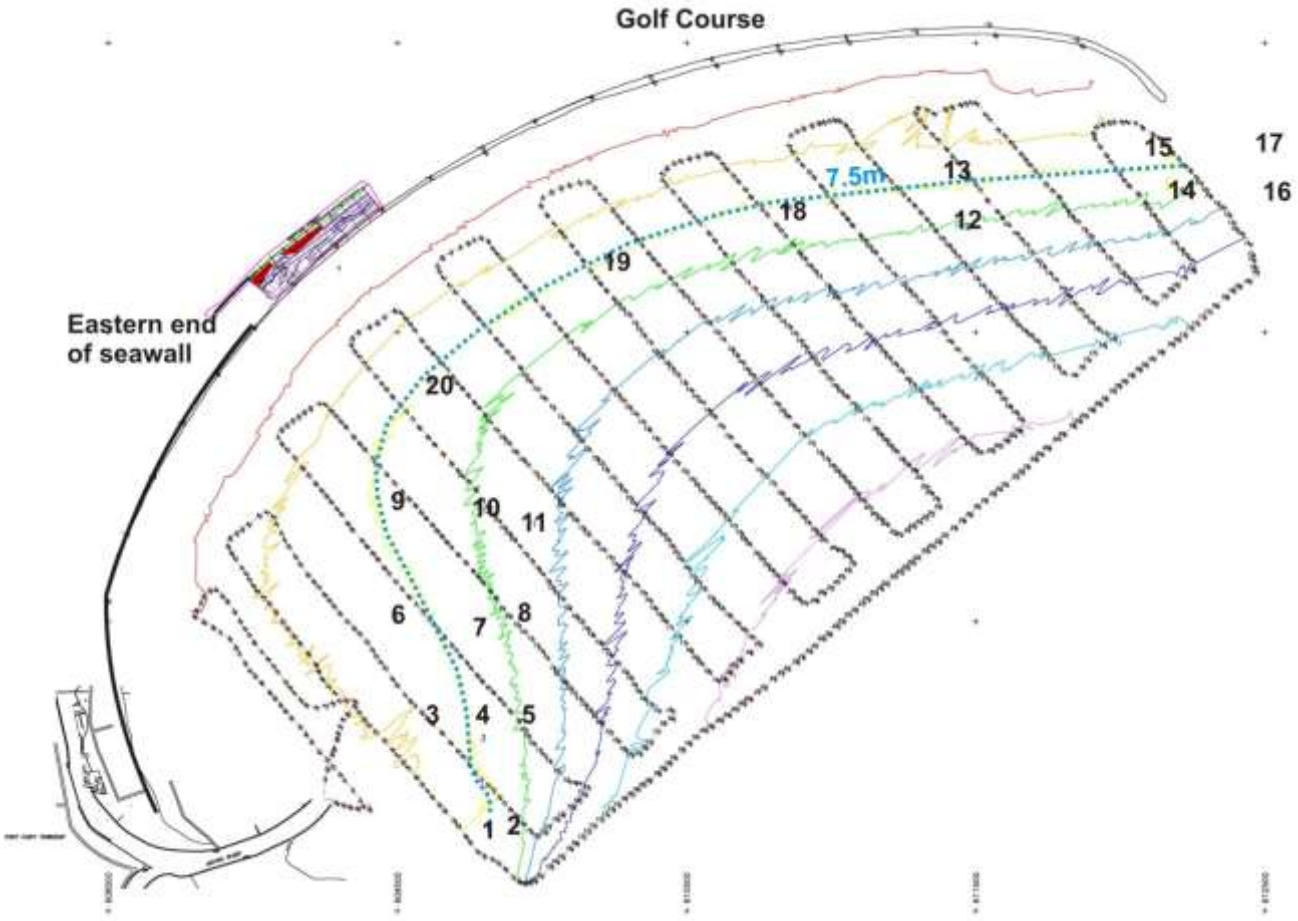



Figure 3.1 : East Beach sand sampling locations

All of the extracted sand samples were of the same colour and overall sizing. Reef was encountered on the seabed at locations 1, 15, 16 and 17. The sand samples were combined according to water depth and general location. A grading analysis was then undertaken by Golder & Associates to determine the physical characteristics of mean sand grain size and the grading distribution.

The reason for combining the samples prior to testing was because offshore sand would most likely be mixed during extraction by a dredge tracking along existing contours approximately parallel to the beach. Such a dredging methodology would create a shallower, broader dredged area rather than a "hole" specifically located in a particular area - and so would have minimal impact on waves and inshore beach processes.

This dredging methodology is suited to a trailing suction hopper dredge, for which the most efficient operation is to extract sand from the seabed by navigating within a uniform depth of water.

The combined samples subjected to sieve/grading analyses were as follows:

- 3, 4, 5, 6 and 9 representing a water depth of about 7 metres north of the training walls;
- 18, 19 and 20 representing a water depth of about 8 metres offshore of the eroding East Beach dunes;
- 2, 7, 8, 10 and 11 representing a water depth of about 10 metres; and
- 12, 13 and 14 in water depths of about 10 metres at the eastern end of the bay.

.
The grading curves are included as Appendix A to this report.

Three of the graded sand samples had very similar grading distributions - with a $D_{50}$ of 0.16mm whilst the other (combined samples 2, 7, 8, 10 and 11) was slightly coarser with a $D_{50}$ of 0.18mm.

Approximately 100,000 cubic metres of sand could be extracted from the nearshore area in water depths of 8 to 10 metres by removing material 100 metres wide by 2,000 metres long by 0.5 metres deep. The approximate extent of such an extraction zone is illustrated in yellow on Figure 3.2. The nature and scale of this sand removal would have negligible impact on the inshore wave climate; and consequently have negligible adverse impact on East Beach.

In 2012 UNSW/WRL (2012) undertook sand sampling and grading along East Beach at three locations in the intertidal zone at the south, centre and north of the beach. A location diagram for the sampling sites was not included in the Memorandum describing the results of the testing. The central sample had a $D_{50}$ of 0.18mm, whilst the southern and northern samples had a $D_{50}$ of 0.29mm and 0.32mm respectively. It is pertinent to note that the central sample has a similar grain size as that found offshore; and this suggests that the offshore sand source would indeed be suitable for beach nourishment.

Coastal Engineering Solutions did not sample on East Beach itself and expects that most of the beach is composed of sand with a $D_{50}$ of 0.18mm ±0.02mm since that size is consistent with the local wave climate and the uniform, very gently sloping nature of this beach.

It is possible that the coarser southern sample reported by the UNSW/WRL investigations resulted from some differential sorting in the intertidal zone caused by a semi-submerged offshore breakwater in this area.

The northern end of East Beach is considerably more exposed to ocean swell; and the presence of coarser sand at this location is likely to be due to sand sorting as a result of storm wave action - where coarser sand fractions have been retained on the beach whilst finer sand particles have been washed offshore.

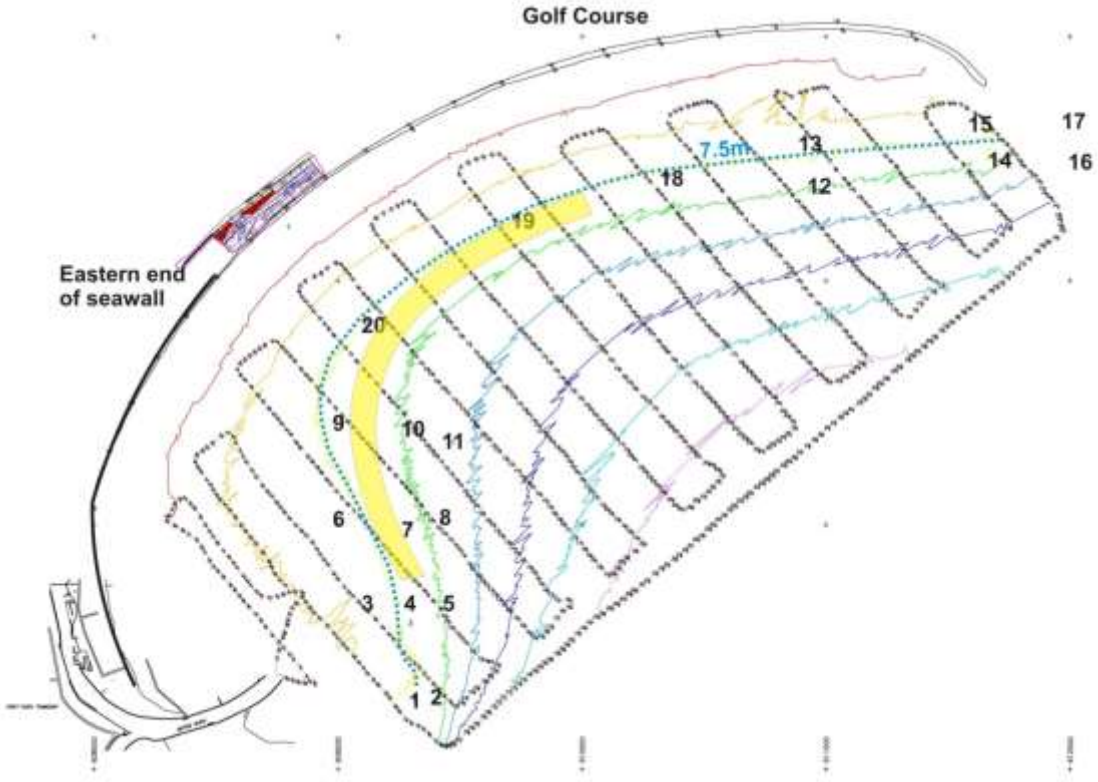



Figure 3.2 : East Beach indicative sand removal area

## 3.2 The Glenelg River System

The Glenelg River and its various tributaries are a potential source of sand which could be utilised for beach nourishment of East Beach. There are extensive sand deposits that have been identified, and their removal could be beneficial to the overall river and flood plain environment (Rutherfurd and Budahazy,1996). Sand has been extracted from the river system for many years; and Vickery Bros. (2010) provides a description of the status of sand extraction to that time. The available sand is known to be typically medium to coarse grained in nature, with some very coarse deposits identified along Bryans Creek.

A site visit to various locations where sand is currently being extracted was made on 6th March 2013 with the assistance of the Glenelg Hopkins CMA and staff from Vickery Bros Pty Ltd.

The Vickery Bros' main sand screening plant at Coleraine stockpiles extracted sand, which is then screened and blended to produce a range of standard commercial products - such as sand for concrete. Figure 3.3 shows an area within the screening plant. Figure 3.4 shows the concrete sand product, which contains a wide sand grading but has a $D_{50}$ median size of between 0.5 and 0.8mm. The photo shows the sampled sand placed for comparison between two prepared standard graded sands - a standard size of 0.4mm to 0.5mm on the left; and a standard of 0.8mm to 1.2mm on the right.

Figure 3.3 : Screening plant at Coleraine

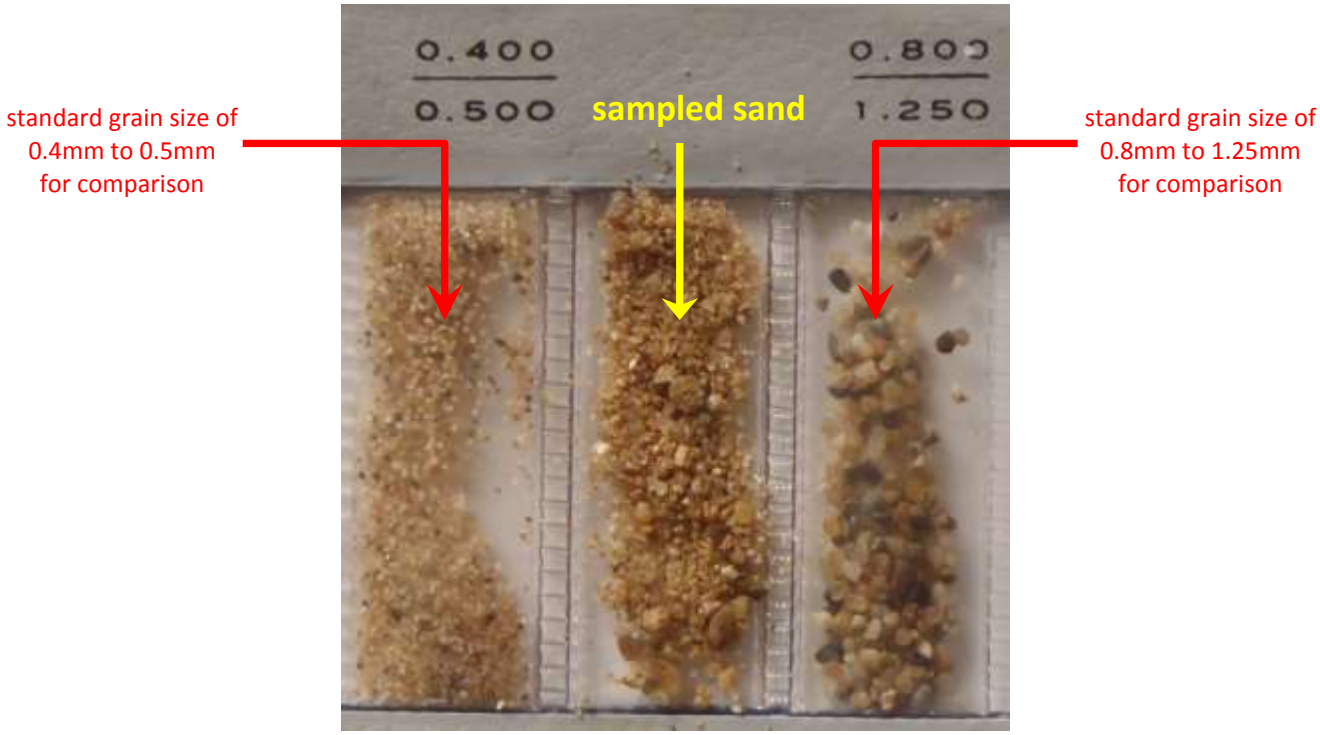



Figure 3.4 : Concrete sand sample placed between 0.4 to 0.5 and 0.8 to 1.2mm standards

Bryans Creek tends to have coarse sand deposits. Figure 3.5 is a GoogleEarth image showing the confluence of Bryans Creek and Wannon River. Sand deposits are clearly evident along the banks of Bryans Creek. Figure 3.6 shows a Bryan Creek sand sample placed on a swatch having standard sand sizes of 0.8mm to 1.2mm on the left and 2.0mm to 4.0mm on the right. This Bryans Creek sample is a very coarse sand, potentially too coarse to be considered for beach nourishment purposes.


Figure 3.5 : Junction of Bryans Creek and Wannon River showing sand deposits

It appears that most of the coarse sand carried by flows in Bryans Creek settles out before reaching the Wannon and Glenelg Rivers. Figure 3.7shows a typical site along the Wannon River where sand extraction occurs. Figure 3.8 shows sand sampled from this location. This sand has a median size of between 0.5mm and 0.8mm.

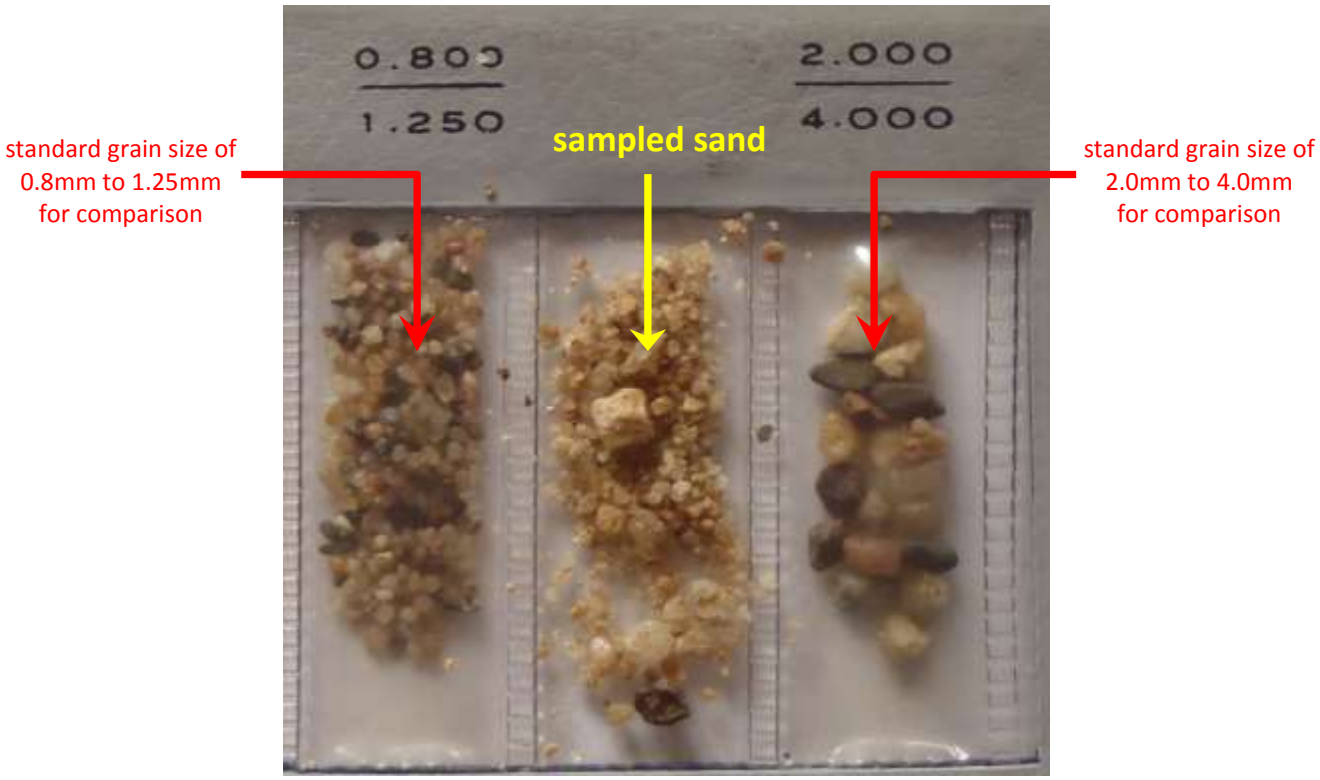



Figure 3.6 : Sand sampled at Bryans Creek

Figure 3.7 : Sand deposit within Wannon River

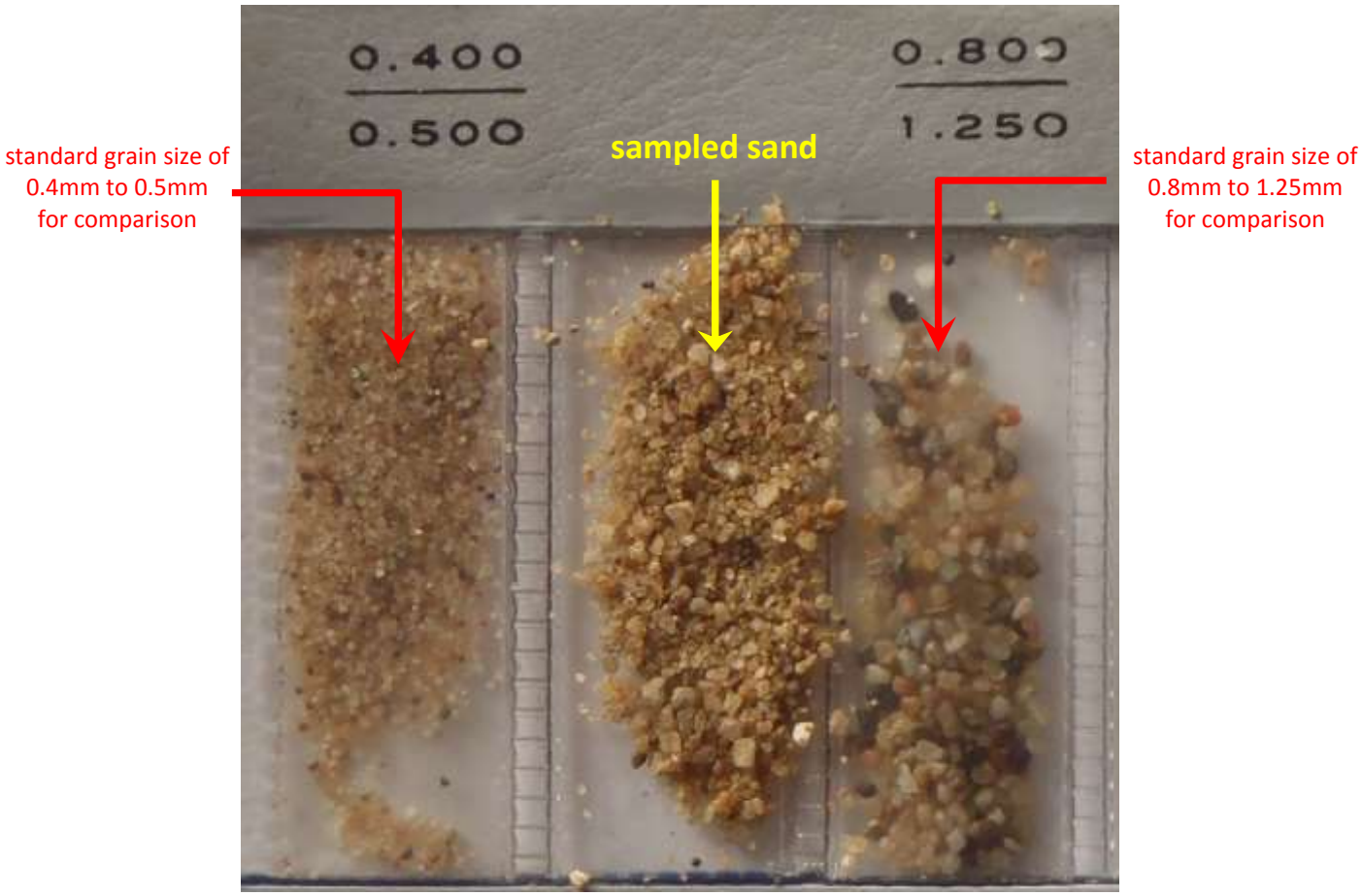



Figure 3.8 : Sand sampled at Wannon River

Another sand sample was collected at the junction of the Wannon and Glenelg Rivers (refer to Figure 3.9). As can be seen in the photograph, sand was being commercially extracted during the site visit. Characteristics of the sand sample are shown in Figure 3.10.

The samples taken from commercial stockpiles at the Wannon and Glenelg Rivers are not washed or graded - and appear to have only a small percentage of fines. Figure 3.8 and Figure 3.10 indicate that the sand grains are quite well rounded. In summary, the unprocessed sand products extracted from the natural deposits in the Wannon River and the upper reaches of the Glenelg River are likely to produce a coarse sand with a nominal $D_{50}$ of about 0.8mm - which would be suitable for beach nourishment purposes.

It is noted that most of the beach nourishment projects in Port Phillip Bay that used coarse sand utilised material with a $D_{50}$ in the range of 0.6mm to 0.8mm.


Figure 3.9 : Sand extraction at junction of Wannon and Glenelg Rivers

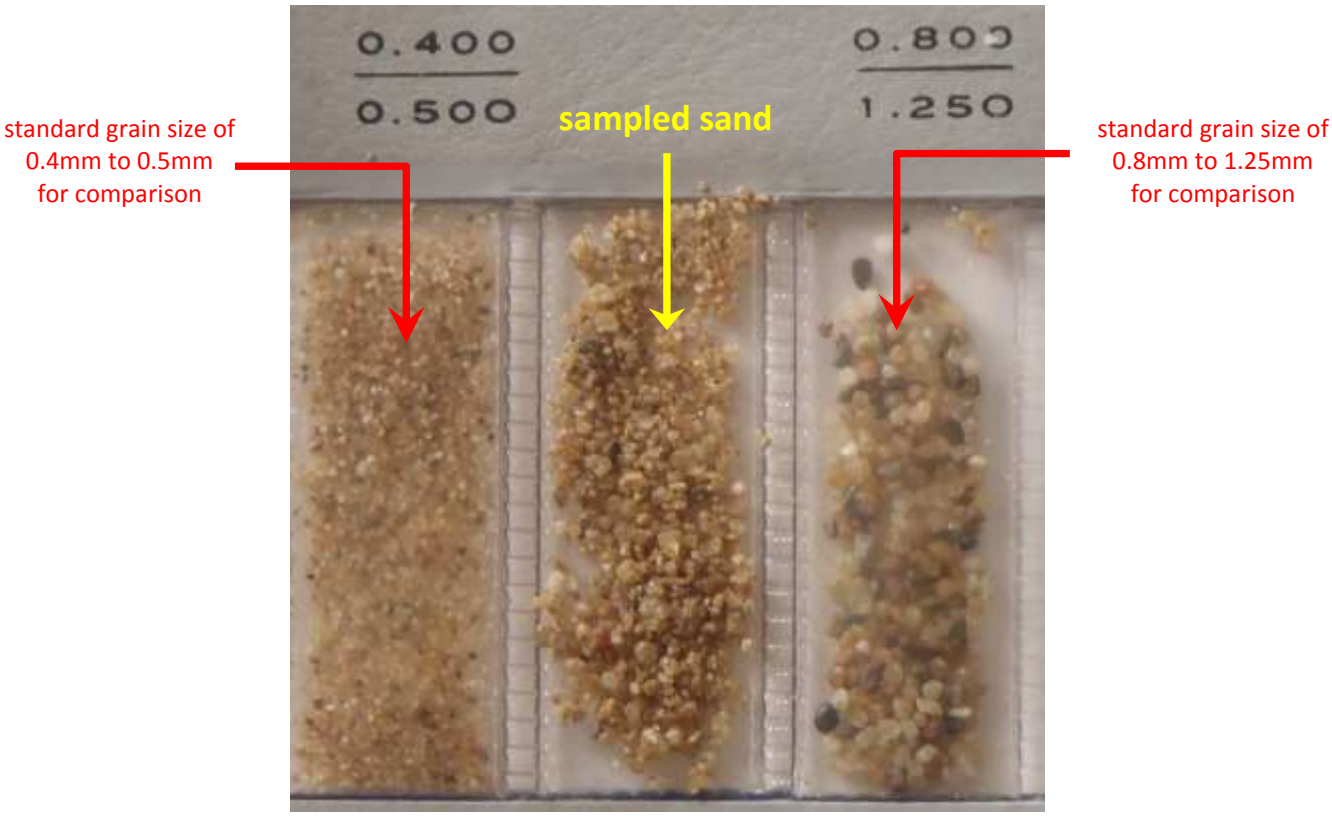



Figure 3.10 : Sand sampled at junction of Glenelg and Wannon Rivers

The limiting factors relating to the use of Glenelg River sand for supplementary nourishment of East Beach are the long cartage distance to Port Fairy (about 150 kilometres); and the need to provide commercial sand suppliers with significant advance notice that sand is required.

The large quantity of sand required for beach nourishment at East Beach is likely to require extraction operations at several locations. Presently most of the sand being commercially extracted is already allocated to existing projects. It may take about a year for existing operations to stockpile a sufficient quantity of sand to service a beach nourishment campaign at East Beach.

### 3.3 Lady Bay, Warrnambool

Sand has been accumulating in Lady Bay ever since the initial construction of the breakwater at Warrnambool Harbour in 1890. There are many technical publications describing the deposition process. Coastal Engineering Solutions (1999) provides a summary of the siltation process in the report "*Siltation Study Including Concept Plans & Preliminary Designs for Improvements to the Harbour*".

Sand accumulates in Lady Bay behind the harbour breakwater at an approximate rate of 10,000 cubic metres per year - the net effect being the shoreline having moved seaward by up to 300 metres since breakwater construction commenced. Sand which is moved into Lady Bay in the lee of the breakwater cannot be remobilised by waves because of the blocking action of the breakwater. In addition the local sea breeze (from the north to east) dries the sand and enables it to be blown up into a local dune system.

This process of sand accumulation is continuing; and reputedly the City of Warrnambool wishes to have about 140,000 cubic metres of this sand removed. The sand has a similar grading to that presently on East Beach.

That is, the sand is fine grained with a $D_{50}$ of slightly less than 0.2mm (Coastal Engineering Solutions,1999). Figure 3.11 shows that the sand from Lady Bay has a similar colour to that at East Beach. In this figure, the scale next to the sand is in centimetres.

From a beach nourishment perspective, this sand would perform in a similar manner as sand derived from the seabed offshore of East Beach. It is therefore suitable for beach nourishment of East Beach. The haulage distance from Lady Bay to East Beach is approximately 30 kilometres.


Figure 3.11 : Fine-grained sand from Lady Bay, Warrnambool

## 3.4 South of the Moyne River Training Walls

Although some 500,000 cubic metres of sand has either accumulated or been placed in this area to the south of the Moyne River entrance, only a limited amount of the sand could be extracted because much of the area is vegetated and colonised by shearwaters. Most of the area is classified as a Shearwater Reserve - as illustrated in Figure 3.12.

Only Puddney Ground and Lighthouse Beach could yield sand without disturbing the vegetation and the Shearwater breeding area. Figure 3.13 shows these areas.

It is pertinent to note that BMT WBM (2007) suggested that some 300,000 cubic metres of sand has accumulated at Lighthouse Beach; and about 100,000 cubic metres at Puddney Ground. These estimates were based on historical survey and aerial photo assessment.

However, given the re-vegetation of much of these accreted areas, along with the proximity of the Shearwater Reserve, the actual volume of sand likely to be accessible for extraction is only around 30,000 cubic metres from each location. However this estimate assumes that the depth of available sand at Puddney Ground is 2 metres. This has not been tested and may be optimistic considering the presence of some outcropping basalt.

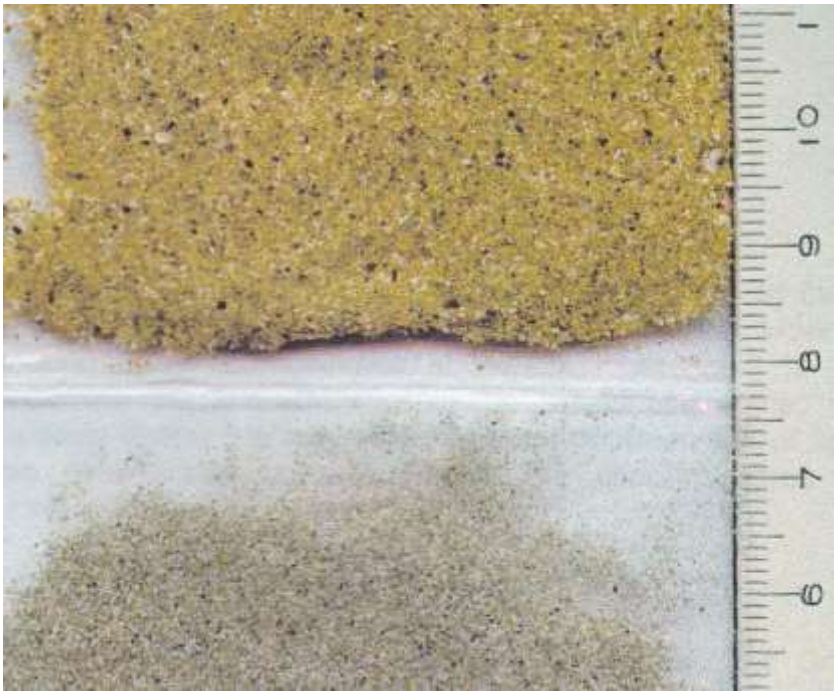
Figure 3.12 : Griffith Island Shearwater Reserve


Figure 3.13 : Potential sand sources south of the Moyne River Entrance

## 3.5 Seabed Offshore of Hopkins River near Warrnambool

An earlier study at Warrnambool (Coastal Engineering Solutions, 1999) identified that the eastern end of Lady Bay near the Hopkins River entrance has a coarser sand than that at the western end - with a $D_{50}$ of about 0.5mm. Figure 3.14 shows the two Lady Bay sand types. As can be seen, the colour of the sand is also different.

Coarse sand
(from near Hopkins River Entrance)



Finer sand
(from the western end, in the lee of the breakwater)

Figure 3.14 : Coarse sand and fine sand sampled at Lady Bay, Warrnambool

An earlier study (Gill,1984) also identified that coarse sand may be quite prevalent in offshore areas. Such deposits are likely to relate to sediment deposition from the Hopkins River during earlier geological times with lower sea levels. However, the extent or depth of any deposits of coarse sand have not been investigated.

Should a sufficient quantity of coarse sand exist in water depths of 6 to 12 metres, then such sand may be a cost effective option for beach nourishment at East Beach. As shown on Figure 3.15, the steaming distance for a dredge delivering sand from offshore of the Hopkins River Entrance to East Beach is about 20 kilometres.


Figure 3.15 : Possible marine source of coarse sand

## 3.6 Overview of Sand extraction by Dredging

The two most commonly used dredges are cutter suction and trailing hopper dredges. There are other specialized dredges that are less commonly used such as bucket dredges and excavator mounted on a barge type dredge. The cutter suction and trailing hopper dredge are most commonly used for the extraction of sand.

### *3.6.1 Cutter Suction Dredge*

Cutter suction dredges vary in size from very small such as the Cormorant which is based in Port Fairy to very large dredges. Figure 3.16 provides a comparative illustration of a small and a large cutter suction dredge. The main feature of these dredges is that they are effectively fixed to the seabed by cables or spud piles (the vertical tubes at the back of each vessel image). The dredge then operates by either rotating around the pile or by being winched along via the cabling system which is fixed to anchor points. This mode of operation means that they can only operate in moderate sea conditions – because they are effectively fixed to the seabed.

Figure 3.16 : Small and Large Cutter Suction Dredges

As a result a small dredge such as the Cormorant can effectively only work where there are no swell waves and locally generated sea waves limited to less than about ½ metre. A very large cutter suction dredge can operate in waves of up to 1.5 metres. However such dredges typically cost over a million dollars just for mobilization and are suited to large sand extraction projects.

The other limitation of a cutter suction dredge in relation to offshore dredging is that the material extracted from the seabed has to either be pumped ashore (via a long pipeline that has to be stable in all wave conditions that might occur) or into barges that then transport the material to the desired location. For open sea conditions both options can be risky and expensive.

### *3.6.2 Trailing Hopper Dredge*

The trailing hopper dredge is effectively a seaworthy ship. Whilst it cannot operate in large swell waves, it can readily sit the storm out at sea. Figure 3.17 illustrates a small dredge (The Pelican) which operates out of New Zealand but does a lot of work in Victoria – Lakes Entrance and Portland, in particular. Figure 3.18 illustrates the operation of such a dredge. It sails over the area being dredged and sucks up the sand, typically via two trailing arms, and stores the sand on board the vessel and then sails to its discharge location. Discharge is usually via bottom dumping if the material is being disposed of. For beach nourishment projects the vessel sails as close to shore as practical and then pumps the sand ashore via its own pumps and a pipeline. Such dredges can be very large with hopper capacities of up to about 50,000 cubic metres, but they then draw about 10 metres. For beach nourishment it is typical to use a smaller dredge such as the Pelican which has a capacity of about 1,000 cubic metres.


Figure 3.17 : Small Trailing Hopper Dredge

Figure 3.18 : Small Trailing Hopper Dredge – operational view

### 3.6.3 Practical Dredging Options – Port Fairy

The available water depth within the confines of the training walls and the port are limited because of underlying harder basalt materials. Consequently it is impractical to consider larger cutter suction dredges than the Cormorant. This implies that the present dredging regime for inside the channel and harbour cannot be improved even with larger, newer equipment. The limited water depth prevents even a small trailing hopper dredge such as the Pelican for dredging within the port. In summary an option for a single dredge that can handle both the internal port requirements and external sand sourcing for beach nourishment does not exist.

For sand sourcing from the bay off Port Fairy it is most likely that a trailing suction dredge will be the most cost effective. If a large cutter suction dredge happened to be working in the area, then it could be considered, but it is anticipated that it would still be more expensive than a small trailing hopper dredge.

# 4 EVALUATION OF BEACH NOURISHMENT OPTIONS

## 4.1 Sand Offshore of East Beach

### *4.1.1 Suitability of Sand*

Sand of a similar size and characteristics to that existing along East Beach occurs offshore of the beach in water depths of 6 to 10 metres. The extraction of sand along a band parallel to the shore and to a depth of up to 1 metre is unlikely to have any significant adverse impact on shoreline stability - or on the size of storm waves that reach the beach and seawall. A sand volume of 100,000 cubic metres has been nominated by Moyne Shire Council in the Study Brief. In order to extract 100,000 cubic metres, the dredged area is likely to be some 2 kilometres long, 100 metres wide and 0.5 metres deep.

Since the sand is effectively identical to the sand presently in the active beach system, ideally it should be placed at the southern end of the beach (just to the north of the semi-submerged offshore breakwater). From that location, wave and current action would transport the sand along the beach in an easterly direction as part of the prevailing littoral processes. This sand would progressively be moved north and eastward along the beach.

On the basis that there is an annual shortfall of 10,000 cubic metres of sand by-passing the Moyne River entrance, then this sand would provide the necessary supply to maintain a stable beach system for the next ten years. The arrangement is shown conceptually in Figure 4.1.

Nevertheless there will still be a need to by-pass sand that is trapped in the harbour and navigation channel at Port Fairy in order to maintain a stable beach. It is important to appreciate that the term *stable beach* refers to an average beach condition. Even with a successful renourishment strategy, storms will erode sand from the upper beach area and deposit it onto offshore sand bars. However this sand is not lost from the active beach system since it will be returned naturally to the beach by subsequent milder waves - but to a location somewhat to the north-east from where the sand was initially eroded by storm waves.

Whilst beach nourishment at the southern end of East Beach will provide a supply of sand to the beaches in front of the developed foreshore, there will be a delayed benefit to East Beach beyond the seawall because of the time needed for sand to naturally migrate along the foreshore.

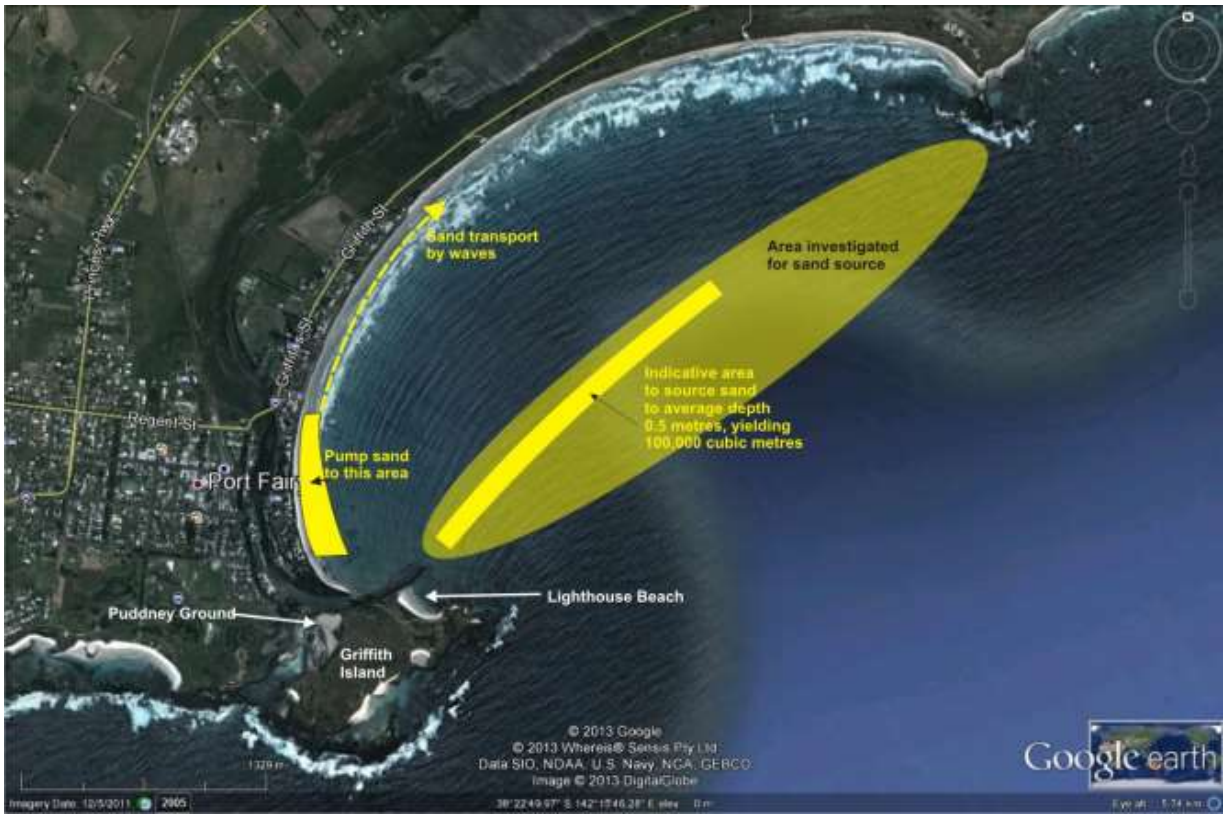



Figure 4.1 : Beach nourishment using sand from offshore of East Beach

Whilst a site specific assessment of the rate of sand movement along the beach is the beyond the scope of this study, a similar assessment has previously been made for the western section of Portland Bay. Portland Bay has similar sediment characteristics and wave climate as East Beach. For Portland Bay it was estimated that the rate at which sand is naturally transported along the beach is about 1 kilometre/year. Therefore any sand placed at the south-western end of East Beach is unlikely to benefit the eroded dune areas to the east of the 2km long seawall for at least two years. If the beach to the east of the seawall is to be stabilised within a shorter timeframe, then sand renourishment will also need to be undertaken along at-risk sections of this foreshore.

The transport of sand by onshore winds also contributes to the stability of a beach system. The fine sand at East Beach is readily transported by wind and it is this mechanism that rebuilds dunes after storms - provided there is sufficient time between such events. Placing sand above the high water mark will make it more readily available for transport by wind as part of natural dune building processes. Any sand nourishment of the foreshore to the east of the existing seawall along East Beach should therefore have sand placed as much as possible above the level of high water.

Nourishment of this beach area would also be enhanced by the installation of wind fences that catch wind-blown sand and therefore assist with the natural growth of the dune. This procedure of wind fencing to manage fine sand and to enhance dune growth is an intrinsic and important part of Metropolitan Adelaide's beach management strategy. Figure 4.2 offers an illustration of the implementation of wind fencing in Adelaide.

Figure 4.2 : Wind fencing for sand accumulation at Brighton, Adelaide

### *4.1.2 Sand Extraction Method and Cost*

#### *4.1.2.1 Description*

A small trailing hopper dredge such as the *Pelican* (see Figure 4.3) could extract sand from offshore and place it on the beach. Operating on 24 hour shifts, the dredge could achieve an extraction/delivery rate of approximately 25,000 $m^3$ per week.

By way of example, the *Pelican* has the following main characteristics:

- Nominal capacity : 960 $m^3$
- Draught empty : 1.0 m
- Draught loaded : 4.0 m
- Dredge pipes : 450 mm 1 only
- Minimum dredge depth : 4.0 m
- Maximum dredge depth : 20.0 m
- Sailing speed empty : 13 km/hr
- Sailing speed loaded : 11 km/hr
- can dredge in swell of up to 2 metres
- has a pump ashore capability

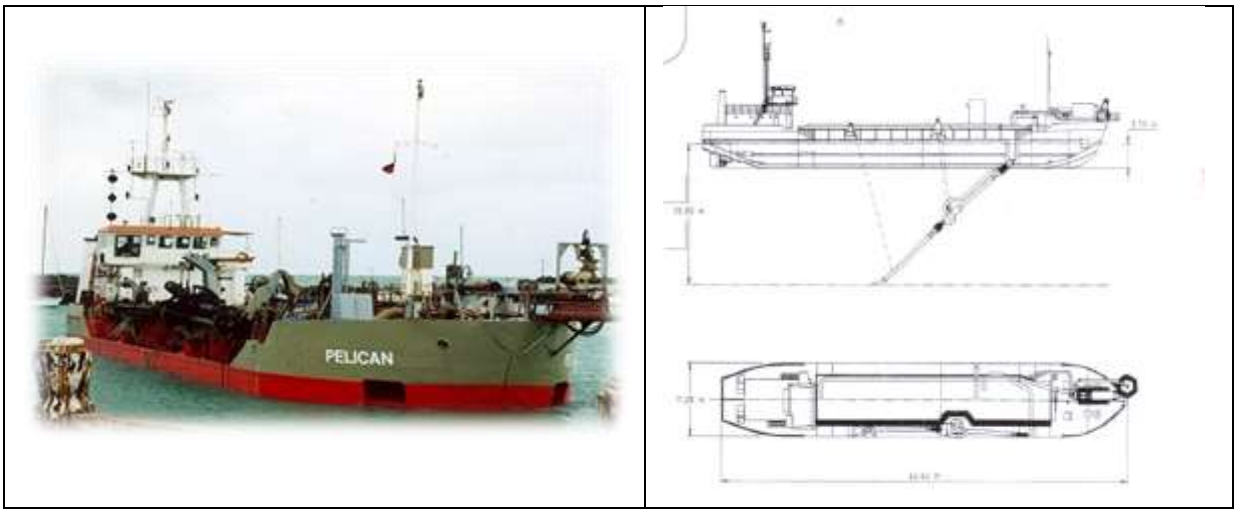



Figure 4.3 : TSHD Pelican. *Picture courtesy Van Oord*

Only two trailer dredgers with suitable similar characteristics are available from time to time in Australian waters.

#### *4.1.2.2 Method*

The method of dredging sand and pumping it ashore to East Beach would typically be as follows:

- A mooring pontoon would be anchored immediately offshore of the beach to be nourished. This pontoon would connect to a partly submerged / partly land-based pipeline that would serve as the delivery line from the dredge to the beach.

- The dredge would remove sand from the seabed in a series of “cycles” until the required quantity has been placed. A cycle would typically consist of dredging, sailing to the mooring pontoon, connecting to the pontoon and the delivery pipeline, discharging by pumping sand from the dredge's hopper, disconnecting and sailing back to the dredging site. The arrangement for pumping ashore is illustrated on Figure 4.4

Figure 4.4 : Typical pump-ashore arrangement

When dredging, the vessel sails slowly (at approximately 3 km/hr) over the area to be dredged with the draghead lowered onto the seabed. As the draghead is being drawn along the seabed, a layer of sand some 0.3m to 0.5m thick is removed. This is in the form of a slurry. This slurry mix of sand and water is sucked up at the draghead and pumped through the dredge pipe and into the hopper of the vessel

Overflow occurs once the hopper has filled with slurry. However the sand content in the hopper will not have reached its optimum volume. Overflow is allowed to continue for as long as there is a marked difference between the concentration of sediment at the intake point (draghead) and the point of overflow.

Once the dredge operator determines that the hopper is filled to its optimum capacity, the draghead will be raised and the vessel will then sail to the mooring pontoon. Given the local sand characteristics, the effective cargo of each cycle is estimated at approximately 650 $m^3$ (being the in-situ volume on East Beach).

Sand pumped onto the beach would then settle under the influence of the local wave climate to form its naturally preferred profile. Land based equipment would only be required on an interim basis; and only to provide assistance with shifting / extending the discharge pipeline. Profiling the beach by bulldozer or truck transport would not be necessary. Figure 4.5 shows the method of placing fine sand on the beach at Glenelg in South Australia.

Figure 4.5 : Beach replenishment at Glenelg near Adelaide

Figure 4.6 : Beach at Glenelg near Adelaide before and after replenishment

#### *4.1.2.3 Duration and Cost*

- The estimated production of the *Pelican* is approximately 25,900 $m^3$ per week.
- The estimated cost of the Pelican spread is approximately $ 267,120 per week.
- The estimated cost is therefore $ 267,120/25,900 = say $ 10 per $m^3$.

| Activity | Quantity | Per unit $ | Totals $ |
|---|---|---|---|
| Mobilisation + installation | item | 530,000 | 530,000 |
| Dredge and place | 100,000 $m^3$ | 10 | 1,000,000 |
| Demobilisation | item | 240,000 | 240,000 |
| **Project Total** | **100,000 $m^3$** | **n a** | **1,770,000** |

Notes on this costing:

The *Pelican* is based in New Zealand, so the cost of mobilisation is based on mobilisation from New Zealand. Nevertheless the *Pelican* is regularly working in Australia (for example once every one or two years it undertakes work at Lakes Entrance) and a substantial saving could be made/negotiated on the cost of mobilisation if the dredging in Port Fairy could be coordinated with another contract in Australia.

The estimated cost includes all running costs for the entire *Pelican* spread, including mooring pontoon, pipelines and incidental land based equipment. It also includes site overheads, head office overheads and profit; but does not include any contingencies or any fees for project design or contract management.

All dredging activity is assumed to be during a period of reasonably calm weather.
The estimated dredging cost is based on the *Pelican* operating 24 hours per day, 7 days per week. This is standard operating conditions in the dredging industry.

## 4.2 Sand from Lady Bay, Warrnambool

### *4.2.1 Suitability of Sand*

This sand effectively has the same characteristics as the in-situ sand on East Beach and that immediately offshore. Therefore it is as equally suitable for beach nourishment purposes as the sand source offshore of East Beach.

### *4.2.2 Sand Extraction Method and Cost*

The sand is directly accessible from the foreshore. Consequently excavation would be by land-based earthmoving equipment. The costs therefore relate to:

- Any royalties that are applied by government agencies;
- Sand extraction from the beach and placement into on-road trucks;
- Road haulage to beach access locations along East Beach;
- Spreading of the sand at East Beach from the dump location into the foreshore area being nourished.

The following costs are estimated for sand supplied from Lady Bay at Warrnambool:

- Allowing for loading/unloading of sand in a restricted space, along with a haulage rate of $5/km for a 35 tonne truck, the overall haulage cost from Lady Bay to East Beach is estimated at $10/tonne.
- The cost of loading and spreading the sand will relate to daily equipment hire rates at the extraction and delivery sites. An allowance for three items of plant at a daily rate of $1,500 plus a supervisor equates to $5,000 per day. Using eight trucks would move about 1,400 tonnes of sand per day. Therefore the loading and distributing cost is approximately $4/tonne.
- The actual requirement is for 100,000 cubic metres of placed sand. Allowing for a sand density of 1.6t/$m^3$ then 160,000 tonnes of sand is required - at a rate of approximately $14/tonne.
- This equates to a total cost of $2.25 million. Any royalties need to be added to this amount.

## 4.3 Sand from South of the Moyne River Training Walls

### *4.3.1 Suitability of Sand*

This sand has effectively the same characteristics as the in-situ sand on East Beach and that immediately offshore. Therefore it is as equally suitable for beach nourishment purposes as the sand source offshore of East Beach.

The primary issue regarding the viability of this sand source at this point is whether there is sufficient sand available to warrant establishing the systems and methodology to extract it and place it on East Beach. The upper limit on the quantity of accessible sand is estimated at approximately 60,000 cubic metres, however it is possible that as little as 30,000 cubic metres may be available due to the actual thickness of the sand beds being less than assumed.

### *4.3.2 Sand Extraction Method and Cost*

For the purpose of costing this alternative it is assumed that 40,000m$^3$ would be available from this source and the balance (60,000m$^3$) would be from either dredging offshore of East Beach or supplied from Lady Bay, Warrnambool. It is anticipated a double handling system would be required for the locally derived sand as indicated in Figure 4.7.

Sand would need to be excavated from the available areas on the south of the river and placed in the river. The Port Fairy based Cutter Suction Dredger *Cormorant* would then dredge this placed sand and pump it onto the beach north of the river (as occurs under existing sand by-passing practices).

In its present configuration, it is estimated that the *Cormorant* can dredge approximately 50 m$^3$ per hour. This production was achieved during a campaign in Warrnambool with sand of similar characteristics. The land based operations (ie. excavation and placement into the river) would need to match this production so as to prevent unacceptable shoaling of the river entrance. However this could be easily accommodated.

It is anticipated that the booster pump belonging to the *Cormorant* spread would be placed in the pipeline system to facilitate placement along the beach - thereby avoiding land-based operations of loading and trucking on the beach itself. Sand placement would therefore be similar to that shown in Figure 4.5.


Figure 4.7 : Sand transport from south of Moyne River

The costing for such activities is as follows:

- Based on a 6 day working-week of 10 hrs per day; the operational time per week would be 60 hours.
- The estimated operating efficiency would be approximately 70%, say 40 hrs/wk.
- The estimated production per week is therefore: 40 hrs @ 50 $m^3$/hr = 2,000 $m^3$/wk.
- For 40,000 $m^3$ the time required would therefore be 40,000 / 2,000 = 20 weeks.

The estimated cost in addition to the present dredging cost in Port Fairy is $16,000 per week. For this costing it is assumed that the balance of the sand would be derived from Lady Bay Warrnambool.

The estimated cost of excavation work south of the training walls and placement of extracted sand into the river is approximately $5 per $m^3$.

| Activity | Quantity | Per unit $ | Totals $ |
|---|---|---|---|
| From Lady Bay land based transport | 60,000 $m^3$ | 22.50 | 1,350,000 |
| Excavate and place in river | 40,000 $m^3$ | 5.00 | 200,000 |
| Dredge from river and pump to beach | 40,000 $m^3$ | 8.00 | 320,000 |
| **Project Total** | **100,000 $m^3$** | | **1,870,000** |

The alternative of supplying the additional sand from offshore of East Beach by means of a dredge is much more expensive because of mobilisation costs. Such a methodology would cost in excess of $2.5 million. Any royalties that may be charged for Lady Bay sand need to be added to this cost.

## 4.4 Sand from the Glenelg River System

### *4.4.1 Suitability of Sand*

Coarse sand from the Glenelg River system is a suitable alternative to the finer sand currently on East Beach. From the sand samples gathered, it appears that sand with a $D_{50}$ of 0.8mm is available - provided sufficient notice is provided to the supplier in order to extract and stockpile the sand. The advantages of a coarse sand are:

- The rate of sand movement along the beach is likely to be at least 20% less than for the natural fine sand.
- Coarse sand tends not to move offshore during storms; in fact sand with a $D_{50}$ of 0.8mm or greater is likely to move up the beach to create storm berms rather than move offshore into sand bars.
- Even for a medium coarse sand with $D_{50}$ = 0.5mm, it is estimated that the extent of beach erosion due to offshore transport during a storm is only around 20% of that moved offshore for a fine 0.2mm sand.
- Coarse sand moving landward during a storm means that there would be a reduced tendency for scour at the toe of the existing seawall.

Disadvantages relate to the changed visual appearance of the beach. The beach will tend to have a hybrid slope with the existing sand located on the seaward side of the beach at the existing gentle slope of approximately 1 : 40 whilst the coarse sand will tend to be located on the upper beach with a slope of about 1 : 10 (as illustrated in Figure 4.8).


Figure 4.8 : Coarse sand beach on an existing fine sand base

Figure 4.8 has been drawn approximately to scale in relation to the seawall that was recently reconstructed at the eastern end of the beach. The volume of sand shown equates to about 8m$^3$/metre length of beach. If this quantity of sand was placed along the entire length of the East Beach seawall, then the total quantity of sand required is about 20,000 cubic metres. Doubling this quantity would provide a substantial buffer on the upper beach.

Placing 40,000 cubic metres of coarse sand from the Glenelg River system onto East Beach would provide a benefit at least equal to that provided by re-nourishing with 100,000 cubic metres of finer sand matching that currently on East Beach.

This coarse sand will tend to stay on the upper beach and move along the foreshore under the influence of longshore transport by waves. The active beach width over which most of the longshore transport occurs will extend to at least one metre below low water, that is a width (with the existing fine sand) of at least 100 metres. That is, the net annual longshore transport for the existing beach is about 20,000 cubic metres. With the added coarse sand, about 80 metres of this width is fine sand and the upper 20 metres of the cross-shore profile is coarse sand.

It follows that about 20% of the longshore transport occurs over the coarse sand beach. Assuming conservatively that coarse sand moves along the beach at the same rate as fine sand, then the longshore transport of coarse sand will be about 4,000 cubic metres per year.

In order to maintain an upper beach area of coarse sand in the longer term, it will be necessary to place up to 4,000 cubic metres of coarse sand annually at the southern end of the beach, or provide a stockpile that can be accessed on an "as-needs" basis for intermittent nourishment campaigns.

The above discussion addresses the requirements to nourish of East Beach along the developed foreshore fronting the existing seawall. Nevertheless, coarse sand could also provide an immediate benefit if placed at the toe of the eroding dunes to the east of the seawall.

### 4.4.2 Sand Extraction Method and Cost

During the site visit in March 2013, indicative costs for supplying sand were offered by the accompanying senior staff from Vickery Bros. The largest cost component relates to road transport since the average haul distance from where the sand might be extracted to East Beach is about 150 kilometres.

The following costs are estimated for sand supplied from the Glenelg River system:

- Extracting the sand, screening it to remove debris and unsuitable sizes; and then loading it into trucks is estimated at about \$12/tonne or \$20/$m^3$.
- The haulage cost using trucks with a 35 tonne payload equates to \$60/$m^3$.
- In addition there will be the cost of placing the sand on East Beach. It is recommended that the sand be spread along the toe of the existing seawall to form a profile shown schematically in Figure 4.8. Spreading the sand in this way is estimated to cost an additional \$5/$m^3$ .
- This yields a total cost of \$85/$m^3$ to supply and place sand from the Glenelg River system onto East Beach.
- About 40,000$m^3$ of sand is required in order to provide a benefit commensurate with, or better than, that achieved by re-nourishing with 100,000$m^3$ of fine sand.
- The project cost is therefore approximately \$3.4 million.

## 4.5 Coarse Sand Sourced from Offshore of Hopkins River, Warrnambool

### 4.5.1 Suitability of Sand

Discussions in this section need to be qualified by noting that this sand source has not been proven to be feasible with regard to the exact size of any available sand - nor the quantity of sand that might be available for extraction.

As discussed previously, coarse sand from the Glenelg River is only about 50% more expensive than using fine local sand when considering a haul distance of about 300 kilometres. However it offers a better long term outcome and there is merit in pursuing this option where a dredge steaming distance from the source to East Beach is only about 20 kilometres.

For the purpose of this exercise it is assumed that a sufficient quantity of sand with a $D_{50}$ sizing in the range of 0.5mm to 0.8mm is available. The nominal quantity of sand required is 40,000 cubic metres.

### 4.5.2 Sand Extraction Method and Cost

A small trailing hopper dredge (trailer) such as the *Pelican* could dredge the coarse sand from offshore of Hopkins River at Warrnambool, then sail to Port Fairy and place that sand on the beach. A rate of approximately 13,000 $m^3$ per week over a 24 hours operating day would typically be achieved.

The method for dredging and placement of sand would be similar to that described previously in Section 4.1. The operational cycle would consist of dredging, sailing to the mooring pontoon, connecting to the pontoon and pipeline, discharging by pumping the material from the hopper, disconnecting and sailing back to the dredging site.

The overall cycle time for delivering sand from offshore of the Hopkins River is almost twice as long as for sand dredged from offshore of Port Fairy - primarily because of the substantial longer sailing time from the dredge area to the pumping station. The effective cargo would be smaller, 550 $m^3$ of sand instead of 650 $m^3$ per trip. Therefore the estimated production of the *Pelican* would be approximately 11,000 $m^3$ per week for delivering sand from offshore of the Hopkins River to East Beach.

Land-based equipment would only be required on an interim basis and only for assistance with shifting / extending the delivery pipeline. Profiling the beach by bulldozer or truck transport would not be necessary.

The estimated cost of the *Pelican* spread is approximately $ 260,000 per week - so the overall project cost is therefore $ 260,000/11,000 per $m^3$ = $ 23.64 per $m^3$, say $ 24 per $m^3$.

| Activity | Quantity | Per unit $ | Totals $ |
|---|---|---|---|
| Mobilisation + installation | item | 530,000 | 530,000 |
| Dredge and place | 40,000 $m^3$ | 24 | 960,000 |
| Demobilisation | item | 240,000 | 240,000 |
| **Project Total** | **40,000 $m^3$** | **n a** | **1,730,000** |

## 4.6 Summary of Estimated Costs for Sand Sourcing Options

The table below presents a summary of the estimated costs of using the various potential sources of sand for beach nourishment of East Beach.

| Potential Sand Source | Sand Type | Quantity | Estimated Cost |
|---|---|---|---|
| Offshore of East Beach | similar to East Beach | 100,000 $m^3$ | $1,770,000 |
| Lady Bay at Warrnambool | similar to East Beach | 100,000 $m^3$ | $2,250,000 |
| South of Moyne River Entrance [1] | similar to East Beach | 100,000 $m^3$ | $1,870,000 |
| Glenelg River System [2] | coarse sand | 40,000 $m^3$ | $3,400,000 |
| Offshore of Hopkins River [2] | coarse sand | 40,000 $m^3$ | $1,730,000 |

Notes :

3. Assumed that 40,000$m^3$ is available from this source; but the balance of 60,000$m^3$ is sourced from Lady Bay at Warrnambool.
4. Due to the sand being much coarser than the native sand on East Beach, only 40,000 $m^3$ is needed to provide a benefit commensurate with that achieved by using 100,000 $m^3$ of the finer sand from other sources.

# 5 ENVIRONMENTAL ASPECTS AND APPROVALS

## 5.1 Placement of Sand on East Beach

Irrespective of the source of sand, environmental approval under the Victorian *Coastal Management Act 1995* would be required for the placement of sand on the beach. It is also possible that a Planning Permit would need to be obtained from Moyne Shire Council. This section considers the particular values of East Beach and what environmental issues should be considered.

### *5.1.1 Available information about environmental values of East Beach*

While the Victorian Coastal Strategy (2008) provides generic guidance as to protecting natural and cultural values along the Victorian coastline, it does not give specific information about the values of East Beach or its surrounds.

The ECC (2000) *Marine Coastal & Estuarine Investigation Final Report* indicates that East Beach falls within the Coastal Recreational Zone; while Griffiths Island falls within the Coastal Protection Zone (refer to Figure 5.1).

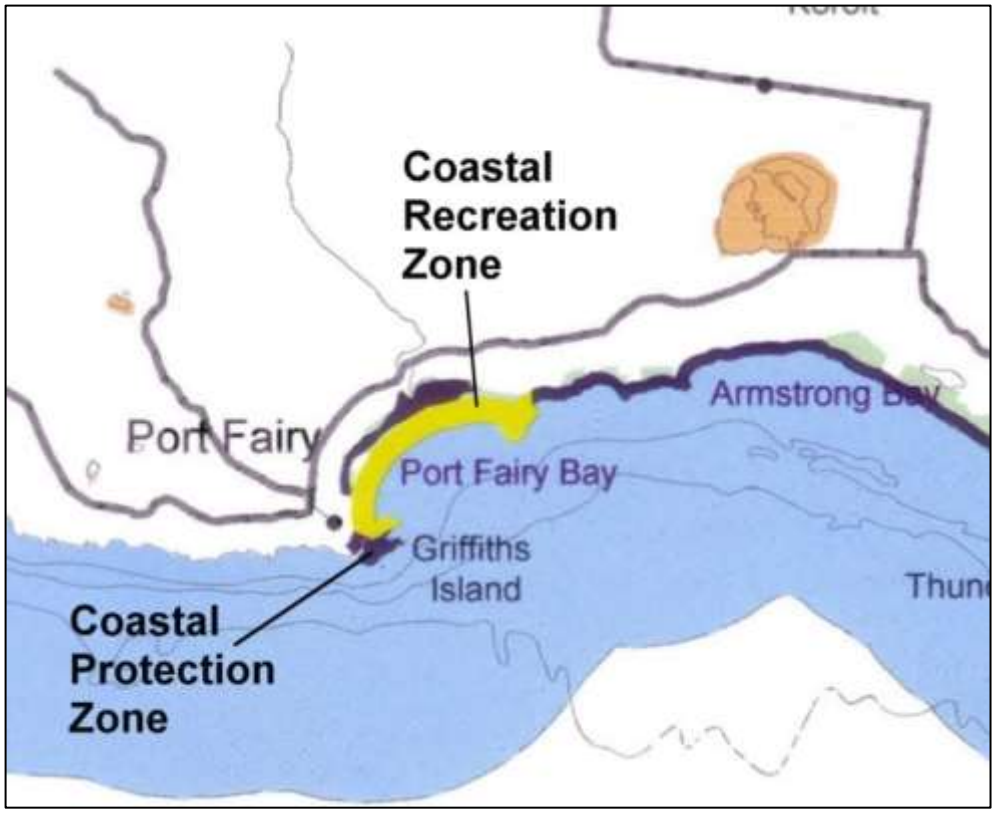



Figure 5.1 : Modified extract from Map A of ECC(2000)

ECC (2000) makes the following comments about these two zones:

> *"The Coastal Recreational Zones are capable of sustaining recreation for larger numbers of people, and should be managed for appropriate recreational use whilst minimising impacts on remnant vales and the coastal environment".*
>
> *"The Coastal Protection Zones should be managed to provide for conservation, or low impact recreation consistent with protection of the natural values of the areas."*

Insights into the nature of the East Beach area can be found in the Ministry of Conservation (1980) Publication 199 "*The Distribution of Important Biological Communities of the Victorian Coastline*" which provides specific maps for the Victorian coast. An extract of Map Sheet 4 of this series is shown in Figure 5.2.

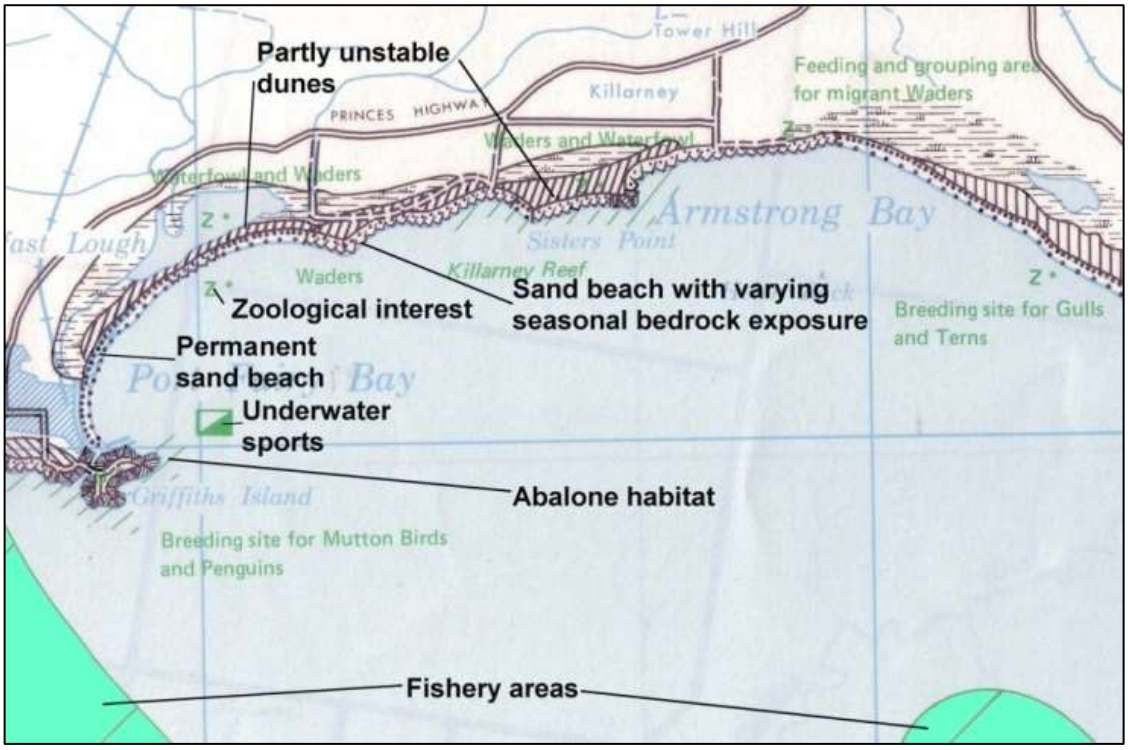



Figure 5.2 : Modified extract of Map Sheet 4 from Ministry of Conservation (1980)

Figure 5.2 recognises the importance of Griffith Island as a breeding area for Mutton Birds (generally known as Shearwaters) and penguins, and the reefs around Griffith Island as an abalone habitat. It also shows natural values for wading birds along some beach areas.

Moyne Shire (2004) published a number of maps showing sites of biodiversity significance. An extract from Map 3 of this series is shown in Figure 5.3.

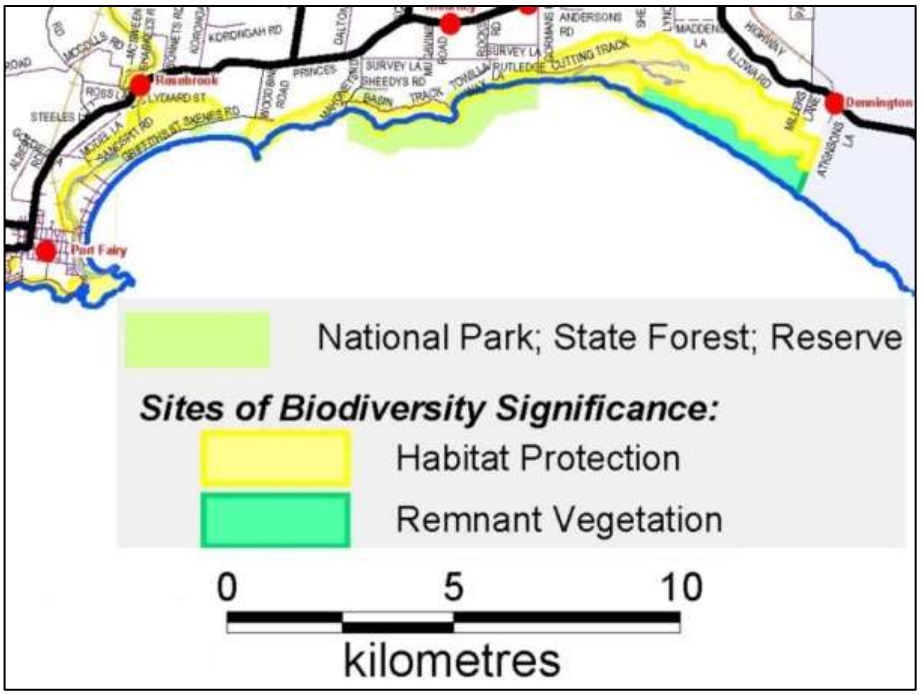



Figure 5.3 : Extract from Map 3 of Moyne Shire 2004

East Beach was not assigned any particular habitat protection or remnant vegetation status.

A final source of information about natural values at and around East Beach was obtained by obtaining a Protected Matters Report from the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act* website. Figure 5.4 shows the search area (including a 1 km buffer) for which the Protected Matters Report was obtained.


Figure 5.4 : EPBC Act Protected Matters Report area

A summary from the above report is offered in Table 5.1. The full report is presented in Appendix B.

| | |
|---|---|
| World Heritage Properties: | None |
| National Heritage Places: | None |
| Wetlands of International | None |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Areas: | None |
| Threatened Ecological Communities: | 2 |
| Threatened Species: | 43 |
| Migratory Species: | 55 |

Table 5.1: Summary from Protected Matters report

Both the identified Threatened Ecological Communities in the report are terrestrial and would not be affected by sand placement on East Beach. The listed threatened and migratory species include marine fauna species - some of which could be likely to live in or pass through Port Fairy Bay.

### *5.1.2 Preliminary assessment of likely environmental impacts of placement activities*

Insofar as East Beach is part of a dynamic system and has received renourishment operations in the past, it is unlikely that further placement of sand would have significant deleterious environmental impacts on the beach area habitat itself. While is possible that the physical action of placement could disturb sea birds roosting or feeding on the beach, such disturbance would be short-lived and is not considered likely to significantly adversely affect these birds.

The use of dredged material placed as a slurry (ie. a pumped mixture of sand and water) to re-nourish beaches is quite a common practice worldwide to mitigate beach erosion, and where suitable sand can be readily sourced. During such operations it is likely that the return water running back into the sea will cause a local increase in turbidity.

As discussed in Section 4, sand from Port Fairy Bay (or other source areas for which dredging options have been considered) has similar properties to the sand already on East Beach - or in some cases it may even be coarser. As a consequence, deposition of this material could be expected to generate turbidity levels at the deposit point which would be similar to that occurring naturally along the entire length of East Beach due to ordinary wave action.

Furthermore, any local turbidity caused by sand placement activities would be short-term since the entire dredging program is expected to be completed within a few weeks. Consequently, it is not expected that marine habitats adjacent to the beach would be significantly adversely affected.

If the sand material was to be placed on the beach by trucks, then it could be expected that wave action working on the placed material could also result in a local increase in turbidity. However this would be of a smaller magnitude than that resulting from placement of dredge slurry because (i) the material would be placed dry rather than mixed with water; and (ii) in some cases the material would be coarser than the dredged material.

## 5.2 Option 1: Sand sourced from offshore of East Beach

This option requires the dredging of sand from Port Fairy Bay to a net depth of 0.5 metres across an area of 2ha (approximately 2 kilometres long by 100 metres wide).

Because the material is to be placed on the beach generally above the low water mark (but still within the nearshore dynamic coastal system), it is unlikely that a Sea Dumping Permit under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* would be required. However, it is recommended that this opinion be confirmed by formal enquiry of the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC).

At the State level, this option would require approval under the Victorian *Coastal Management Act 1995.* Environmental aspects to be considered under this approval would include the natural and cultural values of the dredge area, together with the physical and chemical properties of the material to be dredged. Applications for Coastal Management Act consent are required to document what public consultation has taken place. The Community Updates about East Beach already issued by Moyne Shire Council and the establishment of the inter-agency Port Fairy Working Group demonstrate an awareness of the need to keep citizens fully informed about plans and issues.

It is likely that the dearth of detailed information presently available about the natural values of the seabed to be dredged may prompt regulators to require a marine ecological survey of the area concerned. It is recommended that such an investigation be undertaken should this sand sourcing option be preferred.

The presence of historic wreck(s) in Port Fairy Bay are relevant in terms of local cultural values (refer to Figure 5.5). The proposed dredging area would need to be defined in consultation with Heritage Victoria to avoid disturbing any identified wreck sites.

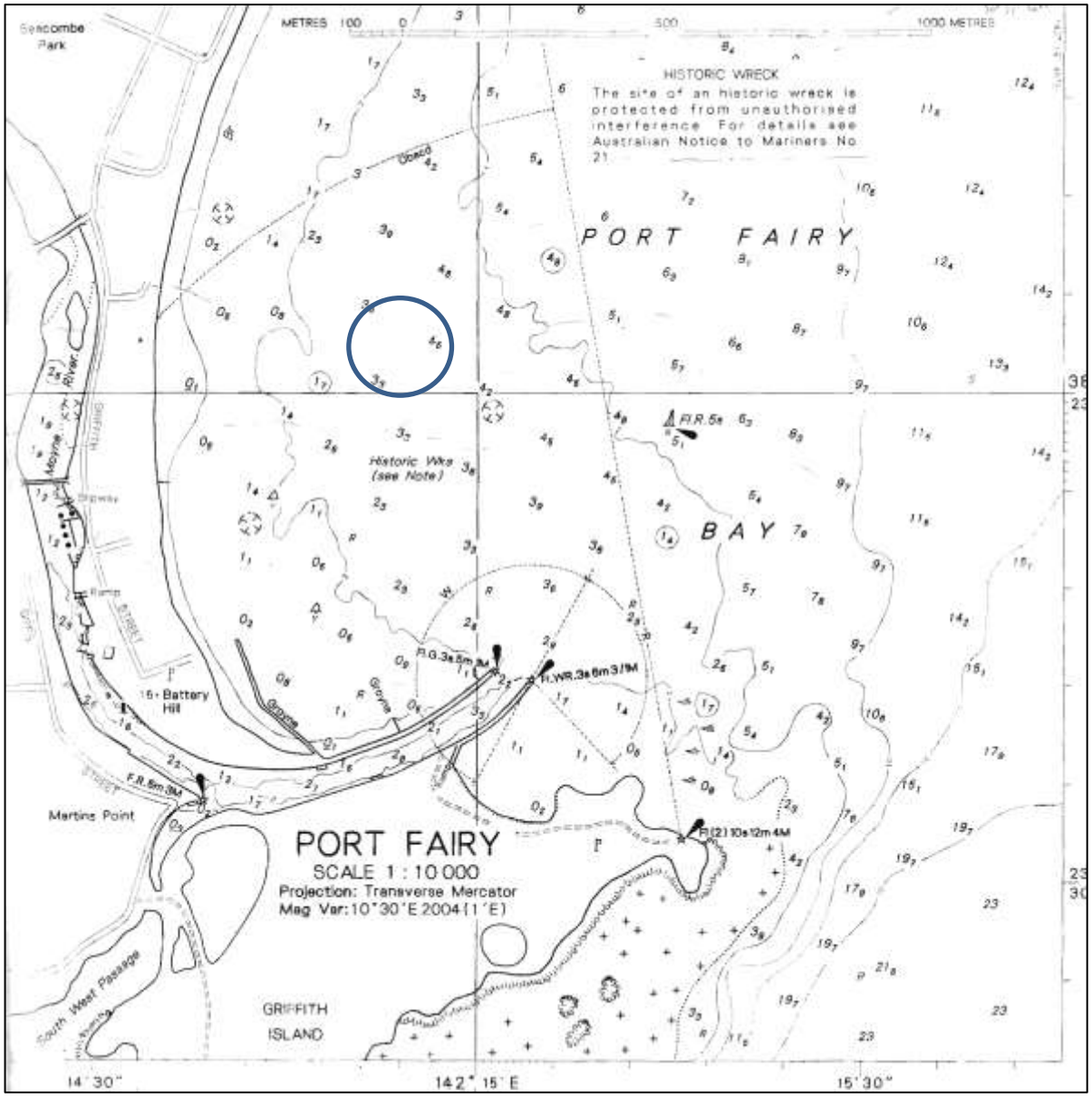



Figure 5.5 : Modified extract of chart of Port Fairy Bay (from AUS 141)

Under the State Dredging Guidelines (EPA 2001), it is necessary to categorise the physical and chemical nature of the material to be dredged. For a project of the proposed size (dredging 100,000 cubic metres), typically 3 to 6 locations should be taken. Insofar as the dredging would only remove an average a depth of 0.5 metres, a single core sample at each of these locations should suffice. It is recommended that should sediment sampling be proposed,

a Sampling and Analysis Plan (SAP) be prepared and discussed with the Department of Environment and Primary Industries (DPEI) and EPA Victoria to confirm its acceptability before proceeding.

The Commonwealth EPBC Act requires that any action that may affect matters of National Environmental Significance must be referred to DSEWPAC. As already indicated above, there is limited information available about the marine ecosystem at and around the proposed dredge area in Port Fairy Bay. The marine ecological survey already recommended would provide the necessary data to make an informed decision about whether a referral to the Commonwealth would be warranted.

## 5.3 Option 2: Sand sourced from Lady Bay, Warrnambool

Reputedly Warrnambool City Council would like to have the excess sand that has accumulated on the beach of Lady Bay removed. Consent under the *Coastal Management Act* would normally be required for this proposed removal.

## 5.4 Option 3: Sand sourced from South of the Moyne River Training Walls

Consent under the *Coastal Management Act* would be required for this sand sourcing option. Since the areas from which sand would be extracted are directly alongside the Shearwater colony on Griffith Island (refer to Figure 5.6), it is likely that a detailed examination of potential ecological impacts of the proposed operations would be required.

The status of Griffith Island as a Coastal Conservation Zone (refer to section 5.1.1) signals its recognised natural values - which regulators would wish to protect should any sand extraction operation be contemplated.

Under the proposed double handling operation, material would need to be placed in the river and then dredged for placement on East Beach. The potential impacts of the temporary placement of material on the river bed would also need to be ascertained. Possible impacts could include direct smothering of habitat in the river, creation of turbidity by the dumping process, and potentially disrupting the movement of fish and/or other aquatic fauna up or down the river.

As dredging would be involved, compliance with the requirements of the State Dredging Guidelines would be obligatory. Discussion with DPEI and EPA Victoria is recommended to establish the scope of what sediment quality investigation may be required.

Figure 5.6 : Edge of Puddney Ground on Griffith island abutting Shearwater habitat
(sign reads “Shearwater Colony Area Please Keep off”

The result of investigations alluded to above, namely the potential impact of the land excavation of the material, and the impact of the temporary dumping of material on the river bed, would be required in order to make an informed decision about whether a referral to the Commonwealth under the EPBC Act would be warranted.

Depending upon the Town Planning Scheme, a Municipal Planning Permit may also be needed.

## 5.5 Option 4: Sand from the Glenelg River System

Discussion with Vickery Bros Pty Ltd indicated that in the short- or even medium-term, the existing areas of sand extraction (which have the necessary permissions) would unlikely be able to reliably provide a sufficient volume of sand (40,000 cubic metres, see section 4.4.2). Accordingly, this discussion assumes that new extraction areas would need to be established within the Glenelg River system.

In Victoria, areas around waterways are designated as being of cultural heritage sensitivity, and the *Aboriginal Heritage Regulations 2007* under the *Aboriginal Heritage Act 2006* require that a Cultural Heritage Management Plan (CHMP) be prepared for any high impact activity within such an area. Sand extraction activities would be considered a high impact activity.

A CHMP comprises an assessment of an area to determine the nature of Aboriginal cultural heritage. The findings of the assessment must be reported along with recommendations for measures to manage and protect all identified Aboriginal cultural heritage issues - before, during and after the activity. It is estimated that the cost of having a CHMP undertaken could be around $25,000.

Other permits and permissions which would need to be obtained for a new sand extraction operation could include:

- A Municipal Planning Permit
- Permission from the land owner
- A work authority from the waterway manager (Catchment Management Authority).
- Extraction licence

It is also possible that some testing of material at a new site may be required to confirm its acid sulfate status (EPA 2009(a)) and “fill material” status (EPA 2009(b)).

As with the other sand source options already discussed, whether or not a referral under the Commonwealth EPBC Act would be necessary could only be determined on a case by case basis. Such determinations would need to consider potential threats to the natural values of the area in question. Ecological surveys could be necessary in order to make an informed decision in this respect.

## 5.6 Option 5: Coarse Sand Sourced from Offshore of Hopkins River

Since the method for extraction and placement of this sand would be similar to that outlined for offshore material in Port Fairy Bay, the environmental approvals and issues as discussed in Section 5.2 would apply to this option.

# 6 REFERENCES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# APPENDIX A: Sand Gradings Offshore of East Beach

COASTAL ENGINEERING SOLUTIONS

## Particle size distribution and consistency limits test report

AS 1289 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1, 3.6.1 and AS 1726 Appendix A (Sec. A2)

Golder Associates

| | | | |
|---|---|---|---|
| **Test request #:** | TR-1300104 | **Lab sample ID:** | 1300635 |
| **Client:** | Coastal Engineering Solutions Pty Ltd | | |
| **Client address:** | 600 Burwood Rd Hawthorn East Melb Vic 3123 | | |
| **Project ID:** | 137612048 | **Location ID:** | Sa 04 |
| **Project name:** | Not supplied | | |
| **Location:** | Melbourne | **Locale:** | |


Golder Associates Pty Ltd
MELBOURNE GEOTECHNICAL LABORATORY
Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond, Victoria 3121


**Sample depth (m):** n/a
**Client sample ref:** 18,19,20 - DS

**Laboratory sample classification:**
AS 1726 Appendix A, Section A2
(includes visual,tactile classification in the absence of relevant test results)

SP, SAND, fine, grey, trace non-plastic fines

| PARTICLE SIZE DISTRIBUTION AS1289 3.6.1 | | | |
|---|---|---|---|
| Sieve Size | % Passing | LB S | UB S |
| 125 mm | 100 | | |
| 75 mm | 100 | | |
| 63 mm | 100 | | |
| 53 mm | 100 | | |
| 37.5 mm | 100 | | |
| 26.5 mm | 100 | | |
| 19.0 mm | 100 | | |
| 13.2 mm | 100 | | |
| 9.5 mm | 100 | | |
| 6.7 mm | 100 | | |
| 4.75 mm | 100 | | |
| 2.36 mm | 100 | | |
| 1.18 mm | 100 | | |
| 600 µm | 100 | | |
| 425 µm | 100 | | |
| 300 µm | 99 | | |
| 150 µm | 49 | | |
| 75 µm | 5 | | |

| Method: | AS 1289 2.1.1 | AS1289 3.1.2 | AS1289 3.2.1 | AS 1289 3.3.1 | AS 1289 3.4.1 | AS 1289 3.4.1 |
|---|---|---|---|---|---|---|
| | Moisture content (%) | Liquid limit (%) | Plastic limit (%) | Plasticity index (%) | Linear shrinkage (%) | Curling/ Crumbling/ Cracking |
| Result: | 19.0 | ND | ND | ND | ND | ND |
| LB S: | | | | | | - |
| UB S: | | | | | | - |

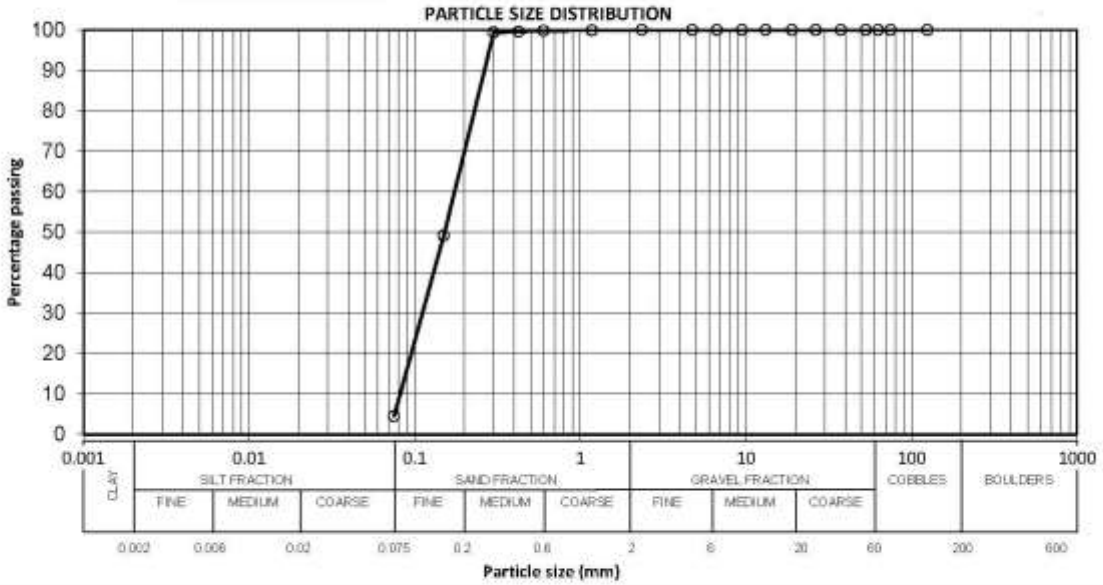
**Preparation method:** Dry Sieved **LSM length (mm):** N/A

**Sample history & comments:** Oven dried

**Definitions:** LB S = Lower bound specification; UB S = Upper bound specification
NP = Non plastic; NO = Not obtainable; ND = Not determined
N/A = Not applicable; Sec. = Section; LSM = Linear shrinkage mould

**GRADING SUMMARY**

| Fines (<75 µm) | Sand (>75 µm - <2 mm) | Gravel (>2 mm - <60 mm) | Cobbles (>60mm - <200 mm) |
|---|---|---|---|
| 4.5 % | 95.5 % | - | - |




**Testing performed by:** AHM, SMT **Results reviewed by:** DJG **Date reported:** 17-Apr-13

**Certificate reference:** 137612048_1300635_TR-1300104_PSD_Rev0

**Approved signatory:**

NATA

**NATA accreditation number: 1961 Melbourne**

Accredited for compliance with ISO/IEC 17025



David Giltinan

COASTAL ENGINEERING SOLUTIONS

## Particle size distribution and consistency limits test report

AS 1289 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1, 3.6.1 and AS 1726 Appendix A (Sec. A2)

Golder Associates

| | | | |
|---|---|---|---|
| **Test request #:** | TR-1300104 | **Lab sample ID:** | 1300634 |
| **Client:** | Coastal Engineering Solutions Pty Ltd | | |
| **Client address:** | 600 Burwood Rd Hawthorn East Melb Vic 3123 | | |
| **Project ID:** | 137612048 | **Location ID:** | Sa 03 |
| **Project name:** | Not supplied | | |
| **Location:** | Melbourne | **Locale:** | |


Golder Associates Pty Ltd
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Richmond, Victoria 3121


**Sample depth (m):** n/a
**Client sample ref:** 12,13,14 - DS

**Laboratory sample classification:**
AS 1726 Appendix A, Section A2
(includes visual,tactile classification in the absence of relevant test results)

SP, SAND, fine to medium, grey, trace non-plastic fines

| PARTICLE SIZE DISTRIBUTION AS1289 3.6.1 | | | |
|---|---|---|---|
| Sieve Size | % Passing | LB S | UB S |
| 125 mm | 100 | | |
| 75 mm | 100 | | |
| 63 mm | 100 | | |
| 53 mm | 100 | | |
| 37.5 mm | 100 | | |
| 26.5 mm | 100 | | |
| 19.0 mm | 100 | | |
| 13.2 mm | 100 | | |
| 9.5 mm | 100 | | |
| 6.7 mm | 100 | | |
| 4.75 mm | 100 | | |
| 2.36 mm | 100 | | |
| 1.18 mm | 100 | | |
| 600 µm | 100 | | |
| 425 µm | 100 | | |
| 300 µm | 99 | | |
| 150 µm | 50 | | |
| 75 µm | 4 | | |

| Method: | AS 1289 2.1.1 | AS1289 3.1.2 | AS1289 3.2.1 | AS 1289 3.3.1 | AS 1289 3.4.1 | AS 1289 3.4.1 |
|---|---|---|---|---|---|---|
| | Moisture content (%) | Liquid limit (%) | Plastic limit (%) | Plasticity index (%) | Linear shrinkage (%) | Curling/ Crumbling/ Cracking |
| Result: | 28.8 | ND | ND | ND | ND | ND |
| LB S: | | | | | | - |
| UB S: | | | | | | - |

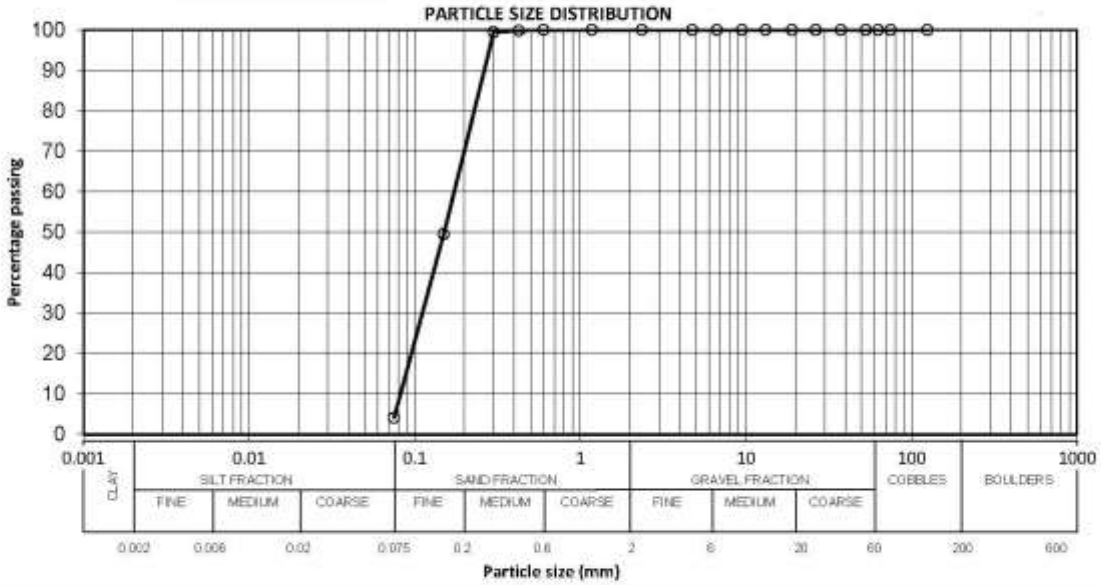
**Preparation method:** Dry Sieved **LSM length (mm):** N/A

**Sample history & comments:** Oven dried

**Definitions:** LB S = Lower bound specification; UB S = Upper bound specification
NP = Non plastic; NO = Not obtainable; ND = Not determined
N/A = Not applicable; Sec. = Section; LSM = Linear shrinkage mould

**GRADING SUMMARY**

| Fines (<75 µm) | Sand (>75 µm - <2 mm) | Gravel (>2 mm - <60 mm) | Cobbles (>60mm - <200 mm) |
|---|---|---|---|
| 4.1 % | 95.9 % | - | - |




**Testing performed by:** AHM, GLC **Results reviewed by:** DJG **Date reported:** 17-Apr-13

**Certificate reference:** 137612048_1300634_TR-1300104_PSD_Rev0

**Approved signatory:**

NATA

**NATA accreditation number: 1961 Melbourne**

Accredited for compliance with ISO/IEC 17025



David Giltinan

These tests were carried out in general accordance with the Australian standards identified in this certificate.

COASTAL ENGINEERING SOLUTIONS

## Particle size distribution and consistency limits test report

AS 1289 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1, 3.6.1 and AS 1726 Appendix A (Sec. A2)

Golder Associates

| | | | |
|---|---|---|---|
| **Test request #:** | TR-1300104 | **Lab sample ID:** | 1300633 |
| **Client:** | Coastal Engineering Solutions Pty Ltd | | |
| **Client address:** | 600 Burwood Rd Hawthorn East Melb Vic 3123 | | |
| **Project ID:** | 137612048 | **Location ID:** | Sa 02 |
| **Project name:** | Not supplied | | |
| **Location:** | Melbourne | **Locale:** | |


Golder Associates Pty Ltd
MELBOURNE GEOTECHNICAL LABORATORY
Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond, Victoria 3121


**Sample depth (m):** n/a
**Client sample ref:** 3,4,5,6,9 - DS

**Laboratory sample classification:**
AS 1726 Appendix A, Section A2
(includes visual,tactile classification in the absence of relevant test results)

SP, SAND, fine to medium, grey, trace non-plastic fines

**PARTICLE SIZE DISTRIBUTION** AS1289 3.6.1

| Sieve Size | % Passing | LB S | UB S |
|---|---|---|---|
| 125 mm | 100 | | |
| 75 mm | 100 | | |
| 63 mm | 100 | | |
| 53 mm | 100 | | |
| 37.5 mm | 100 | | |
| 26.5 mm | 100 | | |
| 19.0 mm | 100 | | |
| 13.2 mm | 100 | | |
| 9.5 mm | 100 | | |
| 6.7 mm | 100 | | |
| 4.75 mm | 100 | | |
| 2.36 mm | 100 | | |
| 1.18 mm | 100 | | |
| 600 µm | 100 | | |
| 425 µm | 99 | | |
| 300 µm | 96 | | |
| 150 µm | 49 | | |
| 75 µm | 2 | | |

| Method: | AS 1289 2.1.1 | AS1289 3.1.2 | AS1289 3.2.1 | AS 1289 3.3.1 | AS 1289 3.4.1 | AS 1289 3.4.1 |
|---|---|---|---|---|---|---|
| | Moisture content (%) | Liquid limit (%) | Plastic limit (%) | Plasticity index (%) | Linear shrinkage (%) | Curling/ Crumbling/ Cracking |
| **Result:** | 6.0 | ND | ND | ND | ND | ND |
| **LB S:** | | | | | | - |
| **UB S:** | | | | | | - |

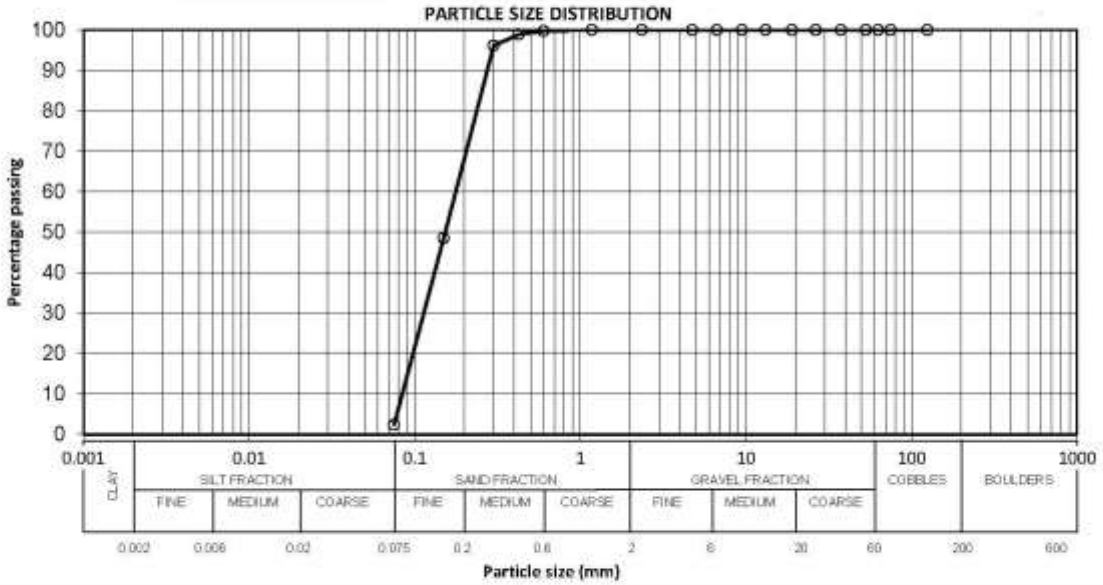
**Preparation method:** Dry Sieved **LSM length (mm):** N/A

**Sample history & comments:** Oven dried

**Definitions:** LB S = Lower bound specification; UB S = Upper bound specification
NP = Non plastic; NO = Not obtainable; ND = Not determined
N/A = Not applicable; Sec. = Section; LSM = Linear shrinkage mould

**GRADING SUMMARY**

| Fines (<75 µm) | Sand (>75 µm - <2 mm) | Gravel (>2 mm - <60 mm) | Cobbles (>60mm - <200 mm) |
|---|---|---|---|
| 2.3 % | 97.7 % | - | - |




**Testing performed by:** AHM, GLC **Results reviewed by:** DJG **Date reported:** 17-Apr-13

**Certificate reference:** 137612048_1300633_TR-1300104_PSD_Rev0

**Approved signatory:**

NATA

**NATA accreditation number: 1961 Melbourne**

Accredited for compliance with ISO/IEC 17025



David Giltinan

These tests were carried out in general accordance with the Australian standards identified in this certificate

COASTAL ENGINEERING SOLUTIONS

## Particle size distribution and consistency limits test report

AS 1289 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1, 3.6.1 and AS 1726 Appendix A (Sec. A2)

Golder Associates

| | | | |
|---|---|---|---|
| **Test request #:** | TR-1300104 | **Lab sample ID:** | 1300632 |
| **Client:** | Coastal Engineering Solutions Pty Ltd | | |
| **Client address:** | 600 Burwood Rd Hawthorn East Melb Vic 3123 | | |
| **Project ID:** | 137612048 | **Location ID:** | Sa 01 |
| **Project name:** | Not supplied | | |
| **Location:** | Melbourne | **Locale:** | |


Golder Associates Pty Ltd
MELBOURNE GEOTECHNICAL LABORATORY
Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond, Victoria 3121


**Sample depth (m):** n/a
**Client sample ref:** 2,7,8,10,11 - DS

**Laboratory sample classification:**
AS 1726 Appendix A, Section A2
(includes visual,tactile classification in the absence of relevant test results)

SP, SAND, fine to medium, grey, trace non-plastic fines

**PARTICLE SIZE DISTRIBUTION** AS1289 3.6.1

| Sieve Size | % Passing | LB S | UB S |
|---|---|---|---|
| 125 mm | 100 | | |
| 75 mm | 100 | | |
| 63 mm | 100 | | |
| 53 mm | 100 | | |
| 37.5 mm | 100 | | |
| 26.5 mm | 100 | | |
| 19.0 mm | 100 | | |
| 13.2 mm | 100 | | |
| 9.5 mm | 100 | | |
| 6.7 mm | 100 | | |
| 4.75 mm | 100 | | |
| 2.36 mm | 100 | | |
| 1.18 mm | 100 | | |
| 600 µm | 100 | | |
| 425 µm | 98 | | |
| 300 µm | 95 | | |
| 150 µm | 36 | | |
| 75 µm | 1 | | |

| Method: | AS 1289 2.1.1 | AS1289 3.1.2 | AS1289 3.2.1 | AS 1289 3.3.1 | AS 1289 3.4.1 | AS 1289 3.4.1 |
|---|---|---|---|---|---|---|
| | Moisture content (%) | Liquid limit (%) | Plastic limit (%) | Plasticity index (%) | Linear shrinkage (%) | Curling/ Crumbling/ Cracking |
| Result: | 9.0 | ND | ND | ND | ND | ND |
| LB S: | | | | | | - |
| UB S: | | | | | | - |

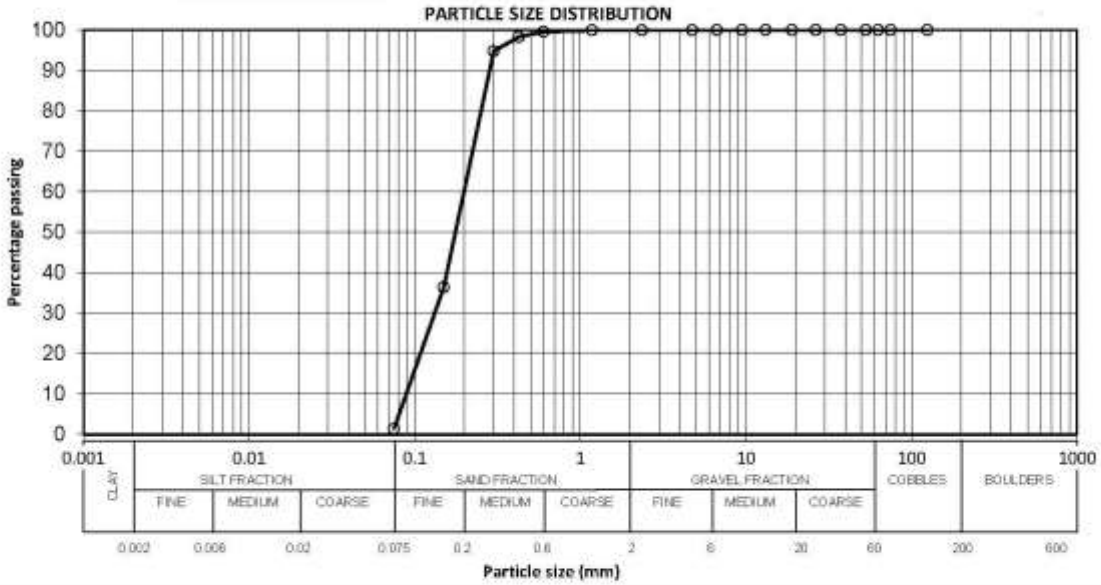
**Preparation method:** Dry Sieved **LSM length (mm):** N/A

**Sample history & comments:** Oven dried

**Definitions:** LB S = Lower bound specification; UB S = Upper bound specification
NP = Non plastic; NO = Not obtainable; ND = Not determined
N/A = Not applicable; Sec. = Section; LSM = Linear shrinkage mould

**GRADING SUMMARY**

| Fines (<75 µm) | Sand (>75 µm - <2 mm) | Gravel (>2 mm - <60 mm) | Cobbles (>60mm - <200 mm) |
|---|---|---|---|
| 1.4 % | 98.5 % | 0.1 % | - |




**Testing performed by:** AHM, GLC **Results reviewed by:** DJG **Date reported:** 17-Apr-13

**Certificate reference:** 137612048_1300632_TR-1300104_PSD_Rev0

**Approved signatory:**

NATA

**NATA accreditation number: 1961 Melbourne**

Accredited for compliance with ISO/IEC 17025



David Giltinan

# APPENDIX B: Protected Matters Report

## *Environmental Protection and Biodiversity Conservation Act*

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

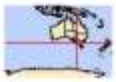
Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Report created: 12/11/12 08:48:22






Coordinates
Buffer: 1.0Km



## Summary

### Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html

| | |
|---|---|
| World Heritage Properties: | None |
| National Heritage Places: | None |
| Wetlands of International | None |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Areas: | None |
| Threatened Ecological Communities: | 2 |
| Threatened Species: | 43 |
| Migratory Species: | 55 |

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.

| | |
|---|---|
| Commonwealth Lands: | None |
| Commonwealth Heritage Places: | None |
| Listed Marine Species: | 85 |
| Whales and Other Cetaceans: | 12 |
| Critical Habitats: | None |
| Commonwealth Reserves: | None |

## Extra Information

This part of the report provides information that may also be relevant to the area you have

| | |
|---|---|
| Place on the RNE: | 41 |
| State and Territory Reserves: | None |
| Regional Forest Agreements: | 1 |
| Invasive Species: | 11 |
| Nationally Important Wetlands: | None |

# Details

## Matters of National Environmental Significance

### Threatened Ecological Communities [ Resource Information ]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

| Name | Status | Type of Presence |
|---|---|---|
| Grassy Eucalypt Woodland of the Victorian Volcanic Plain | Critically Endangered | Community likely to occur within area |
| Natural Temperate Grassland of the Victorian | Critically Endangered | Community may occur |

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

| Name | Status | Type of Presence |
|---|---|---|
| Volcanic Plain | | within area |

**Threatened Species** [Resource Information]

| Name | Status | Type of Presence |
|---|---|---|
| BIRDS | | |
| Botaurus poiciloptilus<br>Australasian Bittern [1001] | Endangered | Species or species habitat known to occur within area |
| Diomedea epomophora epomophora<br>Southern Royal Albatross [25996] | Vulnerable | Species or species habitat may occur within area |
| Diomedea epomophora sanfordi<br>Northern Royal Albatross [82331] | Endangered | Species or species habitat may occur within area |
| Diomedea exulans amsterdamensis<br>Amsterdam Albatross [82330] | Endangered | Species or species habitat may occur within area |
| Diomedea exulans exulans<br>Tristan Albatross [82337] | Endangered | Foraging, feeding or related behaviour may occur within area |
| Diomedea exulans gibsoni<br>Gibson's Albatross [82271] | Vulnerable | Species or species habitat may occur within area |
| Diomedea exulans (sensu lato)<br>Wandering Albatross [1073] | Vulnerable | Species or species habitat may occur within area |
| Halobaena caerulea<br>Blue Petrel [1059] | Vulnerable | Species or species habitat may occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Endangered | Species or species habitat may occur within area |
| Leipoa ocellata<br>Malleefowl [934] | Vulnerable | Species or species habitat may occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant-Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Neophema chrysogaster<br>Orange-bellied Parrot [747] | Critically Endangered | Species or species habitat likely to occur within area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Species or species habitat may occur within area |
| Rostratula australis<br>Australian Painted Snipe [77037] | Vulnerable | Species or species habitat may occur within area |
| Sternula nereis nereis<br>Fairy Tern (Australian) [82950] | Vulnerable | Species or species habitat known to occur |

| Name | Status | Type of Presence within area |
|---|---|---|
| Thalassarche bulleri<br>Buller's Albatross [64460] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche cauta cauta<br>Shy Albatross, Tasmanian Shy Albatross [82345] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche cauta salvini<br>Salvin's Albatross [82343] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche chrysostoma<br>Grey-headed Albatross [66491] | Endangered | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris impavida<br>Campbell Albatross [82449] | Vulnerable | Species or species habitat may occur within area |
| CRUSTACEANS | | |
| Euastacus bispinosus<br>Glenelg Spiny Freshwater Crayfish [81552] | Endangered | Species or species habitat likely to occur within area |
| FISH | | |
| Galaxiella pusilla<br>Eastern Dwarf Galaxias, Dwarf Galaxias [56790] | Vulnerable | Species or species habitat likely to occur within area |
| Nannoperca obscura<br>Yarra Pygmy Perch [26177] | Vulnerable | Species or species habitat likely to occur within area |
| Prototroctes maraena<br>Australian Grayling [26179] | Vulnerable | Species or species habitat likely to occur within area |
| FROGS | | |
| Litoria raniformis<br>Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog [1828] | Vulnerable | Species or species habitat likely to occur within area |
| MAMMALS | | |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Dasyurus maculatus maculatus (SE mainland population)<br>Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184] | Endangered | Species or species habitat may occur within area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Breeding likely to occur within area |
| Isoodon obesulus obesulus<br>Southern Brown Bandicoot (Eastern) [68050] | Endangered | Species or species habitat may occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Species or species habitat likely to occur within area |
| Miniopterus schreibersii bassanii<br>Southern Bent-wing Bat [76606] | Critically Endangered | Species or species habitat may occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Potorous tridactylus tridactylus | | |
| Long-nosed Potoroo (SE mainland) [66645] | Vulnerable | Species or species habitat may occur within area |
| Pteropus poliocephalus | | |
| Grey-headed Flying-fox [186] | Vulnerable | Species or species habitat likely to occur within area |
| PLANTS | | |
| Carex tasmanica | | |
| Curly Sedge [9101] | Vulnerable | Species or species habitat likely to occur within area |
| Prasophyllum frenchii | | |
| Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid, Swamp Leek-orchid [9704] | Endangered | Species or species habitat likely to occur within area |
| Prasophyllum spicatum | | |
| Dense Leek-orchid [55146] | Vulnerable | Species or species habitat likely to occur within area |
| Pterostylis cucullata | | |
| Leafy Greenhood [15459] | Vulnerable | Species or species habitat likely to occur within area |
| Taraxacum cygnorum | | |
| Coast Dandelion [2508] | Vulnerable | Species or species habitat likely to occur within area |
| REPTILES | | |
| Caretta caretta | | |
| Loggerhead Turtle [1763] | Endangered | Breeding likely to occur within area |
| Dermochelys coriacea | | |
| Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat likely to occur within area |
| SHARKS | | |
| Carcharodon carcharias | | |
| Great White Shark [64470] | Vulnerable | Species or species habitat likely to occur within area |

Migratory Species [ Resource Information ]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

| Name | Threatened | Type of Presence |
|---|---|---|
| Migratory Marine Birds | | |
| Apus pacificus | | |
| Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Ardea alba | | |
| Great Egret, White Egret [59541] | | Species or species habitat may occur within area |
| Ardea ibis | | |
| Cattle Egret [59542] | | Species or species habitat may occur within area |
| Diomedea amsterdamensis | | |
| Amsterdam Albatross [64405] | Endangered* | Species or species habitat may occur within area |
| Diomedea dabbenena | | |
| Tristan Albatross [66471] | Endangered* | Foraging, feeding or related behaviour may occur within area |
| Diomedea epomophora (sensu stricto) | | |
| Southern Royal Albatross [1072] | Vulnerable* | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Diomedea exulans (sensu lato) | | |
| Wandering Albatross [1073] | Vulnerable | Species or species habitat may occur within area |
| Diomedea gibsoni | | |
| Gibson's Albatross [64466] | Vulnerable* | Species or species habitat may occur within area |
| Diomedea sanfordi | | |
| Northern Royal Albatross [64456] | Endangered* | Species or species habitat may occur within area |
| Macronectes giganteus | | |
| Southern Giant-Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli | | |
| Northern Giant-Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Puffinus tenuirostris | | |
| Short-tailed Shearwater [1029] | | Breeding known to occur within area |
| Sterna albifrons | | |
| Little Tern [813] | | Species or species habitat may occur within area |
| Thalassarche bulleri | | |
| Buller's Albatross [64460] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche cauta (sensu stricto) | | |
| Shy Albatross, Tasmanian Shy Albatross [64697] | Vulnerable* | Species or species habitat may occur within area |
| Thalassarche chrysostoma | | |
| Grey-headed Albatross [66491] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida | | |
| Campbell Albatross [64459] | Vulnerable* | Species or species habitat may occur within area |
| Thalassarche melanophris | | |
| Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche salvini | | |
| Salvin's Albatross [64463] | Vulnerable* | Species or species habitat may occur within area |
| Migratory Marine Species | | |
| Balaenoptera edeni | | |
| Bryde's Whale [35] | | Species or species habitat may occur within area |
| Balaenoptera musculus | | |
| Blue Whale [36] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Caperea marginata | | |
| Pygmy Right Whale [39] | | Species or species habitat may occur within area |
| Carcharodon carcharias | | |
| Great White Shark [64470] | Vulnerable | Species or species habitat likely to occur within area |
| Caretta caretta | | |
| Loggerhead Turtle [1763] | Endangered | Breeding likely to occur within area |
| Dermochelys coriacea | | |
| Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat likely to occur within area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Breeding likely to occur within area |
| Lagenorhynchus obscurus<br>Dusky Dolphin [43] | | Species or species habitat may occur within area |
| Lamna nasus<br>Porbeagle, Mackerel Shark [83288] | | Species or species habitat likely to occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Species or species habitat likely to occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Migratory Terrestrial Species | | |
| Haliaeetus leucogaster<br>White-bellied Sea-Eagle [943] | | Species or species habitat likely to occur within area |
| Hirundapus caudacutus<br>White-throated Needletail [682] | | Species or species habitat known to occur within area |
| Leipoa ocellata<br>Malleefowl [934] | Vulnerable | Species or species habitat may occur within area |
| Merops ornatus<br>Rainbow Bee-eater [670] | | Species or species habitat may occur within area |
| Myiagra cyanoleuca<br>Satin Flycatcher [612] | | Species or species habitat known to occur within area |
| Neophema chrysogaster<br>Orange-bellied Parrot [747] | Critically Endangered | Species or species habitat likely to occur within area |
| Rhipidura rufifrons<br>Rufous Fantail [592] | | Species or species habitat likely to occur within area |
| Migratory Wetlands Species | | |
| Ardea alba<br>Great Egret, White Egret [59541] | | Species or species habitat may occur within area |
| Ardea ibis<br>Cattle Egret [59542] | | Species or species habitat may occur within area |
| Arenaria interpres<br>Ruddy Turnstone [872] | | Roosting known to occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Roosting known to occur within area |
| Calidris alba<br>Sanderling [875] | | Roosting known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | | Roosting known to occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | | Roosting known to occur |

| Name | Threatened | Type of Presence within area |
|---|---|---|
| Calidris ruficollis<br>Red-necked Stint [860] | | Roosting known to occur within area |
| Charadrius bicinctus<br>Double-banded Plover [895] | | Roosting known to occur within area |
| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | | Roosting known to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | | Roosting known to occur within area |
| Heteroscelus brevipes<br>Grey-tailed Tattler [59311] | | Roosting known to occur within area |
| Numenius minutus<br>Little Curlew, Little Whimbrel [848] | | Roosting likely to occur within area |
| Numenius phaeopus<br>Whimbrel [849] | | Roosting known to occur within area |
| Pluvialis fulva<br>Pacific Golden Plover [25545] | | Roosting known to occur within area |
| Rostratula benghalensis (sensu lato)<br>Painted Snipe [889] | Vulnerable* | Species or species habitat may occur within area |
| Tringa glareola<br>Wood Sandpiper [829] | | Roosting known to occur within area |
| Tringa stagnatilis<br>Marsh Sandpiper, Little Greenshank [833] | | Roosting known to occur within area |

## Other Matters Protected by the EPBC Act

Listed Marine Species [ Resource Information ]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

| Name | Threatened | Type of Presence |
|---|---|---|
| Birds | | |
| Anseranas semipalmata<br>Magpie Goose [978] | | Species or species habitat may occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Ardea alba<br>Great Egret, White Egret [59541] | | Species or species habitat may occur within area |
| Ardea ibis<br>Cattle Egret [59542] | | Species or species habitat may occur within area |
| Arenaria interpres<br>Ruddy Turnstone [872] | | Roosting known to occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Roosting known to occur within area |
| Calidris alba<br>Sanderling [875] | | Roosting known to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Calidris canutus<br>Red Knot, Knot [855] | | Roosting known to occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | | Roosting known to occur within area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Roosting known to occur within area |
| Calidris ruficollis<br>Red-necked Stint [860] | | Roosting known to occur within area |
| Catharacta skua<br>Great Skua [59472] | | Species or species habitat may occur within area |
| Charadrius bicinctus<br>Double-banded Plover [895] | | Roosting known to occur within area |
| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | | Roosting known to occur within area |
| Charadrius ruficapillus<br>Red-capped Plover [881] | | Roosting known to occur within area |
| Diomedea amsterdamensis<br>Amsterdam Albatross [64405] | Endangered* | Species or species habitat may occur within area |
| Diomedea dabbenena<br>Tristan Albatross [66471] | Endangered* | Foraging, feeding or related behaviour may occur within area |
| Diomedea epomophora (sensu stricto)<br>Southern Royal Albatross [1072] | Vulnerable* | Species or species habitat may occur within area |
| Diomedea exulans (sensu lato)<br>Wandering Albatross [1073] | Vulnerable | Species or species habitat may occur within area |
| Diomedea gibsoni<br>Gibson's Albatross [64466] | Vulnerable* | Species or species habitat may occur within area |
| Diomedea sanfordi<br>Northern Royal Albatross [64456] | Endangered* | Species or species habitat may occur within area |
| Eudyptula minor<br>Little Penguin [1085] | | Breeding known to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | | Roosting known to occur within area |
| Gallinago megala<br>Swinhoe's Snipe [864] | | Roosting likely to occur within area |
| Gallinago stenura<br>Pin-tailed Snipe [841] | | Roosting likely to occur within area |
| Haliaeetus leucogaster<br>White-bellied Sea-Eagle [943] | | Species or species habitat likely to occur within area |
| Halobaena caerulea<br>Blue Petrel [1059] | Vulnerable | Species or species habitat may occur within area |
| Heteroscelus brevipes<br>Grey-tailed Tattler [59311] | | Roosting known to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Himantopus himantopus<br>Black-winged Stilt [870] | | Roosting known to occur within area |
| Hirundapus caudacutus<br>White-throated Needletail [682] | | Species or species habitat known to occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Endangered | Species or species habitat may occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant-Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Merops ornatus<br>Rainbow Bee-eater [670] | | Species or species habitat may occur within area |
| Myiagra cyanoleuca<br>Satin Flycatcher [612] | | Species or species habitat known to occur within area |
| Neophema chrysogaster<br>Orange-bellied Parrot [747] | Critically Endangered | Species or species habitat likely to occur within area |
| Numenius minutus<br>Little Curlew, Little Whimbrel [848] | | Roosting likely to occur within area |
| Numenius phaeopus<br>Whimbrel [849] | | Roosting known to occur within area |
| Pluvialis fulva<br>Pacific Golden Plover [25545] | | Roosting known to occur within area |
| Pterodroma mollis<br>Soft-plumaged Petrel [1036] | Vulnerable | Species or species habitat may occur within area |
| Puffinus tenuirostris<br>Short-tailed Shearwater [1029] | | Breeding known to occur within area |
| Recurvirostra novaehollandiae<br>Red-necked Avocet [871] | | Roosting known to occur within area |
| Rhipidura rufifrons<br>Rufous Fantail [592] | | Species or species habitat likely to occur within area |
| Rostratula benghalensis (sensu lato)<br>Painted Snipe [889] | Vulnerable* | Species or species habitat may occur within area |
| Sterna albifrons<br>Little Tern [813] | | Species or species habitat may occur within area |
| Thalassarche bulleri<br>Buller's Albatross [64460] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche cauta (sensu stricto)<br>Shy Albatross, Tasmanian Shy Albatross [64697] | Vulnerable* | Species or species habitat may occur within area |
| Thalassarche chrysostoma<br>Grey-headed Albatross [66491] | Endangered | Species or species habitat may occur within |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | area |
| Thalassarche impavida<br>Campbell Albatross [64459] | Vulnerable* | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable* | Species or species habitat may occur within area |
| Thinornis rubricollis<br>Hooded Plover [59510] | | Roosting known to occur within area |
| Thinornis rubricollis rubricollis<br>Hooded Plover (eastern) [66726] | | Species or species habitat likely to occur within area |
| Tringa glareola<br>Wood Sandpiper [829] | | Roosting known to occur within area |
| Tringa stagnatilis<br>Marsh Sandpiper, Little Greenshank [833] | | Roosting known to occur within area |
| Fish | | |
| Heraldia nocturna<br>Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227] | | Species or species habitat may occur within area |
| Hippocampus abdominalis<br>Bigbelly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233] | | Species or species habitat may occur within area |
| Hippocampus breviceps<br>Short-head Seahorse, Short-snouted Seahorse [66235] | | Species or species habitat may occur within area |
| Histiogamphelus briggsii<br>Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242] | | Species or species habitat may occur within area |
| Histiogamphelus cristatus<br>Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243] | | Species or species habitat may occur within area |
| Hypselognathus rostratus<br>Knifesnout Pipefish, Knife-snouted Pipefish [66245] | | Species or species habitat may occur within area |
| Kaupus costatus<br>Deepbody Pipefish, Deep-bodied Pipefish [66246] | | Species or species habitat may occur within area |
| Leptoichthys fistularius<br>Brushtail Pipefish [66248] | | Species or species habitat may occur within area |
| Lissocampus caudalis<br>Australian Smooth Pipefish, Smooth Pipefish [66249] | | Species or species habitat may occur within area |
| Lissocampus runa<br>Javelin Pipefish [66251] | | Species or species habitat may occur within area |
| Maroubra perserrata<br>Sawtooth Pipefish [66252] | | Species or species habitat may occur within area |
| Mitotichthys semistriatus<br>Halfbanded Pipefish [66261] | | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat may occur within area |
| Mitotichthys tuckeri<br>Tucker's Pipefish [66262] | | Species or species habitat may occur within area |
| Notiocampus ruber<br>Red Pipefish [66265] | | Species or species habitat may occur within area |
| Phycodurus eques<br>Leafy Seadragon [66267] | | Species or species habitat may occur within area |
| Phyllopteryx taeniolatus<br>Common Seadragon, Weedy Seadragon [66268] | | Species or species habitat may occur within area |
| Pugnaso curtirostris<br>Pugnose Pipefish, Pug-nosed Pipefish [66269] | | Species or species habitat may occur within area |
| Solegnathus robustus<br>Robust Pipehorse, Robust Spiny Pipehorse [66274] | | Species or species habitat may occur within area |
| Solegnathus spinosissimus<br>Spiny Pipehorse, Australian Spiny Pipehorse [66275] | | Species or species habitat may occur within area |
| Stigmatopora argus<br>Spotted Pipefish, Gulf Pipefish [66276] | | Species or species habitat may occur within area |
| Stigmatopora nigra<br>Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277] | | Species or species habitat may occur within area |
| Stipecampus cristatus<br>Ringback Pipefish, Ring-backed Pipefish [66278] | | Species or species habitat may occur within area |
| Urocampus carinirostris<br>Hairy Pipefish [66282] | | Species or species habitat may occur within area |
| Vanacampus margaritifer<br>Mother-of-pearl Pipefish [66283] | | Species or species habitat may occur within area |
| Vanacampus phillipi<br>Port Phillip Pipefish [66284] | | Species or species habitat may occur within area |
| Vanacampus poecilolaemus<br>Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285] | | Species or species habitat may occur within area |
| **Mammals** | | |
| Arctocephalus forsteri<br>New Zealand Fur-seal [20] | | Species or species habitat may occur within area |
| Arctocephalus pusillus<br>Australian Fur-seal, Australo-African Fur-seal [21] | | Species or species habitat likely to occur within area |
| **Reptiles** | | |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Breeding likely to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat likely to occur within area |

**Whales and other Cetaceans** [Resource Information]

| Name | Status | Type of Presence |
|---|---|---|
| Mammals | | |
| Balaenoptera acutorostrata<br>Minke Whale [33] | | Species or species habitat may occur within area |
| Balaenoptera edeni<br>Bryde's Whale [35] | | Species or species habitat may occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Caperea marginata<br>Pygmy Right Whale [39] | | Species or species habitat may occur within area |
| Delphinus delphis<br>Common Dophin, Short-beaked Common Dolphin [60] | | Species or species habitat may occur within area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Breeding likely to occur within area |
| Grampus griseus<br>Risso's Dolphin, Grampus [64] | | Species or species habitat may occur within area |
| Lagenorhynchus obscurus<br>Dusky Dolphin [43] | | Species or species habitat may occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Species or species habitat likely to occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Tursiops aduncus<br>Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418] | | Species or species habitat likely to occur within area |
| Tursiops truncatus s. str.<br>Bottlenose Dolphin [68417] | | Species or species habitat may occur within area |

## Extra Information

**Places on the RNE** [Resource Information]

Note that not all Indigenous sites may be listed.

| Name | State | Status |
|---|---|---|
| Natural | | |
| Otway to Port Fairy Coastal Area | VIC | Indicative Place |
| Historic | | |
| Combe | VIC | Indicative Place |
| Doctors Consulting Rooms and Shop | VIC | Indicative Place |
| Port Fairy Hospital | VIC | Indicative Place |
| ANZ Bank | VIC | Registered |
| Battery Hill | VIC | Registered |

| Name | State | Status |
|---|---|---|
| Braim House | VIC | Registered |
| Caledonian Inn | VIC | Registered |
| Cottage | VIC | Registered |
| Cottage | VIC | Registered |
| Cottage | VIC | Registered |
| Cox Street Group | VIC | Registered |
| Customs House (former) | VIC | Registered |
| Emoh | VIC | Registered |
| Girteen | VIC | Registered |
| John Mills Cottage | VIC | Registered |
| Lifeboat Shed Group | VIC | Registered |
| Merrijig Inn (former) | VIC | Registered |
| Motts Cottage | VIC | Registered |
| Orderley Room | VIC | Registered |
| Port Fairy Conservation Area | VIC | Registered |
| Port Fairy Court House | VIC | Registered |
| Port Fairy Fishermens Cooperative Shed | VIC | Registered |
| Port Fairy Gazette Office | VIC | Registered |
| Port Fairy Lighthouse and Ruins | VIC | Registered |
| Port Fairy Post Office | VIC | Registered |
| Powder Magazine | VIC | Registered |
| Riverdale | VIC | Registered |
| Seacombe House | VIC | Registered |
| Seafield | VIC | Registered |
| Seaview House | VIC | Registered |
| St Andrews Presbyterian Church (former) | VIC | Registered |
| St Johns Anglican Church | VIC | Registered |
| St Patricks Catholic Church | VIC | Registered |
| Star of the West Hotel | VIC | Registered |
| Steam Flour Mills | VIC | Registered |
| Talara | VIC | Registered |
| The Market Hotel (former) | VIC | Registered |
| Tynemouth Villa | VIC | Registered |
| Uniting Church | VIC | Registered |
| Woodbine Homestead | VIC | Registered |

## Regional Forest Agreements [ Resource Information ]

Note that all areas with completed RFAs have been included.

| Name | State |
|---|---|
| West Victoria RFA | Victoria |

## Invasive Species [ Resource Information ]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit.

| Name | Status | Type of Presence |
|---|---|---|
| **Mammals** | | |
| Felis catus<br>Cat, House Cat, Domestic Cat [19] | | Species or species habitat likely to occur within area |
| Oryctolagus cuniculus<br>Rabbit, European Rabbit [128] | | Species or species habitat likely to occur within area |
| Vulpes vulpes<br>Red Fox, Fox [18] | | Species or species habitat likely to occur within area |
| **Plants** | | |
| Asparagus asparagoides<br>Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473] | | Species or species habitat likely to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Cenchrus ciliaris<br>Buffel-grass, Black Buffel-grass [20213] | | Species or species habitat may occur within area |
| Chrysanthemoides monilifera<br>Bitou Bush, Boneseed [18983] | | Species or species habitat may occur within area |
| Lycium ferocissimum<br>African Boxthorn, Boxthorn [19235] | | Species or species habitat may occur within area |
| Nassella neesiana<br>Chilean Needle grass [67699] | | Species or species habitat likely to occur within area |
| Rubus fruticosus aggregate<br>Blackberry, European Blackberry [68406] | | Species or species habitat likely to occur within area |
| Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii<br>Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497] | | Species or species habitat likely to occur within area |
| Ulex europaeus<br>Gorse, Furze [7693] | | Species or species habitat likely to occur within area |

## Coordinates

-38.391833 142.226628,-38.372797 142.247796,-38.364574 142.260588,-38.36168 142.277035,-38.365944 142.287999,-38.400818 142.247187,-38.391833 142.226628

## Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

## Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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Please feel free to provide feedback via the Contact Us page.


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