BASIS OF DESIGN REPORT

for

MULTI-CARGO EXPORT FACILITY

at

BARRY POINT, GIPPSLAND, VICTORIA

MAJOR PROJECTS VICTORIA

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Major Projects Victoria

Multi-purpose Export Facility

Barry Point Gippsland, Victoria

Basis of Design Document

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1. Purpose of this Report

The purpose of this document is to obtain agreement from the Client, Major Project Victoria (MPV) on the "Basis of Design Document" for the Gippsland Barry Point Export Facility, high level Concept Study. The intention is for this document to encapsulate all the matters, issues, facts and requirements outlined in the Owner Requirements Specification produced for MPV by Hatch. These agreed facts, issues, matters etc will be used to carry out the High Level Concept Study required by MPV.

2. Introduction

Major Projects Victoria (MPV) has been engaged by the Department of Transport (DoT) to investigate options for freight infrastructure that could facilitate new investment in the Gippsland brown coal resource.

MPV wishes to undertake an initial evaluation of the feasibility of establishing a multi-purposeexport port at the Barry Point.

This high level Concept Design must be based on available existing information about the coastal processes and conditions on the Barry Point stretch of coast and assumptions drawn from that and other experiences within the team.

The MPV requires the facility to export a range of fertilisers, brown coal briquetts, dry brown coal and possible bulk liquid fuels and slurries.

The site for the export facility is generally located on Barry Point in Gippsland, Victoria.

MPV has separately engaged geomorphology and coast engineering consultants to participate in the selection of a range of sites along the beach and to assist Hatch in determining the preferred site(s).

3. Terms of reference

3.1 Context

Industry has approached Government with proposals to establish new coal treatment technologies in Gippsland, with potential for export of significant volumes of solid and liquid products derived from coal.

New freight infrastructure, including expansion of existing ports or the establishment of new ports would be required to facilitate these new developments.

Government wishes to consider all available options for freight infrastructure and is conducting a preliminary 'Scoping' phase study to identify and assess potential sites for new ports.

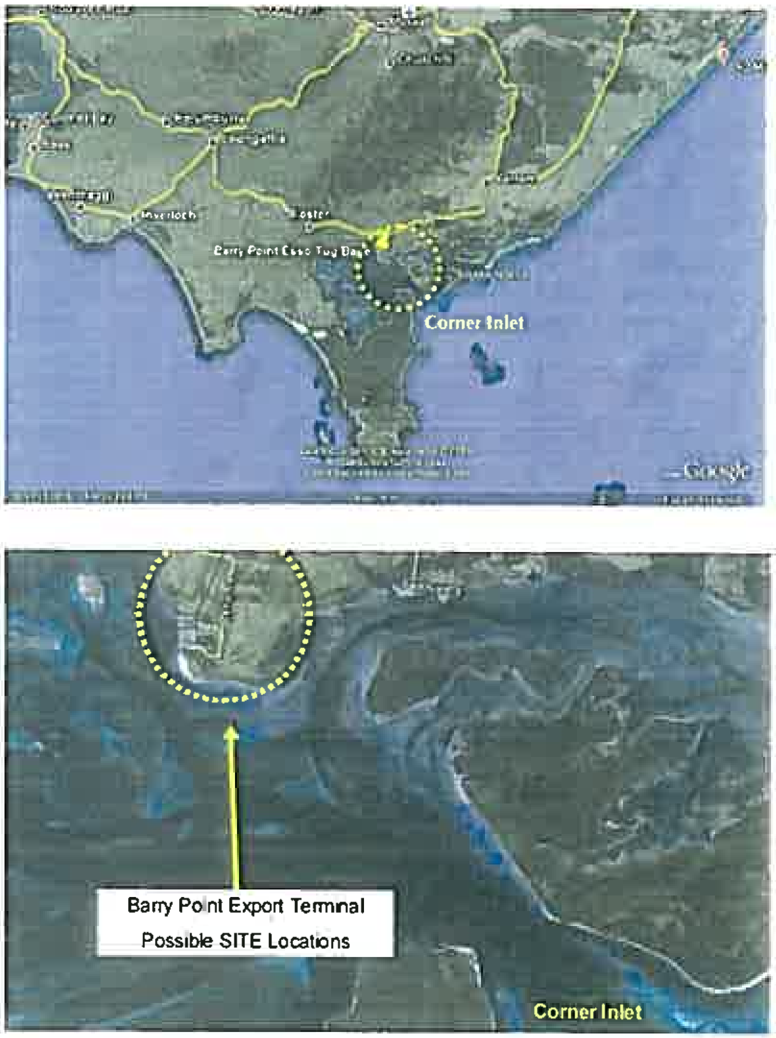
Hatch has been engaged by MPV to undertake this study work in line with the Task Brief attached in Appendix A. Hatch will take a practical approach to this assignment and progress the study as far as practicable within the constraints of time, cost and available information.

MPV acknowledges that the budget available for this work is limited and that the concept design work will therefore be very high-level and cannot be relied upon for decision-making.

3.2 Site Selection Boundaries

It has been agreed that the terrestrial limits of this study shall be limited to inside Cornet Inlet and in particular land sites on Barry Point around the existing Esso Ltd, Oil Rig Tender Base.

Figure 1. Specific Study Area



4. Export Cargo Requirements

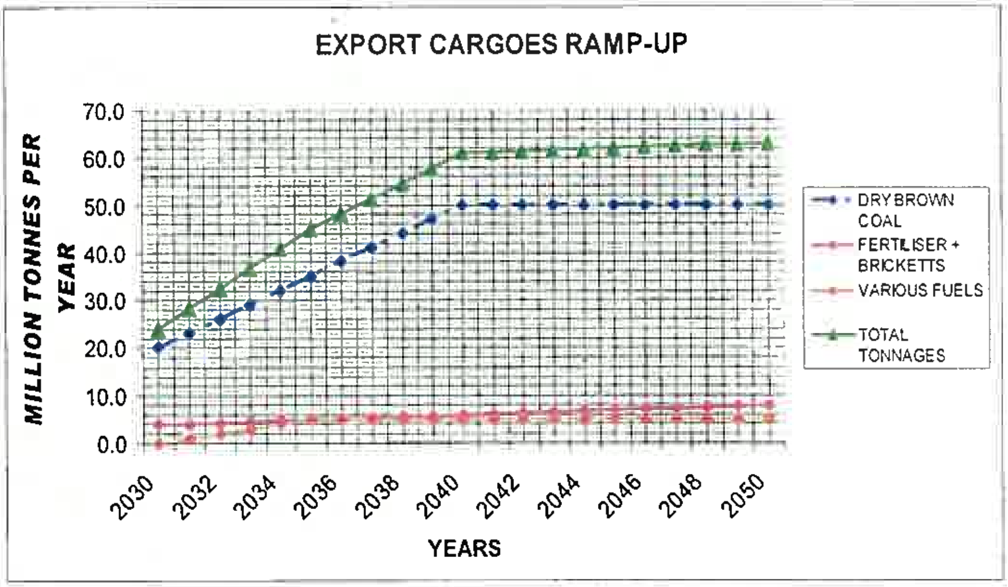
4.1 Cargoes, Tonnages and Ramp-up

The range of cargoes envisaged for the export terminal will originate generally in eastern Victoria and mostly from the south eastern Gippsland coal fields.

The tonnage growth ramp-up for each cargo has been given as follows :-

Table 1 Cargo Tonnage Ramp-ups

CARGO RAMP-UPS	DRIED BROWN COAL (assuming 4 blends)	PROCESSED COAL BRIQUETTS (assuming 2 types)	UREA BASED FERTILISER (assuming 2 types)	VARIOUS FUELS (assuming 5 types)
	Open Stockpiles & Rail delivered	Covered Storages & Rail or Road delivered	Covered Storages & Rail or Road delivered	Tank Farm Storages & Pipeline delivered
At 2030	20Mtpa	2Mtpa	2Mtpa	0
2035	35Mtpa	2.5Mtpa	2.5Mtpa	5Mtpa
2040	50Mtpa	3Mtpa	3Mtpa	5Mtpa
2050	50Mtpa	4Mtpa	4Mtpa	5Mtpa



4.2 Minimum Terminal Cargo Storages

As the delivery system to the port-side terminals is never suitable for "Just-in-Time" dispatch to vessel, some form of constructed, safe and managed cargo consolidation storage is essential.

There are two main operating philosophies governing the deployment and assignment of cargo stoages, namely "Cargo Consolidation" or "Dedicated Stockpiles". It is generally considered, and Hatch's global experience strongly supports, that the "Cargo Consolidation" philosophy, from a terminal operator's point of view, is by far the more equitable, pragmatic and cost efficient. This philosophy will be adopted in this study. In reality a hybrid middle option is also worthy of note in future more detailed studies ~ one based on a combination of Dedicated and Caro Assembly dictated by the frequency of export and the individual Flow Days of each cargo.

For this high level concept study and based on benchmarking with other major facilities , this study will assume that the on-site storage may initially be built to be about 5 ~ 8% of the annual throughputs. As cargo sales ramp-up, any fall of this percentage below 3 ~ 4% will be used as the trigger for a potential expansion of the storage asset. All storages will be sized based on this concept and this will also generate an indicative sequence of capital upgrades to keep pace with cargo tonnage ramp-ups. Generally each cargo will be catered for in two stages ~ stage one of 50% of the ultimate capacity and the stage two of a further 50% totaling up to full capacity, the timing of which will depend on the above percent storage considerations. This philosophy will be further reassessed in this study.

Should the project progress to Pre-feasibility Stage, a more detailed study of storage versus delivery capacities or preferably a dynamic model will be required to more accurately and commercially size the various storages in the facility. In addition, the concept of FLOW DAYS will need to be introduced so as to more closely predict the changing storage/inventory/efficiency/parcel requirements onsite.

4.3 Design Vessels

Based on the types and volumes of cargoes to be exported, the approximate parcel size and therefore the design vessels can be roughly forecast.

The bulk carriers calling at existing similar terminals in potentially competing ports are typically of the range of 40 000 dwt for minor high value bulk cargoes and smaller flammable liquid parcels. Vessel sizes moves up to 180,000 or more dwt for coal cargoes and major liquid transfers. Consequently there is no one design vessel for this facility. The design vessel will be dependant on the cargo type and also on the growth of the new markets and the sale parcel sizes.

As such, all three common bulk cargo carriers categories will constitute the design vessel for the various berths from time to time. Given the long time frame over which this facility will be built and the delays until work is commenced, it is seen as reasonable that all category dimensions should be grown by 5% to allow for the increase in category size with the advent of modern materials and the general improvements in propulsion and naval architecture that may occur over the next few decades. It is also conceded that given the location of this facility, it is unlikely to attract the largest vessels in the respective global trade and hence the dimensions suggested for the design vessels are not the largest in the class but rather the largest expected to trade the southern Australian trade routes. This approximation will require further verification in later studies.

Table 2 - Suggested Future Design Vessel Parameters

Dead weight tonnage Range	Handymax ~ up to 60,000 dwt		Panamax ~ up to 80,000 dwt		Cape ~ up to 180,000 dwt	
Type	Liquids	Solids	Liquids	Solids	Liquids	Solids
Length overall (m)	190	200	230	246	290	300
Beam Range (m)	50	32	35	38	48.5	50
Laden Draft (m)	11	11.9	13.2	14.5	17.2	18
Max Loading Wave (m)	<1.0m		1.0~1.5m		1.5~2.0m	

The above dimensions will be used to size the facilities for each cargo export, based on the above being the largest vessel in their visitation demographic.

4.3.1 *Channel and Berth Depth*

The channel and berth depth will vary for each berth and cargo depending on the largest vessel size deemed likely be chartered to carry the product. These depths have been calculated as follows:

Table 3 - Min Design Channel/Berth Parameters

CONDITION	Additions to Laden Draft allowance
• Allowance for Trim	0.5m
• Allowance for sounding errors	0.1m
• Allowance for siltation	0.2m
• Net under-keel clearance	0.6m
• Allowance for vessel motion and/or squat	0.5m
MIN EXTRA depth requirement "X" (Berth Depth = Loaded Draft plus "X")	**1.9m**
• Extra Allowance for Exposure in Main Channels	**0.5m**

The above will be used to determine the length and position of the various cargo berths against the sites' bathymetry, in accordance with a rudimentary BALANCED DREDGE strategy. This BALANCED DREDGE strategy is one where the activities of dredging, overland conveying of cargo and berth construction are managed along with environmental concerns so as to attempt to find the 'saddle point' in the overall facility's whole-of-life costing. The trade-off being the volume of dredging can usually be diminished by lengthening the access causeway or trestle. Where possible and cost effectivedredging will be avoided completely by prudent site selection. Future studies should actually consider a detailed benefit trade-off between access trestle length, amount of dredging requiredspoil disposal options, conveyor costings and overall facility performance .

4.3.2 *Berth Depths.*

Based on the simple analysis above, the berths will be conceptually sized to have berthing basins of 2.0m deeper than their design maximum draft at zero tide chart datum. Hence all vessels can theoretically load their maximum lift at all tides.

4.3.3 *Channels Depths and widths*

4.3.3.1 Depths

Similarly the approach channels will be sized to be 2.5m deeper than the maximum drafts. This additional allowance provides some level of cover for wind and wave effects and the moderate speed transit (10 ~ 14knots).

However given that the length of the approach channel to Corner Intel entrance is over 12 kilometers long and the berth channels range from 2,500m up to almost 16 kilometers, the transit time from open sea could easily exceed 3 hours. Hence any vessels contemplating using the facilities beyond the design drafts by way of taking advantage of the tidal plane, must allow for at the very least 3 hours of tidal plane loss during its transit from sea. In such cases the prudent position is to design all channels and berthing basins to handle the design vessel at all tides, thereby avoiding the risk of tidal groundings during transit.

4.3.3.2 Widths

The channel width is a function of the beam of the vessels using the channel and the need for one-way or two-way traffic.

Given the multiple cargoes and high throughput expected from the facility and the long channel transit, it is considered prudent to assume that there will be a need for two-way traffic in the channels at some point.

Considering the above a channel width of between 8 and 10 times the largest vessel beam is suggested. The larger width being for the sea approach channel up to Little Snake Island, with the smaller width extending from there up to the selected site's berths. Hence channel widths range from 400 ~ 500m for Cape size vessels and 300 ~ 400m for Panamax size vessels.

Further coastal study and dynamic navigation simulation will be required in order to more accurately size the channel and berth depths and widths.

4.3.4 *Dispatch Vessel Demographics*

As mentioned above, not every cargo will be purchased in the same parcel sizes and hence will not be dispatched in the same size vessels. Given the value of the various cargoes, their usages in industry, likely destination ports and overall volumes to market, assumptions have been made as to the vessel demographic that may be used to transport the cargoes to their destinations.

By far the most favoured workhorse of the shipping fleet for larger moderate to low value bulk cargoes is the Cape size vessel of around 150 ~ 180,000t cargo capacity. This is closely followed by the new sized Panamax vessels with cargo capacity of around 80 ~ 85,000t.

There is still a market for smaller or even boutique cargo parcel sales to J.I.T manufacturing or re-seller facilities, developing countries, smaller ports or smaller industries where their ability to accept the larger size vessels or store the larger cargo delivery tonnages is limited. These markets are still likely to demand dispatch in Handymax vessels of around 30 ~ 40,000t cargo capacity. Given the cargo types envisaged it is not considered that the smaller Handy size vessels will be all that common a caller to the facility. In any event, the off-shore sea state will hamper the safe berthing and loading of such small vessels.

With the above in mind and using examples from other terminals and the overall movements forecast in the chartering market, an estimated vessel size demographic can be derived for each cargo and varied as the volume of each (and hence market demand) increases. See table below.

This vessel demographic is important as the larger the vessel, the higher the annual terminal throughput can be for any given ship t/hr loading capacity. Hence operating and capital costs per tonne are lower for terminals that handle a majority of the larger size vessels. This is largely due the 'non-cargo loading' delays encountered in vessel pilotage, berthing , mooring, agency, inspections, draft survey, hatch changes and departure which generally do not vary in direct linear proportion to the vessel's cargo capacity ~ hence smaller vessels encounter proportionately more inefficiencies per port visit and that reflects in a lower maximum annual terminal throughput.

Table 4 Expected Vessel Demographics

CARGO RAMP-UPS	DRIED BROWN COAL (assuming 4 blends)			PROCESSED COAL BRIQUETTS (assuming 2 types)			COAL or UREA BASED FERTILISER (assuming 2 types)			VARIOUS FUELS (assuming 5 types)		
	Handymax %	Panamax %	Capesize %	Handymax %	Panamax %	Capesize %	Handymax %	Panamax %	Capesize %	Handymax %	Panamax %	Capesize %
At 2030	10	30	60	80	20	0	80	20	0	30	60	10
2035	10	20	70	80	20	0	80	20	0	10	50	40
2040	5	20	75	60	40	0	60	40	0	10	50	40
2050	0	10	90	60	40	0	60	40	0	10	50	40

The above graph suggests that over the coming 40 years, the size of parcels and hence the vessel size needed to carry them may increase over time such that the vessel category carrying the cargoes may also change. This premise is thought to be reasonable as the products' markets mature, destination ports modernize and as the global chartering of bulk cargoes chase more cost efficient delivery strategies via larger vessels. Should the reverse situation develop, then the maximum achievable annual throughputs of the terminals may prove to be undersized, as the impact of smaller vessels' proportionally higher delays reduce the available loading days at the terminals. This may trigger the need for more frequent and costly capital upgrades so as just to move the same volume of cargo. Clearly as the demographic of the vessels change, so too does the average dispatch parcel size for each product.

Given the wave climate, hydrography and bathymetry of Corner Inlet and the neighboring coast line, the bi-directional littoral drift presents a possibly limitation on the depth of channel than may be cost effectively maintained. It is likely that a Cape vessel size channel may require considerably more maintenance effort than a Panamax vessel size channel. If so there will be a need to revisit the vessel demographic and parcel size that each of the larger facilities are designed for.

Should the project progress to further study, this matter may require dynamic coastal and ship modeling in order to properly establish the throughput and demurrage/dispatch and berth activity impacts of changes to the previously assumed vessel demographics.

4.4 Export Facility Requirements

4.4.1 General Requirements

Based on the cargo volumes and types expected, the Export Facility has three distinct streams. Each will have its own distinct requirements for storage area, volume, delivery, stacking, reclaiming and loading. These are characterized as follows :-

- Dried Brown Coal ~ very high volumes, low value, moderate turnover, open stockpiles, multiple train dump stations, requires large bulk materials handling equipment, stackers and reclaimers, high speed ship loader, carried in mainly Panamax-Cape size vessels (if possible).

- Briquetted Brown Coal AND Urea based Fertiliser ~ minor volumes, high value, high turnover, covered storage shed, road or rail receival, modest bulk materials handling equipment, high-line conveyor stacking and retrieval systems, low speed ship loader, carried in mainly Handymax-Panamax size vessels.

- Bulk Liquids and Fuels ~ significant volumes, moderate to high value, moderate turnover, significant tank storages, significant safety considerations and precautions, 100m minimum guard distance from loading vessel, moderate capacity monitor arm loading, major security risk, carried in mainly Panamax-Cape size vessels (if possible).

Each product stream may essentially require its own solution both at a terminal and marine facility consideration.

4.4.2 Marine Facility Structural Form

At this preliminary stage of the project engagement and based on wind, wave and shore processes, Hatch is initially considering a range of hybrid export facility designs, typically used in low lying coastal areas located away from traditional ports.

The structural options investigated are very site dependent as well as water frontage and channel dependent. Given the potentially long channel transits and the large variation in existing channel depths around the inlet, as mentioned earlier, a BALANCED DREDGE strategy has been adopted for this high level concept assessment.

Considering the perceived engineering and environmental difficulty, cost and risk in achieving a traditional dredged berth solution on the range of Corner Inlet sites, the BALANCED DREDGE suggests that a range of structures need to be deployed.

The general structural solutions to be considered for the various sites' marine export facility (from terminal to vessel) is :-

Type 1 — Traditional tubular piled steel jetty or wharf style loading platform supporting both vessel mooring, emergency response, cargo receival and ship loader operations. Based on the expected wave heights in 1:100 and 1:500 yr storms, the underside of the structure should be located at around RL 6.0+m CD.

The wharf version of this option, is located at the shore face adjacent to the Cargo Terminal. This version of structure type usually requires significant dredging.

The free standing jetty version of the option is readily optimised for dredge volume and access length. This would be accessed by a Type 2 structural trestle.

Type 2 — Traditional tubular piled steel jetty access trestle extending from seaward end of the shore/causeway to the remote loading platforms. This will be used as an over-land conveyor and services right of way as well as providing personnel, vehicular and emergency access to the jetty style loading berth (Type 1). The use of a trestle or causeway is a trade-off to extensive dredging in order to bring the vessels closer to the terminal (BALANCED DREDGE strategy).

Type 3 — Filled 10m wide causeway (approx RL 6.0+m CD) extending from Cargo Terminal (situated in-land on high ground), over inland wetlands and low lying areas, to the forecast future HAT mark based on predicted Green-house sea-level rises etc. This will be used as an over-land conveyor and services right of way as well as providing personnel, vehicular and emergency access to the jetty style loading berth (Type 1). The use of a trestle or causeway is a trade-off to extensive dredging in order to bring the vessels closer to the terminal (BALANCED DREDGE strategy). This is considered as an alternative to a Type 2 trestle.

Type 4 — Traditional Type 1 jetty style loading platform, but having its cargoes feed to it by barge loaded from considerably more modest facilities onshore or else by a ROPECON style conveyor. The major limitation of this solution is that the technology is currently limited to around 15Mtpa for each transfer system, hence the large volume of coal planned for export would require at least 3 or more systems in order to meet 50Mtpa export task. Based on the expected wave heights in 1:100 and 1:500 yr storms, the underside of the structure should be located at around RL 6.0+m CD.

Safe haven facility for 2 ocean tugs (70t bollard pull each) is required to be located within 5km of the main export facility, capable of withstanding a 1:20yr storm event is also required inside the Corner Inlet area. Inside Corner Inlet, this will not be difficult to procure.

There are several other hybrid "mixed-cargo" berth and terminal options dependant on specific site conditions but for the sake of this study the general structural solutions above will be adequate to explore the high level concept possibilities of the project.

4.4.3 Terminal Facility Structural Form

The land based export terminals will include multiple large volume bulk stockpiles, covered storage sheds, liquid storage tank farms and large scale bulk liquid and solids receival assets.

As per the MPV Task Scope, the cargo delivery assets of rail, road and pipelines are explicitly outside the battery limits of this study.

Overall, initial indications suggest that suitable sites should have available "all inclusive" areas in the order of approximately 200 ~ 300Ha.

It is anticipated that approximately 150 ~ 200Ha may be needed for coal and other solid bulk cargoes including major stacker and reclaimer machinery rail runways, coal stockpiles around 50m wide and 16m high and 3000m long, approx1 0m deep rail and road dump stations, large span covered cargo storages, kilometres of conveyor galleries, transfer stations, material handling machinery, administration and control buildings, sheds and other ancillary buildings.

Another approximately 20 ~ 50Ha may be required to be dedicated to a range of bulk liquid and fuel storage tanks, pipeline and pipeline equipment, pigging stations, bunding and pollution controls, minor reprocessing facilities, sheds, minor sewage pumping facilities, water reclamation and other ancillary buildings.

Additional lands may be required for major security controls, emergency response, sewerage and waste water treatment as well as major rail loops and roads, parking, marshalling etc. This additional area could be 30 ~ 50Ha depending on design, environmental measures and safe guards and terrain.

All structures are preferred to be founded on raft foundations rather than piles wherever possible.

4.4.3.1 Brown Coal Storage

The Brown Coal Terminal may be similar to other coal terminals in Australia, but with limited onsite storage of the coal to under 1 month throughput. This may well have to reduced the limit to around 14 ~ 17 Flow Days due to the potential for the coal to self-heat in the stockpile.

4.4.3.2 Bulk Solids Storage

The Bulk Solids Terminal may be similar to other bulk solid multi-user terminals in Australia, but may be limited in the onsite storage of the solids to much less than 1 month throughput of each cargo. Given that the solids may well be of high per tonne value, commercial reality will push for a very quick cargo consolidation and export cycle ~ flow days of around 10-12 could be expected.

4.4.3.3 Bulk Liquids Storage

The Bulk Solids Terminal may be similar to other bulk solid multi-user terminals in Australia, but may limit the onsite storage of the product to 1 month throughput of each cargo. Given that the liquids may well be of moderate to high per tonne value, commercial reality will push for a quicker cargo consolidation and export. This is very dependant on the specific cargo that may use the facility.

Given the variable nature and flammability of the intended bulk liquids, it is considered reasonable in this high level concept study to simply allow for a range of 50Kt tank storages inside a bunded area.

4.4.4 Overall Design Efficiency Parameters

As a marine facility design goal, Berth Utilisation (FLO-LLO method) should not exceed 75%, and Berth Occupation (simple continuous loading method) should not exceed 65%. These metrics, combined with the above vessel demographics, will be used to size the assets both in capacity and number.The impacts of weather windows will also need to be considered in the ov erall berth utilization.

All equipment will be sized based on a maximum of 85% of peak capacity.

4.4.5 Terminal Site Selection Requirements

4.4.5.1 Terminal Area Requirements

The search for suitable sites needs to focus on a range of critical success factors necessary for the efficient construction and operation of the terminal. These include :-

- Flood free and level land
- Land secure from future sea-level rise and erosion.
- Total of around 300Ha of land may be required.
- Adequate heavy haul Road, Rail and Pipeline linkages and rights of way or at least space suitable for their construction.
- Adequate power, water and sewerage connections or at least space suitable for their construction.
- A region where the need for employment and commercial stimulus is such that the construction and operation of such a facility generates reasonable community support.
- Little or no existing or planned recreational use of the site.

4.4.5.2 Terminal Geomorphology Requirements

The search for suitable sites needs to focus on a range of critical success factors necessary for the efficient construction and operation of the terminal. These include :-

- Adequate on-shore geological foundations, preferably without major settlement issues or the need for expensive rock excavation.
- Adequate areas of generally level or gently sloping topography.
- Moderate to low wind and rain persistence so as to minimize the creation of dust, run-off pollution and delays.
- Absence of acid soils or polluted soils.
- Landforms secure from impacts of global warming and related sea level rises.
- Absence of environmentally or historically sensitive areas.

4.4.5.3 Terminal Amenity/utility Requirements

The search for suitable sites needs to focus on a range of critical success factors necessary for the efficient construction and operation of the terminal. These include :-

- Existing supply of suitable locally available labour and housing.
- Adequate power, water and sewerage capacity

4.4.6 Marine Facility Site Selection Requirements

4.4.6.1 Marine Area Requirements

The search for suitable sites needs to focus on a range of critical success factors necessary for the efficient construction and operation of the marine facility. These include :-

- Depending on the structural solution chosen and the local bathymetry encountered, the required restricted access water area may be as much as 5000m or more long and at least 1000m wide.
- Little or no existing or planned recreational use of the site.
- Little or no existing or planned commercial fishing or mari-culture use of the site.
- Clear of existing local, state or national navigational passages and seaways.

4.4.6.2 Marine Coastal Engineering Requirements

The search for suitable sites needs to focus on a range of critical success factors necessary for the efficient construction and operation of the marine facility. These include :-

- Suitable bathymetry to allow either direct berthing without the need for overly long access trestles or prohibitively large dredge spoil disposal problems.
- Absence of reefs or other obstacles and hazards to navigation or anchorages
- Lack of littoral drifts and significant sub-surface currents
- Suitable wind and wave persistence to allow for safe and efficient construction and operations (90% utilization required)
- Suitably moderate maximum wave heights and storm frequencies so as to minimize marine structures and possible Single Point Mooring (SPM) structural designs
- Wave climate secure from major adverse impacts of global warming and related sea level rises.

4.4.6.3 Marine Geomorphology Requirements

The search for suitable sites needs to focus on a range of critical success factors necessary for the efficient construction and operation of the marine facility. These include :-

- Adequate off-shore geological foundations, preferably without major settlement issues or the need for expensive rock excavation or dredging. Founding level suitable for piled structures.
- Moderate to low wind and rain persistence so as to minimize the creation of dust, run-off pollution and delays.
- Absence of acid soils or polluted soils.
- Coastline secure from impacts of global warming and related sea level rises.
- Absence of environmentally or historically sensitive areas.

5. Available Data on the General Site Area

5.1 Marine Coastal Engineering Research (by Coastal Engineering Solutions Pty Ltd.)

The full text of the sub-consultant's report is contained in Appendix B.

5.1.1 *Coastal Bathymetry for Barry Point*

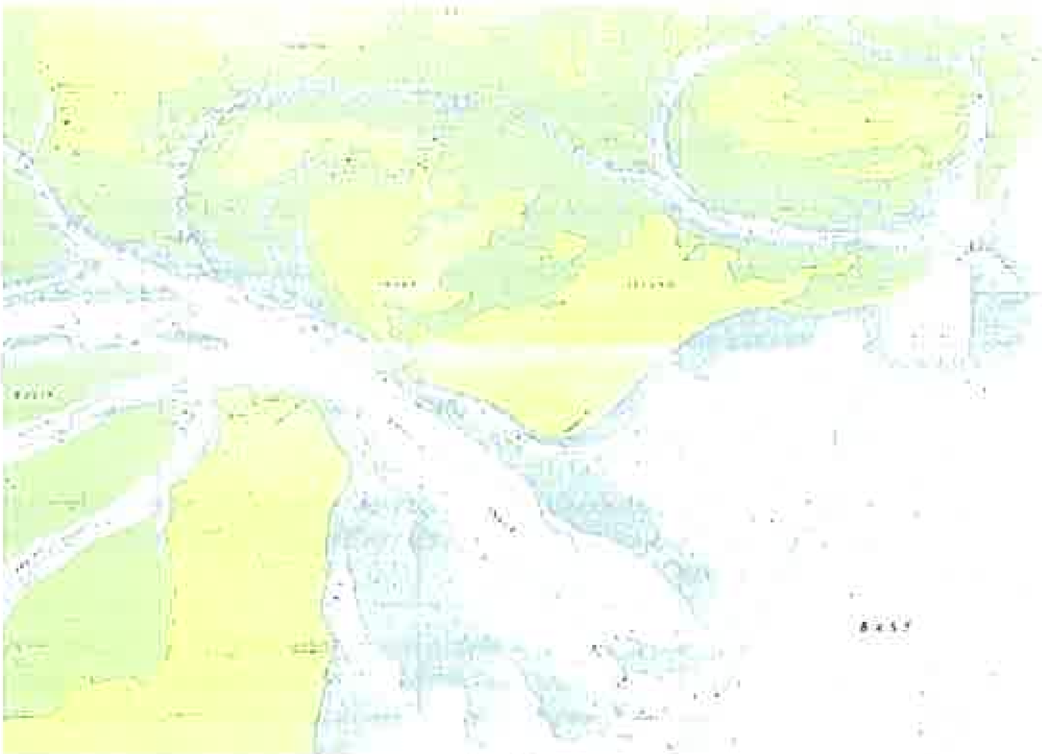
CES has used published AUS Admiralty Charts to develop wave and sediment transport models for the Victorian coastline. They are of relatively good resolution in the study area, AUS181 is at a scale of 1 : 50,000. It is known that even more detailed data is available in the Barry Point area through surveys undertaken on behalf of ESSO and ANCON.

The site bathymetry is shown on the chart AUS181 below.

Of most note is the substantial bar at the mouth of Corner Inlet (RL-3 ~ -6m) and the significant large depression adjacent to Bentley Point (the Singapore Deep), inside the Inlet itself.

The water depth of 20m CD, occurs some 12 ~ 13km from the entrance of Corner Inlet. Thereby requiring a long approach channel before a vessel even enters the Inlet. Barry Point itself is up to another 15km further inside the Inlet. All up, a transit of up to 27km could face vessels using the Barry Point area for an export terminal.

Figure 3. Specific Study Bathymetry



5.1.2 *Wave direction, height and period, exceedence data for each site*

CES has a coarse overall mathematical model for waves along the Victorian coastline. In the Corner Inlet area the model extends into corner inlet as far as the western end of Singapore Deep

Consequently, the model has been operated in order to obtain comparative wave data between the 20 metre contour offshore from Corner Inlet and locations in about 20 metres just off Bentley Point. Further inside Corner Inlet, wave conditions would be reduced even more.

The wave climate offshore (20m depth) from Corner Inlet is very similar to that at the 20 metre depth at the 90 Mile Beach Site investigated in our previous study (24th September).

5.1.2.1 Bentley Point

The shoals and the shape of the seabed contours result in a considerable attenuation of the swell wave conditions at Bentley Point. The swell wave heights will be about 25% of the wave height outside corner Inlet. The implication is that the swell significant wave height will rarely exceed 1 metre and most of the time be less than 0.5 metres.
The shape of the entrance will limit the range of directions from which swell waves can approach Bentley Point to 135 175 degrees, with a predominant direction of about 150 degrees.

5.1.2.2 Western End of Singapore Deep

The swell wave heights at this location are reduced a further 50% compared to that at Bentley Point. The swell waves are effectively uni-directional and from 130 degrees.

5.1.2.3 Barry Point

Swell wave penetration to Barry Point will be negligible and significant wave heights would not be expected to exceed 0.2 metres.

On top of the swell waves there will be locally generated seas. Locally generated seas from Bass Strait will be significantly attenuated entering Corner Inlet and at Bentley Point would be expected to be less than 50% of the wave height in deep water off Corner Inlet. The sea wave heights off Corner Inlet would be similar to those off McLoughlins Beach (90 Mile Beach report). At the western end of Singapore Deep there would again be a 50% reduction in wave height compared to Bentley Point. At the western end of Singapore Deep and at Barry Point there would also be the influence of locally generated seas from within Corner Inlet. These are short period waves of limited height which would not affect Tug or ship operations.

In summary, wave conditions at the potential Corner Inlet port sites are not likely to impact on port operations. Wave conditions in the entrance channel at the bar are still severe and will impact on dredging.

CES has undertaken a project specific analysis of wave conditions for a generic site off McGauran Beach and developed wave data at water depths of 8, 14 and 18 metres. This has been done using a 5 year ocean swell (deep water) and hindcast sea wave data base developed for previous projects in the region. Note that there is little variation in wave characteristics between water depths of 8 and 18 metres. For this initial study one set of wave parameters are presented that should be adequate for water depths of 8 to 18 metres [Calculations have been done for 8, 14 and 18m water depths and data can be made available].

Note that there are two sources of waves that reach the Gippsland coast. They are:

- Waves that are generated in Bass Strait. They have wave periods of up to 10 seconds and are referred to as "Sea" waves. It has been assumed that these waves are generated up to the water depths of interest and will undergo negligible wave transformation in the process.

- Waves that are generated in the surrounding oceans (Southern & Pacific) and Tasman Sea & the Greta Australian Bight. These waves are generally of longer period (up to 18 seconds) and are referred to as "Swell" waves. They are transformed significantly from their deep water characteristics by the time they reach the Gippsland coast.

An analysis for sea, swell and the total (combined sea and swell) wave at a water depth of 14 metres has been carried out which illustrates :

- That there is extensive variability from year to year;

- Generally the swell waves have lower heights than sea waves;

- However, there are exceptions when large swell waves can penetrate towards McGauran Beach Nov 1999 and July 2001. From previous work done by Riedel & Byrne Consulting Engineers in 1987 for the Latrobe Valley Ocean Outfall, we believe that such events are "real".

5.1.2.4 Off-shore Wave Direction

Sea wave can be generated from a full spectrum of offshore directions ranging from ENE through to WNW. The predominant winds in this region are from WSW and sea waves from this sector will dominate.

Swell waves have a more restricted directional spread and may arrive from the east through to the south. The very large storm events that occasionally reach the site arrive from the SSE.

There is little variation in sea and swell wave direction between water depths of 8, 14 and 18 metres. Figures 1 and 2 show the directional wave exceedence for sea and swell waves.

The significant wave height exceedence is shown in Figure 3. Note that the maximum wave height in a storm may be up to 2 times the value of the significant wave height.

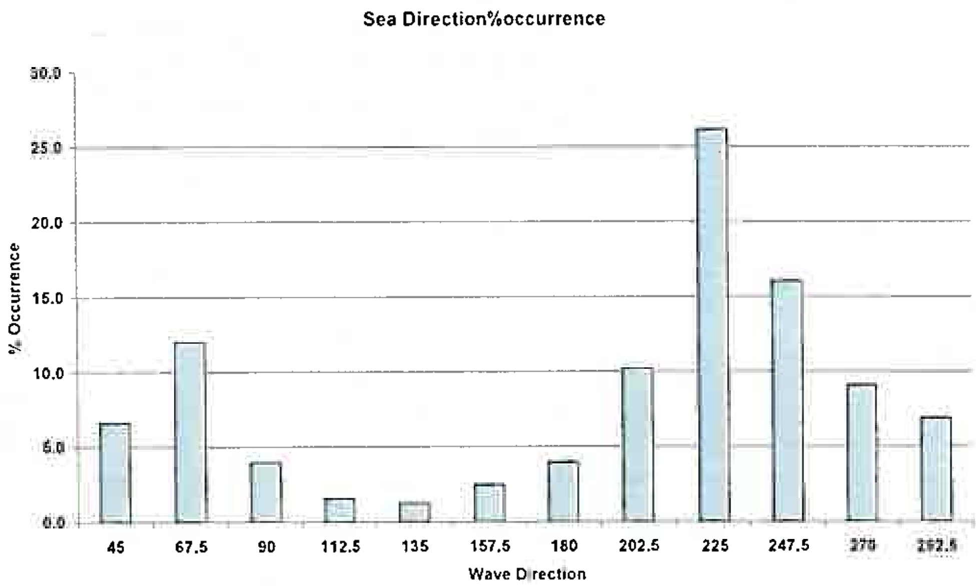


Figure 4: Directional wave exceedence for sea waves

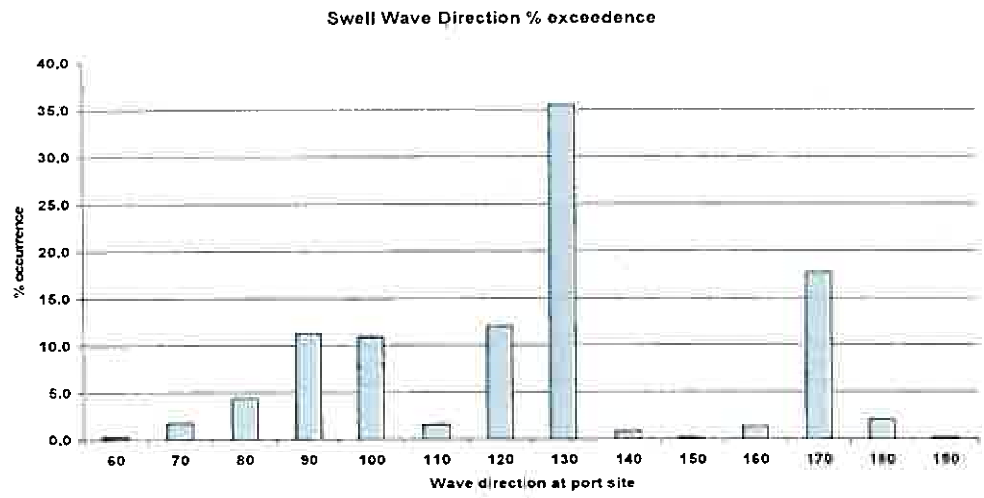


Figure 5: Directional wave exceedence for swell waves

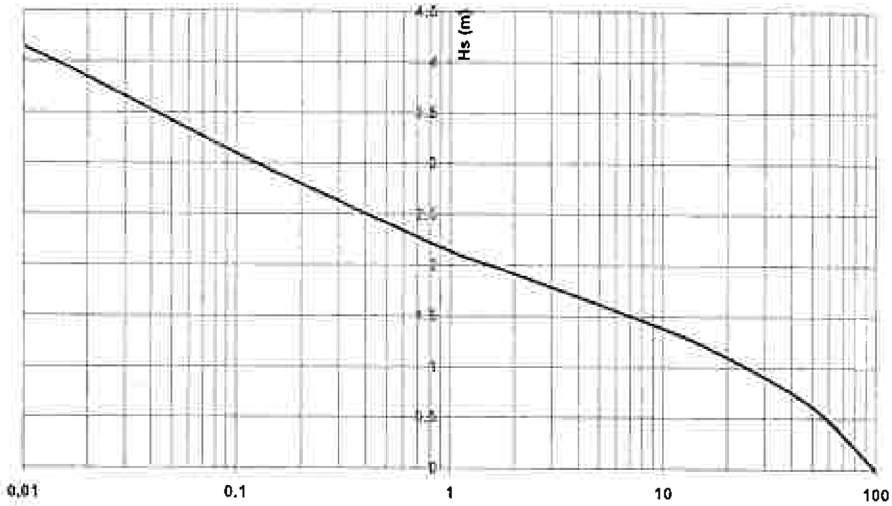


Figure 6: Wave Height Exceedence (8 to 18m water depth)

5.1.3 *Probability of extreme water levels and storm surge long term sea level rise*

Gippsland Coastal Board (2008) "Climate Change, sea Level Rise and Coastal Subsistence along the Gippsland Coast" provide the information shown in Table 1 for Walkerville, in Waratah Bay and Lakes Entrance levels are to AHD. The "New Port" site is approximately mid-way between these locations and values have been interpolated accordingly. According to the Victorian Coastal Strategy (2008) planning for new development should be for the "high" value scenario.

Table 5: 100 year return period levels for the combination of storm tide height and mean sea level rise

Location	Current Climate (m)	2030			2070		
		Low (m)	Mid (m)	High (m)	Low (m)	Mid (m)	High (m)
Port Welshpool	1.71	1.73	1.83	1.91	1.74	1.99	2.28

5.1.4 *Wind speed and direction exceedence data for each site*

Site specific wind data does not exist. There are a number of recording stations onshore, on headlands and islands. Each data source tends to be specific to the anemometer location relative to adjacent topographic features. CES has made an interpretation of the most suitable data in relation to wave generation over Bass Strait. Wind speed statistics are presented in Table 5.

Wind speed km/hr	North	NNE	NE	ENE	East	ESE	SE	SSE	South	SSW	SW	WSW	West	WNW	NW	NNW
	% Occurrence															
80										0.02	0.02	0.01				
70		0.02								0.02	0.20	0.02	0.01			
60		0.18	0.03						0.02	0.10	0.76	0.15	0.01			
50	0.01	1.28	0.13	0.01	0.02	0.02			0.06	0.57	2.61	0.95	0.04			
40	0.02	2.62	1.12	0.11	0.03	0 11	0.01	0.05	0.24	1.03	4.08	2.08	0.15	0.02		
30	0.05	3.12	2.15	0.41	0.13	0.16	0.07	0.19	0.47	1.30	3.70	2.75	0.58	0.02	0.02	
20	0.32	4.48	3.71	1.11	0.49	0.36	0.31	0.53	0.87	2.13	3.90	3.05	1.82	0.32	0.22	0.08
10	1.29	3.24	1.48	0.86	0.56	0.43	0.30	0.58	0.76	1.19	2.01	1.52	2.58	3.54	2.14	0.48
Calm to <10	19.33															

Table 6: Wind Occurrence Statistics

From the Coastal Engineering Consultant's experience, it is noted that the storm that occurred around ANZAC day 2009 produced a storm surge of the order of 0.5 metres along the south Gippsland coast.

Storm surge values apply near the coast. In deeper water there would be some reduction in the value of the storm surge.

5.1.5 Rain intensity and duration, exceedence data for each site

No definitive rainfall data has been sourced for the site. This is not seen as an important criteria at this stage of the project assessment.

5.1.6 Tidal plane for the site

Tidal data exists for Port Welshpool within Corner Inlet and Rabbit Island, just outside Corner Inlet. The tidal planes are shown in Table 3. These levels are to chart datum. The difference between AHD and Chart datum is approximately 1.7 metres. There is little difference in the tide characteristics between the two stations so it is likely that the Port Welshpool data is applicable at all the port option sites.

Table 7: Tidal Planes

Station	Rabbit Is	Port Welshpool
HAT	2.8	2.9
MHWS	2.4	2.6
MHWN	2.1	2.2
MSL	1.6	1.7
MLWN	1.0	1.1
MLWS	0.7	0.7
ISLW	0.3	0.3

5.1.7 *Direction, speed and occurrence of offshore currents*

The only data that is publicly available is that associated with the Admiralty Charts. There are quite strong currents at the entrance to Corner Inlet and within Corner Inlet. These currents arise because of the moderate to high tidal range and the focussing of currents within channels between the inter-tidal flats. 2knot currents are shown on the chart to the east of Bentley Point. No other currents are noted on the chart. It would be expected that currents of the order of two knots would be common around mid-tide through many of the deeper channels. It is these high currents that result in deep channels and holes throughout Corner Inlet. All currents can be expected to closely aligned with the respective channel alignments.

5.1.8 *Littoral drift conditions prevailing along the coast*

CES modeled littoral drift for the 5 year period 1999 to 2003 for a project by Parks Victoria. Figure 5 shows the littoral drift characteristics over this period.

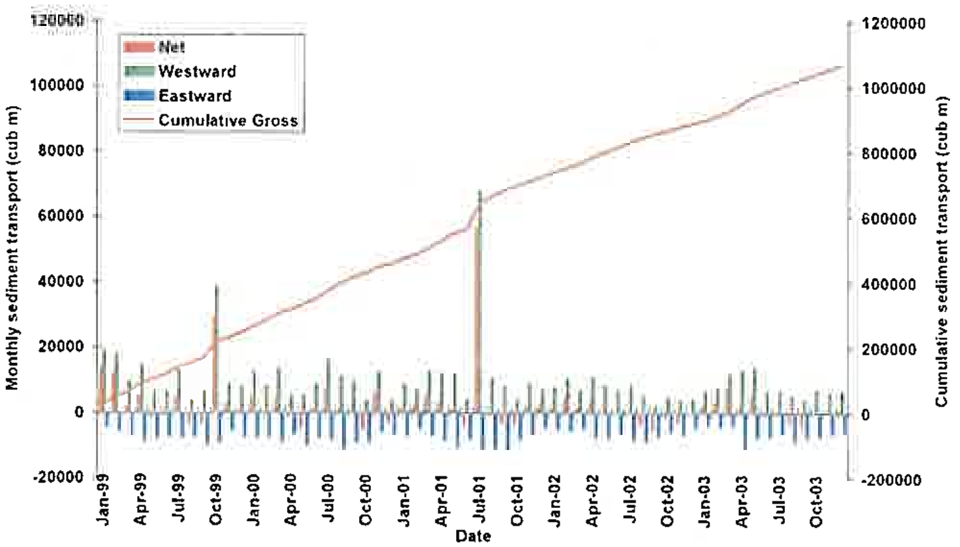


Figure 7: Littoral drift along northern beaches

The following interpretation for littoral drift may be made from Figure 5:

- Sediment transport occurs along the shoreline in both directions with typical monthly rates of 5,000 to 10,000 cubic metres.
- The net sand movement is to the west driven by severe storm events in the Tasman Sea these are represented by the spikes in sediment movement occurring in Oct 1999 and July 2001.

- The long term average net westward movement is about 80,000 cubic metres per year.

- The cumulative volume of sand moving past a given transect out to sea is about 250,000 cubic metres per year.

Note that most of the littoral drift occurs in water depths of less than 5 metres.

CES does not have any littoral drift models set-up for inside Corner Inlet. In fact littoral drift is minor in relation to the sites at Barry Point, within Corner Inlet, due to the presence of the extensive inter-tidal flat areas that limit wave action on the shoreline. CES previously investigated sand movement at Barry Point in relation to the proposed ANCON port to the south of the ESSO facility. From an analysis of aerial photographs it was concluded that there was a slow migration of sand from west to east as evidenced from the change in shape of the sand spit at Barry Point. This littoral drift is due to the predominant WSW winds over Corner Inlet and because of the longer wave generating fetches to the west, compared to the east where Snake and Little Snake Islands limit the length of the fetch.

The extensive dredging and reclamation associated with each of the options at Barry Point will change the littoral drift patterns. It needs to be noted that the existing shoreline at Barry Point is not "natural". The material dredged to form the ESSO facility, and for maintenance dredging was disposed off onshore at Barry Point and changed the shoreline shape.

The floating berth option (No 7) requires minimal dredging at the port and is likely to have little impact on littoral drift at Little Snake and Snake Islands. From Chart 181 it appears that the foreshore facing the berth area is composed of mangroves and there may be negligible littoral drift anyway for existing conditions (I have not been onshore at Little Snake Island).

5.1.9 *Littoral Drift at the Entrance to Corner Inlet*

There will be sand movement along the shoreline to the south of Entrance Point, Wilsons Promontory and along Snake Island. AS well as there being littoral drift (due to waves) there will be a superimposed tidal current effect on sand movement. CES has not undertaken any site specific studies, however, the following overall sediment movement pattern is likely:

- The control point for controlling the current into and out of Corner Inlet is between Entrance Point (Wilsons Promontory) and Bentley Point (Snake Island). These Points also control littoral drift into and out of Corner Inlet.
- The deep channel (Singapore Deep) is current formed and is not related to littoral drift.
- There will be littoral drift along the reaches to the south of Entrance Point and Bentley Point. It is likely that an equilibrium has been set up and no long term changes are occurring. This could be checked through an analysis of long term historical aerial photography which is available back to the 1940's.
- Littoral drift patterns at the entrance are unlikely to be impacted upon by port options within Corner Inlet. However, the dredging associated with port options at Barry Point

may change the hydrodynamic flow patterns because more water will have to pass through the entrance channel to fill and empty the dredged areas each tidal cycle.

- However, dredging of the entrance bar between Corner Inlet and Bass Strait may have a significant impact on littoral drift patterns south of Entrance and Bentley Points. This is because the dredging will change the way in which waves propagate across the entrance in terms of both the wave direction and height. Both these parameters are important in littoral drift determination. Mitigation should be possible by "configuration" dredging that is shaping the dredged area to control wave transformation and subsequent littoral drift patterns.
- Our expectations are that any littoral drift issues or changes can be managed without "hard" control structures (seawalls, groynes etc). It is noted that since there are no "hard " structures in the entrance area, it may be acceptable to have some change in coastal profiles as long as an "equilibrium" may be achieved without introducing "hard" structures.

5.1.10 Possible spoil disposal areas

Spoil disposal from material generated within Corner Inlet may need to be treated quite differently to that for material generated from the entrance channel through the offshore bar. This can be likened to the "Channel Deepening Project" in Port Phillip where sand was dredged from South Channel, whilst silt material was dredged from the port area. Different disposal considerations were required.

The same applies at Corner Inlet. The volume of material to be dredged for Barry Point options is large and the material is expected to contain silt and mud as well as sand. Onshore disposal may be attractive, particularly in the light of sea level rise issues in the future. The dredged material could be used to build up land levels over the port onshore land area.

If onshore disposal is not attractive, and the material is not contaminated, then disposal of the spoil in a deep natural channel such as Franklin Channel (to the west) or Singapore Deep may be practical. Material disposed of in these channels is likely to be redistributed by tidal currents over the whole of Corner Inlet, but the build up in seabed levels would be in terms of a few centimetres. Offshore disposal may be possible if the dredged material is clean, but the steaming distances and hence cost would be significant.

Material dredged from the bar between Bass Strait and Corner Inlet is likely to be clean sand and alternative disposal areas would need to be considered. Often it is good practice to return clean sand to the beach environment so as to minimise potential coastal erosion threats. Disposal of the sand to the north or south of the new channel could be organised so that there is a pathway for the sand to find its way back into the beach system. On the other hand, the bar at Corner Inlet is probably a sediment sink and removal of sand from the bar and out of the active beach system may be acceptable in this case the spoil could be dumped in deep water further offshore.

Extensive studies will be required of dredging and spoil disposal options and the related implications on the shoreline and its stability.

5.1.11 Need for and possible frequency of maintenance dredging

Two channel areas need to be considered, as well as possible siltation of turning circles near Barry Point. From previous studies at Barry Point by CES it is evident that the existing channel silts, and it is only 6 metres deep. Maintenance dredging has been carried out at least twice by ESSO and they are in the process investigating further maintenance dredging which they wish to undertake in 2010. Consèquently maintenance dredging associated with port facilities at Barry Point will be significant as may be the question of suitable disposal areas. The reason for siltation is that deep channels and pockets will have been created in which the tidal current slows down and deposits its sediment load. The sediment load can be considerable because of the extensive inter-tidal mud/silt flats where sediment will be stirred up by local wave action generated within Corner Inlet. Based on the existing siltation patterns at Barry Point, it is anticipated that a 10 year cycle of maintenance dredging, possibly shorter, will be required.

5.1.12 1:100 and 1:500 design waves

Detailed wave studies have not been undertaken, but based on the limited modelling (because of the use of a coarse existing model), wave conditions will be relatively mild at both Option 7 or a single point mooring site within Corner Inlet.

Our estimate of design waves is:

- 1 in 100 years: Hs = 1.5m
- 1 in 500 years: Hs = 2m

These values would need to be refined during studies for detail design using a more refined model.

5.1.13 Structure height above Chart Datum

The height is associated with the wave exposure and will decrease further within Corner Inlet. However, wave conditions are relatively mild everywhere, in comparison to offshore wave conditions. The table below provides estimates of the underside of structure heights (relative to chart datum) to avoid waves (including sea level rise to 2100):

Table 8 Structure Heights

Return Period	Barry Point	Western S. Deep	Bentley Point
100 years	5.2m	5.5m	6.0m
500 years	5.5m	6.0m	6.5m

5.1.14 Likely locations of safe harbours for tugs

The existing facilities at Barry Beach could be expanded with minimal dredging to accommodate the tugs. Alternatively, there is a natural channel/hole with a water depth of 6 metres immediately to the NW of Bentley Point. It is expected that the wave climate would be sufficiently mild to accommodate the tugs at an alongside berth arrangement. If there is a wave climate issue with extremely severe weather, the tugs could be taken into one of the channels with naturally deep water (Toora, Franklin, Middle or Bennison Channels) to ride out the storm, as would be done for tugs operating in cyclone prone areas.

5.1.15 Other advice

CES has a strong preference for locating the port at or near Bentley Point on Snake Island because:

1. There is no need to dredge within Corner Inlet and open up the potential can of worms that goes along with dredging silt & mud adjacent to a marine park area.
2. There is no need to source spoil disposal grounds or landfill areas for silt/mud spoil.
3. Extensive dredging within Corner Inlet at and approaching Barry Point is avoided. The extent of dredging required may change the hydrodynamic balance that presently exists for tidal flows at Corner Inlet. A change in the hydrodynamics may have significant environmental impact that could relate back to adjacent marine park areas.
4. Access to Bentley Point can be provided by a causeway, possibly with some minor bridgeworks without upsetting the hydrodynamics, environment and small boat access across Middle Ground. CES studied middle ground for Gippsland Ports about 5 years ago and has an understanding of this area.
5. Dredging is confined to the bar that separates Corner Inlet from Bass Strait. This area needs to be dredged regardless of the port option adopted.

In terms of dredging the bar it is possible that "configuration" dredging can be designed which (a) minimises impacts on beaches and (b) results in reduced maintenance dredging of the channel. CES designed similar configuration dredging at the Lakes Entrance bar for Gippsland Ports. It appears to be operating as predicted with reduced siltation of the channel through the bar into Lakes Entrance.

5.2 Marine and Terminal Geomorphology (by Environmental GeoSurveys Pty Ltd.)

The full text of the sub-consultant's report is contained in Appendix B.

5.2.1 General

This geomorphologic study area is in South Gippsland and includes: (a) part of the mainland coast fringing the northeast of Corner Inlet and the eastern tidal waterways of Nooramunga, (b) several of the Nooramunga islands, (c) the entrance to Corner Inlet, (d) the ocean coast of Snake Island and Little Snake Island, (e) the northeast corner of Wilsons Promontory National Park (Figure 8). The study focuses on the onshore, supratidal and intertidal terrain and the adjacent islands.

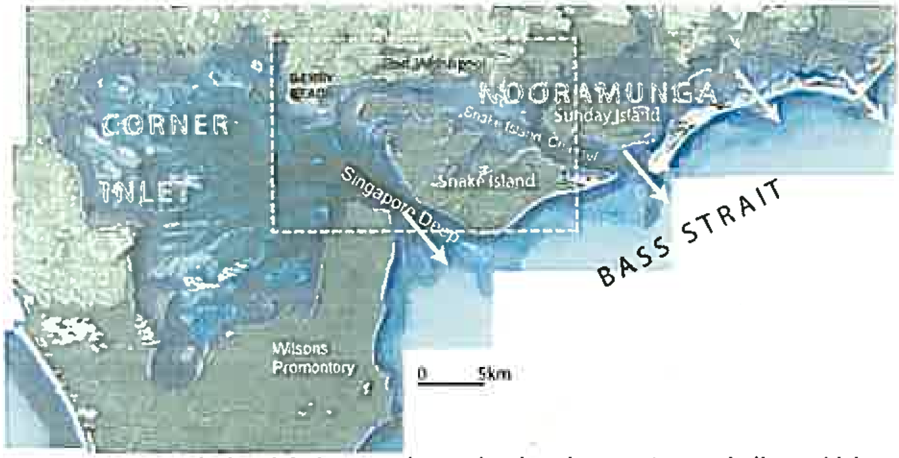


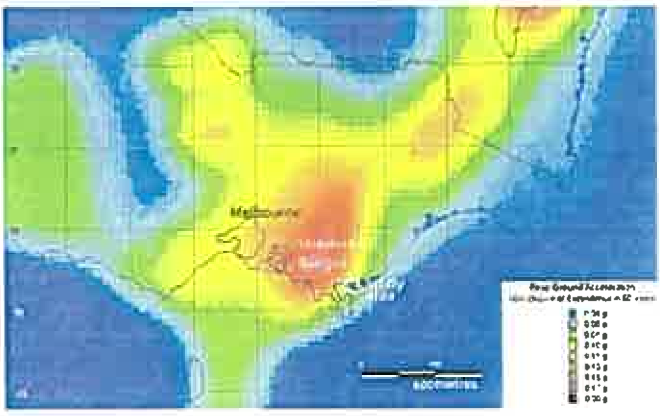
Figure 8. Vertical aerial photograph mosaic of study area. Arrows indicate tidal entrances.

5.2.2 *Geology*

The deep basement of South Gippsland is Late Precambrian and Early Palaeozoic sedimentary rocks intruded by a suite of Devonian granites. The basement boundaries are mainly fault-controlled along alignments that onshore are principally northeast/southwest. The basement rocks outcrop at Liptrap Peninsula and Wilsons Promontory as part of the elongate Bassian Rise that forms the structural divide between the Gippsland, Bass and Otway basins (Figure 3). Overlying the deep basement are sediments of the Gippsland Basin, one of the largest sedimentary basins of southern Australia. The Gippsland Basin is a series of sediment-filled, tectonic depressions that extend east and south of the uplifted fault blocks of the South Gippsland Hills for several hundred kilometres onto the Bass Strait continental shelf. These sediments range from Early Cretaceous to Quaternary and outcrop extensively onshore.

The coast is a complex of shallow marine, tidal, salt and freshwater swamp deposits and coastal barrier and dunes.

The Strzelecki Ranges is the most tectonically active in Victoria with frequent, although relatively low magnitude, seismic movements below.



5.2.2.1 Surficial Geology

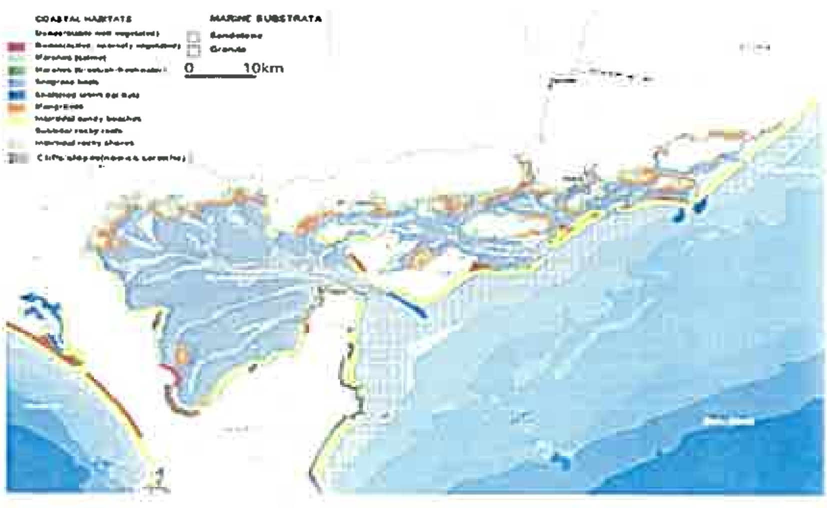
No hard rock materials crop out or occur at shallow depth in the study area. All surficial geology is of Pleistocene or Holocene age and is dominantly unconsolidated sand/or fine-grained sediment. Figure 9 shows location and log of upper part of several boreholes at and north and east of Barry Point. No borehole logs were recovered for any of the islands. It is not anticipated that the sub-surface materials would differ substantially from those recorded onshore.

Figure 9. Location and log of upper sections of boreholes in the study area.
Blue areas are wetlands (most are drained).

All boreholes show several metres of sand and silty sand overlying variable thickness of sand and clay. Brown coal occurs in several boreholes but always at depths greater than 50 metres.

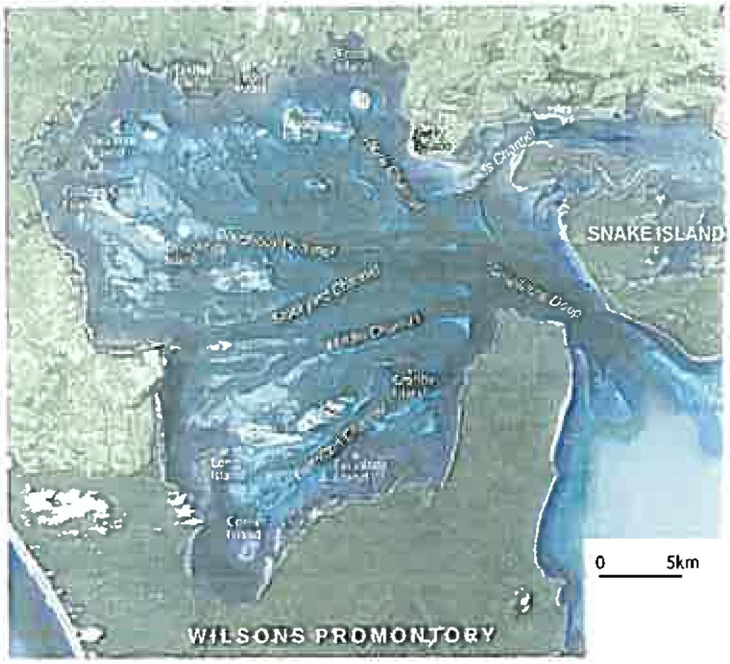
5.2.3 *Corner Inlet, Barry Point and Nooramunga*

Corner Inlet and Nooramunga are shallow embayments with a complex of tidal channels and islands north and east of Wilsons Promontory extending to beyond McLoughlins Beach (Figure 10).



There are five entrances to Bass Strait each with strongly developed ebb and flood tide deltas. The major entrance is the 2 km wide Singapore Deep channel (maximum depth over 50 metres) between Entrance Point on Wilsons Promontory and Bentley Point on Snake Island. The spring tide range across the systems is almost three metres and at low tide broad areas of mud and sand flats are exposed. There is a widespread cover of sea grass meadows on intertidal and subtidal surfaces. There is a considerable area of seagrass that contains a mixture of species, with the most common mix being the Zostera species and Posidonia. Detailed mapping and historical aerial photograph analysis by Roob et al. (1998) showed rapid, continual and extensive changes in seagrass cover. The general trend of distribution and density was of good coverage in 1969, a decline in the 1970's followed by various stages of regrowth and regeneration to return to a healthy coverage again in 1998. However the pattern of seagrass change is not consistent across the whole area and there are quite distinct differences between, Corner Inlet, the Snake Island area and Nooramunga Roob et al. (1998).

Corner Inlet is a broad, shallow, circular tidal embayment on the eastern side of the Yanakie isthmus. and there are seven well-defined tidal trunk channels from 10 metres to 15 metres deep that radiate/converge on the two km wide opening to Bass Strait (Figure 11).



The broad intertidal and subtidal flats between the major channels are incised by widely spaced tributary ebb and flood channels of low gradient. There are long estuarine reaches on the Agnes River and Franklin Rivers and a number of smaller tidal inlets. There are several very small islands in Corner Inlet - either remnants of weathered low granitic hills and ridges or sedimentary and marsh islands. The larger marsh islands fringing the northern and eastern coast may be remnants of peninsulas or deltas isolated by tectonic subsidence and relative sea level rise (Vanderzee, 1988).

5.2.3.1 Terrain Features

Barry Point is a broad, low peninsula that marks the eastern edge of Corner Inlet and the western edge of the Nooramunga island and channel complex. The coast is backed by the west-east escarpments of the Toora Monocline and Gelliondale Fault (Figure 12). Alluvial and colluvial material moved from these escarpments has developed a narrow apron that slopes gently to the coast and interleaves with the coastal deposits. This narrow coastal strip has a complex geomorphological history that shows the interaction of tectonic downwarping and subsidence, alluvial and fluvial deposition, stream incision and shoreline deposits developed at higher sea levels. The most recent phase of deposition is related to a minor Late Holocene fall in sea level, mangrove and saltmarsh development and shoreline recession related to relative and absolute sea-level rise. These processes have developed a series of coastal terraces, ridges and elongate depressions.

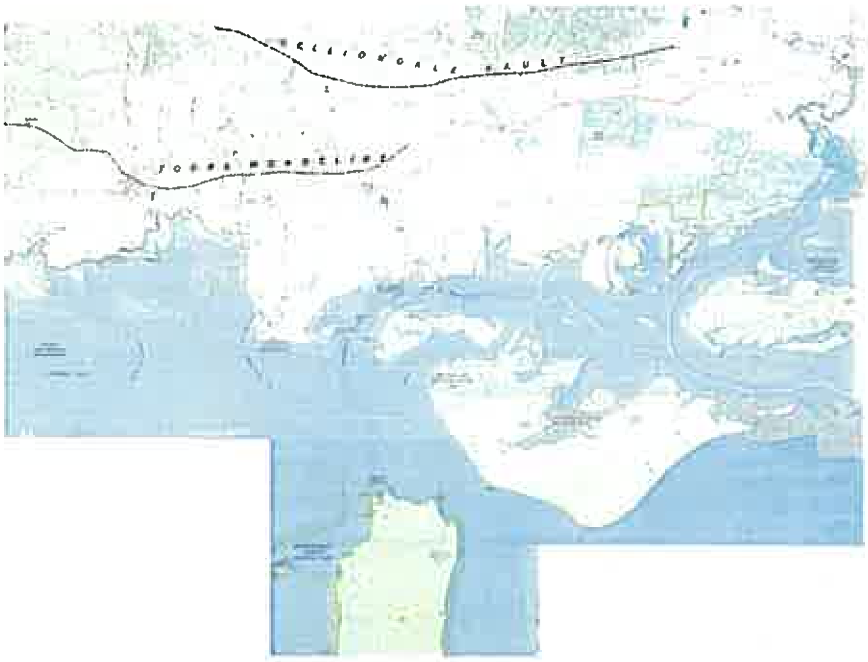


Figure 12. Barrier islands and mainland coast of western part of Nooramunga

5.2.3.2 Elevation and relief.

As LiDAR data was not available, a Digital Elevation (Terrain) Model has been constructed using Global Mapper ™ data from the Shuttle Radar Topographic Mission 2003. Although this has much lower vertical resolution than LiDAR and the elevation levels are exaggerated by trees, it provides better information about this coastal area (of subdued vegetation heights) than is available from the Vicmap Digital Elevation Model which has a vertical resolution of 10 metres. A contoured hill-shaded surface was used to draw representative topographical profiles (1 10 on Figure 13). These are displayed with comments as Figures 14 to 23. Note that the horizontal distance and elevation range is different for each profile hence all have different vertical exaggeration.

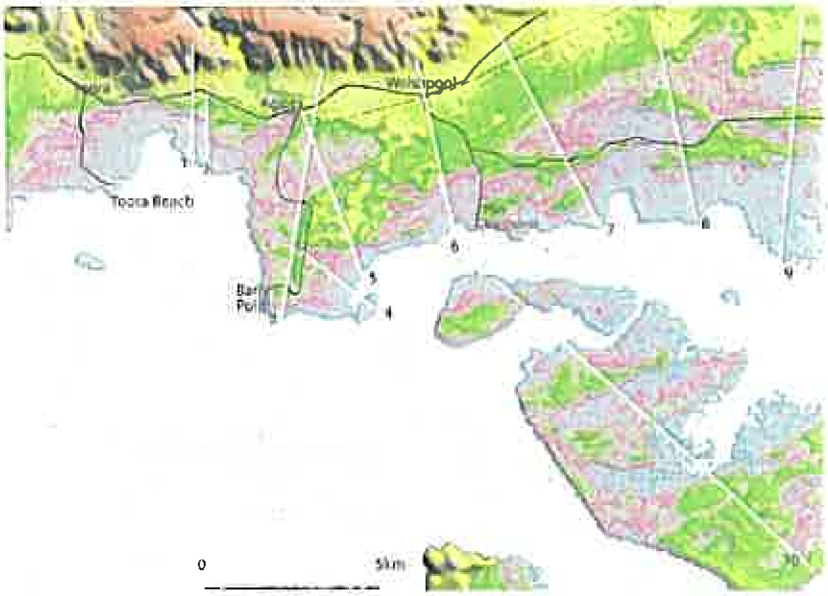


Figure 13. DEM from Shuttle Radar and location of topographic profiles 1 10.

Elevation around Barry Beach is relatively low and ranges from sea level to about 20 metres at the footslopes of the hills north of Welshpool and Toora. Most of the target area is below 10 metres and is flat to gently undulating terrain with subdued elongate, curving ridges and shallow enclosed depressions. Local relief is typically 5 metres or less. The steepest and most complex terrain are the sand ridges on Snake and Little Snake Islands.

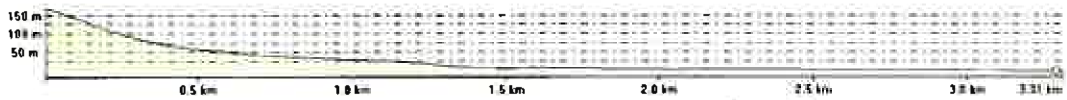


Figure 14. Profile 1, Toora Monocline to east of Toora Beach.

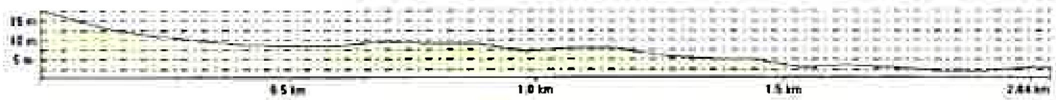


Figure 15. Profile 2, detail east of Toora Beach.

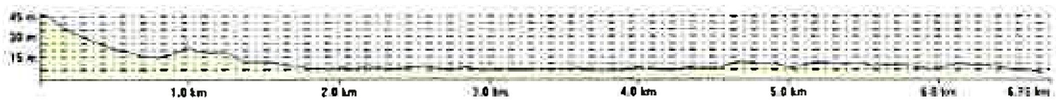


Figure 16. Profile 3, Agnes to Barry Point.

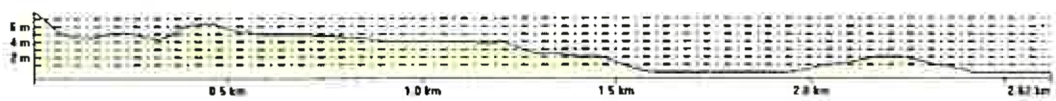


Figure 17. Profile 4, Barry Point to Possum Island.

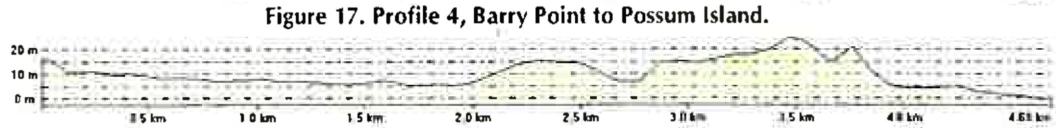


Figure 18. Profile 5, Agnes to north of Possum Island.

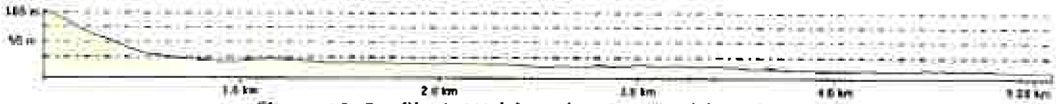


Figure 19. Profile 6, Welshpool to Port Welshpool.

Figure 20. Profile 7, east of Welshpool to Rossiters Road.

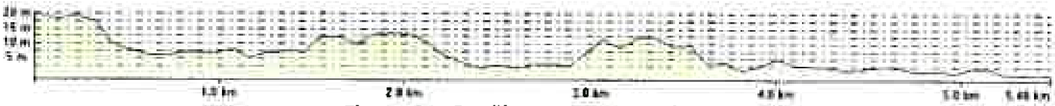


Figure 21. Profile 8, to East Road.

Figure 22. Profile 9, to Dog Island.

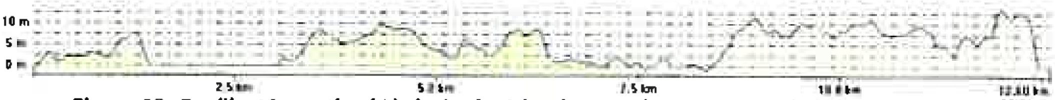


Figure 23. Profile 10, north of Little Snake Island to southern coast Snake Island.

5.2.3.3 Geomorphology

Jenkin (1968) mapped the islands of Nooramunga and adjacent mainland coast in detail and discussed the evolution of the landscape as a response to tectonics, climate and sea level changes and river deposition and incision. He also described the role of vegetation communities in shaping landforms, particularly on sand dunes and coastal and inland wetlands. Figure 24 is part of a detailed geomorphological map by Jenkin (1968).

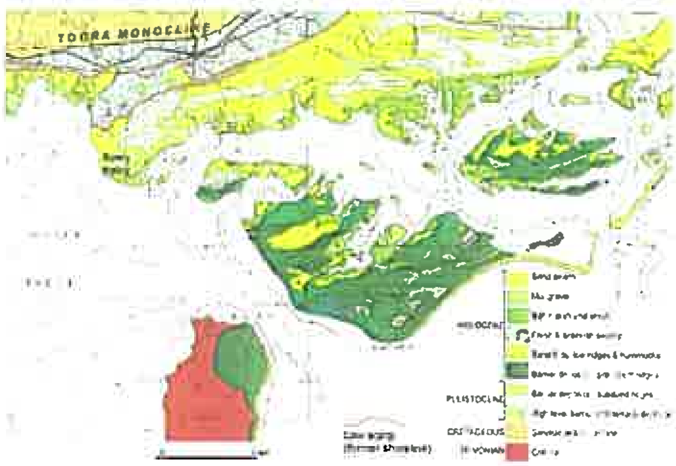


Figure 24. Geomorphology of western Nooramunga (after Jenkin 1968).

The map shows several parallel, low escarpments with relief of 1 to 3 kilometres north of Barry Point marking the position of former shorelines, now stranded by uplift of the coast and/or a relative fall in sea level. Between the escarpments are remnants of coastal and fluvial terraces either weakly dissected by channels (deepened by artificial drainage) or with low ridges and shallow depressions. Curvilinear parallel sand ridges and intervening depressions east of Barry Point are Mid-Holocene higher sea level remnants (see Figures 16 to 22) and the complex of younger ridges on Snake Island and Sunday Island are contemporary sea level features (Figure 23).

Detail of the coastal terrace and ridge sequences is shown in Figure 25 (after Jenkin, 1968).

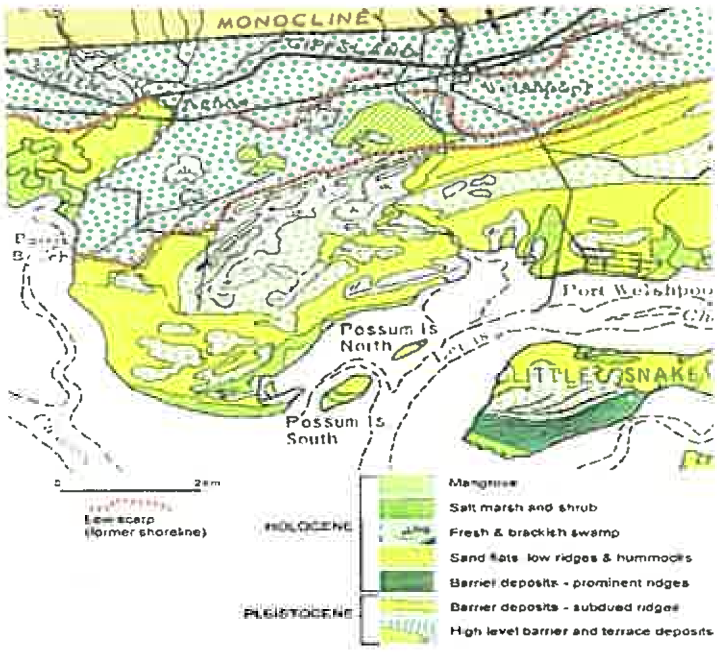


Figure 25. Detailed geomorphology of Barry Point and Port Welshpool (after Jenkin 1968).

5.2.4 *Geomorphological Constraints*

5.2.4.1 Low Elevation

Most of the onshore and island terrain is below 10 metres elevation and much of this is 5 metres or below. Much of the onshore coastline is agricultural land that has been claimed from marine and flood submergence (drained, cleared of coastal vegetation and protected from high tides by seawall and levee banks). These levees will need to be strengthened, extended, elevated and maintained if they are to provide adequate protection for rising sea levels. The surface materials are vulnerable to coastal erosion being sand, clay and organic deposits including areas of peat.

5.2.4.2 Internal Drainage and Flooding

There are a number of areas of impeded drainage at Barry Point and inland. These are enclosed or semi-enclosed depressions between dune ridges and originally were freshwater or brackish wetlands. Most have been drained or isolated form regular inundation by levee banks. Increased tidal penetration of coastal waterways including estuaries and small tidal inlets can be expected as a result of sea level rise and coastal subsidence. This will lead to increased submergence times and levels of bordering terrain. High seasonal water tables occur across most of these depressions.

5.2.4.3 Coastal Recession

Most of the mainland coast is in a stable condition in respect to coastal recession. This is due to a combination of low wave energy, protection afforded by seagrass beds, a fringe of mangroves, and the construction of an extensive artificial levee bank system. Because of the large tide range, the effectiveness of wave action is dampened by the sub-tidal surface, so a combination of high tide and storms is required to initiate erosion. Unlike the Ninety Mile Beach where the outer barrier is subject to storm recession and washover, the risk of coastal recession and inundation is lower on this mainland coast.

Sandy shorelines on Snake Island are subject to strong wave energy and episodes of foredune erosion leading to development of transgressive dunes occur.

The potential for land subsidence as a result of fluid withdrawal both onshore and offshore also appears to be lower than along the Ninety Mile Beach.

5.2.4.4 Soil Engineering Properties

The sediments and soils of the onshore terrain are limited in engineering capacity due to water-logging, locally high organic content and salinity. **They include extensive areas of low strength and compressible soils including stratified dark brown or dark grey saline silty clay and sandy clay. Locally here are areas of high organic content although the extent of peat is probably limited. Seasonal waterlogging, saturation and compressibility will be limiting factors on engineering use of these sites.**

5.2.4.5 Potential Acid Sulphate Soils

A preliminary study by the Victorian Department of Primary Industries of areas of the Victorian coast with potential acid sulphate soils (PASS) identified a number of potential sites around Corner Inlet and Nooramunga (DPI 2003). Since then, further detailed work has suggested that these areas may be more extensive than initially forecast, particularly around Nooramunga (Crawford and Rosengren in prep). Figure 31 shows an assessment of the distribution of PASS based on the evidence from recent drilling and detailed geomorphological mapping. The map shows two categories a) high to moderate risk of PASS and b) moderate to low risk of PASS. Extensive areas of PASS are identified on the coastal lowlands between the Agnes River delta and Dog Island. This terrain includes former tidal embayments now bunded by levee banks but subject to tidal influence prior to this isolation. Other areas that were submerged at Mid-Holocene higher sea levels are also identified as PASS.

There may be subaqueous areas of PASS offshore (south and east) of Barry Point. There is the potential for this material to be activated if these areas are dredged to accommodate shipping and

PASS materials are exhumed and deposited in intertidal or onshore areas where they will be exposed to oxidation processes.

There has been no field investigation for PASS on Snake or Little Snake Islands. The likelihood of PASS is lower due to the predominance of sand rather than muddy sediments and the lack of freshwater inputs. The map identifies areas of low to moderate PASS based on topography and current tidal submergence and areas that developed during Mid-Holocene times and are now isolated from tidal action.

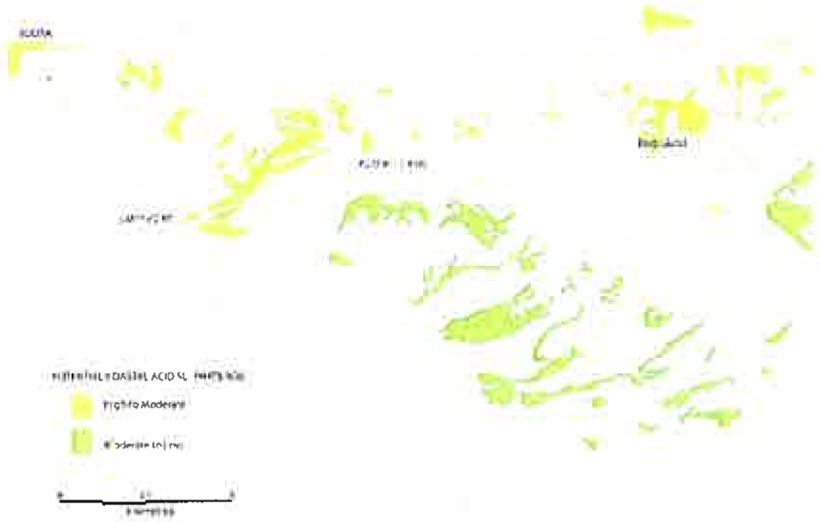


Figure 26. Potential acid sulphate soil risk.

5.2.4.6 Land Tenure and Conservation Status

Most of Corner Inlet and a fringe of the adjacent shoreline are the Corner Inlet Marine and Coastal Park. Two areas on the south east adjacent to Wilsons Promontory National Park are accord the status of Corner Inlet Marine Park. Apart from most of Sunday Island (which is freehold land), the islands, waterways, intertidal and subtidal surfaces and a fringe of the coastal mainland east of Barry Point comprise the Nooramunga Marine and Coastal Park (Figure 27). The parks and additional land are also a major component of the Corner Inlet Ramsar Site (Figure 28).

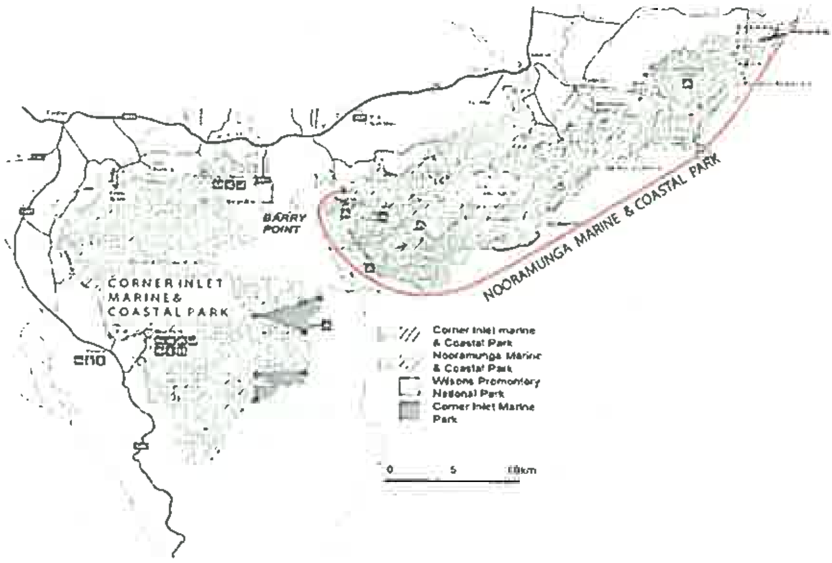


Figure 27. Marine and Coastal Parks in and adjacent to the study area (Parks Vic 2002).

Figure 28. Corner Inlet Ramsar Site (Parks Vic 2002).

These are subject to management plans and strategies that require detailed assessment of the potential impact of land use proposals on or adjacent to these areas. In the marine national parks, no fishing extractive or damaging activities are permitted. By comparison, the marine and coastal parks are managed for a variety of uses which do not impact on their values and objectives. The Corner Inlet Ramsar Site Strategic Management Plan (Parks Vic 2002), recognises a variety of potential risks to the environmental values including some that will or may accompany the establishment and operation of an export facility. These include dredging, introduced pest plants and animals, pollution and resource utilization. The plan does not list prohibited activities but requires a strategic risk analysis to determine management practices for activities that may impact the park and Ramsar sites.

5.2.4.7 Zoning and Overlays

Land in Victoria is zoned for various uses and the zones are subject to planning overlays outlined by the Victoria Planning Provisions (VPP). A number of planning overlays occur across the areas discussed in this report. These overlays constrain activities that are inappropriate for the terrain and location and/or will alter the physical character of landscape. Overlays require that planning approval be obtained from the appropriate level of Government (Local to Federal) that manages the content of the overlay. Overlays in the study area include: Environmental And Landscape Overlays, State Resource Overlays and Land Subject to Inundation Overlays. These will need to be addressed in an early stage of detailed planning for an exporting facility to be constructed near Barry Beach. The relevant outlays will be identified for the potential sites discussed High Level Concept report.

6. Site Identification Process

The suggested possible typical sites for the overall facility will be the result of the assessment of an amalgam of various criteria, including but not limited to :

- Land availability and ownership
- Geomorphologic and Geological considerations
- Coastal Engineering considerations
- Pipeline, Rail and Road access
- Environmental impact acceptability
- Recreational and Commercial acceptability
- Public acceptability
- Accessibility for the provision of rail, road, pipeline and utilities
- Cost
- Other relevant considerations

The prime identification process will be carried out by the MPV engaged Geomorphologic Consultant in co-operation with the Coastal Engineering Consultant. Hatch will assess their works and suggestions and carry forward into the final report, those sites or options considered most reasonable overall.

7. Capital Estimate

7.1 Accuracy

The estimate will be an "Order of Magnitude" estimate similar to a AACE class 5 estimate, namely +/- 50% accuracy and a possible 30% contingency to P_{50}

7.2 Basis of Estimate

The facility will be priced based on confidential empirical data held by Hatch based on a variable combination of other similar benchmarked projects, recent contracts and opinion.

The estimate should not be relied upon for any decision making purposes and is indicative only of the scope of the investment that may be contemplated. Many factors exist that may dramatically positively or negatively affect the final installed cost of the facility and its operations.

7.3 Battery limits of Estimate

Pricing will only **include** the Export Terminal and Marine facilities commencing from the incoming side of all Rail or Road Dump Stations or Final Discharge Flange of any overland bulk delivery pipeline and concluding once the cargoes cross the export vessel s side.

Consequently the immediate near-field **exclusions** are the rail balloon loop, all access roads, truck storage, parking and marshalling areas, pipelines, "pigging" and venting stations and related ancillary facilities and control stations, utilities of all kinds, sewer systems, environmental approvals, all land and right away negotiations and acquisitions, etc.

Appendix A

Sub-consultant Briefs

Request for Information

from

Geomorphology Consultant

BACKGROUND

Further to Hatch's engagement by Major Projects Victoria (MPV) for advice on a prospective major multi-purpose export facility at Barry Point, Gippsland, there is a definite need for expert opinions on a range of issues relating to the coastal geomorphology, geology, erosion, landform and site assessment matters pertinent to the selection of a site for the facility.

It is Hatch's understanding that your company has been retained by MPV to supply such information and opinions.

As suggested at the Client's project kick-off meeting on 4th November 2009, Hatch has compiled a list of issues on which it would appreciate your company's advice and opinion. Your understanding, interpretation and advice on these issues will have a significant impact on the location, form, nature, safety, cost and amenity of the export facility.

CONCEPT DESIGN ALTERNATIVES

At this preliminary stage of the engagement, Hatch is considering a range of export facility design alternatives, especially connected with marine export operations.

The general structural alternatives for the marine export facility include :-

- At first iteration, the facility will need to be capable of loading Handymax, Panamax and Cape size vessels. Should site conditions indicate that the dredged depth for Cape size vessels is not possible, then as a minimum Panamax loading is to be provided for.
- Traditional shore based concrete tubular piled wharf structure and dredged channel (14 ~ 20m deep LAT)

- Traditional tubular piled steel jetty trestle and remote loading platform (located in water 14 ~ 20m deep LAT)
- "Ropecon" conveyor and remote loading platform (located in water 14 ~ 20m deep LAT)
- Floating 80kt DWT Transfer Station (located in water 14 ~ 20m deep LAT), feed by numerous self propelled barges loaded from shore based tubular piled minor loading platform (located in water 6 ~ 8m deep LAT)

There are several hybrid options within these alternatives but for the sake of this study the above will be adequate to explore all salient possibilities.

The land based export terminals will include multiple large volume bulk stockpiles, covered storage sheds, liquid storage tank farms and large scale bulk liquid and solids receival assets.

The land area for the overall multi-purpose terminal is estimated to be in the order of 200 ~ 250Ha. It is anticipated that approximately 150Ha will be needed for coal and other solid bulk cargoes including major stacker and reclaimer machinery rail runways, coal stockpiles around 50m wide and 16m high, approx 15m deep rail and road dump stations, large span covered cargo storages, kilometres of conveyor galleries, transfer stations, material handling machinery, administration and control buildings, sheds and other ancillary buildings. The other approximately 100Ha will be dedicated to a range of bulk liquid and fuel storage tanks, pipeline and pipeline equipment, pigging stations, bunding and pollution controls, minor reprocessing facilities, sheds and other ancillary buildings.

Additional lands may be required for sewage and waste water treatment as well as major rail loops and roads. All structures are preferred to be founded on raft foundations rather than piles wherever possible.

Overall, initial indications suggest that suitable sites should have available areas in the order of 250 ~ 350Ha all inclusive.

The actual location of any specific suitable sites around Barry Point, are to be selected by you based on the estimated bulk cargo terminal area and needs as well as geomorphology and environmental considerations. You will need to liaise directly with the Coastal Engineering Consultant's to refine this site selection process.

Hatch will then assess all consultant's recommendations and advice for each site, together with the structural and operational implications for each and compile a simple multi-criteria analysis to compare the potential suitability of the sites.

For your preliminary information, the attached PowerPoint file contains Google Earth images showing the suggested areas to be generally investigated (A, B & C) and the possible extent of dredging for a range of preliminary berth locations (1,2,3,4,5,6 & 7). Your comment and refinement of these initial suggestions or others that you may identify, is an important input into the main study. You are to recommend two possible locations as an output from this specialist study.

ADVICE AND EXPERT OPINION REQUIRED

In view of the above design alternatives, please provide data and your expert opinion on the following issues :-

1. Identification of one or two potentially suitable coastal sites of suitable area around or nearby Barry Point, having due consideration of area required, intended usage, potential impact of sea level rises, coastal geomorphology and environmental constraints etc.
2. Typical on-shore and off-shore topography of each site
3. Typical on-shore and off-shore geotechnical material profiles of each site and likely dredge materials
4. Possible spoil disposal areas for the dredged material from the construction of berths and channels.
5. Possible existence of acid-sulphate soils on each site
6. Estimated settlement characteristics of each site (esp under 20m high coal stockpiles)
7. Proximity of residential developments to each site
8. Approximate land ownership of each site
9. Likely locations of safe harbours for the 3 No. 70t Bollard Pull ocean tugs (draft 7m max) required for the berthing of cargo vessels
10. Advice on any short and long term risks foreseen in the building of any of the required facilities on the site including issues affecting long-term stability and sea defences of the port land and assets.
11. Any other advice, information or opinion that may be material to the selection of sites, intended designs and their long term safety and usability.

TIMING OF YOUR RESPONSE

As Hatch's main report is to be with MPV by mid December 2009, time is of the essence in respect to your advice.

While it is intended that you will provide written evidence supporting your final advice and opinions for inclusion as appendices in the final report, Hatch requires your interim generic advice by 27th November 2009.

Your final report to Hatch is required by 4th December 2009.

HATCH CONTACT

The Hatch contact for this input is :

Philip McGavin

HATCH Port and Marine Discipline Lead

Cell : +61 (0) 402890109

Email : pmcgavin@hatch.com.au

Request for Information

from

Coastal Engineering Consultant

BACKGROUND

Further to Hatch's engagement by Major Projects Victoria (MPV) for advice on a prospective major multi-purpose export facility at Barry Point, Gippsland, there is a definite need for expert opinions on a range of issues relating to coastal engineering, bathymetry, wind and wave climate, littoral drift, dredging and other matters pertinent to the establishment of port facilities off-shore at Barry Point.

It is Hatch's understanding that your company has been retained by MPV to supply such information and opinions.

As suggested at the Client's project kick-off meeting on 4th November 2009, Hatch has compiled a list of issues on which it would appreciate your company's advice and opinion. Your understanding, interpretation and advice on these issues will have a significant impact on the location, form, nature, safety, cost and amenity of the export facility.

CONCEPT DESIGN ALTERNATIVES

At this preliminary stage of the engagement, Hatch is considering a range of export facility design alternatives, especially connected with marine export operations.

The general structural alternatives for the marine export facility include :-

- At first iteration, the facility will need to be capable of loading Handymax, Panamax and Cape size vessels. Should site conditions indicate that the dredged depth for Cape size vessels is not possible, then as a minimum Panamax loading is to be provided for.
- Traditional shore based concrete tubular piled wharf structure and dredged channel (14 ~ 20m deep LAT)

- Traditional tubular piled steel jetty trestle and remote loading platform (located in water 14 ~ 20m deep LAT)
- "Ropecon" conveyor and remote loading platform (located in water 14 ~ 20m deep LAT)
- Floating 80kt DWT Transfer Station (located in water 14 ~ 20m deep LAT), feed by numerous self propelled barges loaded from shore based tubular piled minor loading platform (located in water 6 ~ 8m deep LAT)

There are several hybrid options within these alternatives but for the sake of this study the above will be adequate to explore all salient possibilities.

The land based export terminals will include multiple large volume bulk stockpiles, covered storage sheds, liquid storage tank farms and large scale bulk liquid and solids receival assets.

The land area for the overall multi-purpose terminal is estimated to be in the order of 200 ~ 250Ha. It is anticipated that approximately 150Ha will be needed for coal and other solid bulk cargoes including major stacker and reclaimer machinery rail runways, coal stockpiles around 50m wide and 16m high, approx 15m deep rail and road dump stations, large span covered cargo storages, kilometres of conveyor galleries, transfer stations, material handling machinery, administration and control buildings, sheds and other ancillary buildings. The other approximately 100Ha will be dedicated to a range of bulk liquid and fuel storage tanks, pipeline and pipeline equipment, pigging stations, bunding and pollution controls, minor reprocessing facilities, sheds and other ancillary buildings.

Additional lands may be required for sewage and waste water treatment as well as major rail loops and roads. All structures are preferred to be founded on raft foundations rather than piles wherever possible.

Overall, initial indications suggest that suitable sites should have available areas in the order of 250 ~ 350Ha all inclusive.

Three sites appear to provide sufficient space for the land-side port development - immediately north, west and south of the existing ESSO port facility. The Geomorphological Consultant will assess the potential suitability of these three locations with regard to geomorphological and environmental considerations.

Hatch will then assess all consultant's recommendations and advice for each site, together with the structural and operational implications for each and compile a simple multi-criteria analysis to compare the potential suitability of the sites..

For your preliminary information, the attached PowerPoint file contains Google Earth images showing the suggested areas to be generally investigated (A, B & C) and the possible extent of dredging for a range of preliminary berth locations (1,2,3,4,5, 6 & 7). Your comment and refinement of these initial suggestions or others that you may identify, is an important input into the main study.

ADVICE AND EXPERT OPINION REQUIRED

In view of the above design alternatives, please provide data, advice and your expert opinion on the following issues :-

12. Coastal bathymetry for Barry Point sites

13. Wave direction, height and period, exceedance data for each site

14. Probability of extreme water levels and storm surge for each site

15. Prudent allowance for long term sea level rise (2030 to 2080)

16. Wind speed and direction, exceedance data for each site

17. Rain intensity and duration, exceedance data for each site

18. Tidal plains for the site ~ ML, HAT, LAT for each site

19. Direction, speed and occurrence of any off-shore currents and in-bay for each site

20. Littoral drift conditions prevailing along each site inside the bay

21. Littoral drift conditions prevailing at the entrance channel at the mouth of Corner Inlet itself. Also of concern is what has to be done with this material in order to preserve the surrounding coastal profiles over the annual drift cycles.

22. Possiblespoil disposal areas for the dredged material from the channels

23. Need for and possible frequency of maintenance dredging if a channel is constructed

24. Perceived 1:100 and 1:500 yr event design wave for a permanently moored Floating Transfer Station of about 80kt DWT at the site (likely located south of berth location 5 or 6, closer to Corner Inlet itself at location 7)

25. Perceived 1:100 and 1:500 yr event design wave for a traditional buoyed Single Point Mooring at each site

26. Safe structure height above Chart Datum, for any marine trestle or loading platform so as to avoid wave crest contact and especially overtopping in 1:100yr event, and 1:500yr event

27. Likely locations of safe harbours for the 3 No. 70t Bollard Pull ocean tugs (draft 7m) required for the safe berthing of vessels ~ eg moored along jetty, shore based breakwater protected harbour or suitable remote site

28. Advice on any short and long term risks foreseen in the building of any of the required facilities on the site

29. Any other advice, information or opinion that may be material to the intended designs and their long term safety and usability.

TIMING OF YOUR RESPONSE

As Hatch's main report is to be with MPV by mid December 2009, time is of the essence in respect to your advice.

It is appreciated that your advice may sometimes differ depending on the specific sites finally contemplated and that these may not be available from the Geomorphology Consultant until early to late November.

While it is intended that you will provide written evidence supporting your final advice and opinions for inclusion as appendices in the final report, Hatch requires your interim generic advice by 27th November 2009 and of crucial importance is the bathymetry of the area. As specific site data comes available from the Geomorphology Consultant, your advice should be updated and forwarded to Hatch for inclusion in the final report.

Your final report to Hatch is required by 4th December 2009.

HATCH CONTACT

The Hatch contact for this input is :

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HATCH Port and Marine Discipline Lead

Cell : +61 (0) 402890109

Email : pmcgavin@hatch

Appendix B

Report from Coastal Engineering Sub-consultant

Appendix C

Report from Geomorphology Sub-consultant