Section 6.3 Hydrodynamics and Sedimentation

Section 6.3.1 Meteorology

During summer, a ridge of high pressure directs easterly winds over the south-west corner of the continent. The pressure gradient during this period generally shifts more north-easterly propagating heat troughs and then shifts south-wards after the passage of the trough. A rapidly reforming high usually then causes a burst of stronger south-easterlies following trough passage.

By April, the cooling continent causes the sub-tropical ridge to migrate northwards and the south-west corner becomes increasingly affected by mid-latitude westerly flow into the winter months. This increasingly subjects the region to passing frontal and low-pressure systems; high pressure may still develop over ocean latitudes but tends to be much more transitory in nature.

Section 6.3.2 Ocean Circulation

The dominant influence on the circulation in the waters of King George Sound and Princess Royal Harbour is strong marine winds which flow over the ocean at scales of tens of kilometres. Albany's meteorology is dominated by easterly winds in summer and westerly winds in winter.

Tides are relatively weak at Albany and vary from diurnal to semi-diurnal throughout the year with a spring tidal range of approximately 1.1 m. Water levels are also influenced by the weather systems, with wind driven setup resulting from sustained winds in King George Sound readily transmitted into Princess Royal Harbour. The water-level ranges within and outside the Harbour are virtually identical (EPA, 1990).

Examples of ebb and flow tides in King George Sound and Princess Royal Harbour, as modelled by GEMS (2006) are provided in Figure 6.3 and Figure 6.4.

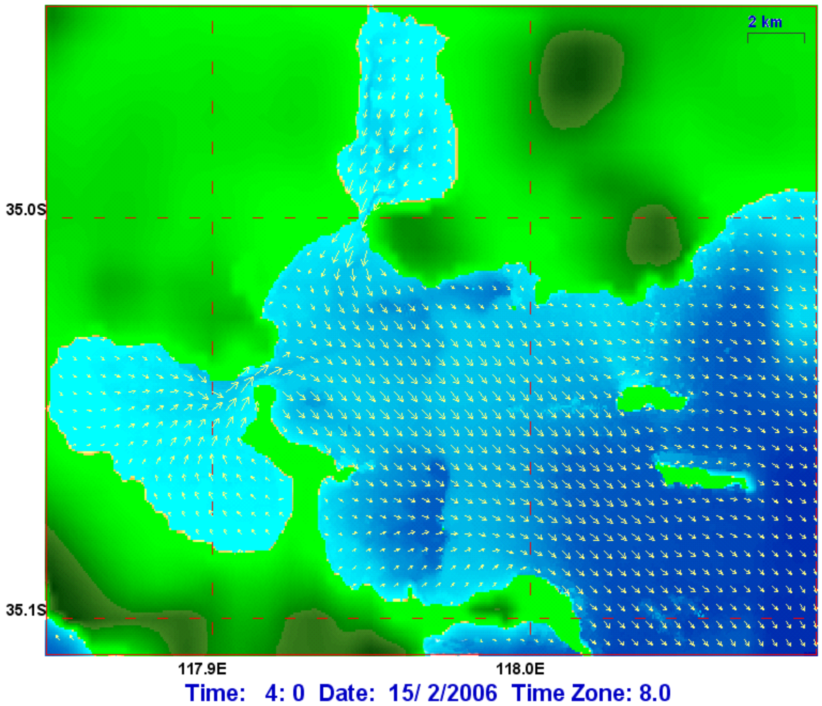

Figure 6.3 Example of the Ebb Tide in King George Sound and Princess Royal Harbour Predicted by GCOM3D.

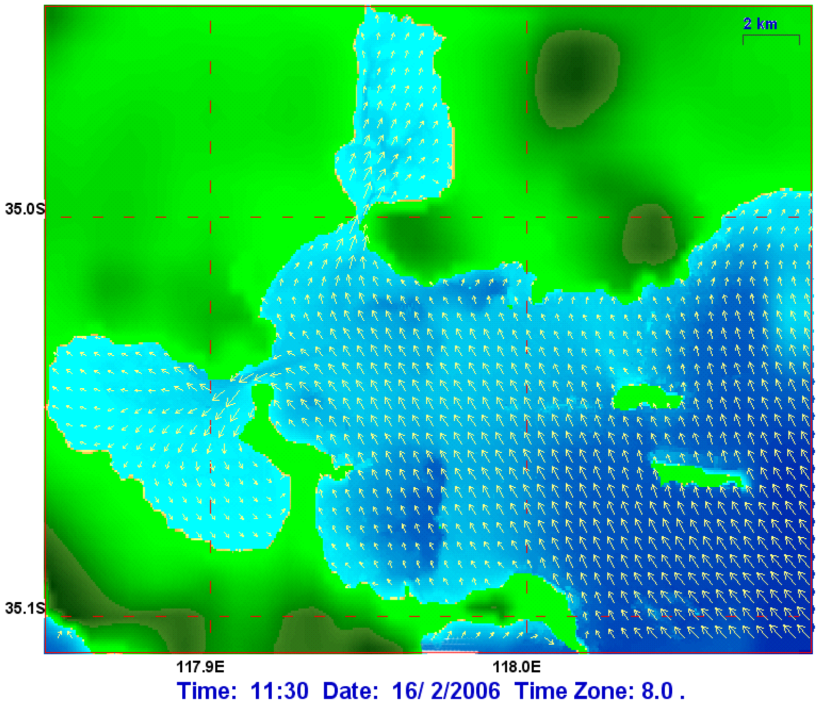

Figure 6.4 Example of the Flood Tide in King George Sound and Princess Royal Harbour Predicted by GCOM3D.

Princess Royal Harbour

Modelling of wind driven circulation of water in Princess Royal Harbour (Mills and Brady, 1985) showed that west to north-west winds in winter generate predominantly anti-clockwise circulation whereas east to south-east winds in summer generate predominantly clockwise circulation. Investigations into water circulation and flushing characteristics of the Harbour (Mills and D' Adamo, 1993) also found that up to 30 000 000 m^3 of water may leave or enter the Harbour within eight hours of rising tides and 16 hrs of falling tides. An important factor in determining water exchange was water movement passing through the entrance channel of the Harbour which was found to accelerate to current speeds of up to 0.5 m/sec.

These findings have been supported by the observations and modelling conducted for the Albany Port Expansion Proposal (GEMS, 2007).

King George Sound

Additional findings regarding the circulation in King George Sound (GEMS, 2007) include:

- During summer, winds from the south to south-east sector generate a predominantly anti-clockwise circulation in King George Sound.
- During summer, winds from the east to north-east sector generate a predominantly clockwise circulation in King George Sound.
- During summer, when winds are from the south-east to north-east sector, the surface flow in the centre of King George Sound is generally towards the west but the bottom flow is generally in the opposite direction.
- During winter, sustained strong westerly winds generate what appears to be a shelf wave along the continental shelf outside King George Sound (at the alternate disposal site) resulting in current speeds over 1 knot at depths of 40 m. The amplitude of the bottom current in these

situations correlates well with the wind speed and the phase of the bottom current variations often leads the phase of the wind. Dredge material placed at the alternate disposal site is unlikely to be stable under these conditions. The preferred disposal site inside King George Sound however, is not affected by the shelf wave and is anticipated to be a stable disposal site (Section 10.3).

Section 6.3.3 Waves

The broad high latitude westerly flow over the Southern and Indian Oceans produces a highly energetic wave climate at the south-west corner of the continent. However, the south-easterly to easterly aspect of King George Sound provides a significant level of protection to these waves.

While there can be sustained easterly wind flow in the region, more particularly in the warmer months, these winds are generally not spatially extensive so that the resulting waves are less energetic, and at higher frequency.

Occasionally, however, the synoptic pattern may be favourable for the development of higher energy south-east waves. Typically, these events occur with the development of a high-pressure system at higher latitudes. Such a system may be accompanied by a slow- moving depression, cut-off from the prevailing westerly flow in the region of the Great Australian Bight. Strong pressure gradients 'squeezed' between such coupled systems are ideal for generating large south-east waves that propagate towards the Albany region. Wave height increases inside King George Sound therefore are highly dependent on the wave direction (GEMS, 2007).

An assessment of the offshore climate at Albany was undertaken for berths 5 and 6 development, by Lawson and Treloar (1999). The resulting estimates of significant wave heights for severe storms offshore and at the entrance to Princess Royal Harbour are as shown in Table 6.1.

Table 6.1 Estimate of Significant Wave Heights Offshore and in Princess Royal Harbour.

Recurrence Interval	Significant Wave Height (m)	
	Offshore	Entrance to Princess Royal Harbour
100 years ARI	10.5 m	1.7 m
50 years ARI	9.8 m	1.5 m

Section 6.3.4 Sediment Physical Properties

The seabed along the proposed dredge footprint is comprised of a layer of predominantly clean grey fine to medium grained sand (approximately 1-1.5 m) overlying more consolidated sands and occasional shell deposits. Unconsolidated limestone rocks are present on the seafloor in the vicinity of Gio Batta Patch, with high plasticity green clay encountered at depth in some locations during geotechnical investigations.

A seam of peaty material was found in the entrance to Princess Royal Harbour. The quantity of peat that requires dredging has been calculated to be 9,450 m^3.

Particle size distribution analysis was undertaken on sediments collected in the three dredge areas (Dredge Area 1–3, Figure 6.6) and the two potential disposal areas. Laboratory reports are provided in Technical Appendix 16.2. A summary of the particle size distribution data is provided in Table 6.2 to Table 6.5 with a graphical representation of the cumulative per cent of weight provided in Figure 6.5.

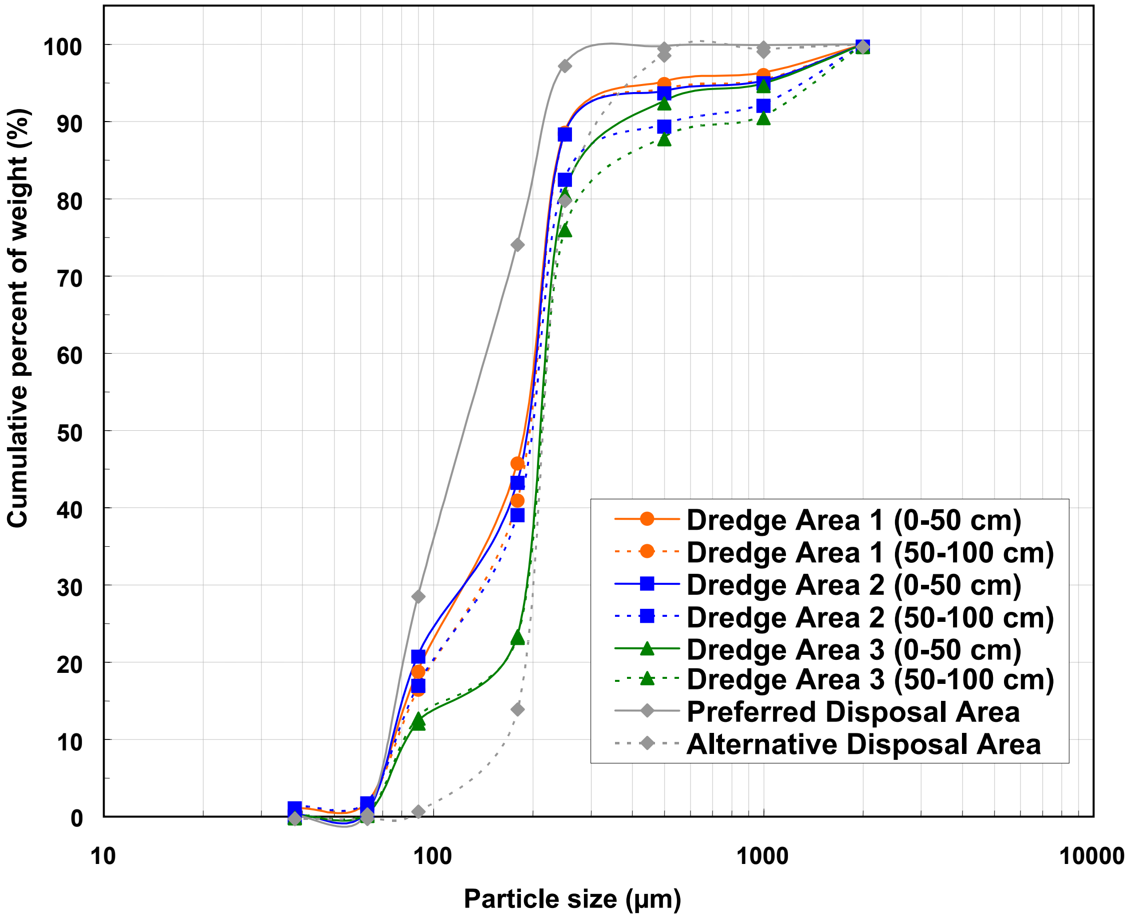

Figure 6.5 Sediment Particle Size Distribution.

Table 6.2 Mean Particle Size Distribution Data for Dredge Area 1.

Description	Size (µm)	Surface (0–50 cm)	Sub-surface (50–100 cm)
Very fine gravel	2000	3.66±3.46	4.54±7.13
Very coarse sand	1000	1.13±0.68	1.25±0.95
Coarse sand	500	6.33±10.11	5.59±4.03
Medium sand	250	42.83±19.14	47.37±15.21
Fine sand	180	26.95±12.73	24.48±8.92
Very fine sand	90	17.14±10.73	14.74±6.61
Very fine sand	63	0.88±0.64	0.94±0.79
Coarse silt	38	1.08±1.29	1.09±2.25

Table 6.3 Mean Particle Size Distribution Data for Dredge Area 2.

Description	Size (µm)	Surface (0–50 cm)	Sub-surface (50–100 cm)
Very fine gravel	2000	4.70±5.99	7.64±8.26
Very coarse sand	1000	1.34±1.38	2.67±2.76
Coarse sand	500	5.32±4.72	6.91±5.49
Medium sand	250	45.09±9.49	43.41±12.67
Fine sand	180	22.51±8.70	22.09±12.05
Very fine sand	90	20.27±6.70	15.21±9.82
Very fine sand	63	0.52±0.32	0.64±0.87
Coarse silt	38	0.25±0.19	1.43±4.21

Table 6.4 Mean Particle Size Distribution Data for Dredge Area 3.

Description	Size (µm)	Surface (0–50 cm)	Sub-surface (50–100 cm)
Very fine gravel	2000	5.08±4.53	9.19±6.87
Very coarse sand	1000	2.24±1.36	2.74±1.83
Coarse sand	500	11.77±7.12	11.79±5.65
Medium sand	250	57.19±11.69	52.78±15.25
Fine sand	180	11.33±3.97	10.47±3.61
Very fine sand	90	11.93±4.78	12.38±6.99
Very fine sand	63	0.35±0.17	0.42±0.24
Coarse silt	38	0.12±0.05	0.23±0.28

Table 6.5 Mean Particle Size Distribution Data for the Two Potential Disposal Areas.

Description	Size (µm)	Preferred Disposal Area	Alternative Disposal Area
Very fine gravel	2000	0.09±0.12	0.61±0.37
Very coarse sand	1000	0.15±0.16	0.52±0.25
Coarse sand	500	2.22±1.63	18.81±11.29
Medium sand	250	23.14±14.10	65.83±8.40
Fine sand	180	45.55±11.40	13.26±4.55
Very fine sand	90	28.25±7.90	0.93±0.50
Very fine sand	63	0.50±0.31	0.02±0.04
Coarse silt	38	0.10±0.12	0.04±0.04

The particle size distribution in the surface (0–50 cm) and sub-surface (50–100 cm) sections in each of the dredge areas is similar, with Dredge Area 3 showing a lesser proportion of very fine sand (~125 µm). The dominant particle size is classified as medium sand (~250 µm). The dominant particle size for the preferred disposal area is very fine sand (~125 µm) whereas that for the alternative disposal area is fine sand (~250 µm).