EXECUTIVE SUMMARY

The Need for Action

The long history of navigation problems in the Swansea Channel area are probably best summarised in an article from the Newcastle Morning Herald on 11 May, 1972:

> *"In almost every generation since the first major works in the early 1880's, there has been constant agitation for improvements, whether major or minor."*
>
> *"The constant demand has been for breakwater restoration, dredging and still more dredging."*
>
> *"...and the uniform reply has been lack of money to meet the cost of such works, sometimes with a variation that while proposals would improve the channel the cost could hardly be justified"*

In the past 50 years, management of the channel upstream of Swansea Bridge has typically involved dredging to maintain navigable depths and the construction of groynes and revetments along the foreshores to reduce bank recession.

The southern entrance to Swan Bay was created by recent dredging activities (refer to figure E1.1 for locality plan) in an effort to improve water quality in the southern sections of the bay. However this opening has coincided with the onset of channel instability and navigation problems adjacent to the southern entrance. This has once again prompted community calls for improved navigation and dredging.

Project Objectives

The overall objectives of the project were to:

- Understand the hydraulic and sediment transport processes along the upper region of Swansea Channel, including the impact of the removal of the southern sand spit from the entrance to Swan Bay. The investigation extends into Swan Bay in terms of understanding water exchange with Swansea Channel and its impact on water quality and sediment transport;
- Understand the link between areas of bank erosion and channel migration. Areas of erosion are present along Swansea Channel within the study area, including the foreshores of Pelican Flat and Coon Island. Identification and assessment of these areas in terms of severity and the processes causing the erosion has been undertaken;
- Understand and investigate options to manage foreshore erosion inside Swan Bay;
- Address community claims that major dredging works along the channel will significantly improve water quality within the Lake; and
- Investigate management options that will assist in managing navigation, sedimentation and bank erosion in the channel in the short and long term. Each management option is to be assessed in terms of environmental, recreational and social impact, as well as cost.

Study Methodology

The study was carried out in two stages:

Stage 1 : Review and analysis of existing historical information, aerial photography, historical survey information, previous reports and other relevant data; detailed site inspections and data collection exercises; development of a numerical model for hydraulics and sediment transport; formulation and selection of potential management options.

Stage 2 : Modelling of selected management options, analysis of selected management options and determination of preferred short and long term management options.

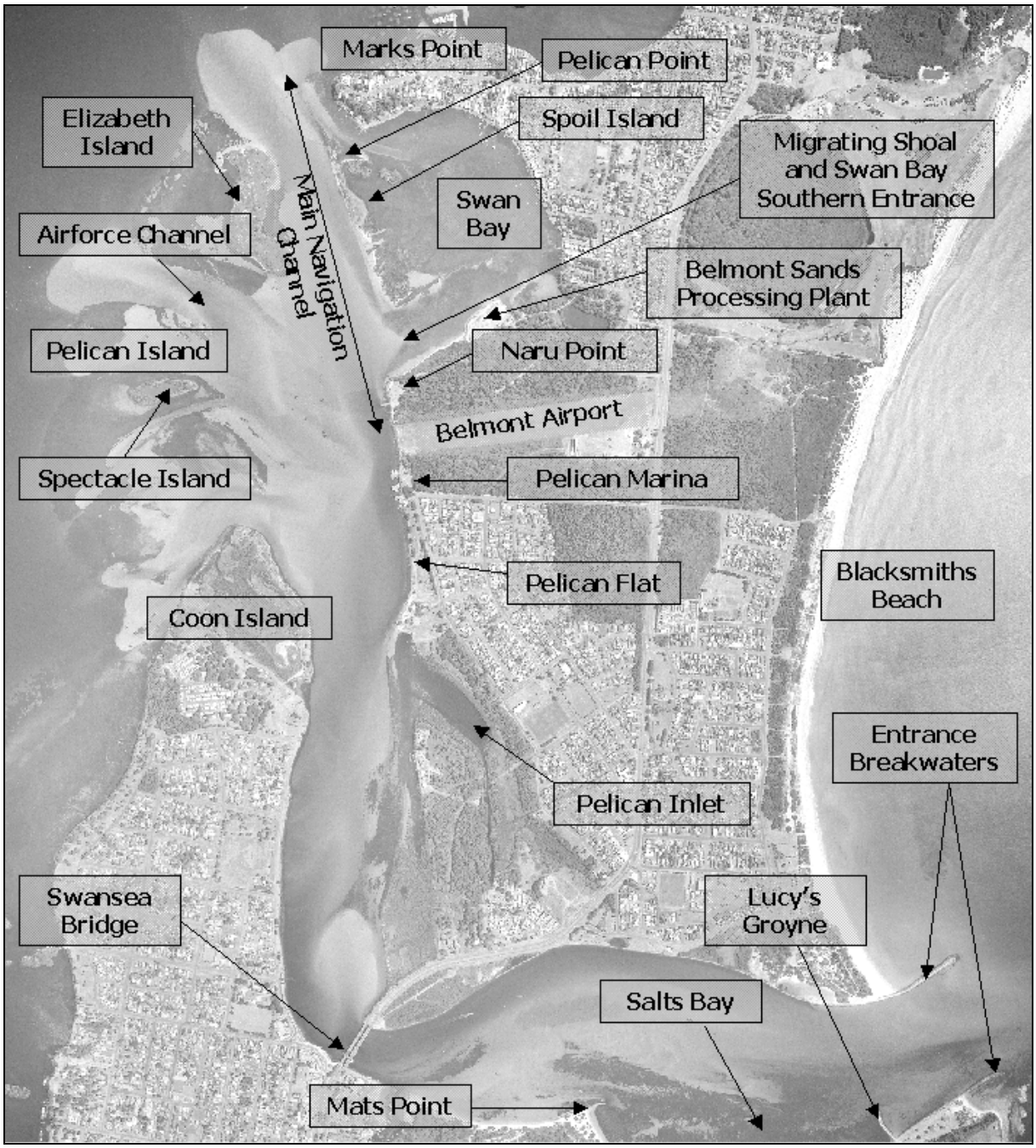

Figure E.1-1 Locality Plan

Important Processes

It was found that the main physical process driving the need for constant management of the channel is the continual supply of sediment from downstream sources. It has been noted that catchment based flooding is minor in Swansea Channel and that the dominant hydraulic process in the channel are tidal. Flooding of the Swansea Channel area is generally associated with high ocean water levels, which often occur concurrently with high rainfall (due to barometric pressure effects).

The most likely source for sediment into the study area is erosion of Salts Bay. Training of the entrance in the late 1800s has resulted in increased wave penetration into Salts Bay, which has receded by over 400 m in response. Another potential source of sand is from offshore, however, studies reported in the Swansea Channel Waterway Planning Study (PWD, 1976) indicated that coastal processes have not changed significantly since construction of the breakwater, suggesting no major changes to marine sediment pathways (and hence limited sediment infeed into the lake).

It is hoped that recent works in Salts Bay, including groyne construction and beach nourishment, will result in stabilisation of the Bay and the reduction and/or cessation of sediment transport upstream from Salts Bay. It is important that this situation be closely monitored to ensure that new sediment entering the system does not exacerbate the current navigation problems experienced upstream of the bridge.

The Lake Macquarie Estuary Management Study (Volume 1, WBM, 1997) reports that Swansea Channel does not currently have a stable channel configuration, and that the cross-sectional area of the channel is gradually adjusting to the impact of entrance training works. The erosion resulting from the 'under-regime' status of the channel has been partially exacerbated by the construction of the road bridges and approaches at Swansea, which cause very high velocities and erosion beneath the bridge.

The expected adjustment required to gain a stable configuration suggests a gradual increase in cross-sectional area will occur, which ultimately means overall erosion of the channel.

Sediment that originated from downstream of Swansea Bridge is the prime cause of the problems presently experienced with respect to navigation within the study area. From year to year, the nature and location of the specific navigation problem changes as pulses of sediment move through the entrance, forming ever changing shoal patterns, and ultimately reflecting a net transport of sediment upstream through the study area and deposition on the tidal dropovers at the edge of the deep lake basin.

Currently, in the area downstream of Pelican Flat, erosion is generally occurring at the greatest rate within the deepest part of the channel. Erosion also tends to occur, albeit at a slower rate, on the shoals adjacent to the main channel. Significant areas of foreshore erosion and channel deepening occur adjacent to the Swansea foreshore south of Coon Island and adjacent to Pelican Flat.

The sediment and hydraulic processes in the study area are complicated. However, with the community expectation that navigability will be maintained, it is important that the navigation situation be managed. At present there exists a system of braided channels of varying depths. This is in conflict with the expectation of a single deep navigation channel from the ocean to the lake. Past attempts to dredge a stable channel have been thwarted by the continued supply of sediment from downstream.

To further complicate matters it appears that re-opening of the southern entrance to Swan Bay has encouraged the migration of sand into the entrance area. However, this is not the only cause of problems in the area. The ongoing movement of sediment upstream of Swansea Bridge is also contributing to the problem. Originally, it was expected that the southern entrance to Swan Bay would tend to close following dredging (Resource Planning, 1988), due to the design of the cross

section of the southern entrance. However, this has turned out not to be the case with sediment depositing within the main navigation channel, pushing the navigation channel into the southern entrance.

In solving the problem, the movement of sand into the southern entrance of Swan Bay must be considered in conjunction with an expected continuation of sediment infeed from downstream. Eventually, the supply of sediment from downstream will reduce as Salts Bay, becomes stabilised and as the channel reaches a more 'in-regime' configuration, however, timescales for this to happen may be long (in the order of decades). Until such time, there will be a need for periodic dredging as a part of any management strategy adopted for the area.

Management Issues

Given the environmentally sensitive nature of the entrance area, there are a number of issues that were considered when formulating possible management options. These issues included:

- Works needed to be consistent with the NSW Coastal Policy, 1997, which ensures that all environmental, economic and social costs are addressed, and that options satisfy ESD principles;
- Management options were assessed holistically, that is, in addition to the physical processes, the impacts of the options on all environmental processes were considered, including the ecosystems of the entrance channel and lake as a whole, water quality, flooding, navigation and social issues;
- Options considered, wherever possible, the potential effects of climate change arising from the Greenhouse Effect as outlined in IPCC (2001);
- Options have minimal effects on the seagrass beds that exist within the entrance channel and the lake itself. Any increase in tidal range is likely to expose seagrass beds around the lake. Similarly, the islands at the dropover were assessed for their terrestrial habitat values and suitable treatment of these islands were incorporated into management options.

These broad issues were considered in developing conceptual management options during Stage 1 of the study, which were subsequently analysed during Stage 2.

Modelled Management Options

The management options selected for detailed analysis include:

Option 1 : Dredging works between Naru Point and Marks Point

Option 2 : Dredging works westwards from Naru Point through the existing Airforce channel, coupled with structural works to train the channel;

Option 3 : Dredging works (as per Option 1) combined with either full or partial closure of the southern entrance to Swan Bay;

Option 4 : Dredging works (as per Option 1) combined with the construction of a groyne at Naru Point;

Option 5 : Dredging works (as per Option 1) combined with the construction of a barrier between Coon Island and Elizabeth Island; and

Option 6 : Removal of the sand islands from the study area (Elizabeth, Pelican and Spectacle Islands)

Long Term Management Option Recommendation

Based on the long term options analysed, it appears that the most cost effective solutions involve dredging the main channel (northwards past Marks Point) to a depth of around –4.0 m AHD with a width of around 120 m. In reality, it is expected that the optimal solution for dredging would involve a depth of between –3.5 m AHD and –4.0 m AHD and a width of somewhere between 60 and 120 m. More refined modelling would be required to find

the optimum dredging configuration, which would be done during detailed design.

Modelling indicated that the dredged channel appears to be susceptible to possible infilling in the vicinity of the southern entrance to Swan Bay for options where an opening to Swan Bay is retained. In this area, the channel 'feels' the effect of the open entrance which takes some of the flow from the main channel, resulting in slower current velocities and deposition of sediment.

The stability of the dredged channel in the vicinity of the southern entrance to Swan Bay can be improved by the partial or full closure of the southern entrance to Swan Bay. Full closure would most likely result in poorer tidal flushing within Swan Bay, although it would significantly minimise the potential for wind wave erosion currently experienced on the eastern foreshore of Swan Bay. By adjusting the width of the opening, it is expected that a balance between channel stability and water quality within Swan Bay could be achieved.

The weighted benefit/cost assessment (Section 8.3.3) suggests that for the "full closure" option, the negative impacts associated with reduced tidal flushing would be outweighed by the improvements to channel stability and the reduced need for future maintenance. As a results, the option to dredge the channel in combination with refilling the southern entrance proved to be the 'best' option, when considering all factors.

Short Term Management Option Recommendation

The large capital expenditure that would be required to achieve the long term objectives suggests that a realistic 'short term' option should also be recommended. It is noted that the practice of recent times, which has involved minimal dredging of the dog-leg prior to the main boating season, has typically had short-lived benefits, prompting considerable community concern.

The main issue which can be addressed in the short term is that of navigation in the immediate vicinity of the Swan Bay southern entrance. Small scale dredging has been suggested adjacent to the southern entrance of Swan Bay, in order to re-establish a straight navigation channel between Pelican Marina and Marks Point. If dredged to a depth of –3 m AHD, which is consistent with current depth towards the northern end of the existing navigation channel, the short term works would involve removal of approximately 80,000 m^3 of sand. Modelling of this short term option was also carried out. Sediment erosion accretion patterns indicate that the subject area would require regular dredging to maintain navigation. Preliminary calculations estimate that maintenance dredging may be required as often as every year, while ever the large sand shoal remains within the main northern navigation channel.

It is considered that wherever possible, implementation of the short term option should also contribute to the long term solution. For this reason, WBM suggests that the material removed from the channel for the short term option is placed within the deeper sections of the southern entrance to Swan Bay, and within the deep holes within the bay relic from the over-dredging by past extraction activities. Any amount of material that can be returned to the southern entrance will result in a reduction in the works required to 'fill the gap', when implementing the preferred long term option.

Modelling with and without filling of deeper sections of the southern entrance to Swan Bay indicates that the deposited material would remain relatively stable, providing that a navigable passage is maintained in the channel. Obviously, hydrographic monitoring of the channel following implementation of the short term option would be essential in determining the need for maintenance dredging in the future.

Also requiring consideration will be the need to maintain navigation through the channel during the course of the short term dredging. In this regard it may be necessary to temporarily stockpile the dredged material before placing it within the current navigation path.