MANLY COUNCIL

Manly Ocean Beach

Emergency Action Plan for Coastal Erosion

Issue No. 6
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MANLY OCEAN BEACH

EMERGENCY ACTION PLAN FOR COASTAL EROSION

Issue No. 6
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Document Amendment and Approval Record

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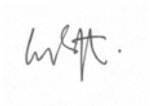
2	Revised Draft	GWB (6.7.06)		
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Note that the Plan was developed, publicly exhibited and endorsed prior to changes in some legislation

Note: This document is preliminary unless it is approved by a principal of Patterson Britton & Partners.

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1 INTRODUCTION

1.1 BACKGROUND

Manly Ocean Beach stretches from Queenscliff to South Steyne, a distance of some 1.6 km, within the Manly Local Government Area (refer **Figure 1.1**). The beach is backed by a seawall of varying design and age, and an adjoining promenade and foreshore reserve. The entrance to Manly Lagoon is situated at the northern end of the beach.

The beach is subject to erosion during coastal storms. Depending on the severity of the storms, the seawall can be subject to undermining and collapse and other damage such as removal of coping stones (refer **Photos 1.1** to **1.10**). Studies have shown that over a period of 107 years to the mid 1990s, sections of the seawall were damaged, on average, once every 10 to 15 years (Patterson Britton, 1995). The position of the damage along the seawall varies depending on a number of factors such as the characteristics of the storm, particularly wave approach direction, the location of rips along the beach, and the particular type of seawall construction.

Beach erosion will continue to threaten the seawall and other foreshore assets along Manly Ocean Beach into the future, since the volume of sand available on the beach is not sufficient to accommodate the magnitude of sand losses in severe storms. The level of threat into the future would be increased by shoreline recession predicted to occur as a result of Greenhouse sea level rise, as this would be expected to cause a narrowing of the beach over time. This narrowing would also cause a loss of beach amenity and adverse economic effects.

Rock protection exists at the toe of the seawall along much of Manly Ocean Beach, as a result of past emergency protection or approved seawall stabilisation works. Exposure of this rock protection at times of beach erosion can present amenity and safety issues in the period prior to natural beach recovery and reburial of the rock following storms.

Manly Council has established a Manly Coastline Management Committee, which will oversee preparation of a Coastline Management Study and Coastline Management Plan for Manly Ocean Beach. The Committee includes Council officers and representatives of relevant government departments, environmental groups and the local community. Patterson Britton & Partners has been engaged by Council to prepare the Coastline Management Study and Coastline Management Plan.

One of the many objectives of the Coastline Management Study is to develop an Emergency Action Plan in case of a major storm event(s) prior to implementation of management options to address the beach erosion and shoreline recession hazards. This report deals with the Emergency Action Plan.

FIGURE 1.1

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STUDY AREA

1.2 SCOPE OF WORK

The scope of work for preparation of the Emergency Action Plan is set out in the Brief for the Coastline Management Study and Coastline Management Plan. The main items in the scope of work can be summarised as follows:

- the Emergency Action Plan must provide sufficient detail to support a development application (DA) for the carrying out of the work (it was noted that preparation of a Statement of Environmental Effects that would need to accompany a DA was outside the scope of work);

- the Emergency Action Plan should include, but not be limited to, the following information:
  - material specifications, including unit size and distribution, shape, specific gravity, strength, durability, adaptability, availability, handling and maintenance requirements and structure flexibility and porosity;
  - compatibility of material with existing insitu conditions;
  - design criteria/standards adopted;
  - design configuration and dimensions, including alignments, elevations and profiles;
  - performance under design conditions, including post-storm configurations;
  - consequences should design thresholds be exceeded;
  - construction methodology and logistics;
  - post storm rehabilitation and monitoring; and
  - detailed construction cost estimates;

- an assessment should be provided of the likely lateral extent of emergency work required at locations along the beachfront, which will tend to be focussed at rip heads;

- the post storm rehabilitation and monitoring plan should specify any remedial work needed to ensure the emergency works remain buried under average beach-recovered conditions.

1.3 STRUCTURE OF THE REPORT

A range of issues and background information needs to be considered in the formulation of an Emergency Action Plan, even though the Plan itself should be a brief document for ease of use.

In recognition of the above, the report is set out in the following way:

- **Section 2** discusses the roles and responsibilities of parties that may be potentially involved in coastal erosion emergencies at Manly Ocean Beach, including the State Emergency Service (SES), Department of Natural Resources (DNR), NSW Police, Manly Council and the Commonwealth Bureau of Meteorology;

- **Section 3** discusses the issue of the approvals that may be required prior to implementation of emergency protection measures for coastal erosion;

- **Section 4** discusses the types of emergency protection measures that are potentially available and identifies a preferred emergency protection measure(s);

- **Section 5** provides some notes on the formulation of an Emergency Action Plan including the trigger mechanisms that might apply in proceeding from one level of activity to another within the Plan;

- **Section 6** comprises the Emergency Action Plan.

A number of Appendices are included that provide further detail on a range of background matters.

Photo 1.1 Beach erosion and seawall, promenade and landscape damage looking north towards North Steyne SLSC, 1950. Note piling under North Steyne SLSC.

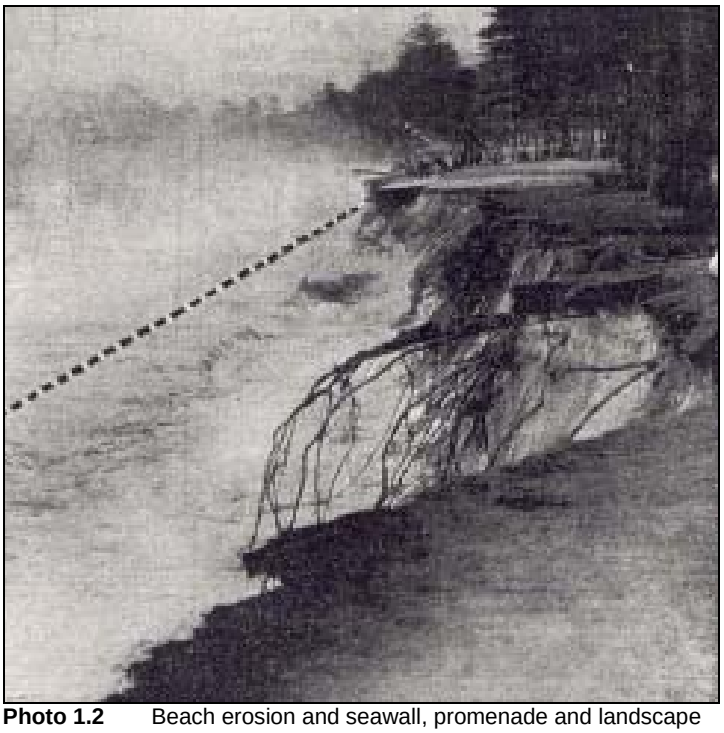


Photo 1.2 Beach erosion and seawall, promenade and landscape damage looking south from North Steyne SLSC, 1950. The dashed line superimposed on the photo shows the alignment of the seawall prior to the erosion event

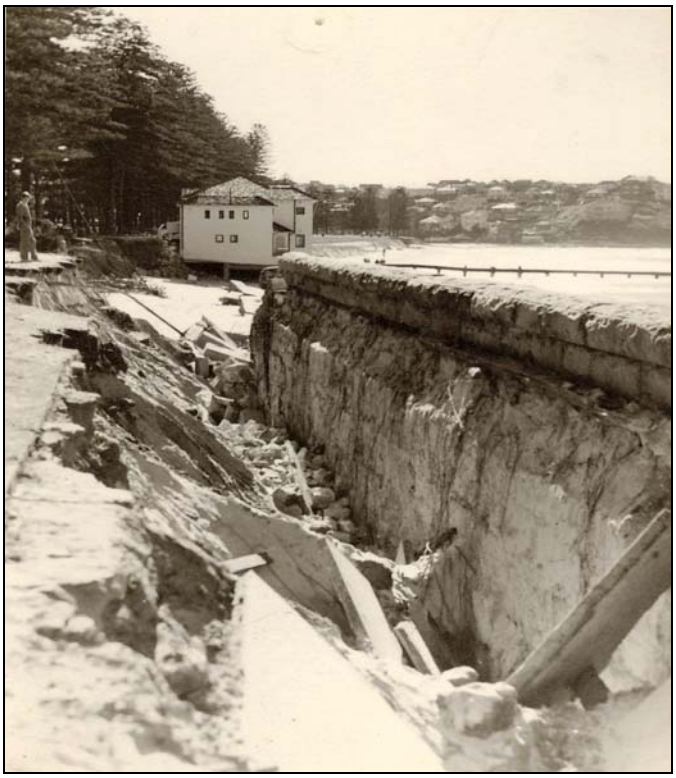


Photo 1.3 Further view of beach erosion and damage, 1950

Photo 1.4 Emergency rock protection at South Steyne in about 1967-1968

Photo 1.5 Emergency rock protection at South Steyne, 1974

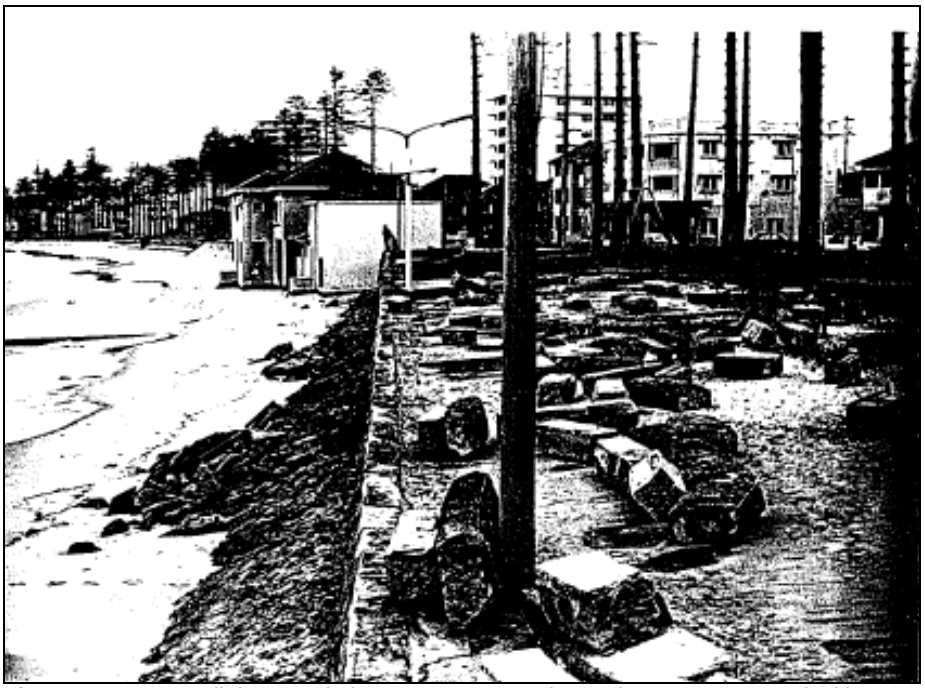


Photo 1.6 Seawall damage during 1974 storms – photo taken 10 June 1974 looking south towards North Steyne SLSC

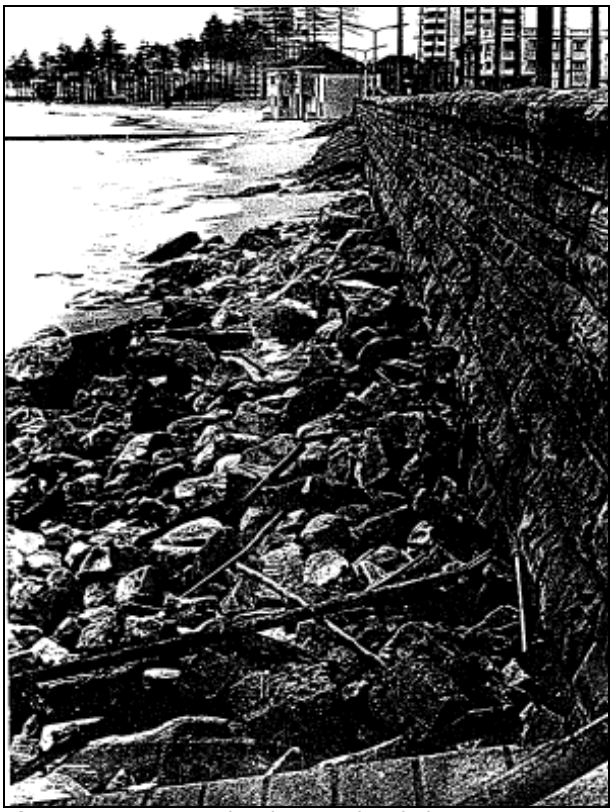


Photo 1.7 Exposed rock protection during 1974 storms – photo taken 10 June 1974 looking south towards North Steyne SLSC

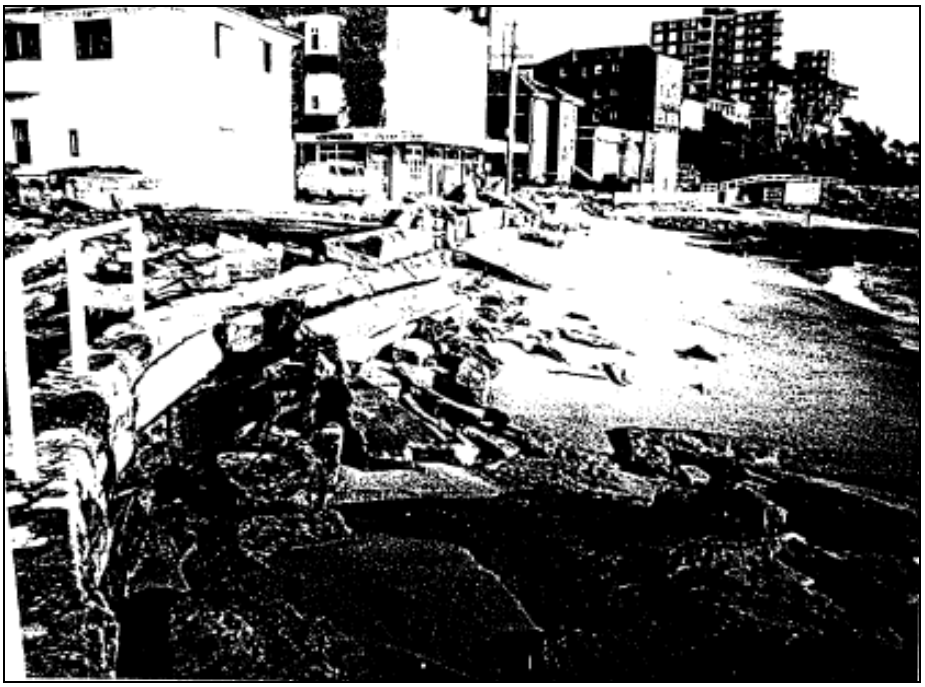


Photo 1.8 Damage to upper courses of blockwork and coping at Fairy Bower seawall caused by the May/June 1974 storms

Photo 1.9 Damage to upper courses of blockwork and coping at Fairy Bower seawall caused by the May/June 1974 storms

Photo 1.10 Exposure of rock protection at Queenscliff in approximately 1986

2 ROLES AND RESPONSIBILITIES

2.1 GENERAL

There are five organizations that would potentially have a role in coastal erosion emergencies at Manly Ocean Beach:

- State Emergency Service (SES);
- Manly Council;
- Department of Natural Resources (DNR);
- Commonwealth Bureau of Meteorology; and
- NSW Police.

The following sections set out the broad roles and responsibilities of the above organizations based on discussions in particular with Mr Steve Opper, Director Emergency Risk Management, NSW State Emergency Service; a review of the paper "Emergency Management of Coastal Erosion in NSW" (Hanslow and Howard, 2005)[1]; and Patterson Britton experience with emergency management issues at other beaches such as Collaroy/Narrabeen Beach and South Curl Curl Beach within the Warringah Local Government Area.

A summary of the broad roles and responsibilities is included in **Section 2.7**, together with some further tabular detail on roles and responsibilities adopted from Hanslow and Howard (2005).

Emergency management arrangements in NSW are primarily guided by the *State Emergency and Rescue Management Act, 1989.* The Act provides the legislative basis for co-ordination of emergency preparedness, response and recovery and provides for the preparation of the NSW State Disaster Plan (NSW DISPLAN) and subordinate plans for specific hazards[2].

The NSW DISPLAN is currently being revised. The revised version has not yet been released. It will include a number of amendments already endorsed by the State Emergency Management Committee to clarify the roles of the SES, Councils and other organisations in coastal erosion issues. These amendments have been explained by Mr Opper.

2.2 STATE EMERGENCY SERVICE

The NSW DISPLAN identifies the State Emergency Service (SES) as the Combat Agency (or Lead Agency) for dealing with "coastal erosion" (refer below for the meaning of coastal erosion in the emergency management context) **but limits that role to mean**:

- the protection of life through warning and evacuation of residents at risk; and

[1] This paper was presented to the Natural Hazards Symposium held at Wollongong University in February 2005.
[2] The relevant subordinate plan for coastal erosion is the NSW State Storm Sub-Plan, as coastal erosion is identified as a severe storm issue.

- the co-ordination of the lifting and/or relocation of readily moveable household items and commercial stock and equipment.

The SES is **not authorised** to undertake expedient or temporary protective measures aimed at preventing erosion of beaches or dunes such as, for example, dumping of rocks or creating some other erosion barrier[3,4].

Coastal erosion in the emergency management context refers to "storm induced coastal erosion". The SES use the release of a "Severe Weather Warning for Damaging Surf" (formerly Large Wave Warning) from the Bureau of Meteorology as a primary test of whether or not they should be involved in a coastal erosion episode (and only then in the role outlined above).

If no Severe Weather Warning for Damaging Surf is issued by the Bureau of Meteorology, it is SES policy and the intent of the amended DISPLAN that Council must deal with the "non-storm" erosion event.

As noted in **Section 2.1**, coastal erosion is identified as a severe storm issue and as such is covered by the NSW State Storm Sub-Plan. The SES does not currently produce Local Storm Sub-Plans, hence the manner in which the SES deals with coastal erosion is being covered through preparation of a Coastal Erosion Annex to the SES Local Flood Sub-Plan[5].

Mr Opper has stressed that an Emergency Action Plan prepared by, or on behalf of, a Council, should link to, but should not duplicate or contradict, the content of the SES Local Flood Sub-Plan. The Emergency Action Plan should be restricted to dealing with Council's role. Mr Opper has indicated that the SES would be pleased to review a draft Emergency Action Plan and such a review is recommended.

In summary:

- the trigger for SES involvement in a coastal erosion episode is the release of a Severe Weather Warning for Damaging Surf by the Bureau of Meteorology. The involvement of the SES at such times would be restricted to the protection of life through warning and evacuation of residents at risk and the co-ordination of the lifting and/or relocation of readily moveable household items and commercial stock and equipment. These activities would be carried out in accordance with a Coastal Erosion Annex to the SES Local Flood Sub-Plan. The SES would not be involved in authorising or implementing any erosion protection measures; and,

- where a Severe Weather Warning for Damaging Surf has not been released by the Bureau of Meteorology, the SES would not be involved in a coastal erosion episode, and in such cases it would be necessary for Council to deal fully with the "non-storm erosion" event.

[3] The SES can still facilitate the use of sandbags to prevent entry of water to buildings, ie to perform some function that is not erosion prevention.
[4] The carrying out of emergency protection measures is Council's role, or possibly that of NSW Police under certain circumstances (refer **Sections 2.3** and **2.6**).
[5] It is understood from Mr Opper that a Local Flood Sub-Plan is currently under preparation for the Manly area.

2.3 MANLY COUNCIL

It is evident from **Section 2.2** that the role of Manly Council during coastal erosion emergencies at Manly Ocean Beach would fall into two main categories[6]:

- where a Severe Weather Warning for Damaging Surf has been released and hence the SES is mobilised and is acting in accordance with the Coastal Erosion Annex to the SES Local Flood Sub-Plan, which will cover warnings, evacuation and removal of contents[7], and the prevention of entry of water to buildings, eg by sandbagging. In this case Council would be responsible for considering the need for implementation of physical erosion protection measures;

- where no Severe Weather Warning for Damaging Surf is issued and hence the SES is not mobilised. In this case Council would be responsible for the activities that would otherwise by conducted by the SES, as noted above, as well as being responsible for considering the need for implementation of physical erosion protection measures. Council could seek the assistance of NSW Police during any need for evacuation, barricading, removal of contents of buildings and the like.

A point worth noting from the discussions with Mr Steve Opper is that the SES has seen recent legal opinion to the effect that: failure to take some action that is technically possible under (emergency management) legislation is not, of itself, sufficient grounds for a claim of negligence. This might arise, for example, if for some reason Council decided not to act in a coastal erosion emergency. Council should approach SES for this legal opinion.

A further relevant point is that Manly Council has already prepared a 'Draft Emergency Response to Rock Exposure Action Plan'. Council prepared this Action Plan in response to exposure of the rock apron at the southern end of Manly Ocean Beach in 1999 and the consequent safety and amenity concerns.

The Action Plan is a two page document that identifies four possible categories of rock exposure from 'minor small rock exposure' (Category 1) to 'full exposure' (Category 4). It also sets out the roles and responsibilities of Council Staff, and the actions and reporting, required for each exposure category, in a matrix format. Contact telephone numbers are included for relevant Council staff, the SES and the then Department of Land and Water Conservation (DLWC), now Department of Natural Resources (DNR).

In the case of a Category 1 exposure, actions involve removing rocks immediately by manual means. In the case of a Category 4 exposure, actions include closing the beach and convening an emergency meeting involving key Council staff, the Mayor, the SES and DNR to discuss an appropriate strategy.

[6] This is aside from the role of Council in environmental planning and development consent procedures under the *Environmental Planning and Assessment Act 1979*, the preparation of coastal zone management plans under the *Coastal Protection Act 1979* and the management of community land under the *Local Government Act 1992*. These matters are considered further in **Section 2.7** and **Section 3**.

[7] Due to the particular circumstances at Manly Ocean Beach, the need for evacuation is unlikely to arise. Removal of contents may be relevant for surf clubs.

A copy of the Action Plan is included in **Appendix B** (note that contact names and numbers are currently being updated)**.** This specific Action Plan could either be referenced by the Emergency Action Plan or incorporated within the Emergency Action Plan. The latter option is considered preferable so that there is a single Plan that deals with the consequences of erosion emergencies on Manly Ocean Beach.

2.4 DEPARTMENT OF NATURAL RESOURCES

The Department of Natural Resources (DNR) is the State government department responsible for advising on coastal zone management.

More specifically, DNR is available to provide advice and guidance to Councils and coastal management committees on coastal processes, coastline hazards, and short, medium, and long term options to address coastline hazards. This is achieved through the process of a Council preparing a Coastline Management Plan.

As part of this process and in particular in relation to preparation of an Emergency Action Plan within the Coastline Management Plan framework, DNR encourages Councils to collaborate with SES to ensure an appropriate link between Council's Emergency Action Plan and the Coastal Erosion Annex to the SES Local Flood Sub-Plan.

An important role of DNR is to provide advice to Councils regarding the most appropriate methods of dealing with coastal erosion and placement of temporary mitigation measures during storm events.

2.5 COMMONWEALTH BUREAU OF METEOROLOGY

The Commonwealth Bureau of Meteorology is the National Meteorological Authority for Australia. It's role is to observe and understand Australian weather and climate and provide meteorological, hydrological and oceanographic services in support of Australia's national needs and international obligations.

As noted earlier, the release of a Severe Weather Warning for Damaging Surf by the Bureau of Meteorology is the trigger adopted by the SES for involvement in a coastal erosion episode. It is understood from the Bureau of Meteorology website (www.bom.gov.au/catalogue/warnings/WarningsInformation_SW_SWW.shtml) that Severe Weather Warnings have been recently introduced (November 2004) to replace a number of miscellaneous warnings that are associated with severe weather. These provide a single type of warning that will advise the community on the threat of severe weather that is not covered by bushfire, cyclone or severe thunderstorm warning services. In some significant events, this allows one warning to cover a multitude of phenomena caused by one weather pattern, thus consolidating the information into one useful package.

According to Hanslow and Howard (2005), a Severe Weather Warning for 'dangerous surf' is issued by the Bureau when onshore waves in the surf zone are expected to reach at least 5 m within the next 24 hours or when a storm surge of 0.5 m or greater is anticipated[8].

[8] This wording is the same as that included in the NSW State Storm Plan (August 2000) where the warning is referred to as "Warnings of Unusually Large Waves and Storm Surges'.

Recent discussions with the Bureau of Meteorology have indicated that the Bureau is currently reviewing, among other things, the thresholds for "dangerous surf" and for "damaging surf" (Ms Julie Evans, Coordinator Public & Marine Weather Services, NSW, pers comm.). This is part of a continual review by the Bureau of the advice they provide.

2.6 NSW POLICE

The possible role of the NSW Police in a coastal erosion event has been discussed with Mr Steve Opper of SES. There would appear to be several situations whereby the Police could become involved:

- where a Severe Weather Warning for Damaging Surf has not been issued by the Bureau of Meteorology, ie a 'non-storm erosion' event exists and the SES is not involved, the Police may assist Council in undertaking activities such as evacuation, barricading, removal of the contents of buildings and the like;

- in a 'non-storm erosion' event where Council decides not to act[9], the Police may act on their statutory police powers to protect life and property. In this respect it is relevant to note that a specific amendment to the latest NSW DISPLAN (not yet released) makes it clear that a Police Officer may not undertake or request expedient/temporary engineering works unless specific advice is sought from a qualified engineer;

- even where a Severe Storm Warning for Damaging Surf has been issued and thus the SES adopts its role as the Combat Agency, theoretically the Police could act on their statutory police powers to protect life and property. In doing so, however, the Police would need to recognise the combat agency's authority, ensure appropriate approvals are in place for any proposed works, and seek proper advice before acting (as noted above).

Situations where a Council may decide not to act to prevent or mitigate erosion damage could be in those cases where, for example, an adopted Coastline Management Plan involves planned retreat or voluntary purchase. This situation does not apply at Manly Ocean Beach. Further, the Coastline Management Committee of Manly Council has resolved not to adopt a "Do Nothing" option (refer **Section 4.2**).

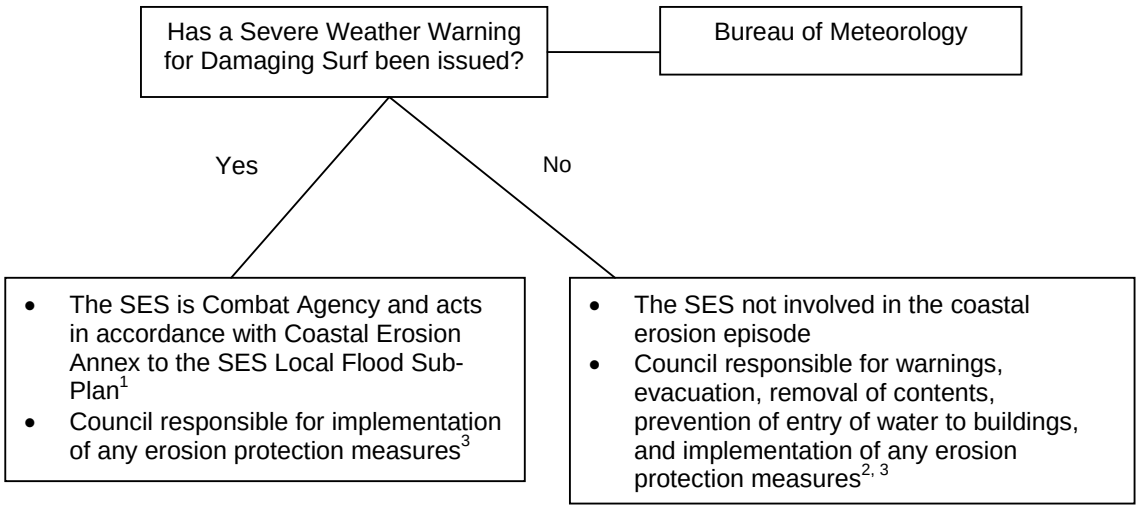
In practice, it is considered unlikely that the NSW Police would play a significant role in coastal erosion emergencies at Manly Ocean Beach, with the possible exception of assisting Council in barricading, crowd control and removal of contents from buildings and the like.

2.7 SUMMARY OUTLINE

The broad roles and responsibilities of the above key organizations as they are likely to occur in practice in a coastal erosion emergency at Manly Ocean Beach are depicted in simple terms in the flow chart shown in **Figure 2.1**.

[9] As noted in **Section 2.2**, the intent of the amended NSW DISPLAN is that Council must deal with 'non-storm erosion'.

Table 2.1 which is reproduced from Appendix 1 of Hanslow and Howard (2005)[10] summarises the roles and responsibilities of the above key organizations in greater detail (excluding NSW Police who are not referred to in the Hanslow and Howard (2005) table).



1. Activities limited to warnings, evacuation, removal of contents, and prevention of entry of water to buildings
2. NSW Police may assist Council in barricading, crowd control and removal of contents and the like
3. Any erosion protection measures to have prior development consent and include consideration of advice from Department of Natural Resources

Figure 2.1 Simple Flow Chart of Responsibilities in Coastal Erosion Emergencies at Manly Ocean Beach

[10] Reference in the original table to the Department of Infrastructure, Planning and Natural Resources (DIPNR) has been amended to read the Department of Natural Resources (DNR). It is also noted that reference is made in the original Hanslow and Howard (2005) table to "unapproved" physical mitigation works to protect coastal property or other structures, under the headings of 'During the Storm' and 'Local Councils'. The word "unapproved" is understood from the authors of the paper to be a typographic error and the word "approved" has been inserted in **Table 2.1**. Refer also to **Section 3** which deals with the approval of physical mitigation works.

Table 2.1 Roles and Responsibilities of Key Agencies (after Hanslow and Howard (2005))

Agency Responsible	Before the Storm	During the Storm	After the Storm
State Emergency Service (SES)	1. Prepare and maintain the Local Flood Plan, including arrangements for the management of coastal erosion during storms 2. Consult with Councils, Coastal Zone Management Committees, DNR and other agencies during the development of emergency management arrangements for the management of coastal erosion for inclusion in SES Local Flood Plans and Council Coastal Zone Management Plans. 3. Prepare, co-ordinate and deliver community awareness programs and educational material with the assistance of the local councils to ensure that people in locations potentially threatened by coastal erosion understand the threat and its management **Note:** the SES is not responsible for the planning or conduct of emergency beach protection works during periods of storm activity or otherwise.	1. Activate the Local Flood Plan. 2. Advise the local council and other emergency management agencies of coastal storms that are likely to affect the council area. 3. Conduct regular reconnaissance at locations identified as being susceptible to coastal erosion. 4. Co-ordinate the provision of advice to the community at risk regarding the likely problem and actions they should take. These actions may include evacuation and/or removal of portable property from households and businesses. 5. Co-ordinate the evacuation of people at risk. 6. Co-ordinate the transport of removable household possessions and stock, records and equipment from business premises (if time and resources permit). 7. Provide a 'phone-in' service for the local community to take requests for assistance and give advice as necessary.	1. Assign personnel to gather intelligence in areas susceptible to coastal erosion/inundation. 2. Review and update the arrangements for managing coastal erosion/inundation in Local Flood Plans following coastal erosion events. 3. Liaise with the DNR to obtain information on the impact of storm events on coastal properties once the storm has abated.

Agency Responsible	Before the Storm	During the Storm	After the Storm
Local Councils	1. Carry out the ecologically sustainable planning and management of the coastal zone. 2. Prepare Coastal Zone Management Plans in accordance with the Coastal Protection Act, 1979 including arrangements for the emergency management of coastal erosion. 3. Consult with the communities at risk, Coastal Zone Management Committees, DNR and other agencies during the development of emergency management arrangements for the management of coastal erosion for inclusion in Council Coastal Zone Management Plans and SES Local Flood Plans. 4. Establish and maintain Coastal Zone Management Committees to facilitate the development of the Coastal Zone Management Plans and ensure that key agencies are represented on such committees. 5. Participate in education campaigns and assist the SES in the development and delivery of educational material to ensure that people in areas potentially threatened by coastal erosion understand the threat and its management.	1. Conduct reconnaissance at coastal erosion trouble spots in consultation with the SES. 2. Liaise with the SES Local Controller to determine the need for any response actions by the SES such as evacuation of residents at risk and any support that may be required to carry out these measures as detailed in the Local Flood Plan. 3. Liaise with the Engineering Services Functional Area Co-ordinator (ESFAC) before constructing or allowing the construction of any approved physical mitigation works to protect coastal property or other structures.	1. Remove and/or mitigate the impact of any temporary physical protective measures from the beach. 2. Liaise with DNR to determine any changes to the coastal zone and any new areas at risk following storms at sea. 3. Maintain and review Council Coastal Zone Management Plans in consultation with other stakeholders.

Agency Responsible	Before the Storm	During the Storm	After the Storm
Department of Natural Resources (DNR)	1. Develop and advise on state wide coastal policy, planning and management. 2. Provide ongoing advice to local councils and Coastal Zone Management Committees on coast and estuary management including procedures for addressing coastal hazards, coastal processes and risks, management options and coastal policies. 3. Provide the SES and Councils with advice on likely erosion 'hotspots' along the New South Wales coastline.	1. Provide advice and approval to councils regarding the most appropriate methods of dealing with coastal erosion and placement of temporary mitigation measures during storm events, via the Engineering Services Functional Area Co-ordinator (ESFAC).	1. Liaise with Council staff to ensure appropriate remediation of beach and dunes following storm events. 2. Provide the SES and Council with updates on the current state of the coastal zone and any new areas at risk following a storm event.
Commonwealth Bureau of Meteorology (BoM)	1. Formulate and issue official forecasts and Severe Weather Warnings and provide them to the SES, radio stations and other organizations prior to and during potential and actual coastal erosion events (Note: Severe Weather Warnings for dangerous surf are issued when onshore waves in the surf zone are expected to reach at least 5 metres within the following 24 hours or when a storm surge of 0.5 metres or greater is anticipated).	1. Formulate and issue official forecasts and Severe Weather Warnings and provide them to the SES, radio stations and other organizations prior to and during potential and actual coastal erosion events.	

3 APPROVALS FOR IMPLEMENTATION OF EMERGENCY PROTECTION MEASURES

3.1 GENERAL

Hanslow and Howard (2005) have noted that neither the *State Emergency and Rescue Management Act 1989* or the *Coastal Protection Act 1979* specifically override the normal approval processes of the *Environmental Planning and Assessment Act 1979*, unless a State of Emergency is declared (and this is not the usual case in coastal erosion emergencies). Accordingly, physical emergency protection measures may require development consent prior to implementation, even if they are selected as the appropriate emergency response in an adopted Coastline Management Plan.

Legal advice obtained by Warringah Council in respect of emergency protection measures for Collaroy/Narrabeen Beach, involving in that case placement of rock on the beach, concluded that such an activity would require development consent under the *Environmental Planning and Assessment Act 1979* and *Warringah Local Environmental Plan 2000* (Report to Council Meeting on 26 July 2005, pages B402 to B422). It was noted in the report that the Minister administering the *State Emergency and Rescue Management Act 1989* can issue a direction to Council to do an act or exercise a function under Section 36(2) of the Act that would prevail over other legislation but such Ministerial approval may be difficult to achieve at short notice at times of storms.

Two options would appear to be generally available to Councils for approval of physical emergency protection measures:

- submit a development application and seek development consent in advance of implementation of the physical emergency protection measures[11], or

- modify the local environmental planning instrument (Local Environmental Plan or LEP) to permit, without consent, the implementation of physical emergency protection measures that are included in an adopted Coastline Management Plan. In effect, such measures would be included in a schedule of 'exempt development' within the LEP.

3.2 CURRENT SITUATION AT MANLY OCEAN BEACH

3.2.1 Legal Advice August 2003

Officers of Manly Council sought legal advice in August 2003 from Council's consultant solicitor Mr Ian Ellis-Jones as to whether emergency protection works would require development consent under Part 4 of the Environmental Planning and Assessment Act 1979 or would otherwise be dealt with under Part 5 of that Act. Mr Ellis-Jones was advised that the emergency protection works could involve, among other things, the proposed depositing on the beachfront of many tonnes of rock, geobags, sand etc.

[11] In order for a development application to be submitted, the proposed development would need to be permissible under the local environmental planning instrument, and land owners consent would need to be obtained.

The advice provided by Mr Ellis-Jones, contained in an email to Ms Christine Chapman of Council dated 5 August 2003, can be summarised as follows:

- the proposed emergency protection works would be the "carrying out of a work" and thus "development" within the meaning of the Environmental Planning and Assessment Act 1979;

- on the basis of the subject land being situated within Zone No 6 ("Open Space Zone") under Manly Local Environment Plan 1988 ("the LEP") and having regard to the relevant "land use table" in clause 10 of the LEP, unless the development can proceed pursuant to some other provision of the LEP, the proposed emergency protection works would be prohibited in the zone;

- however, the provisions of clause 10 of the LEP are subject to the rest of the LEP, including, relevantly, Schedule 8 ("Exempt Development") to the LEP;

- Item 26 of Schedule 8 to the LEP includes "environmental protection works" (not defined in the LEP), and what is proposed by way of emergency protection works could reasonably be seen to be "environmental protection works" and thus "exempt development" within the meaning of the Environmental Planning and Assessment Act 1979 provided all relevantly applicable standards, as specified in the schedule, are complied with.

In summary, the lack of definition of "environmental protection works" within the LEP and the absence of any reference to "scale of works" in the Exempt Development schedule allowed, in the opinion of Mr Ellis-Jones, the emergency protection works to be classified as Exempt Development.

Council officers noted in August 2003 that Mr Ellis-Jones should be requested to review his advice when further details of the proposed emergency protection works are available, such as the content of this report dealing with the Emergency Action Plan for Coastal Erosion.

It is also noted that Mr Ellis-Jones' advice was prepared on the basis that the provisions of the Coastal Protection Act 1979 did not apply, as was the case at the time in August 2003. This situation has now changed with the gazettal by the Minister for Natural Resources on 18 November 2005 of a notice to extend the area declared as the NSW Coastal Zone. This Zone now applies to the greater metropolitan area (from Newcastle in the north to Shellharbour in the south) including the Manly Council local government area. This has the effect of bringing into force certain provisions in three important planning polices that relate to:

- NSW Coastal Policy 1997;
- State Environmental Planning Policy No 71 – Coastal Protection (SEPP71);
- State Environmental Planning Policy (Major Projects) 2005 (Major Projects SEPP).

The Minister for Planning has also issued a Section 117 direction for draft LEPs that applies to the Coastal Zone. The draft Standard LEP is also looking to include provisions for the Coastal Zone.

Updated legal advice was subsequently sought by Council officers in July 2006.

3.2.2 Updated Legal Advice July 2006

The updated advice was contained in an email to Ms Christine Chapman of Council dated 18 July 2006 and can be summarised as follows:

- Council can still rely upon the "exempt development" provisions contained within Item 26 of Schedule 8 of the Manly LEP (considering emergency protection works to be "environmental protection works"), notwithstanding the enactment of the *Coastal Protection Act 1979* and the gazettal of SEPP71, provided all relevantly applicable standards as specified in Schedule 8 are met/complied with;

- accordingly, no amendment to the Manly LEP is legally required[12];

- owing to the nature of the proposed emergency protection measures, the provisions of the Major Projects SEPP would not apply.

The Department of Natural Resources (DNR) representative on the Coastline Management Committee, Mr Mark Moratti, has suggested that matters related to application of SEPP71 be referred to the Department of Planning for comment.

3.3 WAY FORWARD AT MANLY OCEAN BEACH

The way forward in the case of approvals for emergency protection measures at Manly Ocean Beach will be a matter for Manly Council based on the updated legal advice and recommendations of the Coastline Management Committee.

Three options are under consideration by the Committee:

- no amendment to the LEP (current legal advice);
- amendment to the LEP to link "exempt development" provisions with an adopted Emergency Action Plan and Coastline Management Plan;
- amendment to the LEP to make emergency protection measures permissible with consent and lodgement of a development application (DA) to Council.

[12] The advice noted that to avoid any doubt, the expression "environmental protection works" could be defined in the LEP (assuming there was no prohibition to that effect in the LEP template), although this was considered unnecessary.

4 EVALUATION OF EMERGENCY PROTECTION MEASURES

4.1 GENERAL

Hanslow and Howard (2005) make a number of general points which they suggest act as a guide to both planning and response for coastal erosion emergencies. These points are summarised below in italics together with comments as to their relevance to an Emergency Action Plan for Manly Ocean Beach:

- *The first priority of any emergency response should be to protect lives that may be threatened.*

  In the case of Manly Ocean Beach, the risk to life due to a coastal erosion event is very low as there is no residential development along the beach and there would be sufficient warning time to ensure that any observers are not situated in high risk areas, eg by provision of barricading and the like.

- *The second priority should be to minimise damage to property through the removal of household contents or commercial stock and equipment from buildings at risk of collapse or inundation by sea water.*

  In the case of Manly Ocean Beach, as noted above, there is no residential development along the beach. There is one commercial building (a restaurant – formerly the Tourist Office) located close to the beach at the end of the Corso and three surf life saving clubs close to the beach at South Steyne (Manly SLSC), North Steyne (North Steyne SLSC) and Queenscliff (Queenscliff SLSC).

  The single commercial building and the Manly and Queenscliff SLSCs are situated landward of the seawall and, accordingly, retention of the seawall in the erosion event would result in protection of these buildings from collapse. The North Steyne SLSC is located seaward of the seawall but is supported on piles. This type of foundation reduces significantly the risk of collapse during erosion events, even when the adjacent seawall is undermined, as illustrated dramatically in the 1950 erosion event (refer **Photos 1.1** and **1.2**).

  Inundation of the above buildings by sea water is considered a relatively low risk (combination of likelihood and consequence) having regard to the location and the floor levels of the buildings and, in the case of the SLSCs, the uses of the buildings. Any potential for inundation could be mitigated by sandbagging if required.

- *As coastal erosion emergency engineering response measures have the potential to seriously impact on long term public beach amenity as well as neighbouring properties, any emergency response actions should be planned for in advance and based on assessment of all available options and their pros and cons. Emergency engineering works should generally be restricted to the protection of high value built assets. Where possible, natural processes of erosion and accretion should be allowed to continue.*

High value built assets along Manly Ocean Beach include the seawall and adjacent promenade and landscaping, the four building structures referred to above, and services infrastructure, most particularly the Manly Ocean Outfall Sewer (MOOS) which extends over a length of approximately 400 m immediately landward of the seawall between Steinton Street and the Corso.

Due to the value of the above assets and the social, economic and in some cases environmental consequences of damage (eg collapse of the MOOS), the historical practice of Manly Council has been to protect the assets at times of an erosion threat. While Council propose to continue this practice[13], the purpose of this report is to develop emergency response measures that consider beach safety and beach amenity consequences and that are consistent with longer term coastline management strategies.

Owing to the value of the assets along the beachfront, it is not considered reasonable to allow the natural process of erosion to continue without some level of mitigation.

- *Emergency engineering responses to protect development from coastal erosion should favour options that do not compromise the natural and cultural values of the area, such as building relocation, or beach and dune replenishment (with sand).*

  In the case of Manly Ocean Beach, it is not feasible to consider the landward relocation of assets such as the seawall and the three SLSCs due to the constraints of the existing built environment. While the existing beachfront restaurant does not have to be close to the beach for any functional reasons, it is not subject to the erosion hazard if the integrity of the seawall and adjacent promenade is maintained.

  Beach replenishment with sand can be expected to form an essential component of the longer term strategy for management of the erosion and recession hazard along Manly Ocean Beach, but is not a viable emergency protection measure (refer **Section 4.2**).

- *Impacts generated by emergency engineering works on beach environments, beach amenity or beach access must be mitigated following the emergency. This may involve removal of structures, burial with dune sand, re-establishment of dune vegetation, dune re-establishment, and other methods. Where structures are not removed, plans should specify measures to ensure the ongoing mitigation of any adverse impacts for example by burial or revegetation.*

  Post-storm activities are an important element of an Emergency Action Plan, to address issues such as beach amenity, beach safety and beach access. The Brief referred to in **Section 1.2** of this report for the specific case of Manly Ocean Beach noted that the Emergency Action Plan must consider post-storm rehabilitation and monitoring and that remedial work should be specified, as required, to ensure emergency works remain buried under average beach-recovered conditions.

- *Emergency engineering works should be consistent with long term coastal management strategies where they have been adopted. For example where a policy of retreat or voluntary purchase has been adopted, no protection works should be allowed.*

[13] The Coastline Management Committee has resolved not to adopt a "Do Nothing" option.

At Manly Ocean Beach, voluntary purchase is not relevant and a policy of retreat is unlikely to be adopted for the beachfront due to the vast social, environmental, heritage and economic consequences of such an option.

Longer term coastal management strategies for Manly Ocean Beach can be expected to include maintenance of the integrity of the seawall and adjacent promenade whilst ensuring the preservation and enhancement of beach amenity, beach safety and beach access.

4.2 ALTERNATIVE EMERGENCY PROTECTION MEASURES

Hanslow and Howard (2005) describe six options that are likely to have particular relevance to the management of emergency situations involving threats to assets on beaches or dunes. These options are summarised below in italics together with comments as to their relevance to an Emergency Action Plan for Manly Ocean Beach.

- *Do nothing – this option may be appropriate where long-term coastal erosion strategies involve retreat or voluntary purchase, or where the costs of protective works and their likely effects on the environment exceed that of the development at risk.*

  Long term coastal erosion strategies involving retreat or voluntary purchase would not apply at Manly Ocean Beach; a 'Do nothing' option is not considered viable having regard to the social, environmental, heritage and economic consequences was rejected by the Coastline Management Committee at its meeting on 23 August 2006.

- *Building relocation – this is the preferred option for all relocatable structures, and may also be possible for timber structures with raised footings.*

  This situation does not apply at Manly Ocean Beach, the form of construction of buildings potentially at risk is such that their relocation in an emergency is not feasible (refer also **Section 4.1**).

- *Sand dumping – this option involves the addition of beach or dune sand to eroding areas. During an emergency, sand nourishment could be achieved through the dumping or placement of trucked material. This option is likely to be viable only if erosion problems are localised, nearby sand sources can be obtained and the problem areas accessed.*

  The scale of the erosion hazard along Manly Ocean Beach at times of severe storms and the lack of any significant nearby sand sources means that this option is not viable as an emergency protection measure. Note that this is a separate consideration to the placement of sand on the beach to address future shoreline recession, ie beach nourishment, which is a well accepted coastline management option and which is a preferred option for Manly Ocean Beach (refer Coastline Management Plan).

- *Beach scraping – this option involves shifting sand from the lower to the upper part of the beach face or dune to provide a storm erosion buffer. This would usually be undertaken with a bulldozer at low tide, but may be difficult to undertake during the height of an erosion event. Its benefits may be limited since it does not generally involve the addition of sand from outside of the beach system. However, it may provide minor benefits that are sufficient to*

avoid property damage. If only part of a beach is treated, the benefit may be at the expense of untreated areas. Where sediment transport processes are dominated by longshore drift, scraping may effectively 'borrow' sand from the littoral system, thereby increasing local dune storage levels and lowering the risk to property. However, this is likely to increase down drift recession rates.

This option is not feasible for Manly Ocean Beach as it does not involve the net addition of sand to meet the erosion demand at times of major storms and would not be able to be implemented at times of storms.

- *Geotextile or sand bag structures – this option involves protection structures constructed from large, sand-filled geotextile containers. These are generally constructed parallel to the shore as seawalls, and can be built from layers of sand-filled geotextile bags or from longer 'geotubes'. Coastal engineering advice should be sought regarding their design and construction, as well as their potential impacts on beaches and adjacent areas. Construction of these structure is very problematic during the height of a storm event. Impacts of these structures on beach amenity should be mitigated following the event through removal or other action.*

  The use of sand filled geotextile bags (geobags) for emergency and short term protection of the seawall and other assets along Manly Ocean Beach has been recommended in studies conducted for Manly Council by the Water Research Laboratory (WRL, 2003). Their use in such circumstances has also been the subject of consideration by officers of the Department of Natural Resources (DNR). This option is given closer consideration in **Section 4.3**.

- *Rock structures – seawalls, revetments and other structures can be constructed to limit erosion during storms. Varying rock sizes can be used, although larger material is likely to be more stable and less likely to be transported elsewhere on the beach assisting subsequent removal. Coastal engineering advice should be sought about the design and construction of seawalls as well as their potential impacts on beaches and adjacent areas. Rock structures should only be considered as a last resort and preferably only when incorporated as a future element of a long term management strategy. Impacts of these structures on beach amenity should be mitigated following the event through removal or other action.*

  Use of rock is the traditional method of emergency protection of the seawall and other assets along Manly Ocean Beach and other beaches within NSW and elsewhere. This method of protection has been historically favoured since well established design guidelines exist for sizing the rock and the approach is proven. In more recent years the consequences of the emergency placement of rock on beach amenity, beach safety and beach access have received greater attention. Use of rock is given closer consideration in **Section 4.4**.

  A possible variation to the use of rock is the use of precast concrete blocks. This option had originally been ruled out by the Coastline Management Committee, generally on visual grounds, but attention returned to it as some of the issues associated with use of geobags and rock became evident during the evaluation process. Use of concrete blocks is given closer consideration in **Section 4.5**.

A summary table and conclusion regarding the potential use of geobags, rock and concrete blocks is provided in **Section 4.6**.

4.3 SAND FILLED GOETEXTILE BAGS

4.3.1 General

This section considers in more detail the potential use of sand filled geotextile bags (geobags) as an emergency protection measure at Manly Ocean Beach. It includes consideration of recommendations made by the Water Research Laboratory (WRL, 2003), comments expressed by officers of the Department of Natural Resources, correspondence from a geobag supplier (Soil Filters Australia Pty Ltd) and an assessment by Patterson Britton. This assessment has included an objective analysis of the ability of geobags to withstand the likely wave and water level conditions expected to be experienced along the seawall at times of severe storms.

Photographs showing use of geobags for erosion protection, taken from WRL (2003) are included as **Photos 4.1** and **4.2**.

Photo 4.1 Geobags at Belongil Beach Byron Bay, NSW (after WRL, 2003)

Photo 4.2 Geobags at Maroochydore Qld (after WRL, 2003)

4.3.2 Water Research Laboratory (2003)

General

The Water Research Laboratory (WRL) prepared a report for Manly Council titled *Manly Ocean Beach Seawall and Beach Amenity Risk Assessment and Remedial Options* (WRL, 2003). The report found that portions of the current seawall are at risk of failure during extreme events and that management of these risks needs to be considered over three planning horizons:

- emergency or short term (nominally 1 day to 1 year);
- medium term (nominally 1 to 20 years);
- long term (nominally 20 to 50 years).

Emergency and Short Term

In the emergency or short term, WRL noted firstly that the presently buried rock apron should not be removed until an alternative seawall toe protection scheme is implemented. Should the rock apron become exposed in the interim, it was considered that Council's existing management plan for removing mobile rocks[14] is acceptable, but that continued removal of the rock apron is not sustainable over the medium to long term. This is because of the increased risk of damage to the seawall over time as the rock apron is progressively removed.

In the event of major erosion of the seawall toe or collapse of the seawall, WRL recommended use of sand filled geotextile bags (geobags) as an emergency measure to

[14] Refer **Section 2.3** for discussion of this plan.

prevent the seawall being undermined or to prevent further loss of the promenade. WRL noted that the historic response to such emergencies has been to dump rock on the beach or embankment, but that this has had adverse effects on beach amenity, sometimes many years after the rock is dumped. Subject to a detailed installation plan, WRL considered that temporary geobag protection at times of storms could be installed for approximately $500 per metre length of beach protected.

WRL noted that the implementation of geobags in an emergency situation would require a degree of advance planning. It was considered that the following issues would need to be addressed before such works could be undertaken:

- in-principle approvals;
- having empty or prefilled geobags on standby;
- appropriately trained staff and/or contractors;
- a suitable sand source and stockpile; and
- a designated geobag filling areas.

Based on historical precedent, WRL considered that a typical allowance of 200 m of seawall for emergency management may be appropriate[15], however that this allowance should be considered in light of the following:

- the seawall is more vulnerable to damage when the beach is in a depleted state (sequential storms);
- over the medium to long term, global sea level rise is predicted to result in a more eroded average beach state;
- more severe storms than those encountered historically are possible.

Medium to Long Term
For interest, in the medium to long term, WRL considered there were two viable options for the seawall:

- toe protection in the form of sheet piling or Seabee® units[16];
- construction of a new seawall, comprising piled footings and reinforced concrete superstructure, probably with a facing of sandstone blockwall or similar.

WRL also noted that due to shoreline recession associated with the projected global sea level rise, beach nourishment would be needed over the medium to long term to maintain beach amenity.

Further Details Regarding Use of Geobags
WRL noted that geobags are available in many standard sizes. The suggested size for application at Manly Ocean Beach (subject to detailed analysis) was nominally 0.6 m^3

[15] This was based at least in part on the catalogue of seawall damage in Patterson Britton (1995) and Blumberg and Rhodes (1995), which indicated damage typically occurred over limited sections of 100 to 240 m of seawall.
[16] Seabee® units are a proprietary concrete interlocking armour unit used in coastal protection, having an hexagonal shape with a circular central void.

(described as "2 tonne" bags by the manufacturer[17]). The approximate dimensions of these bags were 1.5 m long by 1.1 m wide by 0.4 m high. Larger bags are available, however WRL noted that such bags present handling difficulties due to the increased ratio of bag mass to fabric strength[18].

The nominal design for Manly Ocean Beach consisted of three rows of bags (with the long axis pointing seaward), aligned parallel to the seawall with a stack of three bags against the seawall, two bags in the middle row and one in the seaward row, ie a configuration of six bags every 1.1 m along the seawall.

WRL noted that the above design did not constitute detailed design nor detailed engineering advice, that such a design would serve only to reduce undermining of the seawall and/or undermining of the remaining embankment following collapse of a portion of the seawall[19], and that it was not an alternative to a well engineered seawall.

Additional comments regarding use of geobags were provided by WRL under the headings of precedent, advantages, limitations and other issues. These comments are summarised below:

Precedent

- geobags are a relatively new form of coastal protection, examples of installations include Byron Bay (refer Photo 4.1), Stockton and Maroochydore (refer Photo 4.2).

Advantages

- have been approved in situations where rock may not have been granted approval, due to the ease with which they can be removed and the low hazard to beach users;
- have a soft fabric surface similar in texture to carpet, the sand filling becomes firm once subject to water or mild wave action;
- can offer protection to the seawall toe without becoming an ongoing hazard to beach amenity.

Limitations

- geobags have not been tested to the same degree as rock armour, ie there is less information available regarding the stability of the geobags under wave and water level conditions in the coastal zone;

[17] WRL used inverted commas when referring to the 0.6 m^3 geobags as 2 tonne bags since for the given volumetric capacity and expected density of the sand within the bag, the mass of the bag would be less than 2 tonnes. The 0.6 m^3 bag is also now referred to as a 0.75 m^3 bag based on more recent field measurements. This is further discussed in **Section 4.3.5**.

[18] Recent discussions with the manufacturer (February 2006) have indicated that larger geobags, having a volumetric capacity of 2.5 m^3, can now be satisfactorily handled although large excavators up to 35 tonnes capacity are required. This is further discussed in **Section 4.3.5**.

[19] It is thus important to appreciate that the design was not "guaranteed" to provide protection against undermining and collapse of the seawall.

- the fabric design life with full exposure to ultra violet light is estimated to be at least 10 years and more than 50 years if protected from the sun, thus design life should not be a limiting issue for Manly Ocean Beach as the geobags are only proposed as emergency protection and not a medium to long term solution;

- geobags are susceptible to cutting by vandals, however, in a structure comprising many separate units, damage to several bags does not compromise the entire structure, and damaged bags can also be repaired or replaced.

Other Issues

- the geobags are generally not available for purchase directly off the shelf, they require some lead time for fabrication;

- a source of filling sand is needed, it may not be practical or acceptable to remove sand from the beach during major storms although required quantities are relatively small;

- specialised lifting frames, lifting devices and sewing machines are needed and would need to be available and ready to issue in an emergency;

- it may be prudent for Council to experiment with geobags as a replacement/adjunct to the exposed rock scour protection at the stormwater outlet opposite Pacific Street before committing to this method of protection.

4.3.3 Officers of the Department of Natural Resources

Officers of the Department of Natural Resources have from time to time over the past several years expressed opinions on the use of sand filled geotextile bags for coastal protection, generally through Coastal Management Committee forums or as a part of professional discussions in relation to emergency protection measures20.

Generally, a level of concern has been expressed regarding the use of geobags for coastal protection, including use as an emergency protection measure. These concerns generally take the following form:

- use of geobags for open coast coastal protection is a relatively new concept in Australia;

- unlike conventional engineer-designed coastal protection structures on the open coast, geobags do not currently have approved engineering standards, construction specifications or maintenance protocols guaranteeing their performance under design conditions over a specified (or indefinite) period of time;

- one of the world's most authoritative coastal engineering publications, the Coastal Engineering Manual (CEM) (USACE, 2003) contains no reference or guidance on the use of geotextile materials other than for its predominant world-wide application as a filter fabric;

[20] In particular Mr Mark Moratti, Coastal Engineer, who is the DNR representative on the Manly Council Coastline Management Committee, and Mr Phil Watson, a Senior Specialist within the Coastal Unit of DNR.

- state of the art reviews of the use of geosynthetics and geosystems in hydraulic and coastal engineering, eg Pilarczyk (2000) caution against use of geobags where there is a risk to life or risk to property in the event of failure, and note that further improvement of design methods and more practical experience under various loading conditions is still needed;

- the integrity of each individual geobag is limited by the workmanship and strength of the stitching of the units;

- the geobags are not vandal-proof and can be readily punctured or opened up with sharp objects to release the sand inside;

- due to the lower specific gravity/density of the geobags compared with rock or concrete armour units the required mass of geobags could be very much larger than, say, the required mass of rocks to achieve an equivalent level of protection[21];

- problems can be encountered with lateral 'sliding' of geobags, one over the other.

Accordingly, officers of the Department of Natural Resources have been reluctant to endorse use of geobags where it is necessary to "guarantee" their performance for protection of assets on the open coast of NSW.

4.3.4 Correspondence from Soil Filters Australia Pty Ltd

During the course of discussions regarding the potential use of geobags for emergency erosion protection at Collaroy/Narrabeen Beach, Soil Filters Australia Pty Ltd, a major supplier of geocontainer products in Australia, wrote to Warringah Council in February 2003 indicating that they would prefer not to have their containers (geobags) installed during high seas at times of an erosion event because "….. the end result will be an unsightly and unstable structure….."

A copy of the letter from Soil Filters Australia Pty Ltd to Warringah Council, supplied by Mr Mark Moratti of the Department of Natural Resources (with the knowledge of the officers of Warringah Council) is included in **Appendix C**.

4.3.5 Patterson Britton Comments

General

The use of geobags for emergency erosion protection at Manly Ocean Beach presents a number of challenges as indicated in the preceding sections. The most fundamental challenge is that information does not currently exist to allow the design of emergency works utilising geobags which could be "guaranteed" to be stable under the wave and water level conditions expected to be experienced in a major storm when the seawall is under threat, and thus protect the seawall from undermining and collapse.

[21] The specific gravity of armour units is a sensitive parameter in well accepted equations for determination of armour stability under wave action.

It is understood that WRL has been commissioned by Soil Filters Australia Pty Ltd to undertake an applied research program incorporating field trials and laboratory (wave flume) testing aimed at producing a technical document for the design of geobags in the coastal zone. Recent inquiries to WRL have established that some field measurements of the in-place specific gravity or density of geobags (and their actual volumes) have been undertaken, but that laboratory testing has not yet been completed. Results from the research are unlikely to be available in the near future.

Soil Filters Australia Pty Ltd has kindly made available the results of the determination of the in-place specific gravity or density of the geobags and their actual volumes. These results are summarised in **Table 4.1**.

For purposes of assessment of the stability of the geobags under wave action, use of a mass corresponding to saturated sand is relevant, hence the 0.75 m^3 nominal capacity geobag would have an average mass of say 1.5t and the 2.5 m^3 nominal capacity geobag would have an average mass of say 4.5t.

Soil Filters Australia Pty Ltd have also advised that the nominal dimensions of the 0.75 m^3 geobags can be taken as 1.6 m long by 1.2 m wide by 0.375 m high (slightly different to those adopted by WRL), and that the nominal dimensions of the 2.5 m^3 geobags can be taken as 2.4 m long by 1.8 m wide by 0.65 m high.

Table 4.1 Results of Field Testing of Geobags

Description of Geobag	Volume of Geobag (m^3)	Density of Sand in Geobag (t/m^3)		Mass of Geobag (t)	
		Dry Sand	Saturated Sand	Dry Sand	Saturated Sand
2152R (formerly known as 2 tonne containers or nominally 0.75 m^3)	0.78–0.93	1.2	1.7	0.94-1.12	1.33-1.58
5223R (formerly known as 5 tonne container or 2.5 m^3)	2.43-2.92	1.2	1.7	2.92-3.50	4.13-4.96

Source: Soil Filters Australia Pty Ltd

The following sub-sections consider four important issues in relation to use of geobags for emergency erosion protection:

- the possible design of geobag protection to the seawall, notwithstanding the absence of accepted design guidelines for use of geobags in the coastal zone;
- supply, filling and placement of the geobags;
- compatibility of the geobags with existing insitu conditions;
- whether the geobag protection design can be satisfactorily constructed during storm conditions.

Design of Geobag Protection to the Seawall

An assessment of the required mass of geobags for use in emergency erosion protection at Manly Ocean Beach has been made based on use of the well known Hudsons equation[22], which takes the following form:

$$W = \frac{w_r H^3}{K_D (S_r - 1)^3 \cot\theta}$$

where

W	=	mass of an individual armour unit in the primary cover layer of the protection structure
w_r	=	density of the armour material
H	=	design wave height at the structure
S_r	=	specific gravity of the armour unit relative to the water at the structure ($S_r = w_r/w_w$, where w_w is the density of the water)
θ	=	angle of structure slope measured from the horizontal (note $\cot\theta = 1/\tan\theta$)
K_D	=	stability coefficient that varies primarily with the shape of the armour units, roughness of the armour unit surface, sharpness of the edges and the degree of interlocking achieved in placement (refer Appendix D). The higher the value of K_D the more stable the unit.

The design wave height at the location of any geobag protection (immediately seaward of the seawall) would be 'depth-limited', ie a function of the water depth that exists at the time of the storm event. The water depth would be dependent on the prevailing sand level and water surface level, the latter being a function of astronomical tide, storm surge and wave setup. These factors would vary throughout the storm and with position along the beach. From experience and from calculations it can be shown that the design wave conditions at the seawall at times of a severe storm would be a breaking wave, 2 to 3 m in height.

K_D values have not been determined for geobags. K_D values (or some similar stability coefficient) may be forthcoming from the proposed laboratory testing by WRL on behalf of Soil Filters Australia Pty Ltd[23]. In the meantime, a range of values between 2 and 6 have been adopted as a guide to assess the sensitivity of the required geobag mass to the value of K_D. This range has been selected based on a review of well-established K_D values for rock (refer Appendix D) and having regard to the fact that any erosion protection design using the geobags would involve 'special placement', eg long axis of the bag perpendicular to the seawall and the bags stacked such that there is good 'interlocking'

[22] Hudsons equation was originally developed in the 1950s and early 1960s to determine the stability of armour units on rubble (rock) structures. It is commonly used for the preliminary sizing of rock or specially shaped concrete units in breakwaters and seawalls. It is emphasized that the equation is used here as a guide only. An equation for calculating the stability of sand containers to protect sand barriers, developed following physical model testing in the Large Wave Flume (GWK) of the German Research Center Coast (FZK) in Hannover, has also been reviewed (refer comments in text).

[23] A particular challenge in this modelling will be the means of adequately representing at small scale in the laboratory the physical properties of the geotextile fabric.

between individual bags (for example a bag in an upper layer rests on two bags in a lower layer).

Values of S_r, w_w and $\cot\theta$ have been taken to be 1.7t/m^3 (saturated sand), 1.025t/m^3 (seawater) and 2.0 (structure slope 1 Vertical:2 Horizontal), respectively.

Figure 4.1 shows the required mass of individual geobags for breaking wave heights from 2 to 3 m and for the range of K_D values from 2 to 6, based on Hudsons equation. Also shown in Figure 4.1 is the required mass of individual rocks comprising either basalt or sandstone for breaking wave heights from 2 to 3 m and for a fixed K_D value of 2 (this value is well known and applies to rough angular rock placed randomly in two layers, refer Appendix D).

It is evident from **Figure 4.1** that:

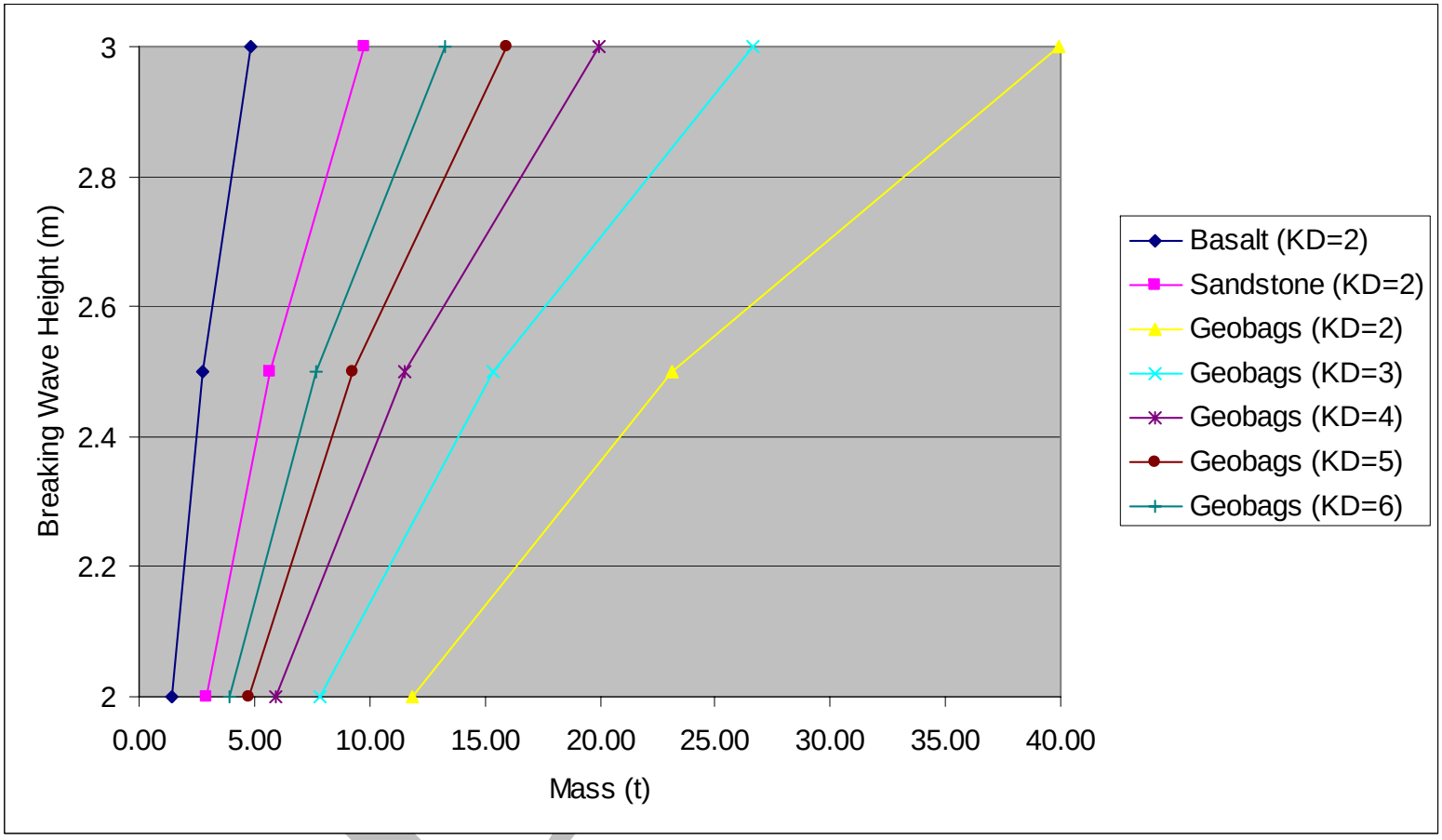
- the required mass of a geobag is greater than the required mass of a basalt or sandstone rock for the equivalent wave height conditions, even when a high K_D value of 6 is assigned to the geobags. This is because of the low density of the geobags (1.7t/m^3) compared to basalt (2.6t/m^3) and sandstone (2.2t/m^3), which outstrips the benefits of any higher K_D value, for K_D values up to 6;

- the minimum required mass for a geobag, corresponding to the minimum wave height of 2 m and the maximum K_D of 6 is approximately 4t. Accordingly, the 2152R geobag which has a typical volume of 0.75 m^3 and an average mass of 1.5t is unlikely to be stable. The 5223R geobag which has a typical volume of 2.5 m^3 and an average mass of 4.5t may just be stable, but would need to exhibit a "real" K_D value in the field approaching the assumed value of 6.

The above results are consistent with the comments made by WRL in respect of the smaller geobag, namely that their use would serve only to reduce undermining of the seawall and/or undermining of the remaining embankment following collapse of a portion of the seawall, not prevent the situation.

The equation for calculating the stability of sand containers to protect sand barriers, developed following the Large Wave Flume (GWK) testing in Hannover (footnote 20), provides an estimate of the required length of sand containers, measured perpendicular to the face of the sand barrier, for given wave conditions and structure slope. For the wave conditions at Manly Ocean Beach and a structure slope of 1 Vertical:2 Horizontal, the equation gives a required length for the sand containers of 5 to 7 m.

FIGURE 4.1



REQUIRED MASS OF INDIVIDUAL ROCK AND GEOBAGS AS A FUNCTION OF BREAKING WAVE HEIGHT

Supply, Filling and Placement of the Geobags

As noted earlier, geobags are generally not available for purchase directly off the shelf, they require some lead time for fabrication. Accordingly, it would be necessary for Council to purchase a sufficient number of bags in advance of the erosion event. In addition to the geobags, it would be necessary for Council to purchase a number of filling frames, hand-held sewing machines and specialised devices for lifting and placing the geobags.

The next question is whether the geobags are prefilled in advance of an erosion event or are filled at times of an event. If prefilled, it would be necessary for Council to dedicate an area for storage of the filled geobags. This storage area would need to be undercover to prevent degradation of the geobags due to ultraviolet light and be secure from the possibility of vandalism.

The number of filled bags that would be stored is dependent on the cross-section design adopted for protection of the seawall and the length that might need to be protected in any one storm. WRL adopted a length of 200 m based on information in Patterson Britton (1995) and Blumberg and Rhodes (1995). This total length is considered a reasonable estimate.

The 'nominal' cross-section design adopted by WRL comprised three rows of 0.75 m^3 bags parallel to the seawall, made up of a stack of three against the seawall, two bags in the middle row and one bag in the seaward row; ie six bags every 1.2 m width of bag or about 5 bags per metre length of seawall. For a 200 m length of seawall the total number of bags required would be 1000.

The nominal cross-section design adopted by WRL is considered to be the minimum that should be considered to reduce the risk of undermining of the seawall given that the 0.75 m^3 bags are unlikely to be stable in severe storms and that the stacking arrangement does not allow 'interlocking' between successive layers. This nominal design has been increased to 7.5 bags every 1.2 m or about 6.25 bags per metre length of seawall to allow for the bag in the upper layer to straddle the joints between bags in the lower layer and thereby provide some additional stability. This would give a total of 1250 bags for a 200 m length of seawall.

For purposes of storage, the geobags would be stacked side by side on their largest base, ie 1.2 m x 1.6 m. Allowing for some space between bags for lifting equipment, storage would require a total area, for 1250 bags, of about 3,000 m^2.

If a 2.5 m^3 geobag is adopted in order to improve the stability of the protection, and an interlocking three row design similar to that described above is adopted, the number of bags would be 7.5 bags every 1.8 m or about 4.2 bags per metre length of seawall. This would give a total of about 850 bags for a 200 m length of seawall and a required storage area, if stacked on their largest base (1.8 m x 2.4 m), of about 4,400 m^2.

In practice it is likely the preferred approach would be to store empty geobags and fill them at times of an emergency, owing to space issues. The question then arises as to the

possible sources of sand available to fill the bags at times of an emergency and the rate of filling and placement of the bags that can be achieved.

Use of sand from Manly Ocean Beach for filling of the geobags at times of major storms is not considered practical. Other potential marine sources of sand within the Manly LGA include Shelley Beach and the Harbour beaches (assuming that they are not subject to erosion in the same event and that removal of sand is acceptable) and the sand delta near the entrance to Manly Lagoon upstream of Queenscliff Bridge[24]. Of these sources the sand at the entrance to Manly Lagoon would appear to have the most potential. This assumes that the coastal storm generating the beach erosion is not also causing flooding in the lagoon (hence the sand is accessible) or that an entrance sand clearance campaign has not immediately preceded the erosion event (hence the sand is available).

If sand is not available from a natural source within the LGA, it would be possible to purchase sand from a commercial source. Some consideration may be given to the compatibility of this source with the native beach sand although the total quantity of sand required to fill the bags is small compared to the volume of sand in the beach system.

Whatever the source of sand, care would need to be taken in the loading, transport and placement of the filled geobags to avoid damage such as tearing or puncturing of the bags.

Information on the rate of filling and placement of the 0.75 m^3 and 2.5 m^3 geobags have been provided by Soil Filters Australia Pty Ltd, as follows:

- for the 0.75 m^3 geobags, the rate of filling is about 20 bags per hour for 6 hours of an 8 hour day, and the rate of placement is about 15 bags per hour for 6 hours of an 8 hour day;

- for the 2.5 m^3 geobags, the rate of filling and placement is much slower as large plant is required, eg 35 tonne excavators, and is in the range of 20 to 25 bags per 8 hour day.

Based on the above rates and assuming a 24 hour day operation during emergencies the rate at which protection could be provided for the nominal minimum 0.75 m^3 geobag design, for one set of placement equipment, would be about 45 m length of seawall per 24 hour day. Similarly, the rate at which protection could be provided for the nominal 2.5 m^3 geobag design would be about 15 m length of seawall per 24 hour day.

It is evident that multiple filling and placement teams would need to be involved in any emergency, particularly if the 2.5 m^3 geobags are utilised. This could introduce logistical difficulties if a source of sand such as the entrance to Manly Lagoon is adopted, due to the restricted space available for excavators and trucks.

Compatibility of the Geobags with Insitu Conditions

As noted earlier in this report, there is an extensive amount of existing rock protection along the toe of the seawall (refer **Photos 1.4** to **1.7** and **1.10**). At times of an emergency it

[24] A suggestion has been made by a member of Manly Council's Scientific Advisory Panel that a suitable sand source might also be material under Keirle Park.

would be necessary to place, and at times probably drop, the geobags onto this rock surface. This raises issues in terms of the possible damage to the geobags during installation.

Accepted practice for the laying of geotextiles on a ground surface involves the removal of elements that can cause damage to the geotextile such as stumps and sharp edged rocks. Product information distributed by Soil Filters Australia Pty Ltd also notes that the construction/installation phase of geotextile placement is recognised as the period where most damage occurs, when rocks are placed or dropped directly onto the geotextile (or in this case where a geotextile is placed or dropped onto sharp rocks).

In view of the above and based on experience there would be a significant risk of damage to the bottom layer of geobags during placement.

Whether the Design can be Satisfactorily Constructed During Storm Conditions
Those seawall structures that have been constructed using geobags, such as at Byron Bay, Stockton and Maroochydore (refer **Photos 4.1** and **4.2**), have been built during periods of calm weather when it has been possible to achieve well prepared foundation conditions (a sand surface free of sharp objects) and to ensure good quality control on construction through the absence of waves and high water levels. Under such circumstances the geobags can be carefully placed to form the desired interlocking pattern. Further, the seawalls have been constructed by excavators tracking along the seaward side of the structure.

At times of an emergency at Manly Ocean Beach the above circumstances are not available and, accordingly, it is unlikely the protection would be constructed in accordance with the design and thus achieve the expected level of protection to the seawall.

It is also clear that the supplier of the geobags would not warrant the product if installed under such conditions (refer **Section 4.3.4**).

4.4 ROCK

4.4.1 General

This section discusses in more detail the possible use of rock for emergency erosion protection at Manly Ocean Beach. It considers the following matters:

- availability of design standards;
- compatibility with existing insitu conditions;
- specifications of rock type, size and durability;
- estimated quantities and cost;
- potential for natural reburial by sand following the storm;
- rate of placement of rock;
- post-storm rehabilitation and relationship to Council's existing Draft Emergency Response to Rock Exposure Action Plan;
- relationship to longer term coastal management strategies.

4.4.2 Availability of Design Standards

Well accepted design standards are available for the sizing of rock for coastal structures, such as Hudsons equation contained in the US Army Corps of Engineers Shore Protection Manual referred to earlier. In particular, rock placed during emergencies could be regarded as 'randomly placed' and values of the stability coefficient K_D apply specifically to this situation (refer Appendix D).

4.4.3 Compatibility with Existing Insitu Conditions

Use of rock is compatible with the existing insitu conditions which comprise rock aprons along the toe of the seawall. The rock must have sufficient strength so as not to break up when dropped onto the existing rock. This can be achieved by specification of a minimum rock strength and other commonly adopted requirements such as maximum rock aspect ratio (relating to the shape of the rock – elongated rock shapes are generally avoided).

4.4.4 Specification of Rock Type, Size and Durability

There are two basic choices for the type of rock, an igneous rock such as basalt, or sandstone. Basalt has a higher specific gravity than sandstone (typically 2.6t/m^3 compared to 2.2t/m^3) hence the required mass of a basalt rock for stability in a given wave climate is smaller than the required mass of a sandstone rock. Figure 4.1, which is based on Hudsons equation, shows that the required mass for a basalt rock in 2 to 3 m breaking waves varies between about 1.5 to 5t (nominal rock dimensions 1 m to 1.4 m) whereas the required mass of a sandstone rock in the same wave conditions is about double, ie about 3 to 10t (nominal rock dimensions 1.3 to 1.9 m).

The use of basalt can be an advantage when it is desirable to reduce the thickness of the rock protection, such as in the case of Manly Ocean Beach where maximising the potential for natural reburial of any emergency rock protection by sand, following the storm, is highly desirable. In addition, since the submerged mass of basalt is 30 to 40% higher than for sandstone, there is a greater propensity for any 'small' basalt rocks to "self bury" during wave action rather than be tossed and rolled around by waves. This advantage has been raised by members of Manly SLSC in the context of the exposure and subsequent behaviour of small sandstone rocks dislodged from the rock apron south of the Corso during 1999.

Durability of rock for use in a marine environment is a function, generally, of rock strength, density and sodium sulfate soundness. Igneous rock such as basalt is generally suitable although testing should be undertaken. Sandstone has been used in numerous seawall applications, testing for sodium sulfate soundness is particularly important for any sandstone that may be permanently located in the marine environment.

At Manly Ocean Beach, given the consequences of past exposures south of the Corso and the generally lower beach berm levels in this area (which are a factor for natural reburial of rock by sand), use of basalt is recommended for at least this zone of the beach.

4.4.5 Estimated Quantities and Cost

The estimated quantity of rock required in an emergency would depend on the actual location along the beach under threat at any one time, since the extent of existing rock apron protection and the toe level of the existing seawall (which affects the risk of undermining) varies along the beach.

Based on placement of two layers of basalt over a distance of 3 to 5 m from the seawall, an average placement quantity of approximately 15t of basalt per metre length of seawall is considered reasonable for planning purposes. For a seawall length of 200 m, the total quantity of basalt rock required would be approximately 3,000t.

The cost to supply basalt to a stockpile area near Manly Ocean Beach in readiness for emergency placement at times of a severe storm would be about $65/t, based on supply from the Hanson quarry at Bass Point, Shellharbour. The area required, assuming the rocks are stockpiled two layers high, say, would be less than 1,000 m^2.

The cost to load, transport from the local stockpile area and place rock on the beach at times of an emergency would be about $10 to $15/t based on use of rock body trucks and 35t excavators loading and placing the rock. This would give a total cost for the supply and placement of emergency rock protection of approximately $80/t or $1,200 per metre length of seawall, excluding supervision and administration costs.

4.4.6 Rate of Placement of Rock

The estimated rate of placement of rock on the beach in an emergency would be about 500 to 800t per day per excavator based on a normal working day. It should be possible to place approximately 3000t of rock if required over a 24 hour period if two sets of excavators and associated rock body trucks are utilised.

Protection of the seawall using rock can therefore be achieved at a significantly greater rate than protection using geobags.

4.4.7 Potential for Natural Reburial by Sand Following the Storm

The potential for natural reburial of any emergency rock protection is a function of the levels of the existing rock protection surface along the beach, the thickness of the rock layers that might be added during an emergency and the levels to which the beach naturally recovers following a storm event. These parameters all vary along the beach, accordingly it is not possible to provide a universal response. It is, however, possible to note that:

- any exposure of emergency rock protection above the natural beach recovery levels would be unacceptable having regard to issues of beach amenity, safety and access;

- the likelihood of exposure is greatest at the southern end of Manly Ocean Beach where beach berm levels are lowest.

As not all of the rock placed in an emergency would be expected to be naturally covered by sand during beach recovery, post-storm rehabilitation action is required, as noted below.

4.4.8 Post-Storm Rehabilitation and Relationship to Council's Existing Draft Emergency Response to Rock Exposure Action Plan

It is considered that all rocks placed on the beach at times of any future emergency should be removed following the storm except where the following circumstances apply:

- the rocks would be covered with sand during natural beach recovery and their existence is consistent with an adopted long term management strategy for maintaining the integrity of the seawall; or

- other rocks in place on the beach prior to the storm are removed in lieu of some or all of the rocks placed during the emergency such that the net outcome is an improvement in beach amenity, safety and access, and seawall stability.

The above approach is consistent with Council's existing Draft Emergency Response to Rock Exposure Action Plan, the content of which should be incorporated into the Emergency Action Plan.

4.4.9 Relationship to Longer Term Coastal Management Strategies

The longer term coastal management strategies for Manly Ocean Beach have not been adopted as yet but can be expected to include maintenance of the integrity of the seawall and adjacent promenade whilst ensuring the preservation and enhancement of beach amenity, beach safety and beach access. The latter would be achieved by means of beach nourishment.

Placement of rock on the beach as part of an Emergency Action Plan would not be inconsistent with the above longer term coastal management strategy providing the rocks placed on the beach during the emergency are completely removed or the circumstances outlined in **Section 4.4.8** apply.

4.5 CONCRETE BLOCKS

4.5.1 General

This section discusses in more detail the possible use of concrete blocks for emergency protection at Manly Ocean Beach. It considers the following matters, consistent with the discussion for rock:

- availability of design standards;
- compatibility with existing insitu conditions;
- specifications of concrete type, size and durability;
- estimated quantities and cost;
- potential for natural reburial by sand following the storm;
- rate of placement of concrete blocks;
- post storm rehabilitation and relationship to Council's existing Draft Emergency Response to Rock Exposure Action Plan;
- relationship to longer term coastal management strategies.

4.5.2 Availability of Design Standards

As for rock, well accepted design standards are available for the sizing of concrete blocks for coastal structures. Concrete blocks placed in an emergency could either be 'randomly placed' or possibly stacked on their flat surfaces depending on the foundation available. Due to the likely unevenness of the foundation (existing rock aprons) it has been assumed for purposes of this report that the concrete blocks (cubes) would be randomly placed and a K_D value adopted accordingly.

4.5.3 Compatibility with Existing Insitu Conditions

Like rock, concrete blocks would be compatible with the insitu conditions (rock aprons) providing they have sufficient strength not to break up should they be dropped during random placement; such strength is readily achievable.

4.5.4 Specification of Concrete Type, Size and Durability

Two types of concrete density have been considered, 'normal' density (typically 2.4t/m^3) and a high density achieved by use of special high density aggregate comprising a mix of basalt and a heavy mineral. The possibility of use of a higher density concrete was raised by a Committee member (Mr Ben Wotton, Manly SLSC) as a means of achieving smaller and lighter, and therefore more easy to handle and place, concrete blocks.

The required mass of normal density concrete blocks (cubes) would be on average approximately 2.7t (side dimension 1.1 m) and the required mass of higher density concrete cubes would be on average approximately 0.8t (side dimension 0.64 m).

The mix design would be adjusted to satisfy durability criteria for use in the marine environment. This would probably involve trial batches in the case of use of the special high density aggregates. It is recommended that the blocks be unreinforced to reduce cost and to minimise durability issues (reinforcement corrosion can lead to spalling and degradation of concrete).

4.5.5 Estimated Quantities and Cost

Based on random placement of two layers of cubes over a distance of 3 to 5 m from the seawall, the number of units for a 200 m length of seawall in the case of the normal density cubes would be about 900 and in the case of the higher density cubes would be about 2,700. The supply and placement costs would be approximately $1,800 and $3,400 per metre length of seawall respectively, excluding supervision and administration costs.

Based on discussions with Council staff, the concrete blocks would be stored within the recently redeveloped Council Works Depot off Balgowlah Road. The area required would depend on the stacking arrangement but would be less than 400 m^2 for normal density blocks if the blocks are stacked three or more high or less than 300 m^2 for higher density concrete blocks if the blocks are stacked four or more high.

Should additional area be required, Council staff have advised that other storage opportunities exist at Council's Suwarrow Street and LL Graham Reserve sites. It was noted by staff that a Plan of Management is currently being developed for these sites, and

accordingly provision could be made in the Plan for possible storage of the concrete blocks.

4.5.6 Rate of Placement of Concrete Blocks

The rate of placement of concrete blocks would be expected to be similar or somewhat greater than basalt rock and higher than for geobags. Lifting eyes could be cast into one or more faces to facilitate handling. Mr Ben Wotton of Manly SLSC has noted that the lifting eyes could also be recessed to enable more straightforward stacking, by ensuring the sides present as a flat surface.

4.5.7 Potential for Natural Reburial by Sand Following the Storm

Similar comments apply to concrete blocks as for rock (refer **Section 4.4.7**).

4.5.8 Post-Storm Rehabilitation and Relationship to Council's Existing Draft Emergency Response to Rock Exposure Action Plan

Similar comments apply to concrete blocks as for rock (refer **Section 4.4.8**).

4.5.9 Relationship to Longer Term Coastal Management Strategies

Again, generally similar comments apply to concrete blocks as for rock (refer **Section 4.4.9**).

4.6 SUMMARY AND PREFERRED APPROACH

A summary comparison of the emergency protection measures (0.75 m^3 and 2.5 m^3 geobags, basalt rock, and normal and high density concrete blocks) is provided in a matrix form in **Table 4.2**. The comparison has also been discussed with the Coastline Management Committee and with Council staff who would be involved in the implementation of the Emergency Action Plan; namely, the Director Corporate Planning & Strategy, Manager Civic Services, Works Manager and Coastal Management Team Leader.

Based on the above discussions there was general agreement that:

- use of concrete blocks would be the best physical emergency protection measure;
- geobags could form a secondary physical emergency protection measure.

The Coastline Management Committee further considered that technical advice should be sought on a range of possible concrete block designs, including use of both normal and high density concrete, and that a trial process involving Council staff should be conducted to ensure feasibility in the transport, storage, placement and removal of the blocks and to confirm costs.

Table 4.2 Summary Comparison of Physical Emergency Protection Measures

Assessment Parameters	Options				
	0.75m³ Geobag	2.5m³ Geobag	Basalt Rock	Concrete Cubes (ρ=2.2t/m³)	High-Density Concrete Cubes (ρ=3.0/m³)
Material specifications	Geotextile bags filled with sand, with an average mass of about 1.5 tonnes per bag. Nominal dimensions of 1.6×1.2×0.4m (depth×width×height). Density of 1.7 tonnes/m³ when sand is saturated.	As per 0.75m³ geobag, except average mass of about 4.5 tonnes per bag and nominal dimensions of 2.4×1.8×0.7m.	Rock of required mass between 1.5 and 5 tonnes, with nominal diameters of 1m to 1.4m. Durability for use in marine environment is generally a function of rock strength, density and sodium sulfate soundness. Igneous rock such as basalt is generally suitable, although testing should be undertaken. Requires less mass to achieve an equivalent level of protection as geobags, due to greater density of 2.6 tonnes/m³.	Required unit mass 1.5 to 5.0t for wave height 2 to 3m, use average 2.7t cubes, side length 1.1m. Durability for use in marine environment is generally a function of concrete strength and soundness of aggregate. High-strength concrete with Basalt aggregate and no reinforcing is generally suitable.	Required unit mass 0.45 to 1.5t for wave height 2 to 3m, use average 0.8t cubes, side length 0.64m. Durability for use in marine environment is generally a function of concrete strength and soundness of aggregate. High-density concrete utilises special high density aggregate. Test batches of this concrete would need to be tested to determine its suitability for marine use. Use of high density concrete mean that individual units are smaller and lighter and therefore easier to handle, while achieving the same stability as basalt or regular cubes.
Compatibility of material with existing insitu conditions	Significant risk of damage to bottom layer of geobags during installation, due to placement (and probably dropping) on to the existing rock apron surface.	As per 0.75m³ geobag.	Generally compatible with the existing insitu conditions (rock aprons). Rock must have sufficient strength so as not to break up when dropped onto the existing rock. This can be achieved by specification of a minimum rock strength and other commonly adopted requirements such as maximum rock aspect ratio.	Generally compatible with the existing insitu conditions (rock aprons). Cubes must have sufficient strength so as not to break up when dropped onto the existing rock. This can be achieved by specification of a minimum concrete strength.	As per regular concrete cubes
Design criteria/standards adopted	Relatively new concept. Information does not currently exist to allow design which could be "guaranteed" to be stable under storm conditions.	As per 0.75m³ geobag.	Traditional method of protection with well established and accepted design guidelines.	Traditional method of protection with well established and accepted design guidelines.	As per regular concrete cubes
Design configuration and dimensions, including alignments, elevations and profiles	Nominal design constructed parallel to existing seawall in three shore-normal rows (long axis of bags aligned shore-normal). Stacked with three layers (bags) against seawall, two in the next seaward row, and one bag in the most seaward row. Bags in upper layers straddle the joints between bags in the lower layers. 7.5 bags used every 1.2m length of beach, or 1,250 bags for a 200m length.	As per 0.75m³ geobag, except 7.5 bags used every 1.8m length of beach, or 850 bags for a 200m length.	Random placement of two layers of rock over a distance of 3 to 5 m from the seawall. Around 3,000 tonnes of rock required for a 200m length.	Random placement of two layers of cubes over a distance of 3 to 5 m from the seawall. Around 900 x 2.7t cubes required for a 200m length.	Random placement of two layers of cubes over a distance of 3 to 5 m from the seawall. Around 2,700 x 0.8t cubes required for a 200m length.
Performance under design conditions, including post-storm configurations	Unlikely to be stable, and therefore unlikely to prevent undermining or further loss of seawall and promenade. The integrity of each individual geobag is limited by the workmanship and strength of the stitching of the units. Also, problems can be encountered with lateral 'sliding' of geobags, one over the other.	As per 0.75m³ geobag, except may just be stable, assuming applicability of traditional design formulae and suitable construction.	Can be designed to be stable with well established procedures. Assuming appropriately sized rock can be supplied, relatively simple construction (random rock placement) would be expected to also provide practical stability under design conditions.	Similar to basalt, can be designed to be stable with well established procedures. Relatively simple construction (random cube placement) would be expected to also provide practical stability under design conditions.	As per regular concrete cubes.
Consequences should design thresholds be exceeded	Requires pattern placement for integrity, so collapse of layered bags and loss of interlocking between bags may lead to undermining of seawall and/or loss of sections of promenade.	As per 0.75m³ geobag.	Potential undermining of seawall and/or loss of sections of promenade, although rock would be more likely to interlock (since the rocks are randomly placed) after any movement and suffer damage more progressively than geobags.	Potential undermining of seawall and/or loss of sections of promenade, although cubes would be likely to interlock after any movement and suffer damage more progressively similar to basalt.	As per regular concrete cubes.
Material sources	Bag fabrics must be purchased well before the storm. Sand source with most potential during storms would be the marine sand delta near the entrance to Manly Lagoon upstream of Queenscliff Bridge. However, this source relies on coincident flooding not occurring, and no recent manual entrance sand clearing. It would also be possible to purchase sand from a commercial source.	As per 0.75m³ geobag.	Example of rock source would include Hanson quarry at Bass Point, Shellharbour.	Concrete cubes can be precast to desired specification using readily available concrete from commercial batching plants.	Concrete cubes can be precast to desired specification using special high density aggregates in commercial batching plants.
Material storage	If bags are pre-filled, a dedicated 3,000m² undercover storage area would be required However, it is likely the preferred approach would be to store empty geobags and fill them at times of an emergency.	As per 0.75m³ geobag, except a 4,400m² storage area would be required.	Rock could be pre-purchased and stockpiled at a location within the Manly Council area (or a nearby Council area) if suitable areas can be found, in readiness for use as emergency protection at times of a severe storm. Area required less than 1,000m² if stacked two rocks high	Concrete cubes could be precast and stockpiled at a location within the Manly Council area (eg Works Depot), in readiness for use as emergency protection at times of a severe storm. Area required less than 400m² if stacked 3 units high.	As per regular concrete cubes. Area required less than 300m² if stacked 4 units high.

Assessment Parameters	Options				
	0.75m³ Geobag	2.5m³ Geobag	Basalt Rock	Concrete Cubes (ρ=2.2t/m³)	High-Density Concrete Cubes (ρ=3.0/m³)
Construction methodology and logistics	Filling frames, hand-held sewing machines and specialised devices for lifting and placing bags would need to be purchased in advance. Bags must be pattern placed. Rate of protection about 45m length of seawall each 24 hours (for each set of loading and placement equipment). Multiple filling and placement teams would be required to achieve the desired 200m coverage. Care needs to be taken in loading, transport and placement of filled bags to avoid damage such as tearing or puncturing.	As per 0.75m³ geobag, except rate of protection about 15m length of seawall each 24 hours (for each set of loading and placement equipment). Multiple filling and placement teams required to achieve the desired 200m coverage. Also require large excavators (35 tonnes capacity) for handling.	Stockpiled rock would be transported from the stockpile in rock body trucks to the beach area. Excavators with a rock grabbing tool would be used to randomly place larger rocks, or smaller rocks could be tipped over the seawall. Rate of protection higher than for geobags. It should be possible to place approximately 3,000 tonnes of rock (over a 200m length) if required over a 24 hour period, if two sets of excavators and associated trucks are utilised.	Cubes could have lifting eye cast in to make them easy to pick up and load onto trucks. Stockpiled cubes would be transported from the stockpile in rock body trucks to the beach area. Excavators could be used to randomly place cubes, or they could be tipped over the seawall. Rate of protection similar to basalt and higher than for geobags. It should be possible to place approximately 1,100 cubes (over a 200m length) if required over a 24 hour period, if two sets of excavators and associated trucks are utilised.	As per regular concrete cubes. Smaller and lighter individual units than regular cubes or basalt mean that lighter plant can be used in handling of cubes.
Installation during storm conditions	Difficult, due to lack of suitable foundation conditions and quality control required to carefully place units forming the desired interlocking pattern. No warranty from supplier under such conditions.	As per 0.75m³ geobag.	Rock can be placed at times of storms from the promenade, and random placement is suitable to achieve interlocking.	Similar to basalt, cubes can be placed at times of storms from the promenade, and random placement is suitable to achieve interlocking	As per regular concrete cubes.
Post storm rehabilitation and monitoring	Low hazard to beach users if exposed, due to soft fabric surface. However, susceptible to puncturing by vandals, but damaged bags can be repaired or replaced. Bags could also be relatively easily taken off the beach by deliberately cutting and removing the fabric, and leaving the formerly contained sand on the beach, if required.	As per 0.75m³ geobag.	Any exposure of emergency rock protection above natural beach recovery levels would be unacceptable having regard to issues of beach amenity, safety and access. All rocks placed on the beach at times of any future emergency should be removed following the storm except where the rocks would be covered with sand during natural beach recovery (and their existence is consistent with an adopted long term management strategy), or, other rocks in place on the beach prior to the storm are removed in lieu of some or all of the rocks placed during the storm to achieve a net improvement.	Any exposure of emergency concrete cube protection above natural beach recovery levels would be unacceptable having regard to issues of beach amenity, safety and access. All cubes placed on the beach at times of any future emergency should be removed following the storm except where the cubes would be covered with sand during natural beach recovery (and their existence is consistent with an adopted long term management strategy). Lifting eyes cast into the cubes would facilitate simple and rapid removal from the beach where cubes are exposed.	As per regular concrete cubes. Smaller and lighter individual units than regular cubes or basalt would aid with removal from beach. Higher density than regular cubes or basalt would also increase tendency to self-bury in the sand.
Cost estimate for supply and placement (excluding supervision and administration costs)	$500 per metre length of seawall protected, assuming sand was obtained at no cost and excluding purchase of lifting frames, sewing machines, and the like.	$1,400 per metre length of seawall protected, assuming sand was obtained at no cost and excluding purchase of lifting frames, sewing machines and the like.	$1,200 per metre length of seawall protected	Approximately $1,800 per metre length of seawall protected	Approximately $3,400 per metre length of seawall protected

5 FORMULATION OF AN EMERGENCY ACTION PLAN

5.1 GENERAL

A number of factors influence the formulation of an Emergency Action Plan (EAP) for Manly Ocean Beach:

- the Emergency Action Plan is intended for the use of Council staff and should be restricted to dealing with Council's role. While it should link to the SES Local Flood Sub-Plan (Coastal Erosion Annex), it should not duplicate, and certainly should not contradict, this Sub-Plan;

- Council already has in place a Draft Emergency Response to Rock Exposure Action Plan (refer **Appendix B**), which deals with beach erosion in so far as it may expose rocks on the beach and lead to safety and amenity concerns. The Plan covers situations from exposure of small rocks that do not form part of the main rock blanket along the toe of the seawall and can be removed manually (Category 1) up to exposure of the main rock blanket itself (Category 4). This Action Plan is still relevant and the preferred approach is to subsume this Action Plan into the overall Emergency Action Plan;

- the Rock Exposure Action Plan does not consider activities before the storm event or activities after the storm event, these activities need to be incorporated into an Emergency Action Plan.

The simplest way forward to make the Emergency Action Plan is considered to be, generally speaking:

- inclusion of a Pre-Storm phase at the 'front end' of the Rock Exposure Action Plan;

- expansion of the existing category system in the Rock Exposure Action Plan to include Category 5 (Standby) and Category 6 (Implementation) in relation to the placement of physical erosion protection measures;

- inclusion of a Post-Storm phase following the actions related to Categories 1 to 6.

Some notes are provided below in relation to the Pre-Storm and Post-Storm phases, and in relation to Categories 5 and 6 including some discussion on triggers that may take Council from Category 4 to Category 5 and from Category 5 to Category 6.

5.2 PRE-STORM PHASE

The Pre-Storm phase is concerned with monitoring and predicting the likelihood of an event that may lead to use of the Emergency Action Plan.

The relevant officer within Council, such as the Coastal Management Team Leader, should be responsible for monitoring weather and wave forecasts on a daily basis. Useful websites for this

purpose include www.coastwatch.com, the NSW Department of Commerce, Manly Hydraulics Laboratory (MHL) website www.mhl.nsw.gov.au and the Commonwealth Bureau of Meteorology website www.bom.gov.au.

The level of monitoring and prediction should be increased when there is the release of a "Severe Weather Warning for Damaging Surf" by the Bureau of Meteorology. The increased activity should include:

- beach inspection by the Coastal Management Team Leader (regular inspections at other times are conducted by Council staff including the waste and cleaning staff, beach inspectors and various works staff);
- assessment of the likely coincidence between tidal phasing and storm waves, including in the case of tides the occurrence of spring and neap tides and low and high water;
- confirmation of the availability of concrete blocks and geobags.

Depending on the circumstances, the situation may escalate from the Pre-Storm phase to Category 1 and beyond.

5.3 CATEGORY 4 AND CATEGORY 5

The existing identification of Category 4 in the Rock Exposure Action Plan corresponds to 'full' exposure of the rock blanket (refer **Appendix B**). It is considered that this identification should be changed to 'any' exposure of the rock blanket since, from about this time, the seawall and other assets could commence to be vulnerable and further erosion could occur quickly, depending on wave heights, water levels and tidal behaviour, eg rising tide.

The action that takes place at the time of Category 4 in the current Rock Exposure Action Plan is, among other things, an emergency meeting to discuss an appropriate strategy. This meeting involves representatives of DNR and SES. It is difficult to be more prescriptive than this since so many factors will influence decision making.

Similarly, there is no single quantitative parameter such as a particular offshore significant wave height or minimum beach width that can be adopted as the sole trigger for Category 5 (Standby). It follows that experienced judgement is required by those persons at the emergency meeting to activate Category 5. Some coastal engineering factors of significance include:

- existing beach conditions at the time (beach width, sand volume);
- location of rips;
- integrity of seawall in those areas at threat[25];
- coastal storm predicted behaviour
  - wave height
  - wave direction
- water level predicted behaviour, particularly tide.

[25] Such information should be compiled and be readily available to persons at the emergency meeting.

Activities undertaken during Category 5 (Standby) would include loading and transport of concrete blocks to the beach ready for placement if required and filling of geobags and transport to the beach ready for placement.

Depending on the circumstances, the situation may escalate from Category 5 (Standby) to Category 6 (Implementation).

5.4 CATEGORY 5 AND CATEGORY 6

Again there is no single quantitative parameter which can serve as the trigger for shifting the status of activity from Category 5 to Category 6. This is also a risk based judgement best taken by experienced persons at the emergency meeting.

Similar coastal engineering factors to those listed above would be relevant, together with any signs of distress of the seawall or the promenade behind the seawall.

5.5 POST-STORM PHASE

The post-storm activities would be conducted after the storm has abated and it is safe to do so. These activities would include general clean up and restoration and removal of all concrete blocks placed on the beach during the emergency, except where the following circumstances apply:

- the concrete blocks would become covered with sand during natural beach recovery and their existence is consistent with an adopted long term management strategy for maintaining the integrity of the seawall; or

- other materials in place on the beach prior to the storm, eg rocks, are removed in lieu of some or all of the concrete blocks placed during the emergency such that the net outcome is an improvement in beach amenity, safety and access, and seawall stability.

The post-storm activities should also include preparation of a report incorporating a description of the storm, all actions undertaken (including removal of materials), lessons learnt, and the like. The report should include photographs and video of storm damage and any physical emergency protection measures.

Further, an opportunity should be taken to undertake a detailed survey of beach levels and other features, eg exposed rock and seawall toe levels, immediately after the storm while beach levels are low and such features are visible.

6 EMERGENCY ACTION PLAN

The Emergency Action Plan is included on the following two pages. The Plan has been kept intentionally concise for ease of use and in a format similar to the Rock Exposure Action Plan which Council officers are accustomed to.

A number of other documents would need to be available to decision makers at any emergency meeting at the Category 4 stage in order to make an informed decision regarding emergency management, eg a document showing seawall integrity along the full embayment.

Manly Ocean Beach
Council Emergency Action Plan for Coastal Erosion

	CATEGORY IDENTIFICATION	A STAFF SUPERVISION RESPONSE	B ACTION	C REPORTING
CATEGORY **PRE-STORM PHASE (PRE)**	**1. No other category is active**	1. Coastal Management Team Leader - **Implements 'PRE-B'** 2. Coastal Management Team Leader to notify Works Manager if "Severe Weather Warning for Damaging Surf" issued by Bureau of Meteorology	1. Coastal Management Team Leader monitors weather and wave forecasts on a daily basis 2. In the event of A2, Works Manager confirms availability of concrete blocks and geobags and source of sand for filling of geobags (source to be agreed by Coastal Management Team Leader)	1. Record on appropriate Council file if "Severe Weather Warning for Damaging Surf" released by Bureau of Meteorology.
CATEGORY 1	**2. Are there small rocks exposed that are capable of being handled manually?** **Yes - Category 1 Identified Go to 1A** **No - Go to 2**	1. Works Manager – **Implements 1B** 2. Works Manager to notify Coastal Management Team Leader at the first opportunity during business hours 3. Coastal Management Team Leader - **Implements 1C**	1. Council staff to remove rocks immediately by manual means 2. Digital photos taken of exposed rocks and location 3. Photos forwarded to Coastal Management Team Leader for reporting	1. As judged appropriate notify: • Divisional Manager CS • Manager Civic Services • General Manager • Mayor • DNR 2. Record on appropriate Council file
CATEGORY 2	**1. Are there medium rocks exposed (not main rock blanket matrix), that require mechanical assistance to remove and a suitable tide?** **Yes - Category 2 Identified Go to 2A** **No - Go to 3**	1. Works Manager – **Implements 2B** 2. Works Manager to notify Coastal Management Team Leader at the first opportunity during business hours 3. Coastal Management Team Leader - **Implements 2C**	1. Council staff to secure area with star pickets and tape 2. Council to remove rocks using mechanical equipment 3. Photos forwarded to Coastal Management Team Leader for reporting	1. As judged appropriate notify: • Divisional Manager CS • Manager Civic Services • General Manager • Mayor • DNR 2. Record on appropriate Council file
CATEGORY 3	**1. Are there medium rocks exposed (not main rock blanket matrix), that require mechanical assistance to remove and is the tide unsuitable?** **Yes - Category 3 Identified Go to 3A** **No - Go to 4**	1. Works Manager – **Implements 3B** 2. Works Manager to notify Coastal Management Team Leader at the first opportunity during business hours 3. Coastal Management Team Leader - **Implements 3C**	1. Council staff to secure exposed rock area with star pickets and barrier tape (as appropriate) and erect "Rocks Exposed" signs 2. Advise Beach Inspectors to place appropriate signage 3. Council staff to close beach if increasing numbers of rocks are exposed. Close beach at entrances with barrier tape and erect "Closed Beach" signs 4. Photos forwarded to Coastal Management Team Leader for reporting	1. Emergency meeting with Divisional Manager CS 2. As judged appropriate notify: • Divisional Manager CS • Manager Civic Services • General Manager • Mayor • DNR • SES 3. Organise emergency meeting to discuss appropriate strategy 4. Record on appropriate Council file
CATEGORY 4	**1. Is there any exposure of the rock blanket matrix?** **Yes - Category 4 Identified Go to 4A**	1. Works Manager – **Implements 4B** 2. Works Manager to notify Coastal Management Team Leader 3. Coastal Management Team Leader - **Implements 4C**	1. Council staff to close beach 2. Council staff to secure entrances with barrier tape (as appropriate) and erect "Closed Beach" signs 3. Advise Beach Inspectors to place appropriate signage 4. Photos forwarded to Coastal Management Team Leader for reporting	1. Emergency meeting with Divisional Manager CS 2. As judged appropriate notify: • Divisional Manager CS • Manager Civic Services • General Manager • Mayor • DNR • SES 3. Organise emergency meeting to discuss appropriate strategy and coordinate with Local Emergency Management Officer 4. Record on appropriate Council file

	CATEGORY IDENTIFICATION	A STAFF SUPERVISION RESPONSE	B ACTION	C REPORTING
CATEGORY 5	**1. Did the emergency meeting decide to proceed to Standby for implementation of physical erosion protection measures?** **Yes - Category 5 Identified Go to 5A** **No - Remain Category 4 or less**	1. Works Manager - **Implements 5B** 2. Coastal Management Team Leader - **Implements 5C**	1. Transport concrete blocks to beach ready for deployment if required 2. Fill geobags with sand and transport to beach ready for deployment if required 3. Photos forwarded to Coastal Management Team Leader for reporting	1. As for Items 1-4 in **4C**
CATEGORY 6	**1. Did the emergency meeting decide to proceed to Implementation of physical erosion protection measures** **Yes – Category 6 Identified Go to 6A** **No - Remain Category 5 or less**	1. Works Manager - **Implements 6B** 2. Coastal Management Team Leader **Implements 6C**	1. Place concrete blocks on beach, as required, under direction of Coastal Management Team Leader 2. Place geobags on beach, as required, under direction of Coastal Management Team Leader 3. Photos forwarded to Coastal Management Team Leader for Reporting	1. Prepare report and place on appropriate Council file
CATEGORY POST-STORM PHASE ('POST')	**1. Storm has abated and it is safe to conduct post-storm activities**	1. Works Manager - **Implements 'POST' B** 2. Coastal Management Team Leader **Implements 'POST' C**	1. Conduct general cleanup and restoration 2. Remove concrete blocks and geobags from beach subject to advice of Coastal Management Team Leader having regard to provisions in Emergency Action Plan. 3. Carry out detailed survey of beach levels and other features as directed by Coastal Management Team Leader 4. Photos forwarded to Coastal Management Team Leader for Reporting	1. Prepare report and place on appropriate Council file

CONTACT NUMBERS

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Bob Spencer 0418 608 494

Council's Coastal Management Team Leader
Tim Macdonald 0400 448 776

Beach Lifeguards
Mark McDougall 0417 662 131
Office Hrs 9976 1497

Cleaning Co-ordination
Lutz Heimann 0417 264 078
Office Hrs 9976 1441

Manager Civic Services
Ted Williams 0418 281 193

Divisional Manager Corporate Services
Anthony Hewton 0417 417 696
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DNR
Mark Moratti 9895 5056

After Hours Emergency Number
0408 212 325

7 REFERENCES

Blumberg and Rhodes (1995)
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Technical Report 2002/39 prepared for Manly Council by J T Carley, R J Cox, A B Phillips and I L Turner, April 2003

APPENDIX A
COPY OF PAPER BY HANSLOW AND HOWARD (2005)

Emergency Management of Coastal Erosion in NSW

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Abstract

The southeast coast of Australia has a long history of adverse impact from coastal storms. Past responses to coastal erosion events have included the placement of temporary mitigation works ranging from sandbag and rock walls through to dumping of building waste and car bodies. These works have varied significantly in their effectiveness and most have had a significant adverse impact on beach amenity.

This paper examines arrangements for emergency management of coastal erosion in NSW. This includes details of the roles and responsibilities of the various agencies involved in coastal erosion emergency management as well as the requirements of relevant legislation. A number of principles are suggested as a guide to both planning and response decisions relating to coastal erosion emergencies.

Introduction

Approximately 60 percent of the NSW open ocean coastline is characterised by sandy beaches. These beaches are dynamic environments undergoing continual cycles of erosion and accretion in response to the action of tides, wind and waves. In many places, existing foreshore development has been built within the active beach system and is at risk from coastal erosion.

Major coastal erosion events along the NSW coast are usually associated with the occurrence of east coast low-pressure systems, decaying ex-tropical cyclones or mid-latitude cyclones, which generate large waves and elevated water levels. Erosion occurs as the beach adjusts to these conditions by transporting sand seawards, lowering the slope of the intertidal beach face and depositing sand on nearshore bars and the lower shoreface. At times the erosion of the beach face may be exacerbated by processes such as rip currents and beach rotation or the presence of structures. Substantial damage may occur to any buildings located within the active zone, including partial or complete collapse, necessitating evacuations. With current predictions of climate change (IPCC 2001, CSIRO 2004) and increasing population growth in coastal communities this situation is expected to get worse with time (Lord and Gibbs, 2004).

Past responses to coastal erosion events have included the placement of temporary mitigation works ranging from sandbags and rock walls through to dumping of building waste and car bodies. Often these hastily erected structures do little to reduce beach erosion during the storm event, which may continue unabated. The adverse effects of such walls and dumped material may, however be long lasting, severely impacting beach amenity and beach access, often posing a serious safety risk to beach users, and exacerbating erosion of neighbouring areas. Many beaches along the NSW coast are still scarred by material dumped during storms in the 1960s and 1970s (eg Byron Bay).

Existing guidelines for the management of coastal erosion as outlined in the Coastline Management Manual (NSW Government 1990) address the long-term management of coastal hazards but provide little guidance for emergency response. To address this issue the NSW Government, in November 2002, amended the *Coastal Protection Act (1979)* to require coastal zone management plans to make provision for emergency actions that may be undertaken during periods of beach erosion, including the carrying out of related works.

The current paper examines the coastal erosion incident and emergency response components of Coastal Zone Management Plans and discusses the relationship between these plans and other emergency response plans prepared under NSW emergency management legislation.

Background

Erosion is part of the natural response of a beach to changing wave and water level conditions. However, the large waves, elevated water levels and strong winds generated by a storm can cause severe damage to coastal properties.

The southeast coast of Australia has a long history of adverse impact from coastal storms. Both Thom (1974) and Chapman et al. (1982) document histories of erosion events dating back to the 'Dunbar storm' in 1857. Major events threatening property have occurred on average every 10-20 years since the mid 1800's. A number of these events involved a series of storms rather than a single storm, for example in 1912, 1950, 1967 and1974. Some of the more recent events have been correlated with the combined occurrence of storm related erosion and beach rotation linked with the El Niño/Southern Oscillation (eg Ranasinghe et al., 2004).

The worst of these historical events, in terms of property damage, were the 1944-6, and 1974 events. During the 1944-6 event two houses were 'lost to the sea' and up to seven others suffered substantial damage at the southern end of Collaroy Beach (Warringah Shire). These were subsequently demolished and the properties within the affected zone were resumed and converted to public reserve and car park (PWD, 1987; Chapman et al 1982).

In 1974 wide spread erosion associated with a series of storms led to damage and later abandonment of the village of Sheltering Palms (Byron Shire) on the far north coast as well as wide spread damage along the central coast including many Sydney beaches. This included the undermining and damage of houses at Bilgola Beach and Narrabeen, the loss of the Paragon restaurant in Botany Bay, and substantial damage to Manly jetty and many surf Clubs.

Emergency response activities undertaken during these events have varied widely both in scale and effectiveness. These have ranged from the construction of sandbag and rock and even hay bale walls through to dumping of building waste and car bodies as undertaken at Byron Bay during 1967 and 1974. While, on occasion, these works were effective in locally halting erosion, they often exacerbated erosion in neighboring areas. More often, the dumping did little to reduce beach erosion during the storm event, which continued unabated.

Only with hindsight do we realise the long lasting effect that many of these structures have had on beach amenity and public safety. On numerous beaches along the NSW coast, material dumped during the 1967 and 1974 storms is still visible today. In many

cases beach widths available for recreational usage have been significantly reduced, public access impeded and the natural character of the beach severely changed. At Belongil Spit (Byron Shire) injuries resulting from the dumping of car bodies are still reported some 25 years after the dumping of cars (Thom, 2004). With rising sea levels and the potential for increased frequency and intensity of storms associated with climate change the impacts of these works are likely to increase, as is the likely pressure for further coastal hardening (Lord and Gibbs, 2004, Herbert and Taplin, 2004). As coastal populations increase, the pressure on scarce coastal resources is likely to grow along with the pressure for more intensive development of the coast. (eg Lord and Gibbs, 2004).

In 1999, concern over ongoing degradation of beach amenity led to a statewide review of beach management by the NSW Coastal Council. The Coastal Council recommendations included measures to provide legal protection to beaches, and to ensure emergency actions during storms are planned in a coordinated way involving the Local Council, the State Emergency Service, the Department of Infrastructure, Planning and Natural Resources, and affected property owners (NSW Coastal Council 2000, Thom 2004). These recommendations have resulted in extensive consultation between the key agencies with the outcome that changes have now been made to policies and legislation in both the land management and emergency management arenas in NSW.

Roles and Responsibilities of Land Managers and Emergency Managers

Land Management

Local councils, as the local land managers, are responsible for much of the day-to-day management of the NSW coastal zone. This includes local environmental planning and development approval under the *Environmental Planning and Assessment Act (1979)*, the preparation of coastal zone management plans under *the Coastal Protection Act (1979)*, as well as the management of community land including most beaches under the *Local Government Act (1993)*.

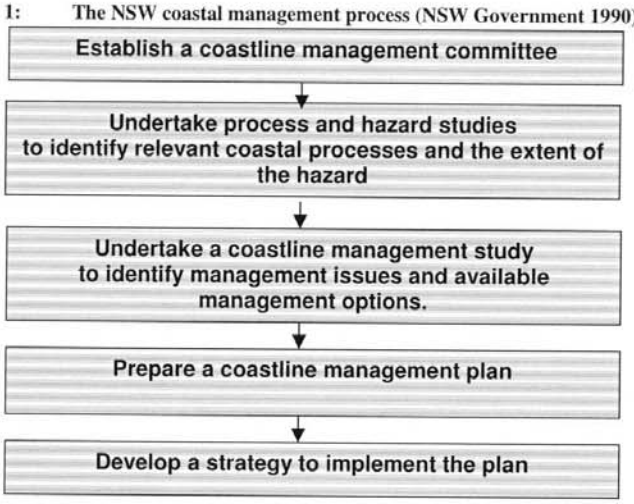
In managing the coast, councils are guided principally by the Coastal Policy 1997 (NSW Government 1997) and the Coastline Management Manual (1990). The Coastal Policy 1997 promotes better management of the coastal zone of New South Wales through the application of ecologically sustainable development (ESD) principles. The policy aims to facilitate the development of the coastal zone in a way, which protects and conserves its values. This includes recognising and accommodating natural process and protecting beach amenity and public access.

The Coastline Management Manual (NSW Government, 1990) provides detailed guidelines for councils to follow to address coastal erosion issues. The manual, which is currently being reviewed, outlines a series of steps for local councils to follow to prepare and then implement Coastal Zone Management Plans (see figure 1).

Emergency Management

Emergency management arrangements in NSW are primarily guided by the *State Emergency and Rescue Management Act, 1989*. The Act provides the legislative basis for coordination of emergency preparedness, response and recovery and provides for the preparation of the NSW State Disaster Plan (Displan) and subordinate plans for specific hazards.

Figure 1: The NSW coastal management process (NSW Government 1990).



The State Displan details emergency preparedness, response and recovery arrangements for NSW to ensure the coordinated response to emergencies by all agencies having responsibilities and functions in emergencies. The primary functions of this document as specified in the *State Emergency and Rescue Management Act, 1989*, are:

- to identify the agency primarily responsible for responding to each different form of emergency (this is done using the 'All Hazards Approach' to emergency management);
- provide for the coordination of the activities of other agencies in support of the agency with primary responsibility for a particular emergency;
- specify the tasks to be performed by all agencies in the event of an emergency; and
- specify the responsibilities of the minister and senior emergency managers.

In NSW, the agency responsible for damage control from storms and tempests, including damage control for coastal erosion and inundation from storm activity, is the NSW State Emergency Service. The State Emergency Service is also the combat agency for floods in this state.

The key responsibilities of the State Emergency Service as specified in the State Storm Plan (a sub-plan of the State Displan) for the management of damage control from coastal storms are:

- The protection of life through warning and evacuation of residents at risk; and
- The coordination of the lifting and/or relocation of readily movable household items and commercial stock and equipment.

This means that the actions carried out by the State Emergency Service and supporting agencies during coastal erosion events caused by storms are carried out under the authority of the *State Emergency and Rescue Management Act, 1989*. Planning for the

emergency management of this hazard is carried out by the State Emergency Service under the authority of *the State Emergency Service Act, 1989* as described in the following section of this paper.

Further details of the respective roles and responsibilities of key agencies are contained in Appendix 1.

Emergency Management Planning

In 2002, The *Coastal Protection Act (1979)* was amended to ensure that Coastal Zone Management Plans prepared by local councils address both coastal emergency responses and the protection of beach environments. The Act stipulates that a Coastal Zone Management Plan must make provision for:

- protecting and preserving beach environments and beach amenity;
- emergency actions of the kind that may be carried out under the *State Emergency and Rescue Management Act 1989*, or otherwise, during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event; and
- ensuring continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion.

Addressing both the protection of beach environments and beach amenity and the management of emergency actions where property is threatened as required under the *Coastal Protection Act, 1979*, as amended, is a difficult balancing act. The agencies involved in each different aspect of planning need to be aware of the various legal requirements and policies guiding both coastal management and emergency management in NSW in order to do the job well. The most effective way to achieve this task is for the key players to consult early and often during the planning process.

In addition, the following points are suggested as a guide to both planning and response decisions relating to coastal erosion emergencies:

- The first priority of any emergency response should be to protect any lives which may be threatened. Under the *State Emergency and Rescue Management Act, 1989*, this includes the safety and health of people and animals. This should usually be undertaken through the warning of occupants and evacuation of buildings identified as being at immediate risk. This is the responsibility of the State Emergency Service (during storms) and is planned for in Local Flood Plans. Councils may also use warning signage and safety fencing to keep individuals away from unstable erosion escarpments. Community education to advise people of the risks and what they can do to reduce the effects of coastal erosion is a joint responsibility of councils and the State Emergency Service and should be ongoing.

- The second priority should be to minimise damage to property through the removal of household contents or commercial stock and equipment from buildings at risk of collapse or inundation by sea water. The State Emergency Service is responsible for coordinating such actions during storms and Local Flood Plans will also make provision for such actions.

- As coastal erosion emergency engineering response measures have the potential to seriously impact on long-term public beach amenity as well as neighbouring properties, any emergency response actions should be planned for in advance and based on assessment of all available options and their pros and cons. Emergency

engineering works should generally be restricted to the protection of high-value built assets. Where possible, natural processes of erosion and accretion should be allowed to continue. Councils are responsible for planning for and conducting any such works both during and outside of storm periods.

- Emergency engineering responses to protect development from coastal erosion should favour options that do not compromise the natural and cultural values of the area, such as building relocation, or beach and dune replenishment (with sand). The Department of Infrastructure, Planning and Natural Resources is responsible for providing advice to councils on appropriate options during preparation of Coastal Zone Management Plans.

- Impacts generated by emergency engineering works on beach environments, beach amenity or beach access must be mitigated following the emergency. This may involve removal of structures, burial with dune sand, re-establishment of dune vegetation, dune re-establishment, and other methods. Where structures are not removed, plans should specify measures to ensure the ongoing mitigation of any adverse impacts for example by burial or revegetation. These actions are the responsibility of council and should be included in Coastal Zone Management Plans.

- Emergency engineering works should be consistent with long-term coastal management strategies where they have been adopted. For example where a policy a retreat or voluntary purchase has been adopted, no protection works should be allowed.

Provisions in Coastal Zone Management Plans

It is suggested that the coastal erosion emergency components of Coastal Zone Management Plans should, as a minimum, address each of the following issues and that all planning should be undertaken in consultation with the State Emergency Service and other key agencies.

- *Coastal erosion hazard*—all coastal hazards present within the area should be identified, as should the extent and nature of the risks posed to existing development.

- *Appropriate responses*—the plan should outline responses that are appropriate given the nature of the hazards and local site conditions. Proposed responses should be based on an assessment of all available options and their pro and cons. A range of typical works options is outlined in Appendix 2.

  Where planning for the protection of life and readily movable property during storms has been included in State Emergency Service Local Flood Plans, the Coastal Zone Management Plan should refer directly to the relevant State Emergency Service plans. Councils may choose to include a copy of these arrangements in the Coastal Zone Management Plan for convenience, although this is not considered necessary.

- *Preparedness*—the plan should include measures to facilitate efficient responses to coastal erosion emergencies, such as:
  - development of monitoring and warning systems (council responsible for components associated with engineering works, plans should also refer to relevant provisions in State Emergency Service plans).
  - identification of potential sources of sand and rock, plant and equipment, geotextile suppliers and other materials and resources required for physical protective works (council responsible).
  - obtaining development consent where works options require prior approval under the *Environmental Planning and Assessment Act, 1979* (Councils).

- public education measures, including awareness of the contents of Flood Plans and the emergency provisions in Coastal Zone Management Plans. The State Emergency Service and councils both have responsibility for educating the community about the contents of their respective plans and this is often done jointly by both agencies.

- *Trigger conditions*—the plan should identify the circumstances in which emergency responses (including any engineering works) should or should not occur.

- *Responsibilities and contacts*—the plan should clearly specify a hierarchy of responsibilities for the emergency engineering responses actions required to be undertaken by councils, and include contact details, default contacts and other details as required. The hierarchy of emergency management responsibilities and specific contact details for emergency management and supporting agencies are contained in Displan, the Local Flood Plan and State Emergency Service Standing Operating Procedures. In order to reduce confusion and duplication, councils should not attempt to reproduce or amend these in Coastal Zone Management Plans, but should simply refer to the Local Flood Plan where appropriate.

- *Recovery and rehabilitation*—the plan should clearly specify those actions which are to be undertaken to mitigate any impact of emergency works on beaches, dunes or other coastal settings, and should specify when they will be undertaken and by whom. (Note: mitigation and remediation of the coast following any physical works undertaken during a storm event is the responsibility of council).

State Emergency Service Plans

The NSW State Emergency Service is the combat agency for storms, including storms resulting in coastal erosion. Under the *State Emergency Service Act, 1989*, the State Emergency Service prepares plans outlining arrangements for preparedness, response and recovery from these events. This is done, in the first instance, through the NSW State Storm Plan. As there are no local storm plans in NSW, planning for emergency management of coastal erosion events at the local level is included, for convenience, in Local Flood Plans.

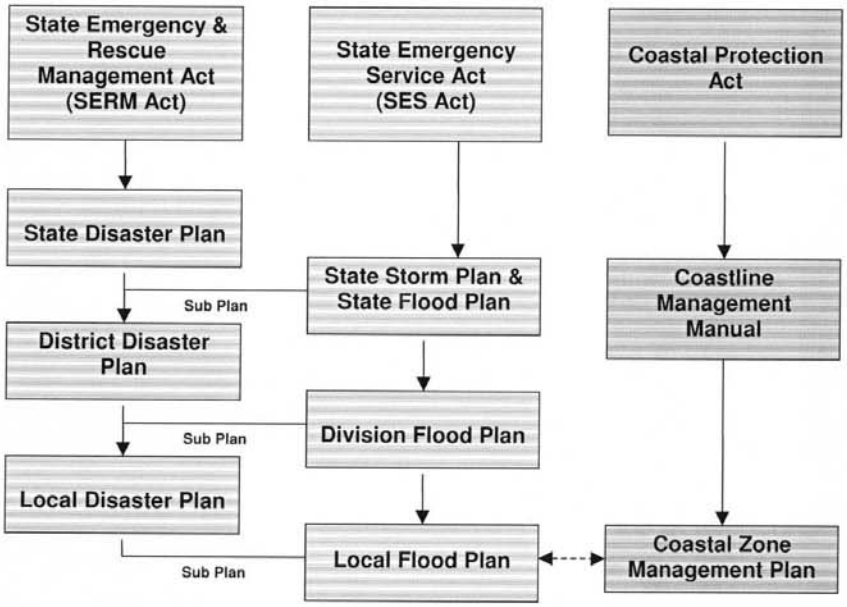
These Local Flood Plans identify and describe the hazard in the local area and the properties at risk. They include details of the responsibilities of all of the emergency services and other key agencies, as well as local community and volunteer organisations with a role in supporting the State Emergency Service during a response operation. Monitoring and warning systems are outlined including the issue of Severe Weather Warnings by the Commonwealth Bureau of Meteorology. Appropriate emergency management response options are identified and detailed in accordance with the primary responsibilities of the State Emergency Service in relation to coastal erosion events - the protection of life and the coordination of the protection of readily movable property.

The plan will also include any other preparedness measures such as preparation and review of the plan itself, consultation with other agencies, involvement in relevant planning conducted by other agencies and community education. Immediate recovery measures are also noted in Local Flood Plans.

It is important to note here that it is through the State Emergency Service plans that the emergency management arrangements for responding to coastal erosion during storms are activated. Local Flood Plans are prepared under the authority of the State Emergency and Rescue Management Act, 1989 and can activate the support arrangements as detailed in the NSW State Displan providing access to significant

resources from other emergency management agencies. Whilst the Coastal Protection Act, 1979 specifies that Coastal Zone Management Plans are required to make provision for emergency actions of the kind that may be carried out under the *State Emergency and Rescue Management Act 1989,* or otherwise, inclusion of such arrangements in council plans does not activate the support provisions of the Displan. It is far simpler and more effective to include a reference to the appropriate Local Flood Plan in the Coastal Zone Management Plan in order to meet this requirement. This then is good cause for councils and the State Emergency Service to collaborate during their planning processes, to ensure that a link between both of these important planning instruments is established and maintained. The Department of Infrastructure, Planning and Natural Resources, in providing guidance to councils during the development and implementation of Coastal Zone Management Plans plays a pivotal role in encouraging councils to foster this collaboration. Figure 2 below illustrates the relationship between emergency management and coastal protection legislation, policies and planning.

Figure 2: Hierarchy of Emergency and Coastal Zone Management Plans in NSW.



Discussion

With effective long-term management by councils, the need for emergency response actions in the coastal zone during storms to deal with the residual risk should, over time, be reduced. There have been many significant achievements to date that have improved emergency management of the coastal zone, both on a statewide and a local scale. Already, a large number of councils have commenced the coastal zone management process and many have progressed through to the planning phase. At the same time, the State Emergency Service has been working closely with councils along the coast in the preparation of specific arrangements for the emergency management of coastal erosion

within Local Flood Plans. The precursor behind many of these changes of course has been the specific requirements for emergency management planning contained in the *Coastal Protection Act, 1979*, as amended.

There is still a long way to go however, before the risk is reduced to an acceptable level and a number of issues are yet to be addressed. One issue relates to the approval of emergency works. Neither the *State Emergency and Rescue Management Act, 1989* or the *Coastal Protection Act, 1979* specifically override the normal approval processes of the *Environmental Planning and Assessment Act, 1979*, unless a State of Emergency is declared (and this is not the usual case in emergencies of this scale). As a result, any physical mitigation works such as sea walls may require approval prior to construction, even if adopted as the appropriate emergency response option in a Coastal Zone Management Plan. This means it may be necessary to seek development consent in advance for adopted options or alternately it may be necessary to modify relevant local environmental planning instruments to allow actions which are supported in the Coastal Zone Management Plan.

Another key issue which many councils face is the ever-increasing value of beachfront property and therefore the low cost-benefit ratio of mitigation options such as voluntary purchase and planned retreat policies. Funding the implementation of management plans is an ongoing challenge for many councils and an important issue which needs to be addressed. Of more immediate significance in this planning phase, is gaining a full understanding of the scope of the coastal erosion hazard in this state.

A number of programs are underway to remedy these deficiencies however, including the Coastal Risk Assessment currently underway and the NSW Coastal Hazards Definition Database soon to be compiled by the Department of Infrastructure, Planning and Natural Resources. Under the Natural Disasters Mitigation Program (NDMP) and Coastal Management Program (CMP) there is also significant Commonwealth and State funding available to councils for coastal zone studies and management plans and a number of councils have successfully applied for and received funding to date. Under the 2004/2005 funding round for NDMP, over $9.5 million of Commonwealth and State funds were allocated to mitigation projects in NSW (including a number of coastal projects). In the 2005/2006 program, there is a further $4.9 million Commonwealth and State funds available for projects in this state. This is in addition to the State Coastal Management Program, which provides about $2 million per year to councils for the preparation and implementation of Coastal Zone Management Plans.

The Department of Infrastructure, Planning and Natural Resources are also in the process of reviewing the 1990 Coastline Management Manual to provide councils, consultants and other relevant agencies with more explicit and up-to-date guidelines on the preparation of Coastal Zone Management Plans. The revised Coastal Zone Management Manual will include a chapter on emergency management of the coastal zone. In the interim, the State Emergency Service and the Department of Infrastructure, Planning and Natural Resources intend to prepare a brief outline of the general requirements of both agencies to assist councils who have already commenced or are soon to begin their Coastal Zone Management Plans.

Conclusion

As with the long-term responses to coastal erosion, emergency actions to protect coastal development must also recognise the value and importance of the beach environment as a community and environmental asset. Structural protection works such as sea walls have the potential to negatively impact on beach amenity, public safety and neighbouring properties. Careful consideration should be given during the preparation

of Coastal Zone Management Plans, to the potential impact of response actions and to how the beach will be rehabilitated after the event. The successful execution of these responsibilities is dependent upon the continuing development of a strong, cooperative relationship between the key agencies involved in planning for and conducting emergency actions in the coastal zone.

Disclaimer

The views expressed in this paper are those of the authors and not necessarily those of either the Department of Infrastructure, Planning and Natural Resources or the State Emergency Management Committee Secretariat.

Acknowledgements

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APPENDIX 1: – RESPONSIBILITIES OF KEY AGENCIES

AGENCY RESPONSIBLE	BEFORE THE STORM	DURING THE STORM	AFTER THE STORM
State Emergency Service **(SES)**	1. Prepare and maintain the Local Flood Plan, including arrangements for the management of coastal erosion during storms. 2. Consult with councils, Coastal Zone Management Committees, DIPNR and other agencies during the development of emergency management arrangements for the management of coastal erosion for inclusion in SES Local Flood Plans and council Coastal Zone Management Plans. 3. Prepare, coordinate and deliver community awareness programs and educational material with the assistance of the local councils to ensure that people in locations potentially threatened by coastal erosion understand the threat and its management. **Note;** the SES is not responsible for the planning or conduct of emergency beach protection works during periods of storm activity or otherwise.	1. Activate the Local Flood Plan. 2. Advise the local council and other emergency management agencies of coastal storms that are likely to affect the council area. 3. Conduct regular reconnaissance at locations identified as being susceptible to coastal erosion. 4. Coordinate the provision of advice to the community at risk regarding the likely problem and actions they should take. These actions may include evacuation and/or removal of portable property from households and businesses. 5. Coordinate the evacuation of people at risk. 6. Coordinate the transport of removable household possessions and stock, records and equipment from business premises (if time and resources permit). 7. Provide a 'phone-in' service for the local community to take requests for assistance and give advice as necessary.	1. Assign personnel to gather intelligence in areas susceptible to coastal erosion/inundation. 2. Review and update the arrangements for managing coastal erosion/inundation in Local Flood Plans following coastal erosion events. 3. Liaise with the DIPNR to obtain information on the impact of storm events on coastal properties once the storm has abated.

AGENCY RESPONSIBLE	BEFORE THE STORM	DURING THE STORM	AFTER THE STORM
Local Councils	1. Carry out the ecologically sustainable planning and management of the coastal zone. 2. Prepare Coastal Zone Management Plans in accordance with the Coastal Protection Act, 1979 including arrangements for the emergency management of coastal erosion. 3. Consult with the communities at risk, Coastal Zone Management Committees, DIPNR and other agencies during the development of emergency management arrangements for the management of coastal erosion for inclusion in council Coastal Zone Management Plans and SES Local Flood Plans. 4. Establish and maintain Coastal Zone Management Committees to facilitate the development of the Coastal Zone Management Plans and ensure that key agencies are represented on such committees. 5. Participate in education campaigns and assist the SES in the development and delivery of educational material to ensure that people in areas potentially threatened by coastal erosion understand the threat and its management.	1. Conduct reconnaissance at coastal erosion trouble spots in consultation with the SES. 2. Liaise with the SES Local Controller to determine the need for any response actions by the SES such as evacuation of residents at risk and any support that may be required to carry out these measures as detailed in the Local Flood Plan. 3. Liaise with the Engineering Services Functional Area Coordinator (ESFAC) before constructing or allowing the construction of any unapproved physical mitigation works to protect coastal property or other structures.	1. Remove and/or mitigate the impact of any temporary physical protective measures from the beach. 2. Liaise with DIPNR to determine any changes to the coastal zone and any new areas at risk following storms at sea. 3. Maintain and review council Coastal Zone Management Plans in consultation with other stakeholders.

AGENCY RESPONSIBLE	BEFORE THE STORM	DURING THE STORM	AFTER THE STORM
Department of Infrastructure, Planning and Natural Resources (DIPNR)	1. Develop and advise on state wide coastal policy, planning and management. 2. Provide ongoing advice to local councils and Coastal Zone Management Committees on coast and estuary management including procedures for addressing coastal hazards, coastal processes and risks, management options and coastal policies. 3. Provide the SES and councils with advice on likely erosion 'hotspots' along the New South Wales coastline.	1. Provide advice and approval to councils regarding the most appropriate methods of dealing with coastal erosion and placement of temporary mitigation measures during storm events, via the Engineering Services Functional Area Coordinator (ESFAC).	1. Liaise with council staff to ensure appropriate remediation of beach and dunes following storm events. 2. Provide the SES and council with updates on the current state of the coastal zone and any new areas at risk following a storm event.
Commonwealth Bureau of Meteorology (BoM)	1. Formulate and issue official forecasts and Severe Weather Warnings and provide them to the SES, radio stations and other organisations prior to and during potential and actual coastal erosion events. (Note: Severe Weather Warnings for dangerous surf are issued when onshore waves in the surf zone are expected to reach at least 5 metres within the following 24 hours or when a storm surge of 0.5 metres or greater is anticipated).	1. Formulate and issue official forecasts and Sever Weather Warnings and provide them to the SES, radio stations and other organisations prior to and during potential and actual coastal erosion events.	

APPENDIX 2:
PHYSICAL WORKS OPTIONS FOR COASTAL EROSION EVENTS

The following options are likely to be of particular relevance to the management of emergency situations involving threats to buildings on beaches or dunes:

- *Do nothing*—this option may be appropriate where long-term coastal erosion strategies involve retreat or voluntary purchase, or where the costs of protective works and their likely effects on the environment exceed that of the development at risk.
- *Building relocation*—this is the preferred option for all relocatable structures, and may also be possible for timber structures with raised footings.
- *Sand dumping*—this option involves the addition of beach or dune sand to eroding areas. During an emergency, sand nourishment could be achieved through the dumping or placement of trucked material. This option is likely to be viable only if erosion problems are localised, nearby sand sources can be obtained and the problem areas accessed.
- *Beach scraping*—this option involves shifting sand from the lower to the upper part of the beach face or dune to provide a storm erosion buffer. This would usually be undertaken with a bulldozer at low tide, but may be difficult to undertake during the height of an erosion event. Its benefits may be limited since it does not generally involve the addition of sand from outside of the beach system. However, it may provide minor benefits that are sufficient to avoid property damage. If only part of a beach is treated, the benefit may be at the expense of untreated areas. Where sediment transport processes are dominated by longshore drift, scraping may effectively 'borrow' sand from the littoral system, thereby increasing local dune storage levels and lowering the risk to property. However, this is likely to increase down drift recession rates.
- *Geotextile or sand bag structures*—this option involves protection structures constructed from large, sand-filled geotextile containers. These are generally constructed parallel to the shore as seawalls, and can be built from layers of sand-filled geotextile bags or from longer 'geotubes'. Coastal engineering advice should be sought regarding their design and construction, as well as their potential impacts on beaches and adjacent areas. Construction of these structures is very problematic during the height of a storm event. Impacts of these structures on beach amenity should be mitigated following the event through removal or other action.
- *Rock structures*—seawalls, revetments and other structures can be constructed to limit erosion during storms. Varying rock sizes can be used, although larger material is likely to be more stable and less likely to be transported elsewhere on the beach assisting subsequent removal. Coastal engineering advice should be sought about the design and construction of seawalls as well as their potential impacts on beaches and adjacent areas. Rock structures should only be considered as a last resort and preferably only when incorporated as a future element of a long-term management strategy. Impacts of these structures on beach amenity should be mitigated following the event through removal or other action.

NOTE: Prior development approval may be required for physical works options for emergency management in the coastal zone, including those examples listed above.

APPENDIX B

COPY OF MANLY COUNCIL 'DRAFT EMERGENCY RESPONSE TO ROCK EXPOSURE ACTION PLAN'

Draft Emergency Response to Rock Exposure Action Plan
Council Staff Responsibility Matrix

Discovery
- Identification of rocks on Manly Ocean Beach by Council staff.

Council Groups Responsible for observing are:
- Waste and Cleansing staff
- Beach Inspectors
- Works staff

▼WHEN ROCKS ARE DISCOVERED

Contact Works Overseer (C&M)
- **In business hours on Tel: 9976 6820 or 0418 608 494**
- **24 hour Emergency Number: 0408 212 325**

▼OVERSEER DETERMINES CLASIFICTION AS FOLLOWS

Category Classification
- Category 1 – Minor Small Rock Exposure;
- Category 2 – Medium Rock Exposure, Suitable Tide;
- Category 3 – Medium Rock Exposure, Unsuitable Tide; and
- Category 4 – Full Exposure

▼ACTIONS REQUIRED FOR EACH CATEGORY, SEE BELOW

	CATEGORY IDENTIFICATION	A STAFF SUPERVISION RESPONSE	B ACTION	C REPORTING
CATEGORY 1	1. **Are there small rocks exposed that are capable of being handled manually?** **Yes - Category 1 Identified Go to 1A** **No - Go to 2**	1. Works Overseer (C&M) – **Implements 1B** 2. Works overseer to notify Environmental Planner at the first opportunity during business hours. 3. Environmental Planner - **Implements 1C**	1. Council staff to remove rocks immediately by manual means. 2. Digital photos taken of exposed rocks and location 3. Photos forwarded to Environmental Planner for reporting.	1. As judged appropriate notify: • Director SPC • Group Manager (C&M) • General Manager • Director SDB • Mayor • DLWC 2. Record on appropriate Council file 3. Record opposite house number
CATEGORY 2	1. **Are there medium rocks exposed (not main rock blanket matrix), that require mechanical assistance to remove and a suitable tide?** **Yes - Category 2 Identified Go to 2A** **No - Go to 3**	1. Works Overseer (C&M) – **Implements 2B** 2. Works overseer to notify Environmental Planner at the first opportunity during business hours. 3. Environmental Planner - **Implements 2C**	1. Council staff to secure area with star pickets and tape. 2. Council to remove rocks using mechanical equipment 3. Photos forwarded to Environmental Planner for reporting.	1. As judged appropriate notify: • Director SPC • Group Manager (C&M) • General Manager • Director SDB • Mayor • DLWC 2. Record on appropriate Council file 3. Record opposite house number
CATEGORY 3	1. **Are there medium rocks exposed (not main rock blanket matrix), that require mechanical assistance to remove and is the tide unsuitable?** **Yes - Category 3 Identified Go to 3A** **No - Go to 4**	1. Works Overseer (C&M) – **Implements 3B** 2. Works overseer (C&M) contact SES if property is in danger. 3. Environmental Planner - **Implements 3C**	1. Council staff to secure exposed rock area with star pickets and barrier tape (as appropriate) and erect "Rocks Exposed" signs. 2. Advise Beach Inspectors to place appropriate signage. Council staff to close beach if increasing numbers of rocks are exposed. Close beach at entrances with barrier tape and erect "Closed Beach" signs 3. Photos forwarded to Environmental Planner for reporting.	1. Emergency meeting with Director SPC 2. As judged appropriate notify: • Director SPC • Group Manager (C&M) • General Manager • Director SDB • Mayor • DLWC • SES 3. Organise emergency meeting to discuss appropriate strategy 4. Record on appropriate Council file
CATEGORY 3	1. **Is there any exposure of the Rock Blanket Matrix?** **Yes - Category 4 Identified Go to 4A**	1. Works Overseer (C&M) – **Implements 4B** 2. Works overseer (C&M) contact SES if property is in danger. 3. Works overseer to notify Environmental Planner 4. Environmental Planner - **Implements 4C**	1. Council staff to close beach 2. Council staff to secure entrances with barrier tape (as appropriate) and erect "Closed Beach" signs 3. Advise Beach Inspectors to place appropriate signage. 4. Photos forwarded to Environmental Planner for reporting.	1. Emergency meeting with Director SPC 2. As judged appropriate notify: • Director SPC • Group Manager (C&M) • General Manager • Director SDB • Mayor • DLWC • SES 3. Organise emergency meeting to discuss appropriate strategy and coordinate with Local Emergency Management Officer (this will included multi agency response ie, police, fire brigade) 4. Record on appropriate Council file

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Melinda Ierace	0409 003 3696
Director Service Planning & Deliverables	
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Director CP&S	
Anthony Hewton	0417 417 696
	9976 1568

APPENDIX C

COPY OF LETTER FROM SOIL FILTERS AUSTRALIA TO WARRINGAH COUNCIL DATED 17 FEBRUARY 2003

SOIL FILTERS AUSTRALIA PTY. LTD.
ACN 005 491 921 ABN 84 005 491 921
Telephone: (07) 5539 3600 Fax: (07) 5539 4027 Email: sales@soilfilters.com.au
31 Activity Crescent, Ernest Junction Industrial Estate, Queensland
PO Box 727, Southport, Queensland, 4215

283899.
Scot Hedge
Narr web Cttee
DA.001.017.
21 FEB 2003

RECEIVED
21 FEB 2003
MAIL ROOM

17 February 2003

Warringah Council
Civic Centre
Pittwater Road
Dee Why
2099

Attn: Mr S Hedge

RE: NARABEEN BEACH PROTECTION

Dear Scot

Please find attached the information pack as discussed.

I feel that our soft rock containers would be the ideal "middle ground" solution for the two opposing factions within the coastal council. The Soft Rock containers provide an aesthetically pleasing and user-friendly solution to the general public. They are also a sound engineering solution, which can provide peace of mind to the homeowners.

In terms of durability there are limitations in the life span of the containers depending on the exposure to sunlight and wave attack. If exposed to intermittent UV exposure and wave attack I would expect the containers to last up to 25 years. Containers manufactured from our standard Terrafix 1200R product have been exposed to direct sunlight and constant wave attack for 10 years. To date only 1 of the 50 containers has failed and the reason for failure could not be directly associated with UV degradation or wave attack.

Based on the discussion at the meeting with regards to placing the containers during high seas and the associated erosion event, I would prefer not to have our containers installed in this manner. The end result will be an unsightly and unstable structure, which will do little to enhance the reputation of Warringah Council or our Soft Rock containers. I believe the best solution to the problem should be to be proactive rather than reactive and to construct a properly designed and constructed geocontainer revetment, which in the medium to long term will satisfy both interested parties.

Brendan Donohoe of the Surfrider Foundation advocated the use of "bulk bags" as a possible solution to the problem and if no proactive works were to be carried out this may be the best temporary solution. However experience has shown that these types of works are seldom temporary and the council will be left with an ugly mess of randomly positioned containers littering the beach for many years to come. The photo's of some of the "temporary" revetments in Dubai constructed using bulk bags reinforces this concern.

I hope I have been able to assist you with your analysis of the possible solutions to your unique problem, if you have any queries or comments regarding any of the information supplied please do not hesitate to contact me.

Yours Faithfully

Warren Hornsey
Development Engineer Coastal & Marine

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APPENDIX D

EXTRACT FROM US ARMY CORPS OF ENGINEERS SHORE PROTECTION MANUAL (TABLE 7-8)

Table 7-8. Suggested K_D Values for use in determining armor unit weight[1].

No-Damage Criteria and Minor Overtopping							
Armor Units	n[3]	Placement	Structure Trunk		Structure Head		
			K_D[2]		K_D		Slope
			Breaking Wave	Nonbreaking Wave	Breaking Wave	Nonbreaking Wave	Cot θ
Quarrystone							
Smooth rounded	2	Random	*1.2*	2.4	*1.1*	1.9	1.5 to 3.0 [5]
Smooth rounded	>3	Random	*1.6*[4]	*3.2*	*1.4*[4]	*2.3*	[5]
Rough angular	1	Random [4]		*2.9*		*2.3*	[5]
Rough angular	2	Random	2.0	4.0	*1.9*	3.2	1.5
					1.6	2.8	2.0
					1.3	2.3	3.0
Rough angular	>3	Random	*2.2*	*4.5*	*2.1*	*4.2*	[5]
Rough angular	2	Special [6]	5.8	7.0	*5.3*	6.4	[5]
Parallelepiped[7]	2	Special [1]	7.0 - 20.0	*8.5 - 24.0*	--	--	
Tetrapod and Quadripod	2	Random	7.0	8.0	*5.0*	6.0	1.5
					4.5	5.5	2.0
					3.5	4.0	3.0
Tribar	2	Random	*9.0*	10.0	*8.3*	9.0	1.5
					7.8	8.5	2.0
					6.0	6.5	3.0
Dolos	2	Random	15.8[8]	31.8[8]	*8.0*	*16.0*	2.0[9]
					7.0	*14.0*	3.0
Modified cube	2	Random	*6.5*	7.5	-----	*5.0*	[5]
Hexapod	2	Random	*8.0*	9.5	*5.0*	*7.0*	[5]
Toskane	2	Random	*11.0*	22.0	--	--	[5]
Tribar	1	Uniform	12.0	15.0	*7.5*	*9.5*	[5]
Quarrystone (K_{RR}) Graded angular	-	Random	2.2	2.5	--	--	

[1] CAUTION: Those K_D values shown in *italics* are unsupported by test results and are only provided for preliminary design purposes.

[2] Applicable to slopes ranging from 1 on 1.5 to 1 on 5.

[3] n is the number of units comprising the thickness of the armor layer.

[4] The use of single layer of quarrystone armor units is not recommended for structures subject to breaking waves, and only under special conditions for structures subject to nonbreaking waves. When it is used, the stone should be carefully placed.

[5] Until more information is available on the variation of K_D value with slope, the use of K_D should be limited to slopes ranging from 1 on 1.5 to 1 on 3. Some armor units tested on a structure head indicate a K_D-slope dependence.

[6] Special placement with long axis of stone placed perpendicular to structure face.

[7] Parallelepiped-shaped stone: long slab-like stone with the long dimension about 3 times the shortest dimension (Markle and Davidson, 1979).

[8] Refers to no-damage criteria (<5 percent displacement, rocking, etc.); if no rocking (<2 percent) is desired, reduce K_D 50 percent (Zwamborn and Van Niekerk, 1982).

[9] Stability of dolosse on slopes steeper than 1 on 2 should be substantiated by site-specific model tests.