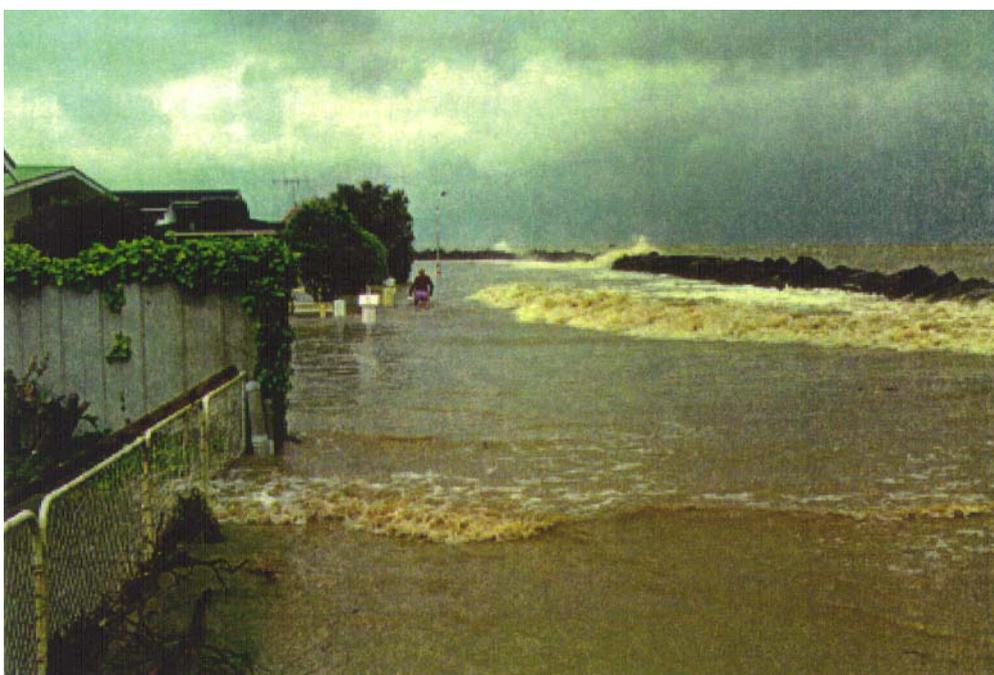


Coastal Flooding Risk Mitigation Strategy



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Executive Summary

Introduction

This report outlines the risk mitigation strategy for coastal flooding in the Waikato region. The strategy is based on the issue and assessment report on coastal flooding hazard presented to Council in February 1998.

Purpose of Strategy

The primary purpose of the strategy is to help promote a consistent, integrated and sustainable approach to the management of coastal flooding hazard in the Waikato Region in accordance with the proposed Regional Policy Statement (RPS).

Relevant Responsibilities for the Management of Coastal Flooding

In line with the proposed RPS, the strategy proposes a partnership with district councils, coastal communities and others for the management of coastal flooding hazard. The strategy adopts the division of responsibilities proposed in the RPS and the approved River Flooding Risk Mitigation Plan.

Proposed Strategy

The strategy proposes a focus on two key areas:

- development, implementation and monitoring of site specific risk mitigation strategies at identified priority sites; and
- improved information on coastal flooding design levels for priority areas.

Site Specific Risk Mitigation Strategies

The development and implementation of site specific mitigation strategies will incorporate hazard mapping and risk assessment, development and implementation of appropriate hazard management measures (including measures related to response and recovery) and appropriate monitoring and evaluation.

While the most effective management options will be assessed on a site by site basis, the strategies will emphasise measures that involve community adjustment to coastal flooding rather than the adjustment of flooding to communities. The protection and enhancement of natural protective systems, such as wetlands and dunes, will also be emphasised.

Existing structural measures will also continue to play a critical ongoing role in the mitigation of coastal flooding. However, new structural measures are unlikely to play a significant role.

As site specific strategies will emphasise mitigation of flooding risk by community adjustment, raising community awareness and preparedness will be critical to their effectiveness. Therefore, development and implementation of the strategies must emphasise community information and participation.

Priorities for Site Specific Action

The proposed priorities for action are:

- ensuring effective implementation and monitoring of existing flood risk mitigation strategies for high risk areas, particularly Thames and Moanatairi
- development, implementation and monitoring of risk mitigation strategies for remaining flood prone sites on a prioritised basis.

Priority sites for new strategies are the settlements of Tararu, Waikawau and Kaiaua. Other areas in need of management strategies include flood prone agricultural land on the Western margin of the Firth of Thames, other Firth of Thames settlements (particularly Te Puru, but possibly also Waiomu, Te Mata and/or Thornton's Bay), and Whitianga.

In the medium term, the management of residual risk in the low-lying areas protected by existing works will also need to be carefully assessed. This is particularly important in respect of the Hauraki Plains, where there appears to be the potential for catastrophic losses in the event of stop-bank over-topping or failure. However, improved information on the risk from over-topping and failure will be required before an effective analysis can be completed.

Improved Information on Risk and Vulnerability.

Improved information is required in regard to risk. The immediate priorities are:

- improved design flood levels for the Firth of Thames, particularly in relation to wave effects and better definition of the risk of extreme flooding events which could potentially over-top existing stop-banks;
- better understanding of the risk posed by distantly generated tsunami events, particularly along the East Coast.

Other information priorities relate to design flooding levels associated with coastal storms for Whitianga and Tairua, land and floor levels in flood prone communities and improvement of existing flood warning ability.

1 Introduction

This report outlines a risk mitigation strategy for coastal flooding in the Waikato region.

The strategy is based on the issue assessment report on coastal flooding hazard presented to Council in February 1998. This latter report is presently being expanded and revised and will be issued as a technical report of Council in April/May 1999.

The primary purpose of the strategy is to help promote a consistent and sustainable approach to the management of coastal flooding in the Waikato Region - in accordance with the purpose and principles of the Resource Management Act and the policies and objectives of the New Zealand Coastal Policy Statement (NZCPS) and the (proposed) Regional Policy Statement (RPS).

2 Structure of the Document

This document has the following structure:

- **Section 3** reviews coastal flooding hazard as a management issue in the Waikato region;
- **Section 4** summarises statutory considerations relevant to the management of coastal flooding hazard;
- **Section 5** reviews the various measures relevant to the management of coastal flooding hazard in the Waikato;
- **Section 6** outlines the proposed risk mitigation strategy.

A proposed implementation programme will also be developed once the risk mitigation strategy has been further discussed with relevant district councils.

3 The Management Issue

This section briefly reviews coastal flooding as a management issue in the Waikato Region based on the hazard report resented to Council in February 1998.

3.1 Causes of Coastal Flooding in the Waikato Region

The flooding of low-lying areas around the Waikato coast is a natural phenomenon and has occurred for centuries. Most coastal flooding around the Region occurs during major storms as a consequence of the combination of astronomical tides with storm surge and wave effects. However, there is also potential for coastal flooding related to tsunami events, though existing information on this risk is limited.

In some areas, human activities, particularly disruption of natural protective coastal features (e.g. dunes or wetlands) or the lowering of land as a consequence of drainage may also have aggravated coastal flooding hazard.

The potential impact of predicted, human-induced global warming might also aggravate existing coastal flooding hazard in the future. Particularly through an acceleration in the rate of rise of mean sea level and possible changes in the nature, frequency and magnitude of coastal storms.

3.2 Coastal Flooding Hazard around the Waikato Coast

Coastal flooding hazard problems in the Waikato Region generally occur as a result of human use and occupation of naturally flood-prone areas.

Most of these hazard problems relate to the flooding of coastal settlements and productive agricultural land. Disruption of infrastructure, particularly roads is also an issue in places. All significant coastal flooding events also have potential to threaten human life and safety.

Over the last 120 years, the most serious coastal flooding has been experienced in low-lying areas around the Firth of Thames, though some East Coast Coromandel settlements have also been affected. Significant coastal flooding has been limited along the West Coast, but has affected farmland in the Lower Waikato.

In recent decades, the most significantly affected coastal settlements have been Thames, Moanatairi (a suburb of Thames), Tararu, Te Puru, and Waikawau along the eastern margin of the Firth of Thames, Kaiaua on the western margin, and the eastern Coromandel settlements of Whitianga and Tairua. Other settlements that have also been affected to a lesser degree include Thornton's Bay, Waiomu and Te Mata along the eastern margin of the Firth of Thames. There are also other communities that have not been impacted in recent history but which could be particularly vulnerable in the event of over-topping or failure of existing stop-banks, especially low lying settlements of the Hauraki Plains (e.g. Turua and Ngatea).

The most significant flooding of pastoral land occurs around the margin of the Firth of Thames (particularly the lowlands along the western margin in the vicinity of Miranda) and the Aka Aka area of the Lower Waikato. The Hauraki Plains is the most low lying area and has been severely flooded in the past. However, this area is now largely protected by stop-banks, though still potentially vulnerable in the event of stop-bank over-topping or failure.

Infrastructure located close to the coast is also vulnerable in some areas. Particularly roads along the eastern and western margins of the Firth of Thames, which are closed by extreme events (typically events with an estimated annual probability of less than 5 percent). Erosion and debris during extreme coastal flooding events can also significantly damage the Thames Coast section of State Highway 25 along the eastern margin.

3.3 Magnitude and Frequency of Coastal Flooding Events

Existing information on the magnitude and frequency of coastal flooding events is limited and more detailed investigation is required.

However, available information (including newspaper and other reports of historical events) suggests that coastal flooding around the Firth of Thames is reasonably frequent, with events similar or more severe than the July 1995 and Cyclone Drena events appearing to have an annual probability of at least 3-5 percent. Damage during such events can be significant, with total damage estimates for each of the last two events (July 1995 and Cyclone Drena in January 1997) being of the order of \$4-5 million or more (including damage to settlements, agricultural land and roads). Further information is required to better define design-flooding levels around the Firth of Thames. However, the limited available information suggests that the protection standard currently adopted for Thames (3.5m above mean-sea-level, MSL) is sufficiently precautionary to meet the minimum flood protection standards (i.e. an event with an annual probability of 2 percent) required by the Building Code.

At Whitianga, the most severely affected settlement on the Coromandel East Coast, flooding is frequent - with the annual probability of flooding in excess of 10 percent. Most events close off the foreshore road at the southern end of the beach, but more severe events (probably events with an annual probability of up to 5 percent) can close the road in several places and result in flooding of houses. Information on design flood levels for eastern Coromandel settlements is still relatively limited and in need of further work.

4 Statutory Considerations

4.1 The Management Framework

The management of natural hazards, including coastal flooding, is primarily conducted within the framework of the Resource Management Act 1991. Other relevant statutes include the Building Act 1991, the Civil Defence Act 1983, the Local Government Act 1974 and the Soil Conservation and Rivers Control Act 1941.

The primacy of the RMA means that the avoidance or mitigation of coastal flooding hazard must be undertaken in a manner that is consistent with the purpose and principles of the Act and with the policies and objectives of subsidiary documents, including the New Zealand Coastal Policy Statement (NZCPS), the proposed Regional Policy Statement (RPS) and Regional Coastal Plan (RCP) and district plans (Figure 1).

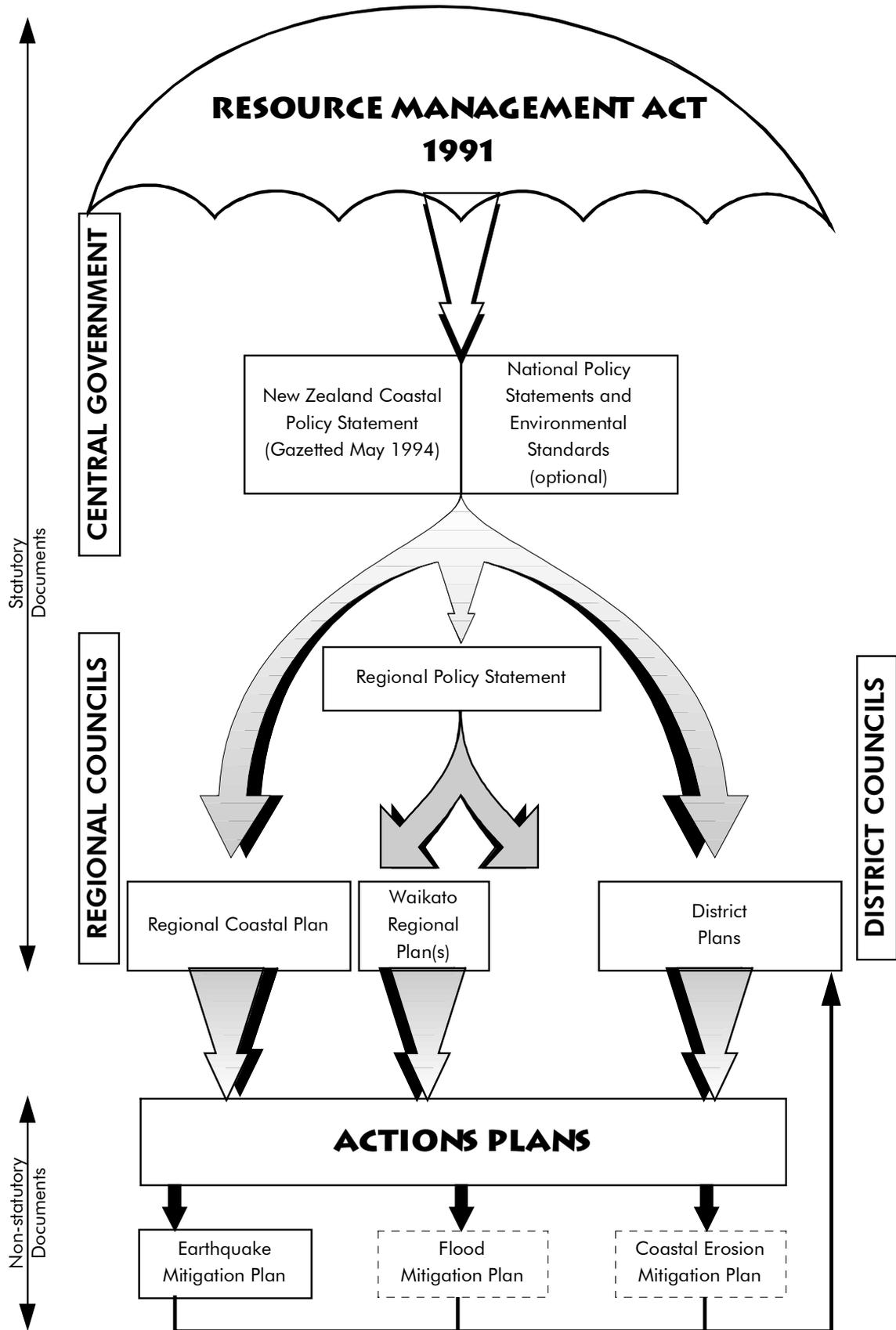
Therefore, environmental matters are now integral to the management of coastal flooding hazard. These environmental management objectives include the preservation of the natural character of the coast and the maintenance and enhancement of public access to and along the coast and amenity values (RMA, Part II, Sections 6a, 6d, and 7c).

The NZCPS establishes policies in order to promote sustainable management of the coastal environment. In regard to coastal hazards, the NZCPS directs that a precautionary approach should be adopted and reliance on coastal protection works avoided. Rather, emphasis is placed on the protection (and, where appropriate, the enhancement) of natural protective features of the coast (such as beaches, dunes and wetlands) and the location and design of new subdivision to avoid the need for hazard protection works. The NZCPS also directs that policies and plans should recognise the possibility of a rise in sea level and should identify areas, which as a consequence would be subject to erosion or inundation.

The major objectives of the proposed RPS in regard to hazard management are to:

- clearly identify the roles of all relevant agencies for the management of natural hazards in the Waikato Region and ensure these responsibilities are consistently implemented
- minimise the adverse effects associated with natural hazards, including threats to life and property, disruption of essential services and infrastructure and adverse environmental effects.

The Planning Framework



The major policy objective in the proposed RCP is the avoidance or mitigation of coastal hazard to people and property. In respect of this objective, the key policies relevant to coastal flooding hazard are:

- identify areas of coastal hazard and develop integrated risk management strategies for these areas
- adopt a precautionary approach in the assessment of coastal hazard and in the assessment of potential risks for coastal permit applications
- promote the protection of natural features that provide a buffer against natural hazards.

4.2 Statutory Responsibilities for the Management of Coastal Flooding Hazard

Under the Resource Management Act, the primary responsibility for the control of the use of land for the avoidance or mitigation of natural hazards rests with regional councils and territorial authorities.

However, the exact division of responsibility is not specified in the Act. Rather, Section 62 (1) of the Resource Management Act (RMA) requires regional policy statements to clarify the relevant responsibilities of regional and territorial authorities in relation to the control of the use of land for the avoidance or mitigation of natural hazards.

Section 3.8.3 of the proposed RPS (as per Variation 1, August 1998) proposes that territorial authorities have the primary responsibility for the control of the use of land for the avoidance or mitigation of natural hazards - including the development of objectives, policies and rules relating to this function. In regard to the coast, this responsibility applies to all land except the coastal marine area (CMA) - where Environment Waikato has primary responsibility (in conjunction with the Minister of Conservation). The management regime for the CMA is set out in the proposed RCP.

Although the RPS is not yet operative, the above divisions of responsibility have met with broad agreement and are unlikely to change. The respective responsibilities, landward and seaward of mean high water springs, emphasise the need for integration and consistency. Clearly, this is particularly important in respect to the management of coastal hazards.

The implementation methods for which Environment Waikato is responsible are directed towards ensuring an integrated and consistent framework for natural hazard management in the Region. Under the proposed RPS, Environment Waikato has primary responsibility for ensuring that objectives, policies and rules relating to the control of the use of land for the avoidance or mitigation of natural hazards are consistent between Councils. As part of ensuring an integrated and consistent framework for hazard management, Environment Waikato also has a lead role in the development of hazard specific mitigation plans and in collection, analysis, storage and communication of natural hazard information to territorial authorities.

Coastal territorial authorities also have responsibilities under the Building Act 1991, which contains specific provisions governing the issue of consents for the erection of buildings on "land .. subject to, or .. likely to be subject to, inundation ..". Under section 36(1) of the Act, a territorial authority is required to refuse to grant a building consent for a new building or major alteration on such land - unless they are satisfied that adequate provision has or will be made to protect the land or building. Environment Waikato has similar responsibility for all structures in the CMA.

The Department of Conservation also has responsibilities relevant to the management of coastal flooding, including its role in monitoring the implementation of the New

Zealand Coastal Policy Statement (NZCPS) and in the consenting of Restricted Coastal Activities. Various public utility operators who provide essential services (e.g. communications, electricity, gas, transport) also have a key role to play in planning to minimise damage and disruption to these services due to coastal hazards.

5 Management of Coastal Flooding Hazard

This section briefly reviews the various measures available to minimise the adverse effects of coastal flooding hazard in the Waikato Region. This review is intended to help identify key elements for the risk mitigation strategy.

5.1 Mapping of Hazard Risk Areas

Good information on the nature and extent of hazard vulnerability is critical to effective management of coastal flooding hazard, including assessment of adverse effects and evaluation of alternative hazard management scenarios.

In the Waikato Region, definition of the risk from coastal flooding at any particular site generally requires information on the:

- magnitude and frequency of flooding associated with coastal storms (particularly the annual probability of various flooding levels associated with the combination of astronomical tides and both storm surge and wave effects);
- magnitude and frequency of potential tsunami events, including both locally-generated and distantly-generated events;
- potential effects likely to accompany predicted global warming (e.g. rise in mean sea-level, change in magnitude and frequency of coastal storms and associated storm surge and wave effects);
- land and building floor levels in low-lying flood-prone areas.

Available information on these factors is limited for the Waikato Region and further work is required to improve hazard assessment and management.

The highest priority work is to further improve design information in regard to coastal flooding in the Firth of Thames. Recent work has improved existing information in respect of design flooding levels arising from the combination of astronomical tides and storm surge. However, further information is required on the magnitude and frequency of wave effects (e.g. wave set-up and run-up) to improve design level estimates. Information on past coastal flooding events indicates that wave effects are generally a very significant element of coastal flooding in this area.

Ultimately, it is probable that some modelling will be required to develop design wave information for the Firth of Thames, though there is some doubt as to how well this work can be conducted using presently available models and the limited available data for model calibration. NIWA have recently initiated a FRST funded research project, which should improve the performance of predictive wave models over the next two to three years. In the interim, wave-monitoring work has been initiated at the Tararu tide gauge to gather wave data. NIWA are presently evaluating initial information from this monitoring to ensure that appropriate data is being collected for later analysis. Some additional wave data collection may also be necessary and will be discussed further with NIWA in the new financial year.

Better definition of the risk posed by tsunami events is also required. This is especially so in regard to distantly generated events along the East Coast where four moderate-sized events have occurred over the last 140 years. Historical reports suggest the

earliest and largest waves have generally been of 1.5-2.2 metres in height. Such waves could cause significant flooding in some areas (e.g. Whitianga) under certain tide and/or wave conditions. There is also the probability that larger distantly generated events do occur, though the frequency and magnitude of such events is not yet well known.

Locally generated tsunamis could also potentially occur along the coast of the region. Such events would cause significant localised flooding. It is not possible to provide useful design advice on this risk given the limited existing information, though they are probably very rare.

While the risk from tsunami events is probably of relatively low frequency, the magnitude and potential impacts of such flooding could be very significant - including a significant threat to human life and safety. Therefore, it is very desirable that further appropriate work be undertaken to better define tsunami risk. The highest priority work probably relates to distantly generated events, given the higher frequency of these events and the effective international monitoring and warning systems available. Any such work is probably best undertaken on an inter-regional basis and Council should work with other regions and with researchers to prioritise and advocate appropriate further work.

The potential for existing coastal flooding risk to be enhanced by sea-level rise must also be recognised in design information as a requirement of the NZCPS. At present, the best estimates are probably the various scenarios developed by the Inter-governmental Panel on Climate Change (IPCC). However, these are global averages and more regionally relevant information is ultimately desirable.

Some information on land levels is generally available for most key sites, though this is often limited in a real extent and/or accuracy. Improved information on land levels will generally be required for adequate assessment of coastal flooding risk and vulnerability at particular localities. In areas of existing development, it is also desirable to have information on the floor levels of existing dwellings. Land and floor level information is probably best gathered as part of the work associated with site-specific management strategies (discussed in section 6).

A related issue relevant to the management of coastal flooding around the Coromandel Peninsula is the lack of inter-related survey datums around this area - though Council has established approximate MSL datums at some sites (e.g. Waikawau and Mercury Bay, with a less certain datum also established at Te Puru). The lack of inter-related datums around the Peninsula makes it difficult to specify design flood levels for the various settlements. It also complicates the management and monitoring of coastal erosion along both coasts. Serious consideration needs to be given to establishing inter-related datums around the Coromandel Peninsula. A joint partnership with local district councils, Transit New Zealand and other parties may be required to facilitate this work.

5.2 Warning Systems

Early warning of coastal flooding events has the potential to significantly reduce losses associated with these events, particularly in regard to items that can be moved above flood risk levels. Warnings can also allow households to make better provision and preparation to cope with the disruption associated with flooding events. However, good communication of such information and community response are required to realise benefits from flood warning. These should be critical elements of site-specific management strategies.

The reliability of advance warnings is also a key issue.

Events with the potential to cause coastal flooding in the Waikato can generally be detected several hours before flooding. For instance, major coastal storms (the primary

cause of coastal flooding in the Waikato) can generally be detected and followed for several days prior to their impact on New Zealand, especially tropical cyclone events. Advance warnings of distantly generated tsunami are probably of the order of several hours. Little advance warning is likely of locally generated tsunamis, though retreat of tidal waters may occur 15-30 minutes before a wave arrives.

Therefore, for all coastal flooding events apart from locally generated tsunami, advance warning of *potential flooding* is likely to range from several hours to two to three days. This provides considerable potential for affected communities to take action to reduce losses. However, with these warnings there will inevitably be a considerable degree of uncertainty in relation to the magnitude and location of flooding. Unless subject to recent coastal flooding events, most people in flood risk areas presently take little action to prevent losses on the basis of such warnings. Little emphasis has also been given to encouraging community response.

By way of contrast, firm warnings of coastal flooding can generally only be given one to three hours before an event. In the case of coastal storms, such warnings are usually based on the judgement of experienced, local civil defence staff. More recently, Environment Waikato has also attempted to supplement this with specialist advice for areas around the Firth of Thames using information from the Thames tide gauge.

An advance warning of one to three hours generally allows sufficient time for establishment of a civil defence response and evacuation of threatened people, but provides very limited time for households and communities to take other action to reduce losses and disruption.

A prototype storm surge warning system, developed by NIWA, is being trialled at the Thames tide gauge site. If successful, this may provide improved warnings of future coastal flooding, especially events in which the storm surge component is significant. A tide gauge is also presently being installed at Whitianga with the longer-term aim of providing improved advice and warning for that area also. NIWA is also undertaking various research projects aimed at better predicting the passage of major storms.

In spite of these and other ongoing efforts, definitive warnings of coastal flooding are unlikely to improve significantly in the immediate future.

Therefore, in the immediate future, realising the potential of communities to reduce losses and disruption may require increased community response to early and less definitive warnings.

5.3 Structural Protection Works

These measures are used to mitigate flooding losses by modifying the natural flood event - essentially providing protection from floods up to a certain design standard (typically events with an annual probability of 1 percent or 2 percent - commonly referred to as the "100 year" or "50 year" events respectively).

Historically, mitigation of flooding in the Waikato Region has focused on structural works, particularly stop-banking and associating drainage and pumping facilities. The Region now has extensive flood protection schemes, primarily providing protection from river flooding. However, there are also extensive works providing protection from coastal flooding, most notably along the southern shoreline of the Firth of Thames to provide protection for the Hauraki Plains. Stop-banks in the lower, estuarine reaches of many rivers (e.g. Piako, Waihou and Waikato) also provide protection from both river and coastal flooding.

These flood protection schemes play a vital role in protecting existing communities, infrastructure and agricultural land from coastal flooding and are fundamental to the use and occupation of some low-lying areas, notably the Hauraki Plains. Council has a

firm ongoing commitment to the maintenance of these existing works and asset management plans have been prepared that outline operation and maintenance programmes.

However, many of the existing schemes were built with the aid of central government subsidies, which are no longer available. Moreover, the Local Government Amendment Act 1996 establishes a framework for identifying the beneficiaries of services and highlights a user-pays approach. i.e. It is now the responsibility of relevant communities to pay for new schemes from which they benefit. Therefore, given the considerable costs associated with the construction and maintenance of flood protection schemes, such works may play a lesser role in the management of remaining coastal flooding risk.

There can also be difficulty with using structural protection measures in many coastal situations because of the proximity of existing coastal development to the sea. In many situations there is inadequate land space between development and the sea for effective stop-banks. Moreover, these measures need to be set back from the shoreline to avoid the dynamic zone periodically subject to coastal erosion and that area which could be vulnerable in the event of future climate change. Otherwise the integrity of the works could be significantly threatened by future coastal erosion. Therefore, a reasonably wide coastal setback is generally required for effective stop-banks. While it is possible to build schemes further seaward by utilising reclamation and/or shoreline armouring works, these measures are expensive and also frequently have severe environmental effects that are not consistent with the requirements of the RMA 1991.

There can also be significant difficulties with structural measures where settlements are subject to both river and coastal flooding. For instance, at Te Puru on the Thames Coast embankments constructed in the 1970s to prevent coastal flooding were subsequently shown to impede land drainage and compound the effects of stream flooding, despite the provision of flapped outlets. Following Cyclone Drena in January 1997, a joint management agency and community committee also investigated the option of embankments along other low-lying areas of the Te Puru foreshore after inundation of a number of properties and some dwellings by sea-water. However, the option was rejected after investigations revealed that the low-lying areas were key drainage outlets for more frequent and serious stream flooding.

A more subtle and longer-term issue with the use of flood protection works is their potential to aggravate hazard losses by promoting inappropriate development within the “protected” area. Most protected areas are still at risk from stop-bank failure or over-topping by larger-than-design events. However, the sense of security fostered by stop-banks can lead to this residual risk being ignored by communities and decision-makers. This can result in inappropriate development being stimulated within the “protected” area, giving rise to the potential for increased (and in some areas, catastrophic) flood losses and damage in the event of stop-bank over-topping or failure.

Therefore, it is of critical importance to avoid treating protected areas as “risk-free”. Rather, structural protection should also be accompanied by other measures designed to minimise losses in the event of larger-than-design floods or stop-bank failure. A detailed assessment of the costs and benefits associated with different hazard management scenarios is required to identify the most appropriate measures. However, land use planning and management and the encouragement of community preparedness are likely to be important.

To ensure that areas protected by structural works are appropriately managed, considerable emphasis needs to be given to building community and decision-maker understanding that such “protected areas” are not “risk-free”.

Within the Waikato Region, this is of particular importance in regard to the Hauraki Plains. This is an extremely low-lying area, rising from about a metre above mean sea-level (MSL) at the coast to about three metres some 25 km inland. About 35,000 ha of

this fertile dairy farming area lie below the presently estimated design flooding level of RL 3.0 m in respect of MSL. The area also includes some significant-sized communities such as Ngatea, Waitakaruru and Turua. As such, there appears to be potential for catastrophic losses with severe stop-bank over-topping or failure. The risk of over-topping of the present stop-banks (built to a design level of 3.5 metres above MSL) is presently unknown due to inadequate information on extreme coastal flooding events in the Firth of Thames. Once adequate design information is available to assess residual hazard and vulnerability, appropriate hazard management measures will need to be developed to ensure that the adverse effects of any future flooding are minimised.

5.4 Community Adaptation and Adjustment

Essentially, this option covers those measures, which aim to avoid or reduce the adverse effects of coastal flooding by modifying human use and occupation of flood prone areas.

There are a wide range of measures, which can be used to modify human use and behaviour in flood risk areas, including:

- planning options
- insurance and other financial or economic instruments
- community information and participation.

As human use and occupation of flood prone areas is the direct cause of most coastal flooding hazard problems and associated losses in the Waikato Region, measures which modify human use and occupation are critically important in avoiding or reducing social, economic and environmental losses associated with hazard events.

Planning Options

There are a wide range of environmental planning measures which can be used to avoid or reduce losses associated with coastal flooding.

Essentially, these include measures designed to:

- **Avoid the location of subdivision and development in flood prone areas**, such as subdivision and development controls and set-backs. These measures are particularly appropriate for new development, but can also prove useful in areas of existing development. Avoiding development in hazard risk areas is clearly a fairly fail-safe option for reducing losses associated with hazard events.
- **Mitigate losses associated with development in flood prone areas**, typically development controls such as minimum floor levels, requirements for the use of suitable building materials and restrictions on development density and size. Other actions such as the lifting of existing development are also useful. These measures are particularly appropriate for reducing losses associated with existing use and occupation of flood hazard areas.
- **Remove development from flood prone areas**, using measures such as relocation or voluntary purchase. These measures will generally only be applicable in situations of serious risk or where there are wider community benefits but are likely to prove cost-effective in certain situations.

Effective use of such planning measures is central to any efficient and cost-effective management of coastal flooding hazard.

Under the division of responsibilities in the proposed RPS, district council planning documents have been identified as the most appropriate vehicle for land use and development management in flood prone areas. However, Environment Waikato

retains a responsibility to work constructively with district councils to ensure that appropriate measures are developed and implemented.

Insurance and other Economic and Financial Measures

These are essentially financial incentives and disincentives that can be used to promote changes in the pattern of human use and development in flood prone areas.

Insurance has traditionally provided a means by which the economic losses associated with use and occupation of flood-prone areas can be spread over both the wider community and time. It is a critically important tool to both individuals and communities in flood prone areas.

As insurance transfers rather than reduces flood losses, it does not directly decrease flood losses to the community or nation as a whole. As such, it is not a substitute for individual and community adjustments to reduce losses and should always be accompanied by such actions.

Historically, insurance has often sheltered individuals and communities from the true costs of use and occupation of flood prone areas - delaying appropriate adjustments. However, this is now less common. Ongoing changes in the insurance industry increasingly ensure that the availability and cost of cover reflects the risk to individual properties and communities. In such circumstances, the availability (or non-availability) and cost of insurance cover can provide a very strong economic incentive for appropriate community adjustments.

Other financial measures have also tended to move in this direction in recent years (e.g. loss of government subsidies for flood protection works, reductions in disaster relief, various legislative changes related to institution of a user/beneficiary pays regime). These changes increasingly ensure that the full costs associated with use and occupation of flood prone areas (including all social, economic and environmental losses) fall on the relevant parties.

These changes will generally provide strong economic incentive for appropriate adjustments. However, while these changes can send strong economic signals to affected communities, efficient and equitable adjustment will generally require some form of government co-ordination or facilitation. The changes to insurance and other financial and economic measures which have previously sheltered individuals and communities also adds urgency to the task of ensuring that individuals and communities are well informed of risk.

In some cases, financial support or incentives may also be appropriate to facilitate appropriate changes to the occupation and use of flood prone areas. In general, the use of such measures has been restricted in flood prone areas because of economic constraints and the lack of benefit to the wider community. However, along coastal margins there is potential for the use of such measures to have significant community benefit. For instance, voluntary purchase of flood-prone coastal lands can be used to enhance public access and amenity and to provide opportunities to enhance natural character and other coastal values.

Community Information and Participation

These measures aim to modify human use and occupation of flood prone areas by raising public awareness and preparedness through information and increased opportunity for meaningful community participation in hazard management.

Community awareness of the causes and effects of natural hazards is generally low, as is their preparedness for hazard events. Greater emphasis on raising community awareness and understanding is critical to appropriate changes in attitude and

behaviour. This is particularly so where hazard mitigation emphasises human adjustment and preparedness.

There is also considerable knowledge and ability in local communities that can be drawn on to improve hazard management and response. Local civil defence teams already make considerable use of the knowledge and abilities in local communities in disaster response. However, as yet there is only limited use of these resources in hazard planning and preparedness. The development, implementation and monitoring of site specific management strategies should give particular emphasis to community participation.

Changes in hazard management and disaster response are also placing greater emphasis on individual and community responsibility for mitigating hazard risk and covering losses. At present, there is still a high level of community expectation that government and insurance will “take care” of these matters. This is increasingly much less the case and can result in much community frustration and distress, particularly following disaster events. Emphasis on raising community awareness and participation is critical to help empower communities to adjust to their increased responsibilities.

Emphasis on greater community participation will also help government agencies adjust to such changes and to better define and develop their roles in the new partnerships that are evolving.

5.5 Protection Of Natural Buffer Zones

There is a wide range of natural buffer systems which provide effective and important protection from coastal flooding in the Waikato.

These include beaches and wetlands (particularly mangroves) which dissipate wave energy. For instance, the mangroves in the southern Firth of Thames provide very effective wave and erosion protection for stop-banks protecting the Hauraki Plains. Local farmers report that there was little to no wave action evident along the landward margins of the mangroves in Cyclone Drena - despite the significant northerly waves impacting directly on the seaward margin of the mangroves.

Coastal dunes and other natural elevated margins are also very important, providing a barrier protecting lower lying inland areas from flooding.

The protection and, where practical and appropriate, enhancement of natural buffer zones is fundamental to any effective management of coastal flooding hazard

5.6 Other

Other relevant activities, including the operation and maintenance of existing flood protection works and the management of emergency response and recovery are also critical elements of coastal hazard mitigation. However, strategies and plans for these activities are detailed in other Council documents.

6 Proposed Management Strategy

It is proposed that a strategy for the sustainable management of coastal flooding hazard should focus on:

- site specific risk mitigation strategies at priority sites; and
- improvement of design information for priority areas.

6.1 Site Specific Risk Mitigation Strategies

Site specific risk mitigation strategies should be developed for flood prone areas on a prioritised basis.

These strategies will need to incorporate:

- hazard mapping and risk assessment
- development and implementation of appropriate hazard mitigation measures (including measures related to response and recovery)
- appropriate monitoring and evaluation.

As envisaged in the proposed RPS and in the flood risk mitigation plan, Environment Waikato Policy series 1997/13 June 1997, a partnership is proposed for the development, implementation and monitoring of site specific strategies. Broad details of the relevant roles and responsibilities of Environment Waikato and district councils are as outlined in the RPS and the flood hazard mitigation strategy, with exact details of the partnerships to be resolved on a site by site basis. However, as noted further below, considerable emphasis should be given to community awareness and participation in the development and implementation of strategies for the mitigation of coastal flooding risk. This is critical to increase the preparedness of communities in flood prone areas and to empower them to accept greater responsibility for risk reduction.

Priorities for Action

The proposed priorities for action are:

- ensuring effective implementation and monitoring of existing flood risk mitigation strategies for high risk areas, particularly Thames and Moanatairi
- development, implementation and monitoring of risk mitigation strategies for remaining flood prone sites on a prioritised basis.

It is suggested that the highest priority sites for new strategies are the settlements of Tararu, Waikawau and Kaiaua. Other areas in need of management strategies include flood prone agricultural land on the Western margin of the Firth of Thames, other Firth of Thames settlements (particularly Te Puru, but possibly also Waiomu, Te Mata and/or Thornton's Bay) and Whitianga.

In the medium term, the management of residual risk in low-lying areas protected by existing works will also need to be carefully assessed. This is particularly important in respect of the Hauraki Plains, where there appears to be the potential for catastrophic losses in the event of stop-bank over-topping or failure. However, improved information on the risk from over-topping and failure will be required before an effective analysis can be completed. Preferably, the work on the Hauraki Plains should be conducted within the next 5 years and attention given to improving design information within this period. The evaluation should be undertaken on a partnership basis with the Hauraki district Council and place heavy emphasis on community participation.

Management Options

The most effective management options will best be assessed on a site by site basis.

However, the review of management options in section 5 suggests that site-specific strategies for the management of coastal flooding should emphasise measures that avoid or mitigate risk by:

- modifying community use and occupation of flood prone areas

- protecting and enhancing natural buffers such as beaches, wetlands and coastal dunes.

Existing structural measures will also continue to play a critical ongoing role in the mitigation of coastal flooding. However, new structural measures are unlikely to play a significant role at sites that are not presently protected, because of:

- costs associated with construction and maintenance of structural systems
- loss of government subsidies for such work
- constraints imposed by development patterns at many sites.

Even at sites where structural measures are used, effective management of residual risk will require the adoption of additional risk mitigation measures.

Therefore, in the future it is probable that mitigation of coastal flooding hazard in the Waikato Region will increasingly emphasise community adjustment to coastal flooding rather than the adjustment of flooding to communities.

The emphasis on community adjustment will require:

- appropriate information on risk and good communication to affected parties
- effective control of subdivision and development in flood prone areas
- effective warning systems linked to community response
- aware and prepared communities.

Focus on these elements will be critical both to the development and implementation of appropriate and cost-effective strategies. However, the emphasis on raising community awareness and preparedness and involving them in the development and implementation of management strategies is particularly critical to success. Especially given the increased emphasis on mitigation of flooding hazard by individual and community adjustment.

Once hazard management strategies have been developed, it is desirable that implementation of the strategies is effectively monitored and reported until complete. Annual reporting of progress is desirable. Ongoing monitoring and evaluation will also be critical to ensure the strategies remain relevant and effective.

As in other elements of the strategy, implementation and ongoing evaluation should emphasise community participation and responsibility.

6.2 Improved Information on Risk and Vulnerability.

The increasing focus on community adjustment in the mitigation of coastal flooding hazard will require improved information on risk and vulnerability and communication of that information to affected communities.

While most of these needs can be addressed at the level of site specific strategies, wider investigations will be required to better define design-flooding levels.

Design Flood Levels in Firth of Thames

The highest priority need relates to design flood events in the Firth of Thames. In particular, improved information on:

- design flooding levels associated with coastal storms; and,
- the risk from extreme coastal flooding events which could potentially over-top existing stop-bank protection.

Improved information on design flood levels associated with coastal storms will require focused work on the magnitude and frequency of wave effects. Design flood levels can then be developed by integrating this information with existing data on water levels arising from the combination of storm surge and astronomical tides.

Both areas of work noted above involve considerable complexities and careful, well-structured investigations will be required if appropriate information is to be obtained in a cost-effective manner. Some of the work, particularly in relation to extreme flooding events, may be able to be conducted as part of wider inter-regional work to reduce costs.

Risk Associated with Distantly Generated Tsunami

Improved information is also highly desirable in regard to distantly generated tsunami events. The limited available information suggests there may be reasonably frequent events (annual probability of 1-4 percent) capable of causing significant flooding of some Eastern Coromandel settlements (particularly Whitianga). While this information is of less immediate priority than design levels in the Firth of Thames, it is still a significant need given the frequency and magnitude of the historical events that have occurred and the possible vulnerability of Whitianga (and perhaps other sites).

Other information needs

Improved information on design levels associated with coastal storms is also required for the eastern Coromandel. This is particularly the case in respect of Whitianga where it appears that wave and storm surge effects may be amplified by local topography and where there is community vulnerability to coastal flooding. Improved information is also required for Tairua Estuary. A tide gauge is presently being installed at Whitianga as part of a longer term monitoring programme for this site and a further tide gauge is planned for installation at Tairua in the near future, subject to funding.

Improved information on land and floor levels is also required to better assess the vulnerability of settlements within flood prone areas, though this work is probably best undertaken as part of site specific strategies.

Improving present warning systems is also desirable though only minor advances in this area are anticipated in the immediate future. However, fundamental research on storm movement and wave generation presently being undertaken by NIWA does hold the potential to improve warnings in the medium to longer term. Council should maintain liaison with NIWA in regard to this issue and advocate appropriate work.

This document was approved for issue by Environment Waikato on (March 30, 1999). It is intended to review the document in 2003/2004. Note that the Civil Defence Act 1983 has now been replaced by the Civil Defence and Emergency Management Act 2002.