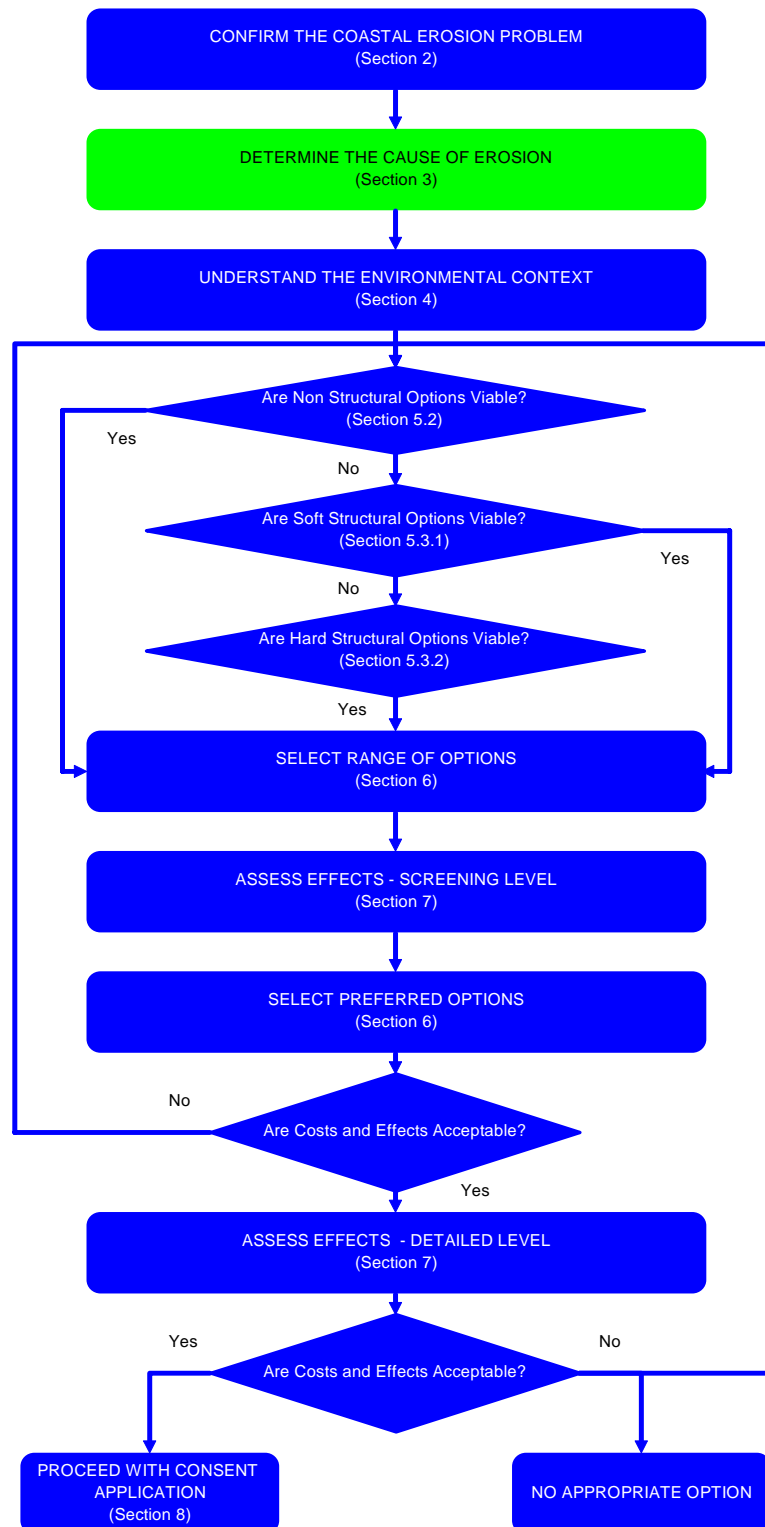


# COASTAL EROSION MANAGEMENT MANUAL



## SECTION 3 - DETERMINE THE CAUSE OF EROSION

EXPECTED OUTCOME OF THIS SECTION:

To identify the cause (or causes) of your coastal erosion problem.

# COASTAL EROSION MANAGEMENT MANUAL

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### 3. DETERMINE THE CAUSE OF COASTAL EROSION

Coastal erosion is often attributed to storm events, and in particular to those storm events when high wave energy, strong on-shore winds and heavy rainfall coincide with periods of high tide. The real cause of erosion however is often more difficult to ascertain, and usually requires the skilled interpretation of the processes and activities affecting the site. For instance changes in the position of the coastline might be associated to a reduction in sediment supply to a beach, the interaction of coastal processes with coastal structures, or the in-appropriate discharge of stormwater.

The correct identification of the cause of erosion is a prerequisite to determining the appropriate management response. In this section the typical range of coastal process information that may be required in order to satisfactorily identify and understand the cause of coastal erosion is outlined. The actual information gathered for any particular problem will depend on the site being considered. In many situations some or all of the information will be able to be obtained from existing data-bases. If it is not readily available either primary data collection and/or expert judgement will be required.

#### 3.1 DETERMINING THE CAUSE OF COASTAL EROSION

##### 3.1.1 UNDERSTAND THE COASTAL PROCESSES

*Refer Section C,  
Coastal Processes  
and Environment*

The key physical parameters that need to be understood when considering a coastal erosion management issue are:

- **Coastal Geomorphology** - including the geological environment, existing morphology and any historic processes (such as tectonic lifting) that have influenced the site. Geological setting and morphology will, in part, define the coastline type. Morphology is indicative of the coastal processes of the site.
- **Sediment Transport** - the supply of sediment and its movement to and from the site. It is important to distinguish between longshore, onshore and offshore sediment transport.
- **Wind** - the primary mechanism of wave generation. In some locations aeolian sediment transport is an important process.
- **Waves** - important in the formation of currents in the surf zone and subsequent sediment transport. Wave energy is an indication of erosion potential.
- **Currents** - influence sediment transport. Currents vary in strength and direction and include regional currents, tidal currents, discharge currents, rips, undertows, and longshore currents.

*Refer Section A,  
What To Look For  
On a Site*

- **Changes in Sea Level** - control the extent to which coastal processes will affect the coastline. Short term changes in sea level result from tides, wave set up, wind set up, changes in atmospheric pressure, and seasonal change in ocean and atmospheric circulation. Longer term changes are associated tectonic movement and climatic change.
- **Runoff and Groundwater** - influence sediment transport, slope stability and the percolation rate of beaches.
- **Vegetation** - trap and binds sediment and in some cases improves slope stability.

Information on coastal processes at a site can be obtained from:

- site inspections - noting particular features, e.g. erosion scarps, deposition of sediment at littoral barriers, and evaluating performance of any existing structures or natural controls (e.g. headlands) on the coastline;
- site specific data collection, e.g. measure and record wave height, period and direction;
- desktop studies; and
- existing studies (e.g. university research, resource consent applications).

Observations during site visits need to be put into context as they are only a snapshot in time and do not necessarily represent the long term average conditions. Therefore analysis and interpretation of historical and contemporary information is required. Depending on the quantity and quality of the data that can be gathered, the environmental context, and the scale of the problem, specific investigations may be required before progressing to the next stage of determining appropriate responses to the problem.

While coastal erosion is a natural process, i.e. the result of coastal processes and their interaction with land, it may be that the process is initiated and/or exacerbated by human activity. In the Auckland region there are numerous examples where human activities have contributed to or caused coastal erosion, e.g. at Omaha and Mission Bay beaches. In some cases the reversal of the human action may rectify the problem, with or without additional work, e.g. at Omaha and Mission Bay beaches. In others, the solution may not be so simple. Therefore when considering the cause of coastal erosion it needs to be determined whether human modifications and/or activities have altered processes, which in turn have altered the rate or scale of coastal change. In particular it needs to be determined whether actions have exacerbated coastal erosion or made coastal land more susceptible to erosion.

Typical human activities that can alter processes and exacerbate erosion include:

- **building site modification** - e.g. reclamation, dune removal, vegetation clearance, which change landform morphology and effect the source and stability of sediment;
- **construction of buildings** - may alter wind flow, obstruct sediment pathways, truncate beach sweep zone;
- **armouring of coastline** - e.g. seawalls, groynes, may alter sediment pathways, change the location and severity of erosion, reduce or prohibit the onshore-offshore exchange of sediment;
- **soft structural stabilisation** - e.g. beach nourishment, sand fencing, may alter the onshore-offshore exchange of sediment, and longshore sediment transport; and
- **channel dredging** - may alter channel hydrodynamics and sediment transport.

### 3.1.2 METHODOLOGY

*Refer Section C.3.4, Sediment Budget*

The 'sediment budget' approach is a useful process for identifying the type and magnitude of changes taking place on a coast. This approach entails identifying all sediment sources, sinks, inputs and outputs to a defined area and determining where the imbalance occurs (e.g. increased sediment output, decrease in sediment volume at a source). Ideally, each of the variables are quantified to an extent where the imbalance can be specified, but this is not always possible. The thought process involved, however, will always be a valuable exercise.

## 3.2 DIFFICULTY DETERMINING THE CAUSES OF COASTAL EROSION

It may be difficult to establish a predominant cause of erosion, nevertheless it is important to understand and to be able to substantiate the relative contribution of each variable to the erosion problem. If the cause of erosion cannot be identified it may not be appropriate to implement any form of coastal erosion management. In such cases it may be more appropriate to implement a monitoring programme or to undertake further investigations.

### 3.2.1 EROSION OF HARD COASTS

*Refer Section C.2.3, Hard Coasts*

All parts of a cliff are interrelated and must be taken into account when assessing the cause of the erosion. If the base of the cliff is eroding rapidly then it is a matter of time before the top retreats. By careful observation of the cliff, and comparison with other cliffs of similar structure and orientation in the vicinity, some conclusions about the major cause of the erosion may be reached.

Table 3.1 summarises typical causes of coastal erosion on Auckland's hard coasts.

Table 3.1 Causes of Hard Coast Erosion	
NATURAL PROCESSES	HUMAN ACTIVITY

<p><b><u>Gradual Erosion</u></b></p> <p>Weathering (wetting and drying)</p> <p>Bioerosion (biological weakening of rock)</p> <p>Undermining due to wave action</p> <ul style="list-style-type: none"> <li>• hydraulic (e.g. pressure, shear)</li> <li>• mechanical (e.g. abrasion)</li> </ul>	<p>Attrition by stormwater discharged down cliff face (accelerated by increase in development and runoff)</p>
<p><b><u>Mass Movement</u></b></p> <p>Increased groundwater levels after storm events</p> <p>Overloading by added fill mass or large trees</p> <p>Block failure due to seaward dipping bedding layers</p> <p>Slumping of upper soil layers</p> <p>Loss of vegetation which was serving a retaining/stabilising function</p>	<p>Increased groundwater levels from irrigation, discharge of stormwater</p> <p>Loading of cliff top by development</p> <p>Removal of vegetation.</p>

**3.2.2 EROSION OF SEMI-HARD COASTS**

*Refer Section C.2.4, Semi-Hard Coasts*

Erosion of semi-hard coasts is largely similar to that of hard coasts. Table 3.2 summarises typical causes of coastal erosion on Auckland’s semi-hard coasts.

**3.2.3 EROSION OF SOFT COASTS**

*Refer Section C.2.5, Soft Coasts and Section C.3.4, Sediment Budget*

Changes in the position of the coastline along soft coasts occur in response to a variety of spatial and temporal processes, e.g. change in sediment supply, wave processes or sea level, over a range of time scales. Short-term fluctuations occur in response to changing wave regimes. For example, short-term fluctuations in beach volume in response to storm and swell regimes is generally a recognised process. By repetitively surveying the beach profile it is possible to define the envelope or sweep zone that encompasses the range of short-term positions the beach adopts (See Figure 3.1). Thus short-term erosion events that lie within the sweep zone do not represent long-term erosion of the beach.

Beach volumes can also fluctuate over much longer time scales (decades) in response to shifts in major controlling processes, such as changes in the supply of sediment to the coast, changes in sea-level, wave climate and the frequency of storms, causing lateral displacement of the entire sweep zone. Landward translation of the sweep zone is indicative of long-term erosion, whereas a seaward translation is indicative of accretion (See Figure 3.1).

Table 3.3 summarises typical causes of coastal erosion on Auckland’s soft coasts.

Table 3.2 Causes of Semi-Hard Coast Erosion	
NATURAL PROCESSES	HUMAN ACTIVITY
<p><b>Gradual Erosion</b></p> <p>Weathering (wetting and drying)</p> <p>Bioerosion (biological weakening of soil)</p> <p>Undermining due to wave action</p> <ul style="list-style-type: none"> <li>hydraulic (e.g. pressure, shear)</li> <li>mechanical (e.g. abrasion)</li> </ul> <p>Current action</p> <p>Loss of vegetation</p> <ul style="list-style-type: none"> <li>on banks</li> <li>in front of banks (e.g. mangroves)</li> </ul>	<p>Attrition by stormwater discharged over bank face (accelerated by increase in development and runoff)</p> <p>Loss of vegetation</p> <p>Loss of beach in front of bank</p> <p>Wearing through human use (e.g. access tracks)</p>
<p><b>Mass Movement</b></p> <p>Increased groundwater levels after storm events</p> <p>Overloading by added fill mass or large trees</p> <p>Bank slumping</p>	<p>Increased groundwater levels from irrigation, discharge of stormwater</p> <p>Loading of upper levels by development</p>

**Figure 3.1**  
Dynamics of Beach Profile Change

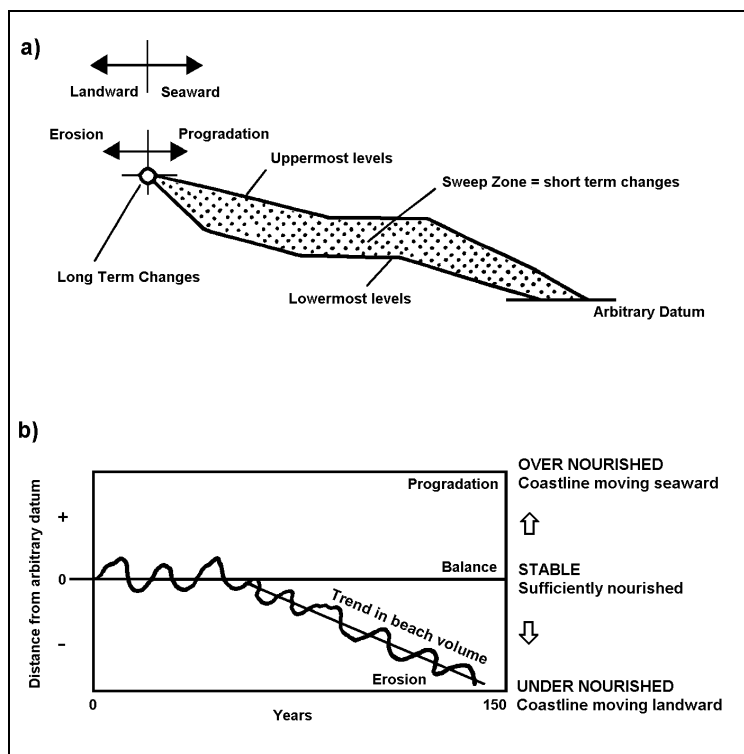


Table 3.3 Causes of Soft Coast Erosion	
NATURAL PROCESSES	HUMAN ACTIVITY
<p><u>Changed Environmental Conditions</u></p> <p>Longterm sea level change</p>	<p>Focusing of wave energy by diffraction/refraction (e.g. at offshore breakwaters)</p>
<p><u>Reduced Sediment Input</u></p> <p>Decrease in onshore sediment transport due to decrease in swell conditions</p> <p>Reduced sediment loads from river and stream sources</p> <p>Formation of updrift littoral barriers (e.g. through rock fall)</p>	<p>Sand extraction or dredging</p> <p>Reduced sediment loads from stormwater discharge sources</p> <p>Containment of updrift sediment sources (e.g. by seawalls)</p> <p>Formation of updrift littoral barriers (e.g. groynes)</p>
<p><u>Increased Sediment Output</u></p> <p>Increased longshore drift due to change in medium term wave climate</p> <p>Loss of downdrift headland</p> <p>Increased windborne sediment transport to backdune areas due to:</p> <ul style="list-style-type: none"> <li>• change in wind climate</li> <li>• loss of vegetation</li> </ul> <p>Increase in offshore sediment transport due to increase in sea conditions</p> <p>Saturation of beach</p>	<p>Scouring of beach due to stormwater discharge</p> <p>Reshaping dunes</p> <p>Structures in dune areas altering wind regime</p> <p>Increased windborne sediment transport to backdune areas due to loss of vegetation</p> <p>Use of exotic plant species</p> <p>Saturation of beach by stormwater discharge</p>