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LANDSCAPE IMPLICATIONS OF COASTAL AGGREGATE EXTRACTION
LANDSCAPE IMPLICATIONS OF

COASTAL AGGREGATE EXTRACTION

This study has been completed in partial fulfilment of the requirements for the Diploma in Landscape Architecture.

Lincoln College, Canterbury, New Zealand 1987

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1 INTRODUCTION
PART 1. INTRODUCTION

1.1 Coastal Aggregate Extraction

1.1.1 Preamble

New Zealand has more than 10,000 kilometres of coastline. A large proportion of this coastline is made up of sand and gravel beaches. Wave and wind action transport the sand and gravel along the coastline. This forms a dynamic interlocking system of the rivers that supply the sand and gravel and the beaches along which it is moved.

On this system human settlement has developed. In New Zealand most large urban populations are based in cities that have expanded around harbours and ports.

Certain raw materials, including aggregate (sand and gravel) for roads and concrete manufacture, are required to service these cities. In overseas countries the majority of this aggregate is supplied from shallow pits that are located near the source of demand. A large amount of research and practical application has gone into the restoration and rehabilitation of these pits when extraction ceases. New Zealand is however different in its extraction and restoration techniques.
The coastlines surrounding New Zealand cities have been mined as though they contain an endless supply of aggregate. As the cities have increased in size so have the requirements for aggregate. As most cities are coastal based ever increasing demands have been placed on the coastal aggregate resource. This has lead to landscape destruction and coastal erosion.

1.1.2 Objectives

The objectives of this study are to:
1. Outline the geomorphology, coastal environment, and cultural development of the New Zealand coastline.
2. Describe what aggregates are and how they are used. The relationship that aggregates have to city development and the landscape conflicts associated with their close connection. The planning used in overseas examples for the location and restoration of extraction sites.
3. Describe the development of the New Zealand aggregate industry and its relationship to coastal aggregate extraction.
4. Explain the different methods of coastal aggregate extraction, the landscape impacts, land use conflicts and restoration techniques used.
5. Review the planning legislation that covers aggregate extraction and coastlines in New Zealand and discuss possible changes.
6. Describe the coastal aggregate extraction operation at Fitzroy Bay, Wellington.

7. Produce Design guidelines for aggregate extraction on the coastline.
PART 2. THE COASTLINE

2.1 Coastal Geomorphology

2.1.1 What is the coastline?
The coastline is the interface between the sea and the land. It can be defined as "those areas adjoining land and sea water which are related physically, visually and through human activity" (MWD 1979).

Morton et al (1973) divided the coastline into three topographical zones.
1. The narrow "tidal" strip or foreshore where the sea edge moves twice a day.
2. The "backshore" strip of land where distinctive vegetation grows, soils form and river water flow. This strip of land is within the reach of salt spray, wind shear and saline estuarine and ground water. This may reach up to 1km inland (Healy, 1980).
3. The "coastal hinterland" which may carry back as far as the eye can run to the first considerable skyline.

2.1.2 What forms the Coastline?
A variety of geological processes work to form the coastal landform where the sea meets the land. New Zealand has a great diversity of coastal land forms. Only two types of coastal landform, those of actively glaciating and coral shores do not occur in New
Zealand (Kirk, 1978). The patterns and shapes of coastal landforms are generated by winds blowing over the sea surface and currents associated with the rise and fall of tides. Cliffs and rocky shores are shaped largely by erosional processes while beaches, spits and marshlands are formed by depositional processes.

2.1.3 Coastal Compartments
Sand and gravel beaches from systems that are interlocked by the persistent transport of sand and gravel sediment in the sea along the coastline. This is commonly called longshore drift. Longshore drift is caused by wave crests approaching the shore at an angle which moves the sediment along the coastline (Gibb, 1978).

Coastal compartments are formed by the systems of longshore drift that transport the sand and gravel sediment through wind and wave action along many kilometres of New Zealand's shoreline (Kirk, 1978).

The persistent southerly swell generated in the southern storm belt creates the regional pattern of net drift around all but the protected parts of the New Zealand coastline (Gibb, 1983). To study the dynamics of such systems one can not just look at the local features but must study the entire coastal compartment.

Sketch map of the direction of net longshore drift around the coastline of New Zealand. Source: Gibb (1983)
2.1.4 Sediment Budget (Kirk, 1978).

The transport of sediment by wind and wave action along and across the coastline focuses attention on the dynamic nature of the system. The amount of sediment or sediment budget is not stable as it moves along the coastline within its coastal compartment. The sediment budget comes from a variety of sources, some from breaking down of coastal rock outcrops others washed in by the sea and others brought down by rivers. The individual grains of sand and gravel sediment have only a finite existence or life span within the system.

2.1.5 Aggradation and Erosion (Kirk, 1978)

When more sediment is being transported and stored along the coastline than is being removed the coastline will advance or aggrade. Alternatively if more sediment is removed than is being transported along the coastline the shoreline will retreat and the beach will erode.

The coastline is therefore merely an expression of the state of balance or imbalance among the various natural and man made influences which affect the supply and removal of the sediment budget.
Erosion does occur naturally and a third of New Zealand's 10,000km of coastline may be eroding because of changes in sea level, climatic changes and the sediment quantities and types being delivered to the coast by the rivers and wave action.

The most important waves on the coastline are normally caused through storm action, reaching the shore either directly as storm waves, or if they have passed out of the area of wave generation, as swell. During heavy storms, waves are deep and extremely erosive (Gibb, 1983).

Apart from the eroding areas the remaining coastline is in a delicate state of stability neither eroding or advancing. It is in these areas that the siting of coastal developments and aggregate extraction can have a serious effect on the beach sediment budget and planning for these proposals needs to be rigorously exercised.

Even Wal Footrot farmer, person of the land and national folk hero can be surprised by the sudden changes that the sea has on the land.
2 THE NEW ZEALAND COASTLINE
2. The Coastal Environment

2.2.1 The Extreme Environment of sand and gravel coastlines

The coastal environment is one of the most extreme and exacting habitats in New Zealand. This environment supports a small group of highly specialized plants and animals (Courtney, 1984).

These species must resist desiccation by unchecked onshore winds, and withstand the burning effects of salt spray. On sandy beaches they must cope with large amounts of drifting sand and constantly struggle against burial and undermining. Plants and animals of sandy beaches must also tolerate the sands high temperature, high reflectivity, low nutrient status and low capacity to hold water. The plants nearest the coast must also cope with periodic inundation by seawater during spring tides and storm surges.

2.2.2 Coastal Zonation

On the sand and gravel beaches of New Zealand dune systems exist with a landward sequence of zones which run parallel to the coastline.

Sand and gravel are transported up the beach by wave action. When the sand dries the wind picks it up and carries it inland to form dunes. The sand dunes are
stabilized by vegetation and as the dunes build up a succession of vegetation zones arises.

The particle size of the sediment transported along the coastline defines the gradient of the foreshore zone. The profile of a sandy beach is low and gentle and is contrasted by the beach profile of a gravel or boulder beach which is steep and tiered.

The strand line just above high tide mark is the second zone and is characterised by washed up flotsam of driftwood and seaweed.

Behind this strandline active dune building occurs. A complex system of rear dunes can occur which may exceed 100 metres in height and extend 4 - 5 kilometres inland. These large dune complexes exist in North Auckland and Stewart Island (Courtney, 1985).

On these reardunes vegetation will stabilise and the sand may eventually form coastal forest like the South Westland podocarp forest, the Catlin forest at the mouth of the Tahakopa River and the Waipoua State kauri forest.

Many of New Zealand's sand dunes were formerly covered in native forest. Few native forested dunes remain today. The best remaining examples are the dunes of the Haast lowlands which are covered in Kahikatea, rimu and silver beech. Photo: Guy Salmon.
2.2.3 Vegetation of the Coastline

The foredune of the coastline is stabilised by the sand binding vegetation. The native sedge pingao (*Desmocheneous spiralis*) and spinifex (*Spinifex hirsutus*) were once the most common sand binders along the New Zealand coastline. But the introduction of the more aggressive and unpalatable European marram (*Ammophila arenaria*) for sand stabilization has transferred the vegetation and shape of New Zealand's dunelands.

These sand binding plants trap airborne sand amongst their spreading shoots and grow progressively upwards through the sand and eventually build up a dune.

The sand sedge *Carex pumila* also creates dunes but not as effectively as other sand binders and is found in the moist sand of the strand zone or in deflation hollows.

On the stabilised dunes smaller, scrambling cover plants and shrubs grow. The more fleshy scrambling cover plants grow on the foredune like the sand convolvulus (*Calystegia solanella*) and the yellow horned poppy (*Glaucium flavum*). Shrubs are restricted to the more stable rear dunes and are low growing, small leaved and wiry to cope with the extreme environment. The native sand coprosma (*Coprosma acerosa*), pohuehue
(Meuhlenbeckia complexa) and tauhinu (Cassihia leptophylla) must compete with the fast growing introduced tree lupin (Lupinus arboreus) and boxthorn (Lycium ferocissimum).

These rear dune plants are not sand binders but act to conserve and stabilise established dunes.

2.2.4 Animals of the coastline

The most diverse group of animals found on coastal dunes are insects and spiders. Many species live in the sand like the sand dune hopper and nocturnal sand scarab. While others live in and beneath driftwood of the strand line, like the katipo, centipede and earwig.

Moths and butterflies are common on the dunes and some species are restricted to the coastal environment. Spinifex, pingao, tauhinu and pohuehue are important food sources for the larvae of both moths and butterflies.

Like the vegetation of the sand dunes birds and animals also occupy specialized zones along the coastline. On the margins of the beach the New Zealand pipit is found hunting for insects and sandhoppers. In the dune swamps scattered throughout New Zealand the rare

Spinifex is a fine silvery plant that dots the coastline of the North Island and the northern part of the South Island. The female plant produces a crazy happy jumble of spiked flower heads that are blown about by the lightest of winds.

Photo: G.C. Kelly
fern bird can be found.

On Northland and Stewart Island in dune country, on spits and adjacent to river mouths the rare New Zealand dotteral is occasionally seen.

Birds play an important part in defining the coastal character in their noise and flying behaviour. On most coastlines in New Zealand seagulls can be seen and often in large numbers because of man's activities. As this boat comes in to Timaru Harbour flocks of seagulls fish for scraps. Source: Matthews (1983)
3. Cultural Development on the Coastline

2.3.1 Coastal colonization

Exploration of New Zealand by both Maori and pakeha was by sea. Early settlement for both cultures was chiefly coastal.

The Maori found abundant food along the tidal strip and shallow waters of New Zealand. Using the highly sacred institution of rahui tapu the Maori protected these coastal resources through the systematic imposition of prohibitions on the use of a resource. "Rahui tapu extended over the land and water areas that were contiguous to tribal land" (Williams, 1983). Areas where the tribe occupied, fished, gathered, cultivate and hunted were areas of tribal territory and seen as a communal asset that cemented the people with the land and sea.

In the early nineteenth century European culture arrived on New Zealand's coastline. This early phase of exploration was purely to exploit the rich resource of seals and whales found along New Zealand's coastlines.

The later stage of colonization was tied heavily to navigable ports and harbours of the Bay of Islands, Hokianga, Auckland, Manakau, Kaipara, Whangarei, Wellington, Lyttelton, and Port Chalmers.
"Early settlement avoided the high backbone and kept chiefly to coastal plains. The old trade routes were by sea, the beaches offering the only access to fertile pockets rimmed and overshadowed by the forest behind. The New Zealander consciously discovered his coasts only after he had long developed a sentiment for the bush. When forests had already been cut and pruned to provide grasslands, the shoreline came under a different form of exploitation." (Morton et al., 1973).

2.3.2 Coastal Conflicts

a. Introduced Animals and exotic conversion

When Europeans began to colonise New Zealand cattle and sheep were introduced and made to graze on the extensive coastal hinterland. Rabbits and hares were also introduced. The trampling and browsing of seedling sand binders by these animals has created extensive erosion of the sand dunes. In tidal flats stock graze native vegetation and pug the mud making them uninhabitable for coastal animals. "Because it is such a widespread practice, grazing may be the single worst offender in destroying natural estuarine systems" (Bellingham & Taylor, 1986).

To reduce erosion on sand dunes extensive planting of European marram grass has taken place, especially on the Manawatu and eastern South Island sand dunes. Once
the dunes have been stabilised by marram they can be converted into exotic pasture or pine plantation. The New Zealand forest service and private forestry companies have stabilised many hectares of natural sand dunes for pine plantation. "Most of the Ninety Mile Beach dunes, dunes from Kaipara Harbour to Muriwai, North Canterbury dunes and some of the Manawatu sand country have been stabilised and converted to exotics in this way" (Courtney, 1984).

Once established marram will spread vegetatively and by seed and has become the most widespread coastal plant in New Zealand. Marram is at a competitive advantage over pingao and successfully invades and supplants much of the original spinifix vegetation. Marram changes not only the vegetation of the sand dunes but the shape of the landform. Sand dunes covered with pingao and spinifix are lower and rounder than dunes covered with marram which are sharp and angular.

b. Residential and Recreational Development

The majority of New Zealanders live in urban areas located around the coast. The coastline has become the home, workplace and recreational resource of most New Zealanders. "Public access to unspoiled beaches and bays is taken for granted" (Healy, 1980). But each year more and more of this coastline is subdivided and

Man's handiwork is often out of keeping with its natural setting. These baches at Matauri Bay at least have the virtues of being unpretentious and having a limited life. The trend now is towards larger and even less appropriate structures, built of durable materials which may unfortunately last a century.

Source: Morton et al (1973)
built upon. From the ribbon development of fibrolite baches of the 1950s and 1960s to the present new coastal developments for the wealthy elite beaches have been bought and subdivided ... "in absence of any national planning guidelines on the best use and conservation of coastal land resources, new subdivisions were promoted by many counties in an effort to increase rating revenue" (Healy, 1980).

Many problems have arisen because of the speed by development and the complete failure of developers and localised authorities to consider the dangers of:

i. long term persistent erosion.

ii. occasional severe storm events

iii. migration and erosion of stream mouths as they cross a beach.

Such oversights have led to spectacular cases of erosion and resulting property loss. Omaha Beach with its subdivision and erosion problems is an obvious example.

Recreation use of the sand dunes with an increased population causes dune erosion. Horseriding, dune buggies and trail bike riding do cause dramatic dune disturbance to this fragile environment.
With such concentrated urban development along the coastline sewage and waste water disposal becomes a problem. The traditional and economically cheapest technique is straight discharge of sewage into the sea. This reduces the value and use of the coastal landscape and poses a considerable health hazard. Sections of urban coastline throughout New Zealand cannot be swum in or fished from because of sewage outfalls. It is a particular insult to the Maori people who find any discharge of human wastes into their fishing grounds a total contamination of that food source and this goes against the rights given to them under the Treaty of Waitangi.

Equally devastating to the coastal landscape is the unlawful reclamation and use of the coastline as a rubbish tip. "New Zealand's largest harbour the Kaipara has over 400 ha of illegal reclamation over the past five years" (Bellingham & Taylor, 1986). Worse still is that when formal application have been made in the past they have invariably been approved under the Harbours Act, 1950.

Rubbish tips have also been common around New Zealand's coastline. Some existing tips include Paihia in the Bay of Islands dumping rubbish at the head of an estuary, Whangarei City landfill operation on the harbour's shoreline and Devonport Borough for year has
progressively been reclaiming Ngataringa Bay with rubbish (Bellingham & Taylor, 1986).

c. Aggregate Extraction

With increased urban development the coastline is looked on as a resource where every possible useful material should be extracted. Extensive areas of New Zealand's coastline have been used or are still being used for the extraction of aggregate.

Although these operations may be small they are able to alter and in some cases destroy coastal systems over a relatively short period of time.

Kirk (1978) sees "the mining of sand and gravel for aggregate from both beaches and the adjacent shallow near shore zone is probably the most widespread and most damaging of man's effects on the beach sediment budget throughout New Zealand."

Aggregate extraction on the coastline is a poorly regulated activity with limited assessment of the coastline before operations are approved.

It is this coastal conflict that will be discussed in detail for the rest of the dissertation.
3 AGGREGATE EXTRACTION
PART 3 AGGREGATE EXTRACTION

3.1 Aggregate

3.1.1 What are Aggregates?

Aggregates are high volume granular materials used loose or bound together to provide bulk strength or protection (Blunden, 1975). Aggregates are the mixture of sand and gravel (essentially the same mineral differentiated only by size) or crushed rock that has a suitable chip size distribution and strength to be used for making the basic materials of concrete and providing the raw materials for roads. Aggregates must be hard, able to withstand shock or continuous pressure, resistant to weathering, and physically and chemically inert. In general aggregates are not reusable or renewable and cannot be replaced by manufactured substitutes.

3.1.2 The Aggregate Resource

Aggregates like any mineral resource, are not evenly distributed throughout a region or nation. They can be expensive to locate and map. Aggregates are fixed by geomorphological events of the past and present.

The cheapest aggregate to extract is sand and gravel which is ready granulated. Crushed rock aggregates involve heavier costs because of the further processing. Aggregates mainly undergo the simplest types of
processing. Sand and gravel are washed and screened to remove impurities such as clay or shell and to grade the aggregate into different sizes. These processes produce little weight loss or added value.

Aggregates tend to be worked as close as possible to the centres of demand as transportation accounts for the major cost of these low unit value minerals.
3.2 Aggregate Extraction and the City

3.2.1 The City Based Aggregate Industry

Aggregate demand is primarily centered on cities. The larger the city the greater the demand for aggregate. The aggregate industry is a key producer of raw materials for city development. Cities use their enormous amounts of aggregate in concrete and asphalt construction.

The most valuable aggregate deposits are those nearest to cities because of their high and major cost of transportation. The aggregate industry is region serving and contributes to the economic activity of the city.

Traditionally aggregates have been extracted from scattered, small to medium, individual owner operated, open cast workings located around cities. This surface mining activity leads to major landscape disturbances over a wide area of land. A study in Waterloo in southern Ontario identified aggregate extraction as the second largest user of land after agriculture in land beyond the city (Bryant et al, 1982).

In the United Kingdom, London's Green Belt has 2% of its area in worked or approved future aggregate extraction sites (Bryant et al, 1982). The importance of aggregate extraction sites on the city's countryside is
often underestimated because the sites tend to be scattered and localized in areas with other significant land use pressures.

In the United Kingdom over the last twenty years larger open pit mines with concentrated ownership have increased. Aggregate is now transported over longer distances. This has been in response to an increase in demand, exhaustion of accessible deposits, tightening of technical specifications and better means of transportation (Blunden, 1975; Spooner, 1981.)

3.2.2 Landscape conflicts
Landscape conflicts arise because of the destructive nature of open cast mining associated with aggregate extraction. Aggregates are generally worked less than 20 metres below ground and therefore need a large area of land for present and future requirements. This surface mining nature of aggregate extraction leads to landscape disturbance during and after its operation. The original landscape is destroyed and a new landscape replaces the one that once existed. Sites of present and past workings often cover a significant area of the city's countryside. The land used for extraction is often left derelict when extraction ceases.

Tougher quarry controls sought

by Suzanne Cowan

Excessive noise, dust and the general eyesore created by a nearby quarry operator has transformed a once quiet section of the Old West Coast Rd into an “abyssal” industrial area, say local residents.

The rural residential area is bordered by quarry zones, but it wasn’t until early June this year that the locals realised what it was like to live a quarry operation almost on their backyard. On Queen’s Birthday weekend Hobson Contractors Ltd began quarrying on a piece of land adjoining the Old West Coast Rd and Miners Rd intersection. The operation was started directly inside the entrance to the neighbouring properties. Walking to the chimes of noisy machinery and the dumping of rocks was only one frusrating side effect of the quarry operation. A nearby wind screen the neighbouring properties wererioted in that wind and noise levels reached their peak.

The quarry’s entrance way also creates a traffic hazard. According to compliance sheets the road remained open to transport due to the required manoeuvres on and off the property.

On requesting Hobson Contractors to reduce the operation in the eastern corner of the property (away from the houses) the residents were told the contractors had every right to do with the land as they pleased. Unwittingly they conducted their own investigations and revealed some disturbing facts.

The group of residents, (15 in total) discovered the setback for quarrying from the owner’s property was a mere 10 metres. They found no restrictions on noise and in their view the allowable hours for operation were nonexistent. Requirements for landscaping, planting and landscaping appeared to lack detail.

Amused by their apparent lack of rights they sought advice from a lawyer. He uncovered a section under the Paparua County Council’s Town and County Planning Act that dealt specifically with the problem. Section 77 states “Every person or persons doing any act or refrain from doing any act, shall keep objectionable elements in connection with certain uses of land in a manner that is objectionable... Objectionable elements included any smoke, smell, sound, dust or other annoyance or danger or disturbance of amenities, in relation to...”

To page 2
The land used for mining is under competition from other present and future land uses. Aggregate extraction becomes an exclusive use for the extraction site and the land adjoining the extraction site. This exclusive use will continue for the life of the operation and if restoration does not occur it will continue after the operation has ceased.

Extraction can only occur where the natural raw material of aggregate (sand, gravel and crushed rock) are found. The extraction site is normally near the main user of the aggregate because of the high cost of transport. In the majority of cases this places the aggregate industry on the urban fringe competing for land from expanding urban development and the countryside. This land is economically and culturally valued by the users of the urban and rural landscape.

The extraction of minerals places heavy social and economic costs on the surrounding community. The "benefits of extraction are reaped by the mine owners, and operators, and their shareholders, whilst the socio-economic and environmental costs of the operation are often broadly shared by the community at large. Local environmental and social issues might thus come way down the list of priorities in extraction." (Cloke and Park, 1985).
It is not only the extraction site that causes problems to the community surrounding the extraction site but the large and numerous trucks used to transport the material. The trucks can generate considerable complaints from the community for their noise during night and day, frequency, traffic hazards in residential areas and destruction of existing roads through extra traffic weight and frequency. These types of disturbance destroy the landscape values held by that community.

The environmental quality for the surrounding community is further reduced at the extraction site. The visible impact of aggregate extraction covers the open pit working waste tips, past workings and roading. It is also important to realise that the architecture of the processing plant can dominate the site with monocoloured stark shapes. The extraction site location is therefore important as it influences the character and extent of visual intrusion.

Some aggregate extraction has enhanced scenic attractiveness through increasing diversity of landscape appearance or through creating new landscape elements such as ponds and lakes. On the whole however the effects on scenery are normally negative, particularly where extraction sites intrude into formally 'natural' habitats and 'unspoiled' scenery (Cloke & Park, 1985).
Through aggregate extraction the possible landuses of an area can be destroyed. Good quality agriculture land is generally at a premium especially on the urban fringe. In these areas the potential for urban expansion to surround extraction sites is obvious.

Open cast sites can be restored but there is little realistic prospect of every site being reclaimed to its former use.

Even with aggregate extraction the processing will produce waste material. "Waste tips and spoil heaps generally reduce scenic attractiveness and they can add to the land take requirements of extraction operations" (Cloke & Park, 1985 pp.165).

Extraction operation can induce pollution of both air and water within and outside the site. Fine dust is produced and dispersed by most operations and communities in the line of the predominant wind direction will suffer. Aggregate processing requires washing and screening of the sand and gravel to remove impurities. After this process the water will often contain fine particles of sediment which without proper processing will work their way into the streams, rivers, lakes and sea of the area.

The advertising of the Owhiro Bay hard rock quarry is not beautified and shows the hungry giant the aggregate industry can be.
3.3 Forward Planning
3.3.1 Balancing Aggregates and the Landscape

To reduce the feeling that the industry is a 'robber economy' and somehow 'a sneaky business' a number of overseas studies have looked at the relationships between centres of demand and availability of suitable localised sources (Bryant et al. 1982).

Some of these studies have concentrated on the need to consider urban development with aggregate exploitation and other forms of landuse inside a properly managed regional framework which avoids unnecessary resource sterilisation and reduces long term environmental damage (Blunden, 1975).

Through a combination of multiple use and progressive rehabilitation it is often possible to restore workings to acceptable and valuable after use.

The need therefore is for local and national government intervention (through legislation and via planning systems) to ensure that such factors as social and environmental impacts are given attention in extraction based decisionmaking. "Overall the main need is to balance the national need for sources of minerals, energy etc., with a growing need to protect the environment ... at both national and local level" (Cloke & Park, 1985).
3.3.2 Location and Zoning of Aggregate Extraction

With competition for land on the urban fringe being extreme; forward planning of aggregate extraction must take into account the need to make wise decisions that do not unnecessarily constrain either present or future land use of a site. Aggregate extraction cannot be totally discounted as a land use because of its destructive nature. It may be operational for a limited life cycle or permitted only for a stated length of time making aggregate extraction a less destructive land use than other possibilities.

Urban expansion with building development covers many potential aggregate extraction sites. Past extraction sites however can be built upon if properly landscaped and zoned. "Careful and sensitive landscaping of the working areas both during and after use is thus a key necessity in planning mine and excavation sites so as to minimise effect on scenery" (Cloke & Park, 1985).

Planning Policy in the United Kingdom around London after the second world war allowed working of the more viable aggregate resources when the demand on land for rehousing and redevelopment due to the population increase was acute. So that underground aggregate resources could be worked buildings were restricted
to specific locations. Worked out extraction sites were restored to produce land suitable for residential and industrial development (Cloke & Park, 1985).

In the United States and Canada the planning policy of 'sequential land use' favours mining over other land uses. While mining is in progress this is the sole land use. When mining stops alternative and compatible land uses are sought. This policy favours extraction before land subdivision and development and is meant to balance the profits of mineral extraction against the social and environmental costs. It is however hard to establish social and environmental costs and this would appear to give mineral extraction the greatest advantage (Cloke & Park, 1985).

Landscapes are destroyed with open cast mining and a new landscape must replace the one that once existed. In many cases the environmental and social costs are too high and the only practical solution is total restriction of mineral extraction.

3.3.3 Restoration and Rehabilitation

After all the aggregate has been extracted or the operation has been stopped what happens to the site? So that the land is not worked and then left in a derelict condition aggregate extraction companies
should be working to a planned restoration or rehabili-
tation scheme.

Restoration returns the land to as near as possible its original condition. Restoration requires a detailed study of the site including topsoil, subsoil, topography, drainage, vegetation, visual quality, conservation and other site characteristics. "Restoration begins on the very first day a site is opened up, with the removal of the first cut of soil. If mistakes are made at this, or any later stage, then the success of restoration is put in jeopardy" (McRae, 1983).

Progressive rehabilitation returns the land to some alternative land use. Progressive rehabilitation is seen by McLellan (1985) as the "returning land speedily and effectively to some alternative, societally acceptable and productive land use."

In looking at restoration or rehabilitation it is important to look at the length of time any aggregate extraction operation is worked.

1. **Short Term workings** under ten years require a scheme worked out in advance with a planned after use (Turner 1987 & McRae 1983). Short term workings tend to be surface mining operations worked over a large area of land.
Turner (1987) has suggested three ways of controlling restoration and rehabilitation of these surface mining operations.

a. Operators deposit a bond or contribute to a restoration or rehabilitation fund. This however tends to encourage the idea that restoration or rehabilitation can be left till the mineral extraction has finished where in short term mineral extraction it must be integrated with the extraction progress. These bonds have been judged more useful with smaller operators who might go out of business rather than larger companies who have substantial resources and can, in theory, be forced to rehabilitate the land.

b. Setting up a system of technical control over the mineral extraction companies working practices which must be set up before a new operation can start. This type of control has been used extensively in the United Kingdom for surface mining practices (Turner, 1987). But these regulations are difficult to enforce and there is no technical problem in the restoration of sand and gravel workings for agriculture recreation or conservation. Restoration is not a technical problem but depends on the commitment by the company and the men working for
the company to restore the land (Street, 1986).

c. Phasing the issuing of extraction permits dependent upon successful restoration of earlier phases. This puts any regulatory authority in a better position as they can concentrate on undertaking an evaluation of land which has been restored.

2. Medium term workings between ten and forty years are more problematic as decisions on a planned after use may change dramatically over the period of mineral extraction.

Two different types of plan can be adopted:

a. 'Continuous restoration' where minerals are extracted and land immediately put back into pre-mining condition. This policy can use phased extraction permits and gives local communities a high degree of security against land dereliction and appears to solve after use problems.

b. 'Progressive Rehabilitation' implies that each phase of the rehabilitation work may take a long time and alternative land uses will be considered. Restoration of the land to its former use may not be feasible and may be short-sighted. Opportunities may arise with the movement of vast amounts of material to
adapt the land to new uses of housing, industry, water storage, recreation, conservation or a totally unanticipated function.

3. **Long Life Workings** over forty years are probably worked longer than the period of employment by the mining engineer or planner who are involved with a particular project. In overseas examples long life workings are quarries that are deep open pits that grow larger and deeper as they are worked. Progressive rehabilitation is rarely possible and it may be difficult to find an after use. With such operations a rehabilitation ethic is more appropriate. Haywood (1974) suggests that: "Respect for the land itself is apt to be a surer guide than popular clamour for 'instant' results. The land is permanent: even a hundred year operation is transitory in a historical sense, and a fleeting moment in geology".
4 AGGREGATE EXTRACTION THE

NEW ZEALAND EXAMPLE
4.1 The Aggregate Industry in New Zealand

4.1.1 Development of the Aggregate Industry in New Zealand

The aggregate industry in New Zealand developed with the establishment of European communities in the nineteenth century. The first aggregates were used to provide serviceable roads. There use was expanded to cater for the building industry which had advanced from timber or brick construction to cement.

The initial siting of aggregate pits and quarries was as close as possible to the source of demand. Naturally occurring aggregate in New Zealand's rivers and coastlines was found to be plentiful and far easier to extract than digging pits or hard rock quarries.

Sand and gravel was often extracted from the nearest beaches and rivers to the developing cities rather than putting plant, investment and scarce energy into manufacturing suitable aggregate from hard rock quarries that would have been nearer. In Auckland, shingle was transported from the beaches in the Coromandel Peninsula rather than hard rock quarries of basalt from Mount Eden and other volcanic cones (Grant, 1982).
4.1.2 Standards of Aggregate

As aggregates were used for a wider number of products standards were implemented for better performance of roading and building material. Many of these standards developed around coastal sand mining operations. In Auckland the standard became the sand dredged from Omaha at Pakiri Beaches and barged to Auckland (Grant, 1982).

Today the New Zealand Railways and National Roads Board set their own standards and the New Zealand Standards Institute co-ordinates users for building codes, local territorial activities and government projects.

Standard specifications can control abrasiveness, angularity, hardness, crushing strength and other features of the aggregate. These standards also set out details of how these properties will be tested.

4.1.3 Users of Aggregates

The main users of aggregates today are:

1. The New Zealand Railways Corporation (NZR). The NZR require large amounts of gravel for ballast, yarding and construction. The NZR specifications require a high standard of stone product which includes a certain amount of angularity to stop
the rock rolling away.

2. The National Roads Board (NRB) and Local Authority Roading.
The NRB and local authorities require roading aggregate for the subsurface and surface of roads and for construction projects like bridges.
A complex set of specifications relating to skid resistance, crushability, stability and other factors are required. The base course aggregates require a proportion of crushed stone in them to ensure stability under heavy traffic loadings and the sealing chips require at least 50% broken faces.

3. Concrete & construction projects.
Aggregates are used in high rise buildings, plastering and other surface decorations. The building industry requires rounded aggregates for concrete pumping machinery. This rounded aggregate can be found in rivers and along the coastline or after costly processing obtained from hard rock quarries.

4.1.4 The Cost of the Aggregate
The overall cost of aggregate is dependent on location, distance to the end produce use, mode of transport, cost of the licence and the source of the product.
These costs are as important to the user as the standard and suitability of the aggregate. In the Hawkes Bay, the preference for coastal extraction at Awatoto over Owhiro Bay Quarry is a hard rock quarry near Wellington that uses the sea to sort and clean the greywacke rock extracted from the coastal cliffs. Owhiro Bay Quarry would find their operation a lot more difficult and expensive if they were not allowed to use the sea as a natural sieve and laundry.
the Tukituki River is almost all due to transport cost. (NWASCO, 1986).

In other areas a higher price for aggregate is paid because of trouble meeting standards from a local source. A bigger transport cost must be paid to transport aggregate into the district. "Taranaki, which is distant from any source of greywacke, has trouble meeting specifications from local sources and so gravel users are prepared to pay a bigger transport cost." (NWASCO, 1986).
4.2 Aggregate Extraction from Rivers and Coastlines

4.2.1 The Natural Source

New Zealand's dynamic eroding landscape brings many tonnes of sand, gravel and boulders down its rivers. This material also forms part of the sediment budget that is transported around New Zealand's coastline. This geological fact has resulted in an easily tapped source of aggregate. It is far simpler to set up an aggregate extraction operation along a river or section of coast than digging a pit or quarry. Essentially an operation can set up in a section of river or coastline and wait for the aggregate to come to the extraction site. These "gravel supplies are often taken for granted. After all our rivers are full of the stuff - at least, they were." (NWASCO, 1986). Only with flooding and erosion problems have recent studies begun to look at the environmental consequences of aggregate extraction from rivers and coastlines.

It may be cheaper for short term financial gain to extract aggregate from rivers and coastlines rather than making surface pits and hard rock quarries. It is however far more expensive in the long term financially and environmentally to restore or rehabilitate eroding rivers and coastline than large, shallow holes in the land.
4.2.2 Rivers

Aggregate extraction from rivers occurs throughout New Zealand. The rivers that extraction occurs from are all different and have different materials and sediment loads. An excess of sand and shingle will enhance flooding and a deficiency will promote erosion of the river bed and banks and can damage man made structures such as bridges.

Aggregate extraction from rivers also has an impact on the coastline as the sediment budget of some coastal compartments relies heavily on river sediment.

4.2.3 Coastlines

Coastal aggregate extraction like river extraction occurs throughout New Zealand. Extraction occurs in harbours, offshore, on the foreshore and in sand dunes. Kirk (1978) believes that "coastal aggregate extraction is probably the most widespread and most damaging of man's effects on the beach sediment budget throughout New Zealand".

Coastal aggregate extraction occurs around all populated areas of New Zealand. The extraction of aggregate (sand and gravel), removes material from the sediment budget and increases the coastlines instability at the point of extraction and further downdrift (Kirk, 1978).
Coastal extraction occurs in many locations where erosion at the site and downdrift could cause landscape damage to natural and cultural environments.
4.3 Changes in the Aggregate Industry

4.3.1 Changes in Scale

As the demand for aggregate increased around the cities and major construction projects, the source of aggregate from rivers and coastlines becomes depleted. Extraction operations are closed down when over extraction causes river and coastal erosion.

Future aggregate in many areas can only come from land based pits and quarries or from aggrading rivers out of the region.

This will mean a change in the scale of present operations. In the United Kingdom over the last twenty years larger open pit mines have increased (Blunden, 1975; Spooner, 1981). This will also have to happen in New Zealand for the same reasons of increased demand, exhaustion of accessible sources, tightening of standard specifications and better means of transport.

A different set of environmental impacts will arise for land based sites that will be subject to statutory town and country planning controls.
4.3.2 Cost Increases

As the 'limitless' supply of aggregate from rivers and coastlines close to the users decreases, other sources must be used. At present aggregate is cheap to find and obtain. "It would appear that the gravel resource is very undervalued economically" (CALNIG, 1986). Any change in aggregate source will increase costs because

1. Transport distances lengthen as alternative replacement sources are used;
2. Land has to be bought for land based pits and quarries if river and coastal aggregate is no longer available;
3. New equipment has to be bought or old equipment adapted to land based extraction;
4. Greater processing will be required of land based aggregate.

As in overseas examples these increased costs will concentrate aggregate extraction ownership into larger companies with a reduction in the smaller operator.
5 LANDSCAPE IMPLICATIONS OF COASTAL AGGREGATE EXTRACTION
5.1 Coastal Aggregate Extraction

5.1.1 Management of Coastal Extraction

When sand is extracted from the coastline a number of damaging effects occur to the sediment budget. It is essential that the sediment reserve extracted is renewable and the rate of sediment supply is established or unforeseen changes will occur.

Coastal systems are in dynamic equilibrium. "If sand is removed from one compartment, the system will attempt to readjust in order to attain a new equilibrium position." (Healy, 1980). This means at whatever point or place sand is extracted the system will respond by attempting to replenish it. If sand is extracted from the foreshore sand will be removed from the offshore bars and/or eroded from the frontal dune to compensate.

Four different types of coastal aggregate extraction occur around New Zealand. Each type of extraction presents particular resource management conflicts and requires formation of planning programmes that will limit landscape conflicts. Unfortunately the examples of coastal management in which the scientific factors were actually considered before development proceeded in New Zealand are rare (Healy, 1980).
5.1.2 Dredging within Habours

Harbours are in a state of close equilibrium having evolved to a certain depth, inlet size, formation and shape. The volume of sediment coming in with the flood tide and leaving on the ebb tide needs to be studied. Sediments should only be extracted where it would be lost to the harbour transport system at its ebb tide (Grant, 1982). Often however sediment is removed where a build up is not welcome in port facilities and around other human activities. This can lead to erosion of the harbours coastline.

So that erosion of the harbours coastline or adverse effects on the transfer of sediment within the harbour do not occur the harbour sediment budget and sediment movement need to be studied in detail. The sediment that is extracted from harbours comes from three possible sources (Grant, 1982).

1. Sediment being transported along the ocean shoreline and brought into the harbour entrance on the flood tide.
2. River sediment supplied from catchments feeding the harbour.
3. Erosion from the harbours shoreline.
Dredging within harbours effects fish and marine life at the proposed extraction site and over the entire harbour. It increases turbidity of the water and disturbs the harbour bottom. Prior to any granting of extraction rights careful consideration should be given to the fish and marine life of the harbour and the sediment budget.

5.1.3 Dredging Offshore

Removal of sand from the offshore zone of the coastline will cause similar effects of foreshore extraction. The impact of offshore dredging may take longer to show on the foreshore and backshore strip of the coastline than foreshore extraction.

To assess the ability of the coastline to sustain offshore dredging an understanding of the coastal compartment is necessary. The sediment budget, movement and build up of sediment along the coastline should be obtained before any offshore dredging is allowed.

The volume of material to be extracted and location of dredging should be set if extraction is allowed. Regular monitoring of the coastal compartments beach profiles should be required to assess the likely coastline changes caused by any offshore mineral extraction (Grant, 1982).
Dredging will effect the fish and marine life through turbidity and disruption of the ocean floor.

Overseas examples have shown a movement away from land based aggregate extraction as sources of the aggregates decline, to offshore extraction. Offshore dredging though limited in New Zealand at the present time shows signs of increasing. Because the effects of offshore dredging take longer to effect the coastline it can be a far more destructive form of coastal aggregate extraction if not properly planned and monitored.

5.1.4 Foreshore Extraction

Mineral extraction from the foreshore will result in an immediate impression on the coastline. The site of extraction and downdrift of the longshore drift in the coastal compartment will show a reduced amount of sand. Any extraction of sand and gravel will increase the instability of the coastline and accentuate the effects of any future erosion.

Extraction of aggregate from an actively eroding beach will accelerate that erosion. Extraction from a beach that is not being replenished and has an isolated sedimentary system will deplete the sediment and cause unrepairable erosion.
The volume of sand and gravel accumulating on the coastline and the interrelationship of sediment passing along the coastal compartment must be assessed to set limits of extraction if a stable coastal system is to be retained.

5.1.5 Sand Dune Pits

Sand is dried and picked up by the wind from the beach and carried inland to form sand dunes. The direction of sand movement within the sand dunes can be away from or towards the coastline. The net movement of sand will depend on the exposure and the dominant wind direction.

Sand being blown further onshore and the progressively moved further landward can be extracted without affecting the sediment supply to the beach and coastal compartment. Sands being blown offshore from sand dunes however may be temporary storage areas for coastal compartments and sand extraction will reduce the overall sediment budget. Many sand dunes have minimal sand being built up on them or they are relict dunes of the past. These sand dunes will be destroyed and will not be able to reform if extraction takes place.
Once the stabilizing vegetation cover is removed from active or relict sand dunes sand removal by wind will increase. The orientation of the working face and pit management during extraction of aggregate can intensify this situation.

Although many aggregate mining operations in sand dunes are small they are able to modify and in some cases destroy dune systems over a very short period of time.
5.2 Landscape Impacts

5.2.1 Landform

Coastal aggregate extraction will automatically alter the landform. Anything that takes cubic metres of material away from a natural process will cause large holes to appear in the landscape.

While dredging within harbours and offshore may not have immediate impacts on the visible coastal landform modifications are bound to happen. These modifications could see a reduction of sand in the foreshore and backshore coastal strip.

The operation of extraction on foreshores and the backshore sand dunes requires trucks processing and loading equipment to be moving in an environment in a fine state of equilibrium. Roads form distinctive straight lines in a rounded landscape. Often the roads to and from the extraction site can be more devastating on the landform than the extraction site itself. Cutting through sand dunes and requiring constant maintenance roads are often left as permanent reminders that man was here. Once the road is in place future aggregate extraction can occur with little financial expenditure on roading.

Aggregate extraction removes the stabilizing vegetation from the sand dunes. The vegetation helps form
the rounded sand dunes. Without the vegetation the sand has nothing to bind to and is blown about by the wind.

The landform of an aggregate extraction site on sand dunes flattens the dunes and forms extraction hollows. The landform at Kaitorete Spit has only one area of flat sand, the area around the aggregate extraction site. The extraction operation is smoothing out the sand dunes. The removal of the native sand binding vegetation pingao is increasing the landform change. Currently a total of 11 hectares of pingao covered sand dunes have been removed (Peace, 1984). The effects of this sand removal are even more dramatic because the natural dune building process at the point of extraction is minimal.

5.2.2 Waste Tips

Most aggregate mining operations of the past and present have operated on coastlines with sand and gravel that required little processing. The processing that did occur would often occur away from the site.

In the future as aggregate supplies become scarce coastlines with a mixed aggregate size and usability will become commercially viable. This aggregate must be sorted on site to reduce transporting unusable or unprofitable aggregate.
Small rounded aggregate can be used and sold at a profit. Large rocks and boulders can not be transported at a profit to the user and are left after processing in waste tips.

These waste tips are mounded as high as possible to reduce the area that the rocks and boulders are covering. A derelict landscape results of large hills that vegetation can not grow on, and the wind can not blow away.

5.2.3. Coastal stabilization with Exotic Plants

To stabilize the sand dunes during and after aggregate mining exotic vegetation is often planted. The species used normally consist of European marram for primary stabilization and possible exotic pasture species or pine plantation for potential after uses.

Even in the few remaining areas of natural vegetation exotic species are preferred to stabilize sand dunes. The dunes around the aggregate mining operation at Kaitorete Spit have European marram growing on them from dune stabilization planting about twenty years ago (Peace, 1984). The sand dunes at Kaitorete Spit represent one of the largest natural remaining dune areas in New Zealand where the vegetation is still dominated by pingao and other rare native plants.
The exotic plants represent a threat to the native vegetation through competition. Once established exotic plants are hard to remove and will probably take over the native vegetation cover.

At present removal of exotic vegetation is limited to a few individuals weeding marram out of pampered pingao plants.

With the introduction of exotic plants the shape of the dunes changes from a smooth rounded form of pingao and spinifex dunes to a larger more angular dune of marram. This change has occurred throughout the majority of dunes in New Zealand.

5.2.4 Coastal Erosion

Coastal erosion is caused by natural and man induced changes which effect the supply and removal of sediment that travels along the coastline. The erosion of the coastline is an expression of inadequate sediment which results in the removal of sand from the foreshore. It is essential when approving aggregate mining operations that "the various sediment transfers will neither be impeded nor accelerated to levels which promote undesirable effects in the coastal land resource under consideration" (Kirk, 1978).
Coastal aggregate mining operations are allowed to proceed with inadequate information and monitoring which leads in a large number of cases to coastal erosion. Examples of erosion caused in part or wholly by aggregate mining can be found throughout New Zealand. Offshore dredging at the mouth of the Mangawhai Harbour is probably linked to erosion and destruction of sand dunes at Mangawhai Spit (Healy, 1980). Offshore dredging in the Bream Bay - Little Omaha Bay coastal compartment partly caused erosion of Omaha Beach (Schofield, 1975). Foreshore extraction fronting the Papamoa Domain in the Bay of Plenty has caused net sand dune recession of 20 metres over a 20 year period. Adjacent coastline in the Bay of Plenty has accreted by 20-40 metres (Healy, 1980). Sand extraction rate at this site exceeds at times the capability of the coastal compartment to replenish the sand naturally by longshort drift.

Coastal aggregate extraction near Timaru contributes significantly to coastal erosion where the sediment budget is already in deficit from other man induced changes (Kirk, 1979).
5.3 Land Use Conflicts

5.3.1 Recreation

The coastline throughout New Zealand is a valuable recreational resource. The demand for recreational use of the coastline increases around towns and cities. Sandy beaches are places where New Zealanders picnic, swim, fish, surf, sail and play. Aggregate is extracted from these very beaches. Around Auckland and Northland coastlines with high recreational pressures have ten coastal aggregate extraction operations (Grant, 1982).

Recreational opportunities are reduced when aggregate mining causes erosion downdrift and at the extraction site. The turbidity of the water caused by dredging reduces recreational fishing and makes swimming unpleasant.

Large machinery working on the coast spoils the atmosphere of a natural coastal wilderness. Many operations leave loading and permanent processing equipment on site when work is not taking place.

The landscape that is formed during aggregate extraction is not a suitable one for recreation. Large holes and steep working faces in sand dunes are dangerous traps for playing children. Erosion of offshore bars and the
foreshore produce difficult swimming conditions.

The roading of aggregate operations along the coastline can create easier access and increase the recreational disruption. Dune buggies and trail bikes, though some peoples preferred form of recreation, leave permanent scars on fragile coastlines.

Overall aggregate extraction on the coastline reduces the recreational land use of the coastal landscape.

5.3.2. Natural Environment

In 1896 New Zealand had over 10,000 hectares of natural duneland that covered an array of distinctive native environments (Courtney, 1984). Today these dunes have been reduced to a fraction of their former extent.

Many of the existing coastal aggregate extracting operations are found on the few remaining natural dune systems such as those on Kaitorete Spit, Lake Ellesmere and Kokota Spit bordering Northland's Parengarenga Harbour. Although many of these operations are small, they are able to modify and in some cases destroy these dune systems over a relatively short period" (Courtney, 1984).
The removal of sand and vegetation cover reduces the high natural values of these environments. These disturbed coastal environments are made more accessible to other human interference. Competitive introduced plants are able to colonise weakened native vegetation cover.

Nature conservation and aggregate extraction along the coastline would not appear to be compatible land uses.

5.3.3 Urban Development

Most aggregate extraction sites are situated near large urban populations. Future urban development can eventually surround existing workings or be developed on old extraction sites. Coastal aggregate extraction removes material from the coastal sediment budget and decreases the stability of the coastline at the extraction site and further downdrift. Aggregate extraction on the coastline occurs in localities now subject to urban development or where there is significant investment in other uses downdrift. "Many development proposals are made for locations which have a history of aggregate extraction so that considerable care is required in establishing the state of shoreline stability before proceeding" (Kirk, 1978).

Aggregate extraction offshore from Omaha Beach in part caused disastrous erosion problems to the surrounding
urban development. "Some nearby houses were threatened and a disillusioned property owner, wishing to rid himself of continuing erosion and subdivision problems advertised cynically in the 'Property For Sale' columns that 'every storm brings you closer to the beach'.

Healy, (1980).

Future developers should gather as much information as possible on shoreline profiles where past and present coastal aggregate extraction sites have been worked. For present developments threatened with coastal erosion caused in part or wholly by present aggregate extraction the only remedial measure is to stop the operation.
5.4 Rescue, Restoration and Rehabilitation

5.4.1 A Coastline Rescued

Unfortunately as previously mentioned the examples of coastal aggregate extraction in which scientific factors are considered before the development proceeds are rare in New Zealand. One example of a beach that was rescued before an extraction operation started exists at Mataora Beach. "Mataora Beach is geomorphically a pocket beach with high enclosing headlands to north and south located about 2km south of Whiritoa on the Coromandel east coast" (Healy, 1981b). Scientific data showed that the beach was a closed system and any substantial extraction of sand "would deplete the resource and cause erosion of the beach and additional environmental damage to the pohutukawas growing along the terrace" (Healy, 1981b). The application for extraction was declined because of the scientific argument.

5.4.2 Restoration and Rehabilitation

The examples of restoration and rehabilitation of mined lands in New Zealand are not easy to find "Rehabilitation of mined areas is not new in New Zealand. It is rare but not new" (Ward, 1981).

The Government policies of the past have resulted in rehabilitation differing from district to district and...
little happening. "In the past there was little emphasis on the way disturbed areas were treated during mining. In most situations the area was largely abandoned when the mining company moved out" (Mines Division, 1986).

The present trends towards restoration and rehabilitation have occurred through legislation and pressure groups. "Wide scale use of land restoration associated with mining is relatively recent. For although mining has been a long established land use in New Zealand it is only recently that the mining industry has been under a positive obligation to undertake land restoration" (N.Z. Mineral Exploration Association).

In the past most cases of rehabilitation have involved a 'tidy up' operation at the extraction site brought about by public pressure or the private conscience of the mining company. Up until the early 1980's there was no large scale operation undergoing 'progressive rehabilitation' (Ward, 1981).

Rehabilitation of the coastal landscape has happened with the New Zealand Steel and Waipipi Ironsand mining operation. Both companies extract titaniferous iron-sand concentrate for local use and for the steel mills of Japan and South Korea. These operations use
dredging equipment on sand dunes to extract the iron-sand.

The Waipipi Ironsand Ltd. mines on land used primarily for cattle grazing. The rehabilitation of this site involves pre-mining stripping and storage of topsoil with post-mining levelling and spreading of the topsoil. "The dune system has been replaced by a series of flat terraces which allow a more intensive fencing system and a greater range of farming options" (N.Z. Mineral Exploration Association).

The New Zealand Steel Mining Ltd. mines on bare coastal sand dunes near Lake Taharoa. "Restoration of the mined land is converting dune land into an economic forest unit as well as halting sand drift onto farmland and the local village. The former useless dune country will in a few years be able to support stock in among the growing trees" (N.Z. Mineral Exploration Association). While rehabilitation, the changing of the land use, is happening, restoration returning the land to its original condition is not.

In the eyes of the companies and the New Zealand Mineral Exploration Association dune country and the coastal system that these dunes are part of are "useless". Only with the full appreciation of the natural values of the coastal system will positive restoration and
rehabilitation be able to take place.

At present coastal aggregate extraction in New Zealand occurs on many natural and unspoilt coastlines. The restoration that should be taking place should involve careful replacement of what once existed there before extraction.

Coastal aggregate extraction can cause erosion at the extraction site and downdrift. The financial and environmental cost of restoring the coastline after an erosional event normally falls on the community rather than the extraction company which is partly or wholly responsible. Restoration of coastal aggregate extraction must take into account erosion at the site of extraction and downdrift in the coastal compartment.

Waipipi Sand Dredge at Waverly has mined over 650 hectares of coastline over a 11 year period. The majority of this land has been 'rehabilitated' into farmland. The land may now be marginally productive but the former landscape has been totally destroyed.

Photo: NZ Mineral Exploration Association
6 LEGISLATION AND PLANNING FOR AGGREGATES AND THE COASTLINE IN NEW ZEALAND
6.1 Mineral Extraction

6.1.1 Who owns the Minerals

A mineral is defined in the Mining Act 1971 as any mineral, mineral substance, or metal; and includes precious metals, precious stones, clay, stone, gravel and limestone.

The ownership of minerals on or under a piece of land is generally fixed when a formal title is issued by the Crown. The ownership is determined by whatever legislation is (or was) in place at the time the land was alienated. The Crown however owns all gold and silver.

All modern titles reserve mineral ownership to the Crown. These 'Crown owned' minerals are subject to provisions in the Land Act 1948, the Mining Act 1971, and various other Acts.

Many older titles are not subject to these Acts as the legislation was in place at the time when the title was formally issued. In these older titles minerals, other than gold and silver belong to the landowner just like the land itself. These 'privately owned' minerals may be on a separate title or lease which can be owned and traded separately from the land title.

### AVENUES FOR PLANNING AND PARTICIPATION IN MINERAL EXTRACTION ACTIVITIES

<table>
<thead>
<tr>
<th>Mineral/Mining Ownership</th>
<th>Licence/Permit</th>
<th>Inquiry/Public Participation</th>
<th>Formal Planning Procedure</th>
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<tbody>
<tr>
<td>1. Crown Minerals</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>a. Mining Act</td>
<td>Exploration</td>
<td>Planning Tribunal</td>
<td>Not Required</td>
<td>Required</td>
</tr>
<tr>
<td>b. Aggregate</td>
<td>Various</td>
<td>Possibly in some cases</td>
<td>In some cases</td>
<td>Could be involved</td>
</tr>
<tr>
<td>c. Coal</td>
<td>Part III of Coal Mining Act</td>
<td>None</td>
<td>Possibly</td>
<td>Probably</td>
</tr>
<tr>
<td>2. Private Minerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Aggregate</td>
<td>Not Required</td>
<td>N.A.</td>
<td>Yes</td>
<td>Not required</td>
</tr>
<tr>
<td>b. Coal</td>
<td>Coal Proprietor District Court</td>
<td>Not Required</td>
<td></td>
<td></td>
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</table>

NB. Water rights for activities in all these instances would be subject to appropriate statutory procedures for public participation.

6.1.2 Planning and Public Participation

All minerals irrespective of ownership may be subject to regional and local government controls through district schemes and bylaws or permits and bylaws issued by catchment authorities. The Town and Country Planning Act, 1984 however, is not binding on licences issued under the Mining Act 1971 and the Coal Mines Act, 1979.

Crown owned minerals are subject to licences under the Mining Act or the Coal Mines Act, both of which are controlled by the Mines Division of the Ministry of Energy. These Acts are subject to Planning Tribunal enquiry if objections are received when mining licences are applied for. There are no formal planning procedures. Formal Environmental Impact procedures may be required for larger operations or those considered to have a significant environmental impact.

The extraction of Crown owned aggregate in or near rivers and the coast is licensed by other Government Departments and Catchment boards and are not subject to the Mining Act.

The Department of Conservation (DOC) issues licences under the Harbours Act 1950 regarding aggregate extraction from the foreshore, sea bed, harbour bed or bed of navigable rivers. DOC also licences under the
Conservation Act, 1987 extraction of sand and shingle from land under its management. Catchment Boards issue permits for aggregate extraction from rivers by a variety of means from delegation of authority under the Conservation Act, 1987 to shingle extraction by laws under the Soil Conservation and Rivers Control Act 1941.

These licences and permits do not involve formal planning procedures or public participation. Theoretically environmental impact procedures can be used but examples do not exist (Ward, 1986). Application for water rights which particularly concern extraction of aggregate from rivers does involve formal planning procedures and public participation.

Privately owned minerals are mainly aggregate and make up to half the mining activity of New Zealand (Ward, 1986). Privately owned aggregates require no Crown licence for prospecting or mining as they are not subject to the Mining Act 1971 or the Coal Mines Act, 1979. Privately owned aggregates are therefore not subject to Environmental Impact Procedures. The extraction of privately owned aggregate however is subject to formal planning procedures through the Town and Country Planning Act, 1984.
6.1.3 Town and Country Planning Act, 1977

The Town and Country Planning Act is designed to regulate land uses and promote a co-ordinated and efficient pattern of development. The Act gives territorial Local Authorities the responsibility to prepare regional, district and maritime planning schemes for the "wise use and management of the resources, and the direction and control of the development, of a region, district or area in such a way as will most effectively promote and safeguard the health, safety, convenience, and the economic, cultural, social and general welfare of the people, and the amenities, of every part of the region, district, or area".

This control of land uses also controls mineral resources and aggregate extraction especially the minerals that are privately owned.

The location, scale, character, density and distribution of mineral exploitation activities throughout rural and urban areas are achieved through Local Authorities' using zoning techniques. Zoning techniques arrange land uses or groups of land uses on a plan or map with a code of ordinances that detail control on the uses within each zone.

Mineral extraction in a district scheme can be generally zoned as:-
1. A permitted use. This allows mineral extraction to be undertaken as of right, providing it complies with controls specified in the scheme;

2. A conditional use. The extraction operation may be suitable but every site may not be appropriate and will be subject to conditions not necessarily specified in the scheme. A conditional use is often used in situations where the local authority is generally prepared to accept a use in a particular zone, but wishes to withhold an "as of right" consent because it is not considered that suitable development conditions can be drafted to provide for all possible situations;

3. Nonconforming Use. These are mineral extraction sites that do not conform with those specified in the zone. Nonconforming uses are generally created when the existing use of the property is not one which is going to be continued by zoning. The mineral extraction operation has only an 'existing use right' which allows the use to continue. Normally discontinuation for more than six months has been the major ground for abolishing the existing use rights and bring the land under the current zoning;

4. Specified Departure. This cover proposals for mineral extraction operations when they are not included in the permitted or conditional uses for that zone. Specified Departures must be applied for
as they are contrary to the district scheme. This allows local authorities the right to exclude mineral extraction from certain zones.

In the Wellington Region mineral extraction is excluded from urban, industrial, commercial, town belts, reserves and water catchment zones. Only on land zoned rural are mineral extraction operations allowed as a permitted or conditional use.

6.1.4 Regional Planning

No single local authority has all the aggregate it needs for roading and construction projects occurring naturally within its boundaries. Transportation planning and road standards are also important factors in the effective utilisation of aggregates.

Aggregate extraction is usually more than a regional concern as the transport and the user of the aggregate cross regional planning and catchment authority boundaries. The extraction, processing and distribution of aggregates becomes a regional and inter-regional industry. Aggregate mining in the past has seldom been systematic or planned in New Zealand. This must change in the future as it is essential now that regional planning schemes ensure the long term supply of mineral products with the least possible impact on the community and environment.
A number of regional planning studies of mineral resources have been undertaken to establish the distribution of mineral resources, extraction sites and transport to users. These have included the coastal sand and shingle resource of Auckland and Northland (Grant, 1982), the planning of mineral resources of the Wellington Region (Ward, 1978) and a recent report on river and coastal aggregate in the Central and lower North Island issued by CALNIG (1986).

These studies provide the necessary regional overview on which policy decisions can be made. From this point local authorities have guidelines to plan, draw up and implement zoning boundaries for or against mineral extraction.
6.2 The Coastline  
6.2.1 Coastal legislation

There are a large number of Government organisations and statutes involved in the management of the coastline. The majority of Acts either control specific activities or one particular resource. The result in many cases is an overlap of administration and jurisdiction (United Nations, 1979).

Legislation has established the Mean High Water Mark (MHWM) as the planning boundary that usually separates the sea from the land. The coastline is however a dynamic system of both sea and land within which this artificial boundary has little real meaning.

The unnatural splitting of sea and land management adds to the general confusion of present coastline management.

In New Zealand there is no national policy on coastline management. The many Government organisations that are involved in the management of the coastline often have conflicting policies it is often difficult to find out which agency is responsible for which management function. Even local authorities have revealed through questionnaires considerable confusion about statutorily defined boundaries on the coastline (Bellingham & Taylor, 1985).
Four principal Acts govern coastline management:
- Harbours Act 1950
- Town and Country Planning Act 1977
- Soil Conservation and Rivers Control Act, 1941

6.2.2 Mean High Water Mark

One of the problems leading to confusion are the legal boundaries. Many of these boundaries relate to the mean high water mark (MHWM) as defined in Section 35 of the Crown Grants Act (1908). The MHWM is interpreted as the 'mean of all high tides occurring in the ordinary course of nature throughout the year.' Seven natural markers have been used in the past to establish the MHWM. It is common for more than one of these marker lines to be used on different maps for the same section of coastline. Some of these markers bear no relationship to the long term changes of the coastline.

"The difference in apparent shoreline position between two maps made at different times of the year may simply reflect the run of weather in the weeks preceding the respective coastal surveys. The shoreline reference displayed on many maps and plans is thus probably not MHWM in the strict sense, and in any case it is an extremely ambiguous indicator of coastal change" (Kirk, 1983).
This boundary can also lead to development that may be
detrimental to the coastline because the development
is taking place on land legally owned by an individual
or developer. "There are many instances where it
(MHWM) is not an appropriate boundary for determining
what developments may safely take place on the coastal
land. For example, a residential subdivision on
privately owned land may be legally upheld by virtue
of the land status - even though it may be shown to
have a harmful impact on adjacent tidal and coastal
areas" (Gibb, 1978). This also applies to aggregate
extraction on privately owned land along the coastline.

6.2.3 The Harbours Act, 1950

The Harbours Act 1950 was administered by the Ministry
of Transport but the new Conservation Act 1987 gives
the Department of Conservation (DOC) the "responsibility
for managing activities on the foreshore, seabed, and
navigable river beds outside of commercial port areas,
from the mean high water mark to the 12 mile limit."
This includes the licensing of aggregate extraction in
this coastal zone.

The DOC has set up a Coastal and Marine Resource
Directorate responsible for managing coastal resources.
"It will promote an holistic, bicultural and inter-
agency approach to coastal zone management which
recognises the dynamic processes that constantly shape
our coastline and provide the spectrum of coastal and marine resources so highly valued by the community" (Gibb, 1987).

To carry out its licensing function of coastal aggregate extraction the DOC must recognise and weigh up a variety of viewpoints. "The fact that it has a mandate to take into account the sustained resources makes it unlikely that activities which impact negatively on the coast will be licensed" (Gibb, 1987).

6.2.4 Town and Country Planning Act 1977

The Town and Country Planning Act 1977 is the only Act that both covers the coastline and is not restricted to specific interests. The Town and Country Planning Act also selects the coastline as an area of national importance for "the preservation of the national character of the coastal environment and the margins of lakes and rivers and the protection of them from unnecessary subdivision and development". However, it separates planning functions of land into regional and local authorities and sea into maritime authorities.

Regional authorities have powers to plan for both land and coastal waters out to the twelve mile territorial limit. The regional authorities co-ordinate and plan the activities of their region. Operational regional planning schemes are binding on the Crown and every
local and public authority.

Local authorities plan at a district level for all land above MHWM. Many local authorities however plan for the coastline in their district under grants of control under other Acts (Bellingham & Taylor, 1986). These coastal areas within local authority districts include some substantial areas of coastline including the Bay of Islands, Hokianga Harbour, Tauranga Harbour and Doubtful Sound.

Maritime authorities are similar to local authorities except that they plan for designated areas below MHWM. Maritime authorities have presently only been established where extreme conflict is encountered or expected. "Maritime Planning is therefore being used as a tool for direct conflict resolution rather than for the comprehensive planning of the coastal zone" (Bridgewater 1985). Four maritime planning authorities have been established in Waitemata, Manukau, Wellington, and Marlborough Sounds. Three of these are adjacent to urban local authorities suggesting that maritime planning only occurs in areas of high population density. Bellingham and Taylor (1986) are of the opinion that regional and local authorities are perfectly capable of planning for maritime areas.
6.2.5 Soil Conservation and Rivers Control Act 1941

Water and Soil Conservation Act 1967

The Water and Soil Conservation Act 1967 is "An Act to promote a national policy in respect of natural water, and to make better provision for the conservation, allocation, use and quality of natural waters, and for promoting soil conservation and preventing damage by flood and erosion, and for promoting and controlling multiple uses of natural water and the drainage of land, and for ensuring that adequate account is taken of the needs of primary and secondary industry". This is an Act which covers a wide number of habitats including coastlines. The definition of 'natural water' illustrates the extensive nature of the Act. "Natural water means all forms of water (including fresh water, ground water, artesian water, sea water, water vapour, ice, snow and water or steam or vapour heated by geothermal energy, whatever its temperature) that are within the outer limits of the territorial sea of New Zealand."

The two Acts form the basis for soil and water conservation in New Zealand and are implemented through the National Water and Soil Conservation Authority (NWASCA). The overseeing of water and soil management at the regional level is the function of catchment boards and regional water boards.
Provisions in the Acts relevant to coastline management include the ability to carry out, record and publish surveys and investigations on the nature and extent of soil erosion, flood control, soil conservation and reclamation. This covers various aspects of water and soil conservation along the coastline.

When aggregate extraction is authorised it lies within the Soil Conservation and Rivers Control Act, 1941. However the supervision of impacts, hazards and penalties for water pollution lie in the Water and Soil Conservation Act 1967.
6.3 Conflict Resolution
6.3.1 Planning Tribunal

The mediator of conflicting policies and between conservation and development is often the Planning Tribunal. The Planning Tribunal considers each case in isolation and usually in terms of its local effect. However because of the confusion of legislative controls involving aggregate extraction along the coastline controversies arise with Planning Tribunal decisions. An example of this confusion is the Kaitorete Spit sand mining application on the dune system between Lake Ellesmere and the sea. "The dune system is a finite system, of high natural values, and is important as a source of pingao" (Bellingham & Taylor 1986). The objectors to the mining application believe that the correct application of legal procedures was not achieved by the Planning Tribunal and have taken the decision to the High Court on appeal. The various Acts that control this sand mining application are the Land Act, The Reserves Act, The Mining Act and the Town and Country Planning Act. "The Planning Tribunal in fact responded to this conflict between conservation and development values by compromising. It granted a mining licence for a reduced term over a reduced area. The case highlights the fact the the Planning Tribunal is very reluctant to say no to a developer. The best that conservation interests can usually expect is some reduction in the
size of the development which may minimise its impacts" (Bellingham & Taylor 1986).

The criteria used by the Planning Tribunal to make decisions are often flawed. When so many statues overlap and confuse issues changes are needed to take into consideration a variety of viewpoints.
6.4 Legislation and Planning Changes
6.4.1 New Institutional Changes

Over the last three years a dramatic change has occurred in the areas of environmental management and planning. These changes have been particularly evident in the new environmental Acts and the establishment of new government departments and ministries.

"An act to:
   a. Provide for the establishment of the office of
      Parliamentary Commissioner for the Environment.
   b. Provide for the establishment of the Ministry for
      the Environment.
   c. Ensure that, in the management of natural and
      physical resources, full and balanced account is
      taken of:
         i. The intrinsic values of ecosystems; and
         ii. All values which are placed by individuals
             and groups on the quality of the environment;
             and
         iii. The principles of the Treaty of Waitangi; and
         iv. The sustainability of natural and physical
             resources; and
         v. The needs of future generations."
The Parliamentary Commissioner for the Environment and the Ministry for the Environment have been set up as advocates of good environmental management. "These include a need to ensure that we have a safe, healthy and aesthetically pleasing environment, to ensure that the principles of the Treaty of Waitangi are taken into account in the management of our resources, and the need to promote effective public participation in the environmental planning and policy formulation processes" (Blakeley, 1987).

This management will directly affect aggregate extraction, especially as one of the first tasks of the new Ministry is to formulate environmental assessment procedures. "Rather the aim is to rationalise and simplify them to ensure that they are efficient and effective while at the same time ensuring adequate opportunity for public participation and environmental control. A fundamental review of a number of Acts, most importantly perhaps the Town and Country Planning Act, may be needed to ensure that the new environmental assessment provisions are in keeping with the new policy environment established by the Government" (Blakeley, 1987).

The three primary roles of the new Ministry for the Environment are advising, advocating good environmental management and being a neutral facilitator. These
tasks may be hard to handle with limited staff and resources. But Roger Blakeley (1987), the new Secretary for the Environment sees the Ministry as having "a unique opportunity to forge a framework for sound resource utilisation and environmental management that will be of benefit to all New Zealanders, both now and in its future. I am confident that an appropriate balance between conservation and development will be achieved."

2. The Conservation Act 1987

"An Act to promote the conservation of New Zealand's natural and historic resources and for that purpose to establish the Department of Conservation."

The Department of Conservation "has a limited advocacy role for conservation values and is manager of that part of the Crown estate which has primary conservation values" (Environmental Council, 1987).

The Department of Conservation management role extends along New Zealand's 10,000 kilometres of coastline from the marginal strip to the 12 mile territorial limit.

"Marginal strip means any land for the time being held under this Act for conservation purposes that lies on
the high side, and within 20 metres of ... Any fore­
shore,". Section 24 of the Act maintains that "Every
marginal strip shall be held for conservation purposes,
and subject to Sections 18 to 23 of this Act, shall
be managed -

a. For the conservation of its natural and historic
resources and those of the adjacent water, and

b. Subject to the conservation of those resources so
as to enable public access to the adjacent water".

The Department of Conservation has set up the Coastal
and Marine Resources Directorate which is responsible
for the management and conservation of New Zealand's
coastline. "The directorate is seen as a transitional
unit for identifying management needs and incorporating
them into the work of other directorates, so that
coastal zone management becomes an integral part of the
Department's management role rather than a separate
function" (Gibb, 1982).

To attain these goals the DOC will be looking at revising
the Harbours Act 1950. The Harbours Act 1950 is listed
under the second schedule of the Conservation Act, 1987,
but all the former constraints of the Harbours Act still
apply. "The directorate would like to see those
sections of the (Harbours) Act which relate to the
management of coastal resources either put into a
separate statute or included under other existing
legislation" (Gibb, 1987).

Under the DOC a coastal resource inventory will be undertaken for each region using available information on coastal dynamics, marine resources and cultural values including those of the Maori people. The main motivation for this is for informed forward planning rather than ad hoc planning on an action and reaction basis.

The directorate will have a training role for staff in the districts and regions carrying out the DOC coastal zone management responsibilities. "The directorate is seen as a transitional unit for identifying management needs and incorporating them into the work of other directorates, so that coastal zone management becomes an integral part of the Department's management role rather than a separate function" (Gibb, 1987).

6.4.2 Government Reviews

"Since July, 1984 the Labour Government has overturned many of the old policies under which the economy previously operated. New Zealand is now a less regulated economy. The Government has introduced greater flexibility into the economy. We continue to strive for a climate and conditions under which efficient business can develop and resources can be allocated to
their most productive areas" (David Caygill, Minister of Trade and Industry, August, 1987).

This new deregulated economy with greater flexibility has resulted in a rash of reviews, policy changes, and new or changed Government Acts. Many of these changes have related to resource allocation as seen in the New Environment Act 1986 and the Conservation Act, 1987.

At present two major reviews that affect mineral extraction have been published. These are the review of The Mining Act, 1971 by M.G. Summers leader of the Ministry of Energy review team (October, 1986), and the Review of the Town and Country Planning Act, 1977 by A. Hearn Q.C. published by the Department of Trade and Industry, Wellington (1987).

Both these reviews are comprehensive and detailed. The reviews inter-relate and a number of options have been proposed that separate or tie together the Mining Act 1971 and the Town and Country Planning Act 1977.

Hearne (1987) points out four possible options that are presently being discussed:

"a. Continue as at present with the Mining Act and/or the new minerals Act (should there be one) being treated as a separate code, not subject to the
provisions of the Town and Country Planning Act, recognising that aggregates are excluded and that certain matters akin to town and country planning considerations are already taken into account when any objection is considered in terms of Section 126 of the Mining Act.

b. Amend the Mining and/or Minerals Act to make it clear it is subject to the Town and Country Planning Act. This would involve consequential amendments to the Town and Country Planning Act looking at it in its present form.

c. A "... central licensing agency, in the case of mining this would be the Minister, and vest the power to grant licences for mining in local authorities. Local authorities would be seized of both the application for a licence and the application for planning consent and could deal with both in an integrated way, if not as one.

d. Preserve the existing procedure of an applicant for a mining licence applying to the Minister with the right of objectors to have their objections referred to the Planning Tribunal and the Planning Tribunal to report with a recommendation to the Minister, but introduce a greater degree of town planning considerations into the matters to be considered by the Planning Tribunal on the hearing of objections".
At the present point in time it would appear that aggregates, sand, rock, gravel, limestone and clay would be favoured by both the Mining Act review team and the Hearne report to be owned by the surface land owner and excluded from the provisions of the Mining Act. This would mean mining of aggregates on freehold land would come under the Town and Country Planning Act.
7 CASE STUDY: FITZROY BAY, WELLINGTON
PART 7  CASE STUDY: FITZROY BAY, WELLINGTON

7.1 The Coastline
7.1.1 The Coastal Compartment

Aggregate is extracted from the coastline at Fitzroy Bay on the eastern side of Wellington Harbour. The coastline is made up of a series of raised gravel beaches formed by tectonic uplift at the foot of a coastal cliff. The last major uplift was in 1855 and raised the beach approximately 2:1 metres upwards. Since 1855 a new gravel beach has been built up. The new beach face width varies from 10 metres at Eastbourne to 30 metres on the exposed south facing coast at the harbour entrance (Stevens, 1974).

The coastal compartment of which these beaches are part extends from the Orongorongo River which supplies the majority of sediment to Eastbourne. Most waves arrive on this coastline from the due south (Matthew, 1980a). The waves produced by southerly storms can reach up to 6 metres high but average round 1.5 metres (Matthew, 1980a). Because most wave fronts arrive from the south the predominant direction of longshore drift is to the north. Inside Wellington Harbour this northward movement is opposed by the longshore drift initiated by short period northerly waves generated inside the harbour. The opposing longshore drifts cancel each other out at Eastbourne where sand and gravel has

Orongorongo River the start of the coastal compartment that continues north towards Eastbourne. The gravel that pours out at the sea here makes up the material of all the beaches towards Eastbourne and defines the nature of the entire coastline. Its importance should not be underestimated.

All the beaches along the coastline are gravel and can be very steep. The flat sea, roaring waves and sloping crunchy gravel beach are enclosed by steep sea cliffs along most of the coastal compartment. These coastal cliffs have largely been built on in the inner harbour of Wellington except for this section of coastline. Here this rugged coastline can be worked on by the natural elements of sea, sand and wind.
accumulated forming a cuspate foreland (Matthew, 1980b). It is on this cuspate foreland that the township of Eastbourne now stands.

7.1.2 Sediment Budget

The Orongorongo River supplies the majority of sediment to the coastal compartment in the form of gravel, sand, silt and clay. The Wainuiomata River supplies small quantities of sand and finer grades of material to the coastal compartment (Matthew, 1980b). "From river discharge records one can deduce that sand supplied by these rivers is of the order of $15,000 \text{m}^3/\text{y}^{-1}$" (Matthew, 1980b).

"The supply of sediment by rivers is thought to be controlled largely by rainfall, by changes in vegetative cover and slope stability and by the occurrence of earthquakes, factors which are complex and interrelated, making it difficult to relate any particular one of them to the rate of supply." (Matthew, 1980b). Increased sediment supply to the Orongorongo River may be expected to recur every four to ten years because of heavy rainfall. But the most significant fluctuation in gravel supply is probably caused by earthquakes. "Earthquake-induced fluctuations, which have a return period of centuries and which appear to be larger than those caused by other events, are probably the most
important cause of fluctuations in the supply of gravel to the coast" (Matthew, 1980b).

Since 1941 the beaches at the mouth of Lake Kohangapiripiri and the beach south of Pencarrow lighthouse have advanced at a far faster rate than between 1855 and 1941. This combined with a northwards moving gravel front downdrift of Hinds Point; has led Matthews (1980a) and Gibb (1975) to speculate that the change is related to an arrival of earthquake induced gravel pulses. The 1840 to 1855 earthquakes which formed the raised beaches also caused a number of landslides that loaded the Orongorongo River with gravel. This gravel has been calculated to take 100 years to reach the coast. Once on the beach it would take 14 years to reach the harbour entrance (Matthews, 1980b). Experiments by Matthews (1980a,1980b) have shown that the two bays south of Pencarrow Head are no longer efficient traps for gravel and accretion is probably now proceeding at a slower rate or not at all.

The longshore drift along this coastline is dependent on high energy storm events which are on average twice as common in mid winter as in summer (Matthew, 1980a). But as any year varies seasonal variation will be irregular. The longshore drift along this coastline is believed to be by small slugs of gravel separated from the main body of sediment and moved rapidly along shore when storms produce high energy waves (Matthew,
1.7 metres (Matthews, 1980b). This advance has been measured from the position of the 'wetted line' on the beachface as seen in the successive aerial photographs. "In Pencarrow Bay the concrete jetty used in the 1920's for loading shingle from the raised beach deposits and navigable until 1952 is now beyond the reach of normal high tide waves, confirming that rapid progradation has occurred here" (Matthew, 1980b).

At the end of the coastal compartment at Eastbourne on the cuspate foreland the general trend of that of aggradation but there are periods of erosion. At Robinson Bay on the south side of the foreland protective works have been necessary. In the 1900s a low sea wall and groyne field was constructed. In the early 1950s severe erosion resulted in property damage and the present seawall and groyne field was constructed between 1956-57.

Since 1978 erosion has occurred at the northern end of the groyne field where the southerly wave energy is concentrated by offshore topography (Matthew, 1980b). In contrast the northern side of the foreland has built out at a rate of 0.7 metres per year since 1925. "Vegetative changes discernible on aerial photographs show that this progradation has occurred at a similar rate for 300m to the north of Rona Bay Wharf and for
1980a).

Coarse sand and gravel makes up the majority of the beach sediment. Sand does occur infrequently on the beaches from Fitzroy Bay to Hinds Point and forms thin veneers on the beaches (Matthew, 1980b).

7.1.3 Aggradation and Erosion
Since the 1855 earthquake that raised the eastern side of Wellington Harbour by 2.1 metres the coastline has continued to change. Immediately after the earthquake the uplift beaches would have eroded because the sediment being carried along the coastline would be undernourished. The raised beaches contained the natural sediment of the coastline which was no longer available to the newly active beach.

The increase in sediment now reaching the coastline because of the 1855 earthquake has allowed the new beaches to increase in volume, particularly where the beach is protected from the direct wave action by rocks, reefs and headlands (Matthew, 1980b).

Since 1941 when aerial photos were taken a number of advances of the coastline have occurred. Two bays, one seaward of Lake Kohangapapiripiri and the other south of Pencarrow lighthouse, have seen beach aggradation between 1941 and 1969 at an average rate of
200m to the south. This represents accumulation at a rate of 994m$^3$y$^{-1}$" (Matthew, 1980b).

The advance of the coastline due to a present increased sediment budget could change dramatically to erosion. "At Pencarrow there is currently a net deficiency of material in the beach system due to extraction practices at Fitzroy Bay, and hence when this deficiency reaches Eastbourne (could be ten years hence) there will likely be further problems of serious coastal erosion" (Arnold, 1986). The rate of erosion will be dependent on the amount of material extracted at Fitzroy Bay and elsewhere in the coastal compartment.
7.2 The Coastal Environment

7.2.1 An Extreme and Changing Environment

The eastern side of the Wellington Harbour is exposed to the two predominant winds in Wellington the northwest and the southerly. The coastline is wild and drenched with salt spray. Strong to gale force winds are not uncommon along this coastline. Stormy conditions are on average twice as common in mid winter as in the summer. The southerly storms that pass over this coast often occur without any rainfall. These strong winds are however loaded with salt spray that will burn and destroy all but the most hardy vegetation. The northwest winds that buffet the coastline in spring and summer and remove all moisture from the soil and plant life. The plants and animals of this coastline must be hardy and withstand all the extremes that this coastline can bring.

The tectonic movement along this coast has resulted in periodic uplift exposing a strip of foreshore and forming a series of beaches at the seaward edge. In some areas along the Wellington coastline these ancient raised beaches have been preserved from erosion and represent a record of the past. Turakirae Head is the best example of raised beaches in New Zealand. It is preserved because it has been developed on the hard rocks forming the Rimutaka Range (Stevens, 1975). These raised beaches
not only record the time of earthquake movements but also show the rate of soil formation and succession in vegetation.

The youngest raised beach is caused by the 1855 earthquake and the next oldest in 1460. The older raised beaches do not extend north of Baring Head. These have been destroyed by roading north of Pencarrow Head and aggregate mining in other localities (Matthews 1980b).

The beach profiles inside the harbour near Eastbourne are lower and flatter than the steeper exposed beaches closer to the harbour entrance (Matthew 1980b). The beaches show a sequence of storm and post storm beaches. During storms the strandline of the beaches recedes towards the land. Between storms the strandline moves seaward with the build up of the beach (Matthew, 1980b).

7.2.2 Vegetation of the Coastline

On the raised gravel beaches of the Wellington coastline a succession of vegetation has been formed. On the youngest gravel beach grow the maritime plants of the yellow horned poppy (Glaucium flavum) spinifex, and European marram.
Three areas of the native and rare pingao still exist along this coastline. An extensive population on the foredune between the Orongorongo River and Wainuiomata River, and two smaller relict populations at the mouths of Lake Kohangapiripiri and Lake Kohangatera.

Behind the foredune in areas not disturbed by roading or aggregate extraction a shrubland community comprising *Muehlenbeckia complexa*, lupin (*Lupinus arboreus*), Tauhinu (*Cassina leptophylla*) *Muehlenbeckia australis*, *Olearia solandri* and *Plagianthus divaricatus*. On disturbed areas where aggregate extraction has formed low level areas yellow horned poppy, shore bind weed (*Calystegia silvatica*) and vegetable sheep (*Raoulia hookeeii*) are present.

On the steep coastal cliffs a variety of grass and shrubland communities exist. On the less exposed cliffs near Eastbourne gorse (*Ulex europaeus*) and *Ngaio* (*Myporium laetum*) are dominant. On cliffs with greater exposure to southerly winds grassland communities dominate with scattered spaniard (*Aciphylla squarossa*), tauhinu, *Olearia solandri* and vegetable sheep. In a few localities tall cabbage trees (*Cordyline australis*) can still be seen from past forests. In sheltered areas near fresh water the karaka (*Corynocarpus laevigatus*) planted by the Maori still survives in small numbers.

A mixed shrubland of lupin and a few native plants covers the beach at Fitzroy Bay. This vegetation is growing on material that is made up of fine gravel and sand. This Bay is therefore quite different from the other bays in the coastal compartment and a prime target for an aggregate extraction operation.

Pencarrow Roads steep cliffs are covered in an assortment of vegetation that can be linked ecologically with Marlborough Sounds. The cliffs define the boundary of this coastline and form only a thin strip of land between sea and cliff. The coastline that exists here is a thin corridor that any disturbance by man can create disastrous results.
Many plants are scarce or do not regenerate because of grazing pressure from sheep and rabbits. Young shoots are browsed or trampled and grass species are left to dominate the coastal cliffs and valleys.

7.2.3 Animals of the Coastline

The gravel beaches of the eastern side of Wellington Harbour present an extreme environment for animals to live in. But the wild and predominantly undisturbed nature of the coastline makes it possible for many sea birds to live and breed in this area. Many wading and sea birds are found in the regionally important lakes of Kohangapiripiri and Kohangatera. Swans, ducks, banded dotterals and bittern breed on these lakes.

The coastline provides nesting areas for black backed gulls, blue penguins, variable oyster catchers, banded dotterals and white fronted terns.

The other major animals are the introduced grazers that include sheep and rabbits.
7.3 Cultural Development.

7.3.1 Historical Information

The Maori had several pa sites around the Wellington Harbour. These include Parangerehu Pa in Fitzroy Bay and Te Rana Pa near Bearing Head. These pa would have been used in the favoured route, around the coast, to Wairarapa.

The first European exploits along this coastline favoured the exposed headlands for the first beacons and lighthouses in to the port of Wellington. In 1842 the first beacon consisting of a wooden pyramid on Pencarrow head, was erected and blown over. Two years later in 1844 the Government erected another beacon. It took till the loss of life in 1854 before a lighthouse at Pencarrow Head was built.

The first lighthouse keeper a Mr. Bennett had to suffer the extreme conditions of the environment plus having to fetch water half a kilometre and firewood several kilometres away. In heavy gales his family abandoned their hut for a cave dug in the hills, so rugged was his accommodation.

On January 1859 a new lighthouse costing £2,500 was opened and run by Mr. Bennett's widow. But the accommodation was still rugged and the roof was blown off.
in a gale in 1867 (McGill, 1984). About this time the control of the lighthouse was passed to the Marine Department and upgrading and repairs were carried out. Today the lighthouse at Pencarrow Head is automatic and serviced by the coastal road of the Hutt Valley Drainage Board.

In 1849 the ship Inconstant drifted onto rocks near Pencarrow and the point was soon named Inconstant Point. Over twenty ships since then have been wrecked on this coastline. In 1981 the Pacific Charger ran aground at Baring Head on her maiden voyage. The gravel road was extended from Lake Kohangatera to Baring Head to help with the salvaging of this ship.

7.3.2 Degradation of the Coastline

Many changes have occurred to this coastline since human occupation. The Maori reduced the existing vegetation cover for cultivation and planted karaka trees.

When Europeans arrived they introduced sheep for grazing and brought many areas into pasture. Today very little of the natural vegetation remains and sheep grazing stops revegetation. Gorse is colonising the coastal cliffs that have been burnt and will provide a nurse crop for shrubland species if left undisturbed.
The most dramatic human induced changes along the coastline have arisen over the last sixty years. An all weather gravel road has been built by the Hutt Valley Drainage Board to provide access along the Hutt Valley Sewer Pipe. The sewer pipe outlet is now placed near the entrance to Lake Kohangapiripiri locally known as 'Sewer Bay'. The discharge of raw sewage at this point affects the entire coastline on the eastern side of the Harbour. The outfall pumps out a plume of polluted water as far as Baring Head or back to Inconstant Point depending on the tide and wind directions.

Aggregate extraction has occurred on a spasmodic basis along the coastline for the past sixty years at the Wainuiomata River and at Fitzroy Bay. The present operation at Fitzroy Bay is the main extractor of aggregate along this coastline and will be studied in detail in the following sections.
7.4 Aggregate Extraction at Fitzroy Bay

7.4.1 Aggregate Extraction History
Since the 1920's aggregate has been extracted from the coastline between Fitzroy Bay and Pencarrow Head. This first operation extracted the sand and gravel from the foreshore and sand dunes of the raised beach (Matthew, 1980b). The aggregate was transported from Pencarrow Bay jetty across to Wellington by barge.

The original owners of the sheep station sold the land but kept the mineral title under the Fitzroy Bay Sand Company. The rights for mineral extraction have been given to Horokiwi Quarries which have been extracting sand from Fitzroy Bay for the past 20 years. The mineral title they are working with extends over an area from the sewer outlet south covering 'Sewer Bay' and the entire Fitzroy Bay (Pers.comm. Ross Baker).

There is at present no Mineral licence for this extraction operation as it is on private land (Arnold, 1986). There also appears to be no planning consent. "Apparently no planning consent exists for the extraction, although it may have some existing use rights under the Hutt County District Scheme" (Arnold, 1986).

Horokiwi Quarries pays royalties to Fitzroy Bay Sand Company for the right to extract the aggregate. The
Fitzroy Bay Sand Company then pays the Hutt Valley Drainage Board for the right to use its road which extends along the coastline.

The aggregate that is transported to Horokiwi Quarries main depot is fine to small sized shingle. This shingle is mixed with other sands to be used for concrete, Humes Pipes, Monotiles and basement course for cobblestones (Pers. comm. Ross Baker). The shingle is always mixed and is not a standard grade.

The cost of transportation from Fitzroy Bay to the depot accounts for half the cost of the aggregate. The transport cost is therefore equal to the value of the aggregate. The present operation extracts almost solely at the mouth of Lake Kohangatera and does not extend further because of the cost of transporting the sand back to the processing plant (Pers. comm. Ross Baker).

7.4.2 Extraction, Processing, and Transportation

To extract the fine shingle Horokiwi Quarries must 'play with the beach'. They extract the fine shingle that is constantly being moved by the wind and wave action as a thin veneer along the frontal dune. By digging large deep pits three metres or more down behind the storm ridge on the legal side of Mean High Water Mark the extractors can wait for nature to
take over.

During southerly storm events the storm ridge of the beach is washed away because all its support has been removed. The fine shingle is quickly washed into the borrow pits up to 60 metres in land. It may take several storms to wash enough shingle into the pits for extraction to resume. The 'wetted line' left by debris in these borrow pits show how fragile any boundary line on paper for the coastline can be.

The extraction operation from the borrow pits and few remaining sand dunes is done by one man on a loader. The shingle is graded and washed on site. The shingle is graded into three types: the large rounded stones, smaller gravel and fine sand. At present it is only economical to transport the fine sand and gravel and the rounded stones are left on site.

A diesel generator pumps water from Lake Kohangatera and turns the screening machine. The water discharge is left to seep through the gravel base of the processing site.

Transportation is by truck to the depot of Horokiwi Quarries and the rate of trucks using the road depends on the amount of aggregate being extracted.
7.5 Landscape Implementations

7.5.1 Landform Destruction

The past and present aggregate operations between Baring Head and Pencarrow Head have destroyed a number of coastal landform features.

The past raised beaches of the 1855 and 1460 earthquakes have been removed. This has ruined a valuable geological record of a part of the Wellington's coastline.

The coastline of Sewer Bay is scarred from past extraction operations and a loading bay is still present and could be reused in the future.

At Fitzroy Bay the landform disturbance is more extreme. Over the past 20 years aggregate has been extracted from the area of Fitzroy Bay at far greater quantities than in the past, as can be seen from aerial photographs. The large borrow pits scattered along Fitzroy Bay near Lake Kohangatera today did not exist in the 1960's.

Because the borrow pits remove the material that supports the storm ridge during storm events it is destroyed. This erodes and reduces the stability of the coast. Constant extraction by this means must stop the building out of this coastline. The extraction operation is meant to be achieving frontal dune protection by only
taking aggregate above Mean High Water Mark. This may be alright in theory but in practice the extraction operation leads to some destruction of the frontal dune at nearly every southerly storm event. Without extraction the beach would slowly be raised above its present level to equal that of the highest storm waves.

7.5.2 Waste Tips

Several waste tips exist on the site consisting of large rounded stones. At present this material can not be sold at a profit as the transportation cost would be too high. As the extraction at the site continues so do the waste tips. These large mounds of rounded stones produce an extreme environment which even the hardiest vegetable sheep can not colonise.

Eventually the site will have to be reorganised if the waste tips are not to hinder the extraction operation. At present however the ecologically barren mounds of well sorted stones subdue the once hardy vegetation.

7.5.3 Coastal Roading

The road along the coastline serves three functions:- the first to maintain the Pencarrow lighthouse; the second to maintain the Hutt Valley Drainage Boards Sewer pipes and outfall; the third for transportation
of aggregate by Horokiwi Quarries from Fitzroy Bay to their depot in Horokiwi.

The road was probably built on the 1855 raised gravel beach. The road has covered this beach and reduced the foreshore in some bays into a pile of rubble. The road has split the coastline into two parts, the foreshore which may be left with some frontal dune, and the cliff face. The link between these two landforms has been lost by the contraction of this road.

Erosion of the road in the past has led to reinforcement with large concrete blocks and rubble. These features produce an unnatural, rubbishy and neglected coastal landscape.

7.5.4 Coastal Erosion

Coastal erosion has been an ever present threat to the township of Eastbourne. The main area of erosion is at Robinson's Bay where a seawall and groynes field have been built to protect against further erosion.

The Eastbourne Borough Council has an extensive stretch of coastline under its control. The Borough Council spends on average $10,000 a year on coastal erosion control plus $5,000 for riprap to be supplied to the groynes field and sea wall at Robinsons Bay.

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From all available information extraction of aggregate at the present rate at Fitzroy Bay will eventually cause coastal erosion at Eastbourne. "Fitzroy Beach gravel extraction is causing coastal erosion problems downdrift of the site at Eastbourne. If problems with Eastbourne Beach are to be avoided extraction from the Fitzroy storm beach must cease." (NAWASCA 1987). The scientific data is supplied by Matthews (1980a & 1980b) whose research shows that gravel is transported into the harbour by storm events. The present influx of gravel will not always be present and Arnott (1986) suggests a deficit at Pencarrow Head is already present. "At Pencarrow there is currently a net deficiency of material in the beach system due to extraction practices at Fitzroy Bay, and hence when this deficiency reaches Eastbourne (could be ten years hence) there will likely be further problems of serious coastal erosion" (Arnott, 1986).
7.6 Land Use Conflicts

7.6.1 Recreation

The coastline is one of the main areas of passive recreation for the Wellington Region. The coastline forms an important playground between the land and the sea. Many areas of wild and scenic coastline have been tamed by roads and houses.

The eastern side of Wellington Harbour from Eastbourne South is one of the few remaining areas of coastline where houses do not exist. Access to the gravel coastal road is limited. Entry is by locked gates and keys are issued by the Hutt Valley Drainage Board. This reduces the pressure on the coastline from vehicular traffic but encourages walkers and picnickers. Other activities include surfing, horse and bicycle riding, fishing and communing with nature.

Two major obstacles exist that reduce the full enjoyment of the coastline. The first is the sewage which is pumped out at Sewer Bay, this should be secondary treated to reduce the obvious pollution of the coastline. The second is aggregate extraction.

Aggregate extraction is reducing the recreation potential of this coastline by removing the fine shingle. The present influx of gravel has the potential to transform the rocky coastline north of Pencarrow Head into fine
shingle beaches. The extraction site also provides an obvious intrusion on an otherwise 'natural' coastline.

7.6.2 The Natural Environment

The immediate environment within and surrounding the aggregate extraction site at Fitzroy Bay has been changed from a 'natural' rugged coastline into a controlled extraction site. The first extraction operations in the 1920's removed the raised gravel beaches along the coastline. This destroyed a unique geological record and vegetation succession sequence.

The extraction methods used today reduce the build up of the beach out towards the sea and up towards the height of the storm waves which crash onto this coastline. The beach and foredune should hold the sand for future storm events and act as 'shock absorbers' dissipating the energy of storm waves (Kirk, 1978). Instead the present operation uses the storm waves to break down the foredune and spread fine shingle for extraction inland into its borrow pits.

The vegetation on the sand dunes is removed or never allowed to establish. This prevents stabilization of the sand and formation of dunes which play an important part in coastal protection.
The natural processes of the coastline are controlled but reaction mechanisms will result in erosion at the point of extraction and downdrift towards Eastbourne.

The extraction operation at Fitzroy Bay is producing large waste tips of rounded stones which are visually unattractive and impossible for plants to colonise. At present the waste tips are higher than the natural raised sand dunes and will probably continue to increase in size.

Water must be used to wash the aggregate of impurities. The only two major sources of fresh water along this coastline are found in the regionally important Lakes of Kohangapiripiri and Kohangatera. Therefore any extraction and processing plant will be placed at the mouths of these lakes. The coastline forms a plug that retains these lakes. This makes the two lakes very sensitive to any coastal alteration. The change of the mouths of the lakes caused by aggregate extraction have at present not been regarded as a threat. But any lowering of the sediment budget travelling along the coast combined with the present rate of extraction could cause major problems to these lakes.
7.6.3 Urban Development

The sediment budget along the coastline has increased since 1941 and resulted in rapid accretion at Fitzroy Bay and northwards towards Eastbourne. The surge of sediment has not reached the eroding coastline of Robinson Bay at Eastbourne but when it does a build up of sediment should occur. This could enable the existing groyne field to be partially removed (Fletcher 1984). The amount of sediment supplied to this coastline will fluctuate. A deficiency has already been reported downdrift of Fitzroy Bay due to aggregate extraction (Arnold, 1986).

The data presented by Matthews (1980a & 1980b) shows that the present increased sediment budget along this coastline cannot be expected to remain at this rate. If future erosion at Robinson Bay in Eastbourne is to be stopped aggregate extraction along the entire coastal compartment (Orongorongo River to Eastbourne) and from the Orongorongo River must be stopped or severely reduced.
7.7 Aggregate Extraction in the Wellington Region

7.7.1 Mineral Resources in the Wellington Region

Two comprehensive reports have been published on mineral resources in the Wellington Region. The first by Ward et al (1978) concentrates on obtaining, collating, and interpreting information on mineral resources within the Wellington Region to assist the Wellington Regional Planning Authority and the Wellington Regional Water Board in developing regional policies. The second report by CALNIG (1986) is prepared in conjunction with the central and lower North Island catchment authorities to produce a gravel resource management plan that indicates areas of naturally agrading rivers which would benefit from extraction for river control purposes.

Both reports concentrate on aggregate extraction, the dominant mineral extracted in the Wellington Region.

In 1978 the total growth of aggregate extracted in the Wellington Region was foreseen to increase but from fewer extraction sites. The number of extraction sites was decreasing because of amalgamation due to tighter operational controls and more stringent standards for the mineral products produced. In 1978 approximately 15% of the aggregate in the Wellington Region was imported by road from Horowhenua and the
Wairarapa. The major component of imported aggregate was rounded shingle (12-20mm diameter) used in concrete aggregate (Ward et al. 1978).

7.7.2 Relationship to the Orongorongo River - Eastbourne Coastal Compartment

Both reports predict a major shortfall of small sized aggregate in the Wellington Region coming from either the Orongorongo River or the Orongorongo River Eastbourne coastal compartment. "The largest resource of shingle occurs in the lower reaches of the Orongorongo River and in the raised beaches from the north of the Orongorongo River west past Wainuiomata River. Expansion of its rate of production is limited by the 20km of class II road linking it to the arterial route to the major markets. ... Increased production from the Wainuiomata Coast can meet the river aggregate shortfall with the least environmental objection, subject to satisfactory transport arrangements" (Ward et al. 1978).

The CALNIG report also took a similar viewpoint "the Orongorongo River is the most aggraded river in the Wellington Region and has a very extensive untapped source of partly rounded gravels" (CALNIG, 1986).

These statements fail to take into account the total system of the Orongorongo River and its relationship
to the Orongorongo River - Eastbourne coastal compartment. It is impossible to extract any amount of aggregate, large or small, from the Orongorongo River without having an effect on the sediment budget of the Orongorongo River - Eastbourne coastal compartment. The Orongorongo River is the major source of sediment supply for the entire coastal compartment.

However both Ward et al (1978) and CALNIG (1986) see extraction sites along the coastline as problems. "A further three sites exist within uplifted beach gravels and at river mouths near Wainuiomata on the south eastern coast. These later sources are of concern in regard to the environment and stability of the coast on a number of counts" (CALNIG 1986).

The whole river-coastal system must be assessed to make sure adequate controls are placed on aggregate extraction. This means both the Orongorongo River and the Orongorongo River - Eastbourne Coastal Compartment.
7.8 Controls on Extraction

7.8.1 Orongorongo River - Eastbourne Coastal Compartment

At present the only controls placed on extraction along the coastline are through the Hutt County District Scheme, as all extraction operations are above Mean High Water Mark. The Fitzroy Bay operation does not appear even to have this planning consent and only operates on a historic existing use right (Arnold, 1986). The two other extraction operations along the coastline between the Orongorongo River and the Wainuiomata River are operating under current approvals.

As what happens at these extraction sites affects not only the Hutt County but also the Eastbourne Borough Council, it is up to the Wellington Regional Council to look at possible controls for this coastline.

Apart from the District Schemes the Wellington Regional Council has two other methods of control (Arnold, 1986).

1. Regional Council Bylaws. At present the Wellington Regional Council bylaws cover water courses and extraction from them but do not relate to general extraction except where this is likely to cause erosion directly. This would appear to provide adequate management controls for the aggregate resource of the Orongorongo River - Eastbourne
coastline. However Arnold (1986) says that "the bylaws could be used but would require changing and extension to provide a realistic means of control. This is not a favoured option at this stage."

2. Soil Conservation and Rivers Control Amendment Act 1959, Section 34 under the control of the Wellington Regional Council. This would require any extraction operation to obtain a permit with appropriate conditions and enforcement procedures. This however would probably only relate to the immediate environment and current erosion problem and not to the long term management of the coastline as a whole (Arnold, 1986).

But "A section 34 notice applied to the whole of the Orongorongo catchment and coastal area from the top of the adjacent bluff to the mean low water line extending to Eastbourne Borough and then along the beach front to Days Bay would be appropriate to control shingle and sand extraction and other activities likely to cause soil erosion" (Arnold, 1986).

7.8.2 Further Studies

The option proposed by the Wellington Regional Council is for further study.
"While a lot of work has been done by Water and Soil Division MMD and others, particularly during the 70's, to identify actual coastal movement from Pencarrow to Eastbourne, considerably more work is necessary in the following areas:

a. Determine the rate of supply of material from the Orongorongo Rivers and factors affecting it.

b. Complete the coastal studies of material movement from the Orongorongo to Eastbourne, to identify potential material for extraction (if any) and the methods/control appropriate for that extraction.

c. Investigate immediate and long term effects and the options, for the Eastbourne area as far as this is influenced by this study.

d. To study the extensive resources of gravel and sand on the coastal platform, behind the foredune, its value to the region and its end use.

e. To take into account the requirements (and possibly make input to) the Regional Scheme from the Water and Soil point of view in respect of the coastline.

f. To take into account recreational considerations.

g. Any other aspects identified as important during the study" (Arnold, 1986).

While it is commendable that the Wellington Regional Council has initiated this study, present management requirements of this coastline are left unresolved.
The study will take two years to complete and as yet has not started. The long term management of this coastline with or without aggregate extraction can not rely on short term studies but must have a Regional Based policy with continued monitoring.

7.8.3 Conclusion
The aggregate extracted from the Orongorongo River and Orongorongo River - Eastbourne coastline represents a major part of the total aggregate extracted in the Wellington Region. It is economically viable to extract because the aggregate is made up of fine shingle which is a scarce resource in the Wellington Region.

However, the cost of extracting this aggregate is high to the environment around and downdrift of the extraction site, to the users of coastline and finally to the residents of Robinson Bay in Eastbourne. The study initiated by the Wellington Regional Council should produce firm policy guidelines for the management of this coastline that result in some action taking place. But the current data available on the Fitzroy Bay extraction site should put this operation in doubt. It is an extremely harmful and destructive way of extracting aggregate by borrow pits that cause the breaking of the storm ridge during southerly storm events.
The Wellington Regional Council has admitted that there is no formal planning consent for this operation (Arnold, 1986). Planning consent should be sought for at least then objectors to the extraction operation would have a right to oppose the present operation.

Coast erosion control project given impetus

A coastal erosion control project on the eastern harbour and south coastline is likely to be undertaken by the Wellington Regional Council — some two years after it was originally agreed to do so.

The problem arises from the continuing extraction of shingle and sand at the Fitzroy Bay, Waimanumata river mouth and the removal of boulders from the Orongorongo Station.

Gravel from the Orongorongo River, fed by natural geological processes, passes on to the south coast at the Orongorongo River mouth and is then taken north-west, during southerlies, to lie in Eastbourne near Days Bay.

In October, 1985, the Ministry of Transport (Harbours and Forelands) convened a meeting to bring together representatives of all interested parties to look at the Fitzroy Bay shingle extraction problem.

Eighteen different authorities were represented — from extractors to administrators. The meeting resolved to ask the regional council to investigate ways of controlling shingle extraction.

The Eastbourne Borough Council followed this up and asked for financial assistance to maintain seawall protection.

There are three extraction operations in the area: Horobelt Quarries, Firth Industries and an operator taking the boulders from the side streams and hill-sides behind the Orongorongo homestead.

The council environment and planning committee yesterday heard that the only form of control at the moment on any of the extractors was through the Hutt County District Scheme.

However, catchment engineer Mr Bill Arnold said legislation existed sufficient to deal with the problem under the Soil Conservation and Rivers Control Act."

Committee head Hazel Bibby said after the meeting, that the council could be sure if it did not take up its statutory role.

In a report to the committee, Mr Arnold said the investigation, management and control of the Orongorongo river, coastal beach system and coastal platform in relation to Eastbourne were important and needed a regional viewpoint.

The committee agreed to put $47,300 of the draft estimates to do a study of the problem. It is expected this will be completed in the 1988-89 financial year.
8 CONCLUSION
PART 8 CONCLUSION
8.1 Design guidelines for Coastal Aggregate Extraction
8.1.1 Know Your Coastline

Adequate information must be collected and considered when any development takes place along the coastline. This is a dynamic system. The coastline is in a delicate state of balance.

The boundary between the sea and land does fluctuate. Coastline boundaries should not be legally based on the Mean High Water Mark but on other more accurate landward markers that are specific to each case.

Changes along the coastline can be very dramatic. What's here today may be gone tomorrow. Or coastline changes can be subtle. The shape of the sand dunes can change with vegetation and climatic alterations.

Aggregate extraction from harbours, offshore, foreshore and sand dunes remove material from the coastal system. The coastline will attempt to replenish it and reach a new state of equilibrium. This means if aggregate is extracted from one place the system will take it away from somewhere else. On coastlines that are actively eroding, aggregate extraction will increase the erosion problem. On coastlines that are stable, aggregate extraction can cause erosion
problems. On coastlines with past erosion problems, aggregate extraction may produce another erosional event.

8.1.2 Know Your Aggregate Resource

Regional and local authorities need to know their aggregate resources. Regional and inter-regional studies must take place on the aggregate resource and be constantly updated.

With this knowledge regional and local authorities will be able to plan where aggregate extraction can and can not take place.

Planning consent for aggregate extraction must include restoration or rehabilitation of the site and any affected areas. This includes erosion downdrift of the site of extraction caused by the aggregate extraction operation. Restoration or rehabilitation must be an ongoing concern and not a one-off final clean up operation.
8.1.3 Coastal Aggregate Cheap?

At present the financial cost of coastal aggregate extraction to the operator is minimal. In some areas this is the main reason for exploiting this resource. However the cost of landscape destruction and land-use destruction is not cheap. Small aggregate extraction operations can and do destroy our coastline. A large number of cases around New Zealand's coastline exist where erosion has resulted because of aggregate extraction. This coastal erosion due to aggregate extraction often threatens urban development. The extraction of coastal aggregate then becomes very expensive to the property owner with an eroding coastline.
8.1.4 Changes Needed

Every coastline that is made up of sand and gravel should not be seen as a cheap and easily available source of aggregate. In the past and at present this attitude has led to devastating erosional events and landscape destruction.

A change is needed in how we view the coastline that surrounds New Zealand. The coastline is used and valued by many people who rate highly the natural rugged quality of this landscape. This landscape quality is destroyed with aggregate extraction.

Aggregate is widely available from other sources including open pits and hard rock quarries. These sources should represent the bulk of our aggregate supply. It is much easier to rehabilitate an open pit than it is to restore an eroding coastline.

The coastline needs protection through adequate legislation and a concerned population. This is the only way that the natural quality of the coastal landscape will be retained. To preserve this natural character further all coastal aggregate extraction must be stopped.
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