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COASTAL OUTFALLS:

Proceedings of a workshop, Christchurch
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Edited by
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Water Quality Centre
Ministry of Works and Development
Hamilton

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COASTAL OUTFALLS: Proceedings of a workshop, Christchurch, 4 December 1985.

Edited by D. S. Roper and B. L. Williams, Water Quality Centre,
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Proceedings of a workshop on coastal outfalls are presented. The objectives of the workshop were to identify problems associated with coastal outfalls in New Zealand and to discuss planning, management and research requirements to alleviate problems where they exist. Four position papers are included, followed by a summary of workshop discussion.

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Front Cover The construction staging for the new Timaru City sewage outfall, located 3 km north of the old shoreline discharge site. The outfall diffuser (120 ports) is located 450 metres offshore in 6 metres of water.
Photo: R. G. Bell, Water Quality Centre, Ministry of Works and Development, Hamilton.

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CONTENTS

PREFACE

On 4 December 1985, a workshop on "Coastal Outfalls" was held at the University of Canterbury, Christchurch, as part of the 1985 Australasian Conference on Coastal and Ocean Engineering. The workshop was organised by staff of the Water Quality Centre (Water and Soil Directorate, MWD). The 80 people who attended included representatives from regional water boards, city councils, government departments, and universities, plus many overseas engineers and scientists (see appendix 1).

The objectives of the workshop were:

1 To identify problems associated with coastal outfalls in New Zealand.

2 To discuss planning, management and research requirements to alleviate problems where they exist.

The 3.5 hour workshop began with the presentation of the four position papers which appear in this document. (These had been precirculated to most participants beforehand.) Responses to the position papers were then given by a panel, consisting of Prof. Margaret Loutit (University of Otago), Mr W.E. Bayfield (Taranaki Catchment Commission) and Mr R.J. Weaver (Timaru City Council). This was followed by general discussion. The proceedings were chaired by Mr I.W. Gunn (University of Auckland).

A summary of the discussion and recommendations was subsequently sent for verification to all those participants who spoke. Together with the position papers this summary was also sent for comment to the regional water boards listed in appendix 2. Some minor changes were subsequently made.

We would like to thank all participants, and the regional water board officers who commented on the proceedings. We are grateful to Dr R.G. Bell and Messers R.W. Fullerton and H. Missen who recorded the workshop discussion; to Messers E.G. Fox and I.W. Gunn who acted as referees; and to Mrs Mary Stokes for typing the manuscript. We are also grateful to Mr Gunn for chairing the workshop so skilfully.

D.S. Roper
B.L. Williams
Workshop Organisers

INTRODUCTION TO COASTAL OUTFALLS IN NEW ZEALAND

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1 INTRODUCTION

This paper presents introductory information on the major coastal outfalls in New Zealand, briefly outlines procedures for controlling discharges, and summarises recent work done in New Zealand.

DEFINITIONS

Coastal outfall.	An outfall discharging community and or industrial waste into saline waters.
Ocean outfall.	A coastal outfall sited along the open coast.
Estuarine/harbour outfall.	A coastal outfall sited in an estuary or a harbour.

In addition, the terms **offshore** and **shoreline** are used in this document to distinguish between ocean outfalls that discharge into deeper offshore waters and shallow shoreline waters, respectively.

2 MAJOR COASTAL OUTFALLS

Major outfalls are regarded as those discharging, on average about 0.1 $m^3.s^{-1}$ or more. With many cities sited along the coastline, approximately 60% of New Zealand's community sewage is discharged into coastal waters (Gunn, 1980). There are also many minor discharges, many of which discharge on the shoreline. The wide continental shelf around much of New Zealand results in offshore ocean outfalls being sited at depths ranging from 4 to 24 m; which is shallow compared with those in some countries (e.g., USA, Australia).

Figure 1 shows a breakdown of the 32 major coastal outfalls on the basis of their wastewater source and the receiving water. Figure 2 indicates the proportion of ocean outfall installations adopting the various options for treatment. Only six of the twenty three ocean outfalls discharge wastewater

after secondary treatment compared with seven of the nine estuarine/harbour outfalls.

Further details on the 32 coastal outfalls are listed in Table 1, and their locations are indicated in Figure 3. Additional information on the 17 ocean outfall discharges receiving primary treatment or less is presented in Table 1 of Smith et al. (1986). Improvements are in progress, or at least proposed, for most of the shoreline ocean outfalls discharging relatively untreated sewage.

3 EFFLUENT DISCHARGE CONTROL PROCEDURES

The quantity and quality of effluent discharged is controlled by a system of water rights under the Water and Soil Conservation Act 1967. The regional water board issues the discharger with a legally binding right which permits the discharge of wastewaters complying with specified conditions. The discharger must provide adequate wastewater treatment or source control measures to ensure that the discharge complies with the granted right. Water right procedures and related topics are elaborated in Boshier (1986).

4 RECENT STUDIES IN NEW ZEALAND

Staff of several regional water boards, scientists at the Water Quality Centre, university researchers and others (e.g., consultants) have conducted intensive studies on ocean outfalls and related topics in the last few years. Most of this work has been directed at developing proposals for new outfalls, although some effort has also been directed at evaluating the performance of existing ones. A comprehensive handbook coordinated by Water Quality Centre scientists, dealing with the design and monitoring of ocean outfalls has been published (Williams, 1985).

Callaway (1985, 1986) (NRAC Fellow: October 1984-September 1985) has reported on aspects of New Zealand outfall performance. He concludes that some poor waste discharge practices are evident and recommends that scientific, engineering and public relations efforts continue in order to improve the quality of our coastal environment.

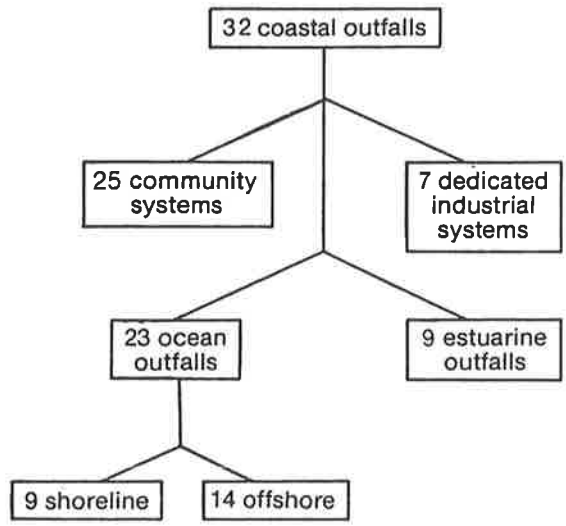

Figure 1. Breakdown of major coastal outfalls in New Zealand.

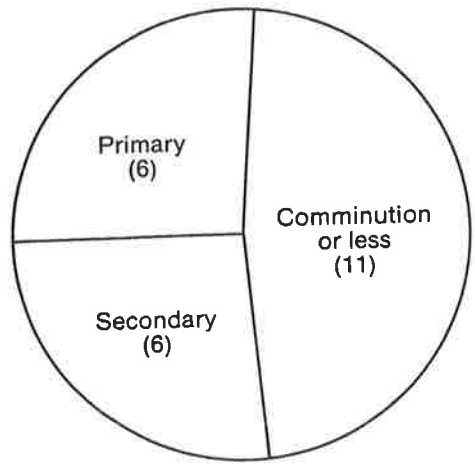

Figure 2. Treatment applied to ocean outfall discharges. (Numbers indicate the number of installations adopting that treatment provision.)

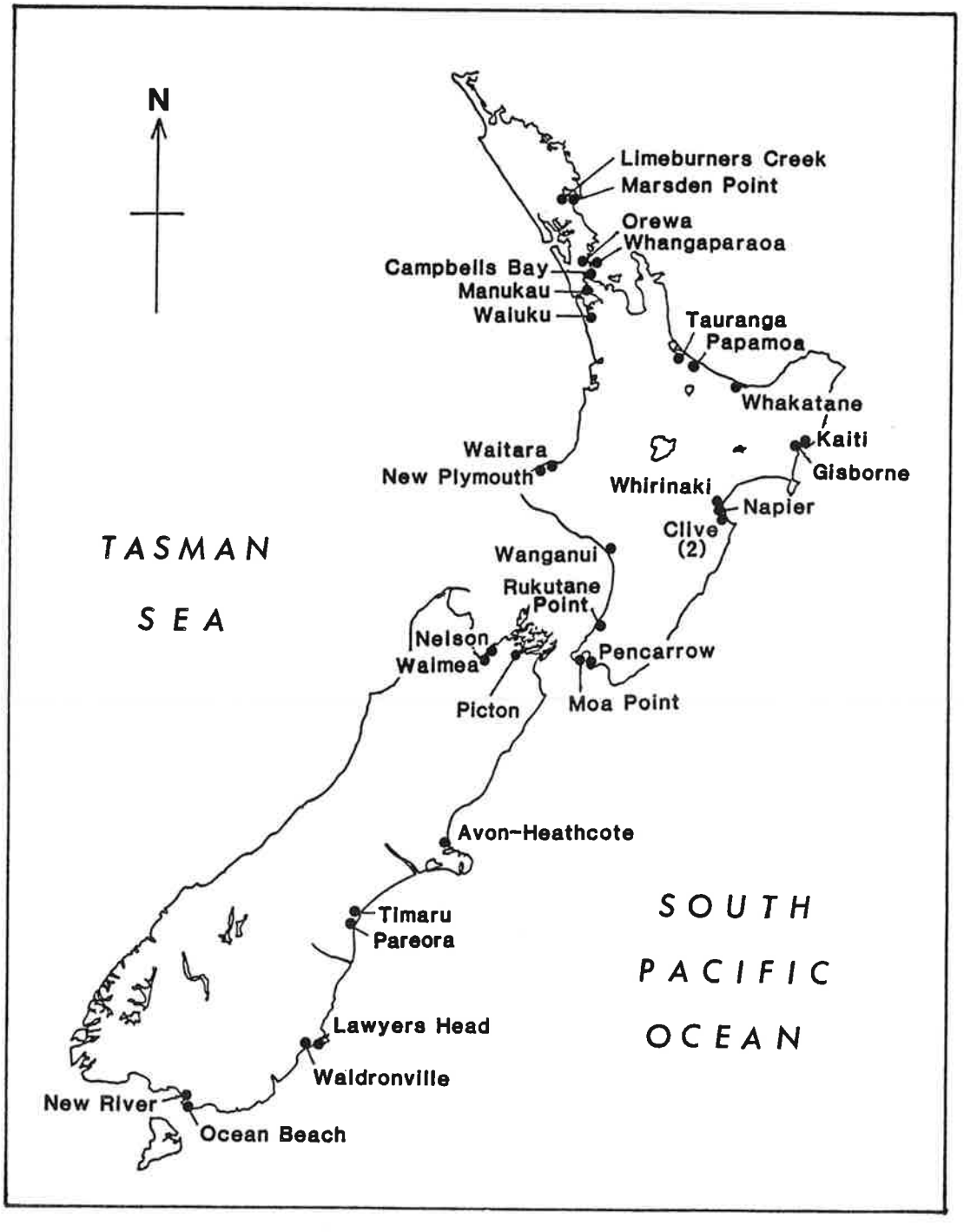

Figure 3. Locations of major coastal outfalls in New Zealand. There are also many minor discharges (not indicated) along the coastline.

5 CONCLUSION

In view of the attention coastal outfalls in New Zealand have received in recent years, it is timely to pause and identify outstanding problems, discuss appropriate remedial measures and formulate any pertinent research needs.

ACKNOWLEDGEMENTS

I am grateful to Messers I.W. Gunn (University of Auckland) and E.G. Fox (Ministry of Works and Development) and Dr N.M. Burns (Water Quality Centre) who refereed this paper.

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		Receiving Water Type		Discharger		Comments		Technical Details		
Outfall Site Name	Local Authority or Industry	Ocean	Estuary or Harbour	Local Authority	Industry	Secondary treatment	Improvement proposed or in progress	Outfall length(m)	Outlet depth(m)	Flow ADDWF** ($m^3.s^{-1}$)
Limeburners Creek	Whangarei City Council		X	X		X	X	*	-	0.11
Marsden Point	New Zealand Refining Co		X		X	X		120	12	0.10
Orewa	Rodney County Council	X		X		X		880	4	0.14
Whangaparaoa	Rodney County Council	X		X				900	24	0.03
Campbells Bay	Northshore Drainage Board	X		X		X		610	10	0.29
Manukau	Auckland Regional Authority		X	X		X		*	-	3.0
Waiuku	NZ Steel Ltd		X		X	X	X	*	-	0.11
Tauranga	Tauranga City Council		X	X		X	X	1000	6	0.08
Papamoa	Mt Maunganui Borough Coun.	X		X		X		915	12	0.22
Whakatane	Whakatane District Council	X		X		X		500	10	0.05
Kaiti	Gisborne Refrig. Co	X			X			1160	12	0.09
Gisborne	Gisborne City Council	X		X				1830	17	0.19
Waitara	Waitara Borough Council	X		X			X	1230	11	0.35
New Plymouth	New Plymouth City Council	X		X		X		450	5	0.37
Whirinaki	Whirinaki Mill (COKPP Ltd)	X			X			244	10	0.11
Napier	Napier City Council	X		X				1500	11	0.15
Clive (offshore)	Hastings City Council	X		X				2950	13	0.80
Clive (shoreline)	Hastings City Council	X		X				*	-	0.20
Wanganui	Wanganui City Council	X		X				1800	10	0.59
Rukutane Point	Porirua City Council	X		X			X	*	-	0.23
Moa Point	Wellington City Council	X		X			X	*	-	0.50
Pencarrow	Hutt Valley Drainage Board	X		X			X	*	-	0.52
Nelson	Nelson City Council	X		X		X		500	12	0.09
Picton	Picton Borough Council		X	X				75	16	0.08
Waimea	Nelson Regional Authority		X	X	X	X		570	6.5	0.14
Avon-Heathcote	Christchurch Drainage Board		X	X		X		*	-	~ 1.4
Timaru	Timaru City Council	X		X			X	*	-	0.23
Pareora	Canterbury Frozen Meat Co	X			X			*	-	0.10
Lawyers Head	Dunedin City Council	X		X				*	-	0.06
Waldronville	Green Island Borough Coun.	X		X			X	*	-	0.13
New River	Invercargill City Council		X	X				*	-	0.15
Ocean Beach	Ocean Beach Freezing Co	X			X			*	-	0.18

Table 1. List of major coastal outfalls in New Zealand. (The outfalls are listed in order from north to south. Major outfalls are defined as those discharging about or in excess of 0.1 $m^3.s^{-1}$. The outfalls at Whangaparoa, Whakatane, and Lawyers Head have also been included for completeness.)

*Indicates a shoreline discharge.
**ADDWF Average daily dry weather flow.

IMPLICATIONS FOR THE MARINE ENVIRONMENT

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1 INTRODUCTION

It is now generally accepted that carefully sited and planned ocean discharges of appropriately treated sewage effluents, via properly functioning deep, long sea outfalls, are a satisfactory means of sewage disposal (Bascom, 1974; Cole, 1979; Waldichuk, 1985; Water Authorities Association, 1984). This paper attempts to review the success, or otherwise, of major coastal outfalls in New Zealand with respect to biology, public health, aesthetics and nuisance problems, and Maori cultural values. Ways of dealing with outfall derived problems are covered and points relating to management and research needs are presented for discussion at this workshop. The names and locations of outfalls are given by Williams (1986).

2 BIOLOGICAL ASPECTS

The biological effects of New Zealand coastal outfalls are discussed in two sections, the first covering general effects of ocean and estuarine outfalls and the second covering effects of toxic substances (i.e., toxic chemicals and heavy metals).

2.1 General Effects

Ocean outfalls. Biotic changes are usually restricted to the benthos in the vicinity of an outfall (Pike and Gameson, 1970). Nearly all of the few New Zealand biological studies to date indicate that effects around ocean outfalls occur within a few hundred metres of the discharge. For example, the Pencarrow outfall, when discharging untreated sewage (0.5 $m^3.s^{-1}$) at low water mark, produced a "severe" impact within 50 m of the outfall, lesser impact out to 200 m, and at 500 m no effect could be discerned (Steven, Fitzmaurice and Partners, 1981). The Moa Point outfall, where untreated sewage is discharged (0.5 $m^3.s^{-1}$)

into an embayment at low water mark, produces the most obvious effects within 250 m of the outfall, and possible effects occur between 250 and 600 m away within the bay. Included in such effects were stunting of seaweed growth and a reduction in the species diversity and abundance of seaweeds. Changes in the patterns of occurrence and reduced vigour affected some invertebrates, while the diversity and abundance of others were increased (Beca Carter-Caldwell Connell, 1980).

However, the first published study of the biotic impact of a New Zealand ocean outfall did not support this notion of limited change (Knox and Fenwick, 1981). This study looked at the old Clive outfall which discharged untreated sewage (1.6 $m^3.s^{-1}$) through a short outfall, just 50 m offshore. Pollution effects were assessed by making a detailed analysis of benthic invertebrates. Community structure (measured in terms of diversity, richness and equitability) increased steadily moving offshore away from the outfall, and the total density of organisms was raised in a zone between 0.25 and 2 km offshore. Knox and Fenwick (1981) concluded that "the faunal transition resulting from sewage enrichment extends for more than 5 km from the sewage source. Although no abiotic zone was detected, an opportunistic zone was very obvious, extending 1.5-2 km from the outfall. Beyond this a transition zone extends for more than 3 km."

It is quite possible, however, as Knox and Fenwick (1981) noted, that many of the changes reported in this work were attributable to natural patterns of zonation associated with increasing distance from shore, and were not caused by the discharge.

A recently completed study of the Clive (offshore) and Gisborne outfalls (Roper et al., in prep.) forms the most detailed of any yet carried out in New Zealand and reinforces the notion of limited change. These outfalls discharge, respectively, 0.8 and 0.2 $m^3.s^{-1}$ comminuted, combined domestic and meat works waste. At both sites biotic, physical and chemical effects extend to only a few hundred metres either side of the outfalls. Numbers of benthic macrofauna species were reduced at the diffusers and possibly up to 400 m on either side. Total numerical densities were also low at the diffusers, but tended to increase above background levels between 100 to 400 m away. Sediment concentrations of total volatile solids, readily oxidisable carbon, total Kjeldahl nitrogen and oil and grease peaked at the outfalls. Changes in sediment particle size tended to produce a dominance of a very fine sand fraction at the outfalls.

Estuarine outfalls. The restricted water circulation within estuaries results in outfall discharges being dispersed more slowly than on the open coast. The increased levels of nutrients that can result, have been known to stimulate the growth of seaweeds which then smother more desirable life on the mudflats. When these large masses of seaweed rot they are malodorous and affect the estuarine ecosystem further by causing deoxygenation of the sediments and overlying water. Well known incidences of 'nuisance' growths of seaweed, apparently related to sewage outfalls, have occurred in the Avon-Heathcote Estuary (Knox and Kilner, 1973), Manukau Harbour (Henriques, 1978), Waimea Inlet and Nelson Haven (Nelson Catchment Board, unpublished data). Also, Williams and Rutherford (1983) suggested that if sewage inputs into the Upper Waitemata Harbour continue to increase, future nuisance algal growths are possible there.

Low dissolved oxygen concentrations associated with outfall discharges have also been found in the upper Whangarei Harbour and the Otamatea River estuary (G. Venus, Northland Catchment Commission, pers. comm.). Deoxygenation seems to have been caused jointly by the presence of oxidisable material in the effluent, and the stimulated growth of phytoplankton. In these 2 instances, however, no obvious biological effects on the estuarine fauna have been found.

2.2 Toxic Substances

Organic chemicals. New Zealand does not have a significant organic chemicals manufacturing industry. Therefore toxic organic chemicals are unlikely to be present in significant concentrations in the majority of wastewaters. Potential exceptions to this are from pulp and paper manufacturing (discharging toxic materials present in wood and by-products formed during processing) and petrochemical plants (which may discharge phenols and hydrocarbons) (Shanks, 1982).

Some industrial plants have cooling systems which require the use of biocides, dispersants and corrosion inhibiting compounds. Modern compounds are wholly organic and possess toxic properties. Information on the environmental consequences of discharge of such chemicals, and their degradation products, is not always available and toxicity testing is sometimes performed prior to their use (Power, 1984). Generally speaking, modern corrosion inhibitors tend to be innocuous chemicals, and most biocides are relatively innocuous to non-target organisms such as shellfish and fish (Power, 1984).

The wastewaters from modern industries receive extensive treatment prior to discharge, and concentrations of toxic organics are low and probably of little consequence. For example, Larcombe (1983) found no effects which compromised the integrity of the ecosystem as a result of the New Zealand Refining Company wastewater discharge into Whangarei Harbour. Petrochemical industries in North Taranaki have only recently been commissioned and will be the subject of continuing investigations. Ecological effects of the only pulp and paper discharge to coastal waters (at Whirinaki) have not been investigated.

Heavy metals. Sources of metals to the New Zealand aquatic environment, their chemistry and biology, and their effect on aquatic organisms have recently been extensively reviewed (Smith, in press). All wastewaters contain heavy metals, many of which are essential to the well-being of biota, and some of which are not essential but tolerated at low levels. However all heavy metals can be toxic to aquatic organisms if the concentration is high enough and exposure time sufficient. All aquatic organisms concentrate heavy metals present in surrounding waters, sediments or food. Some metals (e.g., mercury) may be biotransformed into other, more toxic, metal species. Biomagnification (i.e., increases in the concentration of elements in biota at higher trophic levels) is not a common mechanism for heavy metals; however, elevated levels of mercury do occur in some fish higher in the food chain (van den Broek et al., 1981). These concentrations are likely to be natural and not the result of discharges.

In terms of mass load, municipal wastes may, in the absence of urban runoff, be a major contributor of heavy metals to partially enclosed water bodies such as estuaries. It is possible that there will be some localised sediment and shellfish contamination, although there is little evidence to suggest that this is taking place to any marked extent at present (Smith, in press). Because these discharges are likely to continue indefinitely, their effects on sediments and shellfish require long-term, but low-level, monitoring.

Industries with dedicated outfalls are now few in number. The New Zealand Steel Ltd. discharge into the Waiuku River estuary has been extensively studied and shown to have caused no major adverse biological effects in the immediate outfall area, although some enrichment of several metals has occurred in sediments and Pacific oysters (Larcombe, 1984). Some discharges in the past, which were not controlled, have caused considerable elevation of metal

concentrations in sediments. For instance, a tannery waste discharge into Sawyers Bay, Otago Harbour, caused very high localised chromium concentrations in the sediments (Smillie, 1980). The environmental consequences of this have been described by Thrush (1980). Ecological changes appeared to extend throughout the intertidal area of the bay, but the presence of several other discharges made it difficult to assign the observed effects solely to the tannery effluent.

Fluoride. Pankhurst et al. (1980) examined the ecological effects of a fertilizer works discharge into Otago Harbour. They found that fluoride in the effluent appeared to be affecting the distribution and abundance of organisms up to 400 m from the outfall.

3 PUBLIC HEALTH

3.1 Microbiological aspects

Effects of waste discharges on human health can arise because of ingestion of bacteria and viruses during bathing in contaminated water, or by consumption of contaminated shellfish.

The risks to human health in New Zealand have recently been summarised by Fox (1984, 1985).

Risks are related to:

i disease incidence in the community;
ii level of waste treatment;
iii adequacy of outfall design;
iv proximity of outfall to bathing beaches or shellfish gathering areas.

Many old outfalls in New Zealand are poorly sited and discharge either on, or close to, bathing beaches (e.g., Rukutane Point, Timaru) or shellfish gathering areas (e.g., Moa Point). This is clearly unsatisfactory. Recently constructed outfalls tend to be sited more appropriately (e.g., Clive (offshore), Wanganui). Nonetheless, the potential for disease in humans is still of concern to many people and these concerns require attention. This potential is often assessed by conducting microbiological surveys. Normally, waters are analysed for the presence of faecal contamination indicators (i.e., coliform bacteria). The use of faecal coliforms, and more especially total coliforms, as indicators of sewage contamination may not be adequate (Cabelli et al., 1983), but numerical coliform standards are used in our

legislation. One major problem in using coliform bacteria is that they are not specific to outfalls and may come from a variety of sources (e.g., birds, urban stormwater, farmland runoff, rivers). The interpretation of surveys is often confounded by this multiplicity of sources, and elevated coliform concentrations in coastal waters cannot always be ascribed to outfalls. For instance, in 1971 the foreshore waters off Gisborne were found to contain faecal coliforms derived from nearby rivers and not from the submarine sewage outfall which was 1830 m out to sea (H.C. Williams, Gisborne City Council, pers. comm.). Faecal coliform contamination of coastal waters near the Rukutane Point outfall was attributed to adjacent farmland run-off as well as the sewage outfall (Wellington Regional Council, 1983).

While the extent of microbial contamination around coastal outfalls is not clear, recent work suggests that bacterial contamination of sediments extends 8 km from the Lawyers Head outfall (Loutit and Lewis, 1985).

Bathing. Based on considerable work carried out overseas (e.g., WHO, 1975) and experienced medical opinion in New Zealand, Fox (1985) stated that "the health hazard from swallowing infected water while bathing can, in the case of sea water, be dismissed for all practical purposes". Certainly, the risk of contracting a serious (i.e., notifiable) disease in New Zealand from bathing in sewage-contaminated sea water seems slight, due in part to the low disease incidence in the community. Obviously the risk is increased if wastewaters are discharged directly into an area of human recreation (e.g., Lawyers Head, Moa Point, Timaru).

The risk of contracting a minor infection (i.e., gastrointestinal disease symptoms) from bathing in sewage contaminated water has been assessed in terms of concentrations of indicator-organisms (Cabelli et al., 1983). Although the linkage between indicator-organism concentration and disease incidence is not clear, adherence to indicator-organism standards for bathing waters will provide some protection to bathers.

Shellfish consumption. Filter feeding shellfish (e.g., cockles and mussels) concentrate bacteria and viruses in their gastrointestinal tracts. These portions of the shellfish can be consumed by humans. There is also evidence that flesh of non-filter feeding shellfish (e.g., paua) can also be contaminated (Patrick and Hendrick, 1980). Therefore there is considerable potential for

human disease if shellfish taken from sewage contaminated waters are consumed. Consumers receive some protection if microbial standards (in terms of indicator-organism concentrations) are applied to the waters, and shellfish are depurated and/or cooked prior to consumption. However, depuration is less effective at reducing virus concentrations.

There are about 10 cases of the notifiable disease typhoid (Salmonella typhi) in New Zealand per year. From 1977 to 1984, 23 adult cases of typhoid were admitted to Auckland Hospital. Of these, 5 were possibly related to the consumption of sewage contaminated shellfish (Downey et al., 1986). There are instances of Hepatitis A seemingly related to the ingestion of shellfish contaminated by outfall discharges. The incidence seems low; for example, the New Plymouth District Health Office has recorded only one such possible instance (B.J. Archer, Department of Health, pers. comm.). Investigations by the Napier District Health Office, for the period 1968 to 1984, showed that one of the 2924 notified cases of putative food-borne illness was related to the consumption of shellfish taken near an outfall (Wilcox, 1985). The other causes are not stated. The significance of this case is not clear because the shellfish (mussels) were "loose" when gathered. A survey of mussels for bacterial and viral quality was carried out in 1984/85 at reefs 6 km south-east (i.e., down current) of the Clive (offshore) outfall. The mussels "were found to be of excellent microbial quality" and viruses were not detected (Wilcox, 1985).

The Whangarei District Health Office has no record of any outbreaks of food poisoning, hepatitis or enteric infections attributable to consumption of shellfish from Whangarei Harbour (Brownlie, 1983), despite the presence of a sewage outfall from Whangarei city. However, it is not clear how close to the outfall shellfish are harvested.

Signs warning against shellfish gathering are sometimes erected, by the Department of Health, adjacent to shellfish beds thought to be contaminated by sewage. However, they may be ignored by the public (e.g., Wilcox, 1985).

It is possible that many minor and self-limiting cases of illness go unreported, and even with reported cases it is difficult to ascribe causes. Hence the full effects that sewage outfalls are having on human health are not easily assessed. However, it is axiomatic that sewage should not be discharged near shellfish gathering areas.

3.2 Other

Two other aspects of concern to human health and wellbeing due to shellfish consumption are the possibility of toxic and carcinogenic substance ingestion, and tainting of the flesh itself.

Toxic and carcinogenic substances. Of interest here are toxic heavy metals, and organic substances which are toxic and/or carcinogenic to humans. Fox (1985) has stated that the health risk from consumption of shellfish containing heavy metals is low, and not expected to be enhanced by most outfalls. We know of no instances where there have been adverse human effects attributed to heavy metals contained in New Zealand shellfish. Indeed, in view of the low levels of metals normally found in New Zealand shellfish (Smith, in press), adverse human health effects are extremely unlikely as a consequence of consuming shellfish taken from even close by legal waste discharges.

Organic chemicals do not seem likely to pose problems mainly because substances which are likely to cause problems are discharged in very small quantities. The Marsden Point oil refinery discharge, which contains low levels of potentially toxic and carcinogenic substances, does not seem to have had any effect on human health, and commercial shellfishing in nearby waters has expanded (Brownlie, 1983).

Tainting. Tainting of shellfish is likely to be a problem only if they contain extremely high metal concentrations, which is unlikely, or if certain organic substances are present. There are no known tainting problems in New Zealand caused by metals. If some organic substances (e.g., phenols) are chlorinated, the potential for tainting is enhanced. Wastewaters discharged to our coastal waters are chlorinated only at Lawyers Head and New Plymouth and, because wastes are not likely to contain sufficiently high concentrations of the organic compounds which cause tainting, it is not likely to be a problem. Hydrocarbons and phenols discharged from the oil refinery at Marsden Point have the potential to cause tainting of shellfish. Tainting has occasionally been reported to the Department of Health in Whangarei but thus far spillages of oil seem to have been the cause, not the discharges from the outfall (G. Venus, Northland Catchment Commission, pers. comm.; Brownlie, 1983).

4 AESTHETICS AND NUISANCES

An important consideration in evaluating the performance of coastal outfalls is the extent to which a discharge detracts from the aesthetic or amenity value of nearby coastal waters or the adjacent coastline (particularly beaches), or causes a nuisance in other ways. Reaction to these effects is partly subjective and will reflect differing individual and community expectations and values, and access to the area under consideration.

The main undesirable manifestations of coastal outfalls are:

i discoloration of water;
ii slicks on water;
iii floatables on water;
iv suspended material in water;
v deposits on shore;
vi odours.

There are no reports of aesthetic or nuisance problems as a direct consequence of any coastal outfalls which discharge secondary treated effluent.

Problems associated with large ocean outfalls without secondary treatment, are presented in Table 1. For convenience, the table distinguishes between shoreline and offshore discharges. Seven of the nine major shoreline outfalls have attracted public criticism for many years. The Ocean Beach and Clive (shoreline) outfalls have not been so contentious because of their remoteness. The Pareora meatworks outfalls, which discharge untreated wastes above high water mark onto a beach south of Timaru, have been regarded as eyesores and quite unacceptable. There are numerous smaller outfalls around the country which, because of a lack of readily available information, are not included in this discussion.

Although discoloration, slicks and floatables have been reported as problems associated with offshore discharges, because of their distance from shore they attract less public attention than problems arising from shoreline discharges. The long submarine outfalls at Gisborne, Clive, Napier, Waitara and Wanganui have not always been effective in avoiding the deposition of material (particularly fat) on adjacent beaches. Until recently, fishermen have also reported clogging of their trawl nets, whilst fishing in Hawke Bay, as a result of wool fibre discharged from the Hastings outfall (A.D. Carruthers, Ministry of

Agriculture and Fisheries, pers. comm.). Although outfalls, especially shoreline discharges, will always be a potential source of odours there is little reported evidence that this is a real problem.

5 MAORI CULTURAL VALUES

The Maori people of New Zealand hold the sea and its food resources as being vital to their cultural identity (O'Regan, 1984). Traditionally they have harvested food from the sea and their rights in this regard are enunciated in the Treaty of Waitangi. Different tribes have the stewardship of certain fishing grounds and reefs. Such reefs may be subdivided so that tribal subgroups (hapus) each have stewardship of designated areas. Thus if one sector of the reef system is detrimentally affected by a discharge it is no easy matter for the traditional apportionment to be reviewed.

Traditionally the sanctity of the sea was preserved and therefore coastal waste disposal, particularly of human waste, is regarded as objectionable (Hughes, 1986). It is therefore particularly important, over and above more general ecological considerations, to ensure that seafood resources important to Maoris are protected from any contamination originating from a coastal discharge. The proceedings of the Waitangi Tribunal (1983) and the special Act passed by Parliament in 1983 to deal with the Motunui discharge highlighted the increasing need to carefully consider the Maori perspective very early in the course of the investigations for an ocean outfall.

It is also worth noting here that there may also be Maori cultural values associated with coastal land where outfall shore stations, treatment plants or pipelines are proposed (e.g., Moa Point).

6 SUMMARY OF EFFECTS OF OUTFALLS

In general, biological effects around New Zealand outfalls appear to be very limited, although nutrient enrichment and subsequent 'nuisance' growths of algae can occur in estuaries. Neither toxic organic compounds nor heavy metals seem to be having a deleterious biological effect. Discharge of these chemicals is controlled partly by the water rights procedure and, although there is sometimes difficulty in deriving defensible conditions, such investigations that have been carried out indicate that the conditions seem adequate to protect the environment.

For a variety of reasons, it is difficult to assess the extent of microbial contamination of marine waters caused by sewage outfalls. However, it appears

that the risk of contracting disease as a result of bathing in water contaminated by sewage is slight. While there is considerable potential for human illness if sewage contaminated shellfish are consumed, the available evidence suggests that serious health problems are not occurring. The incidence of minor self-limiting ailments, which will frequently go unreported, is not known. There does not seem to be any documented evidence of tainting of shellfish, or ill-effects in humans due to consumption of shellfish which have been affected by toxic or carcinogenic substances, as a result of wastewater discharge. However, the extent to which shellfish are gathered around outfalls is not known.

Estuarine and ocean outfalls which discharge secondary treated effluent do not directly cause aesthetic or nuisance problems. (In estuaries indirect effects such as algal blooms may occur.) Aesthetic concerns mainly arise from unsightly shoreline outfalls discharging untreated sewage. Occasional problems arise from most of the long outfalls as a result of shoreline deposition of debris.

Many existing outfalls offend Maori cultural values.

7 SOLUTIONS TO PROBLEMS

Shoreline discharges can be improved by either upgrading the pretreatment or relocating the outlet offshore, or a combination of both. The Lawyers Head and Ocean Beach outfalls have been upgraded using the first option, and the remainder have opted for the third option. The Waldronville and Timaru outfalls are currently being upgraded but procedural difficulties have stalled progress at Moa Point and Rukutane Point. A milliscreening plant has already been installed in Lower Hutt for the Pencarrow discharge and submarine extension of the outfall has been proposed (Steven, Fitzmaurice and Partners, 1981).

The options available to the municipal offshore dischargers (notwithstanding an outfall relocation) are the implementation of an effective source control programme and/or installation of some form of additional treatment. Hastings City Council has made substantial progress on the reduction of wool fibre discharged, by focusing on source identification and control for the Clive outfall (K. Thomson, Hastings City Council, pers. comm.). Chlorination of wastewaters can alleviate microbial contamination of receiving waters and shellfish. This has been employed at the Lawyers Head and New Plymouth outfalls.

The two industries with dedicated outfalls, the pulp and paper mill at Whirinaki and the meat works at Gisborne, have upgraded their treatment systems to alleviate the nuisance and aesthetic problems caused by wood fibre and fat respectively.

To reduce the occasional aesthetic problems caused by surface slicks and shoreline deposition of debris, additional treatment in the form of conventional primary sedimentation or milliscreening could be employed. Milliscreening is reported to be substantially cheaper on both a capital cost and maintenance cost basis (Beca Carter-Caldwell Connell 1980, Fitzmaurice and Hedgland, 1981). Both processes will remove at least 95% of the floatable solids, and between 35% and 50% of the grease, respectively (Fitzmaurice and Hedgland, 1981). The occurrence of slicks can also be reduced by increasing the initial dilution at the outlet.

Early consultation during the planning stage of outfall projects is essential to ensure that Maori cultural values are accounted for.

8 POINTS FOR DISCUSSION

This review set out to assess the environmental implications of coastal outfalls. This was hampered by a paucity of accessible data on all facets of outfall effects. However, certain management principles and topics for research do emerge and they are presented here for discussion.

The authors consider that the following points can be made:

Management

1 The disposal of milliscreened wastewaters via appropriately sited long sea outfalls is not likely to affect:
   (a) coastal ecosystems, provided due attention has been paid to toxic substances, or
   (b) the amenity value of the coast.

2 The risk of humans contracting serious disease via swimming in sewage contaminated water is slight. The risk of minor infection is greater but probably still not high.

3 Discharges of sewage should not contaminate seafood-gathering areas. Such areas should receive protection in accordance with New Zealand and/or

international water quality standards and criteria, and the Treaty of Waitangi.

4 Unsightly onshore and surf-zone discharges of any wastewater should be actively discouraged and efforts made to discontinue such discharge methods.

5 For discharges to partially enclosed water bodies, long-term low-level monitoring should be in place to assess the effects, on sediments and biota, of pollutants such as metals.

6 Regional water boards with coastal outfalls in their areas should consider the development of programmes to monitor these outfalls and publish their results on a regular basis. Monitoring efforts should include aesthetics.

7 In an endeavour to allay public fears of disease from swimming, and to put a perspective on the safety of shellfish consumption, available information on the effects on human health of coastal sewage discharge should be published.

Research

The following are recommended as topics for study.

1 The causal relationship between nutrient concentrations and algal growth in estuaries. (This has already been suggested by Williams and Rutherford 1983, and Rutherford 1983).
2 The incidence of disease-producing organisms (especially viruses) in New Zealand shellfish.
3 The risk of disease in humans by ingestion of contaminated shellfish.
4 The link between disease-producing organism concentrations in shellfish and sewage outfalls.

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Table 1 : Major aesthetic and nuisance problems reported for large (i.e., discharge > 0.1 $m^3.s^{-1}$) ocean outfalls (based on Callaway, 1985, 1986).
The major wastewater inputs are defined as domestic (D), meatworks (M), and other industrial (I).

Group	Outfall	Major wastewater input(s)	Treatment	Length	Problems				
					Discoloration	Slicks	Floatables	Suspended materials	Shore deposits
Shoreline discharges	Clive (shoreline)	I	Untreated	-	X				
	Lawyers Head	D	Primary + chlorination	-	X		X		
	Moa Point†	D	Untreated	-	X	X	X		X
	Ocean Beach	M	Milliscreen	-	X				
	Pareora	M	Screened	-	X	X?	X	X	X
	Pencarrow†	D	Milliscreen	-	X	X			
	Rukutane Point†	D	Comminution	-	X	X	X		X
	Timaru*	D,M	Untreated	-	X	X	X		X
	Waldronville*	D,M	Comminution	-	X		X		X
Offshore discharges	Clive (offshore)	D,M	Comminution	3000		X	X	X?	X
	Gisborne	D,M	Comminution	1830		X	X		X
	Kaiti	M	Fat reclaimers	1160	X				
	Napier	D	Comminution	1500			X		X
	Waitara†	D,M	Comminution	1230	X	X	X		X
	Wanganui	D,M	Comminution	1800			X		X
	Whirinaki	I	Screened	244				X?	

Note : The offshore outfall (900 m) at Whangaparaoa discharges primary treated domestic sewage but we are not aware of any problems.

Key : * Improvements in progress.
† Improvements proposed.

PLANNING AND PROCEDURES

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1 INTRODUCTION

The disposal of domestic sewage and industrial effluents to prevent health hazards and to minimize environmental effects has, over the years, exercised the minds and purses of both local authorities and industries in New Zealand. The responsibility for efficient disposal of effluents can generate a great deal of action or reaction from citizens. This paper outlines the procedures and statutory approvals required for an ocean outfall proposal and looks at the planning of some recent outfall proposals. As a number of these have encountered delays or resistance, this paper looks at some of the reasons that could have caused these problems. Finally some of the factors that can influence the acceptance or rejection of an ocean outfall by a community are given for the benefit of future outfall proposals.

2 PRESENT PROCEDURES

Before the construction of an outfall can proceed, there are several statutory and administrative procedures that have to be satisfied (Figure 1). A brief description of each procedure follows, although more detail on procedures can be found in Williams (1985).

2.1 Planning Approval

Planning approval under the district scheme provisions of the Town and Country Planning Act 1977 may be required for on-shore facilities such as a pumping station or treatment plant associated with the outfall. District Schemes are administered by the local territorial authority. There are several planning options depending on the ownership of the outfall, e.g., designation of land for the purposes of a public work, a change to the District Scheme (in terms of zoning) or a specified departure. A decision of the local authority can be appealed to the Planning Tribunal.

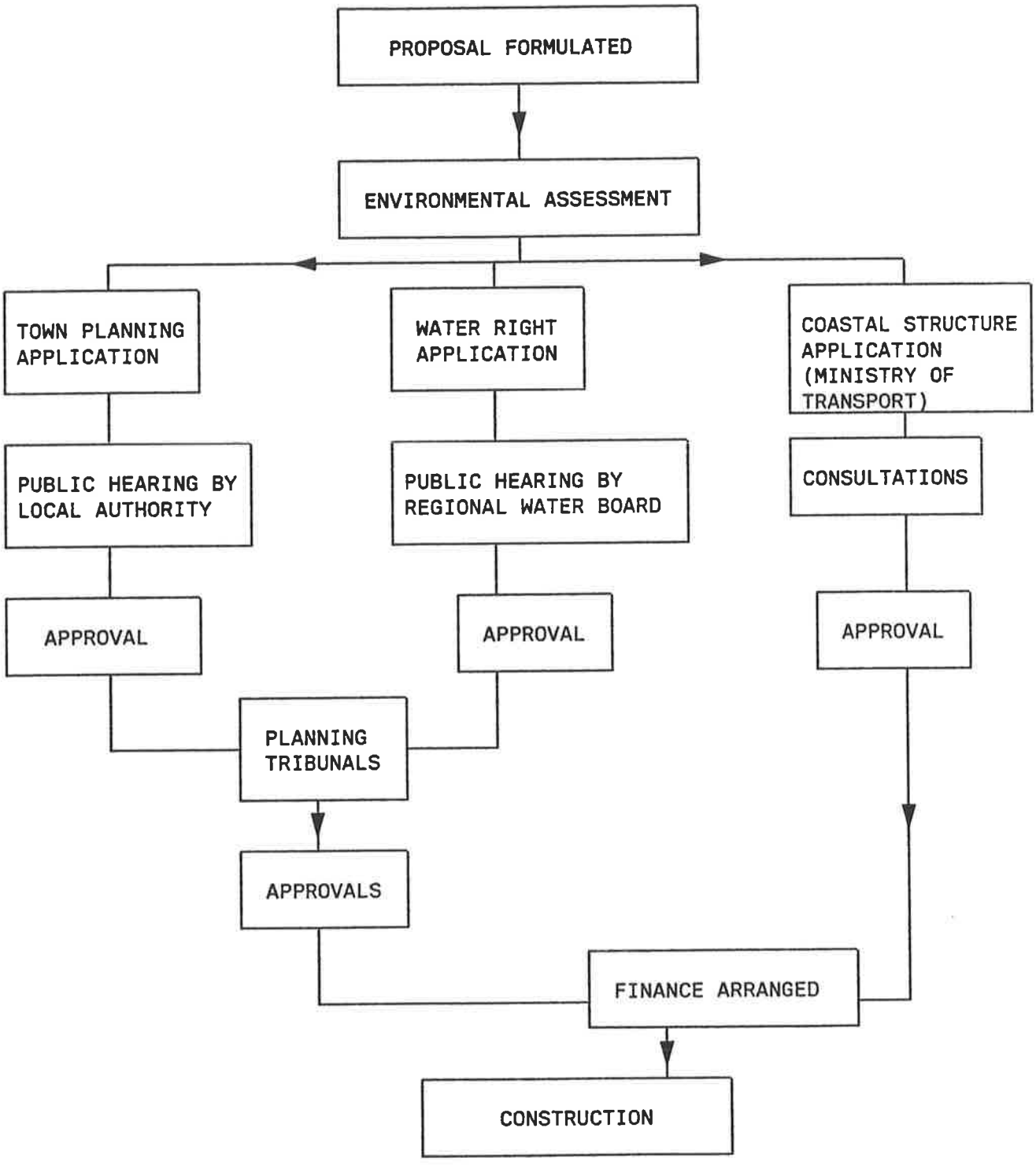

Figure 1. Procedures for ocean outfalls proposal

2.2 Outfall Construction

Approval is required under the Harbours Act 1950 to construct an outfall across tidal land, tidal waters or the bed of the sea. This act is administered by the Ministry of Transport and approvals are sought for the plans (Section 178) and a licence to occupy the area is sought (Section 162). An application must be accompanied by plans, consent of the landowner immediately behind the site, comments of the local authority and environmental information.

2.3 Effluent Discharge

The quantity and quality of the effluent which can be discharged from an outfall at a designated location is specified in a water right issued under the Water and Soil Conservation Act 1967. Water rights, other than Crown water rights, are administered by regional water boards who are required, when setting the terms and conditions of a water right to take into account the cumulative effect of all discharges on a body of water. A decision of the regional water board can be appealed to the Planning Tribunal.

In some cases the regional water board has preferred not to consider an application for a sewage discharge until the receiving waters have been classified under the Water and Soil Conservation Act 1967 by the National Water and Soil Conservation Authority (NWASCA). This involves setting minimum standards for the quality of the waters after a programme involving preparation of a draft classification, objections, promulgation of a final classification and appeals, if any.

2.4 Environmental Assessment

The Environmental Protection and Enhancement Procedures (EPEP) are administered by the Commission for the Environment, with government departments being responsible for incorporating the procedures into their operations including the licensing of private works. The process of environmental assessment of a proposal can range from a simple checklist through to detailed documentation in the form of an Environmental Impact Assessment (EIA) or an Environmental Impact Report (EIR), the latter being followed by an Audit undertaken by the Commission for the Environment. The purpose of the Procedures is to explore the options for effluent disposal and to predict the environmental impacts of an ocean outfall early enough in the life of a project for mitigation measures and public comment to be taken into account in the planning and design phases.

2.5 Subsidy Approvals

If a local authority requires a subsidy to assist in the provision of an ocean outfall for domestic sewage disposal then there is a two stage approval procedure administered by the Department of Health. The first of these stages is approval in principle. Documented environmental assessment is required by the Department to identify environmental impacts and if these issues will not be dealt with at any other approval procedure, then a more detailed environmental study will be required at the second stage of Ministerial approval. This is given only after all other statutory approvals, including recourse to the Planning Tribunal, have been granted.

2.6 Local Authority Loans Board

Because the cost of an ocean outfall is considerable a local authority usually raises a loan to meet its share of the cost. Application can be made to the Local Authority Loans Board and supporting technical information may be provided by the Department of Health and the Ministry of Works and Development. However, the issue of the Local Authorities Loans Exemption Order 1986 means that loans for major territorial authorities under $50M can be raised without recourse to the Loans Board. Other local authorities can raise loans up to $15M.

2.7 Order of Procedures

The order in which these approvals are usually sought is shown in Figure 1. Approval in principle was required for sewerage schemes prior to 19 May 1986 but since this date Government has cancelled the sewerage subsidy scheme. Those schemes that were lodged with the Department of Health prior to that date will be assessed by the department for subsidy eligibility.

The results of the changes in subsidy and in the source of loan money should shorten the time taken from formulation of a scheme to implementation. The time taken to gain approvals, however, is dependent on many factors including the complexity of the outfall proposal and the degree of public acceptance of the proposal.

2.8 Other Procedures

Under the National Development Act 1979 an Environmental Impact Report, planning matter, water rights, and other approvals may be considered at one hearing by the Planning Tribunal. This Act has been used for large energy projects but was repealed in 1986.

Another procedure involves the Treaty of Waitangi Act 1975 which established a Tribunal to make recommendations on claims brought by Maori people. The Tribunal can consider any claim "that a Maori or group of Maoris is or likely to be prejudically affected by legislation, policy or practice or act of the Crown and that these matters are inconsistent with the principles of the Treaty". The actions or policies that precipitate a claim must have occurred since 1975. There is presently a Bill before Parliament to amend this Act. An ocean outfall proposal may be included in a claim particularly if Maori fishing grounds could be affected.

3 PRESENT OUTFALL PLANNING

Some examples of ocean outfall proposals and the procedures they have encountered are oulined below. There are other examples of outfall proposals that have not approached construction stage but whose delay can be attributed to procedural difficulties combined with other factors (e.g., Moa Point and Rukutane Point).

3.1 NZ Synthetic Fuels Corporation GTG Plant at Motunui

An ocean outfall at Motunui on the north Taranaki coast was proposed for effluent disposal from the NZ Synthetic Fuels Corporation's gas to gasoline plant. Applications for approvals under the National Development Act were lodged in February 1981. An Environmental Impact Report was forwarded to the Commission for the Environment in the same month. As well as the Commission's Audit, there were other investigations by the Taranaki Regional Water Board, the Taranaki United Council and other groups proceeding at the same time. The Commission's Audit was completed in June 1981 and made a number of recommendations. With regard to effluent disposal the Audit suggested that a combined solution for all the north Taranaki effluent streams would improve coastal water quality and that this could be "offset" against the invevitable impacts large projects have on a rural area. The Planning Tribunal hearing for the project approvals began in August 1981 and continued for seven weeks. Opposition to the ocean outfall came from local environmental groups and the Te Atiawa people who were concerned that outfall construction and effluent discharges would detrimentally affect the shellfish on the Motunui reefs. The Planning Tribunal's report, issued in December 1981, gave approval to an outfall at Motunui but required the outfall length to be increased from 600 m to 900 m offshore. An appeal to the Court of Appeal on various matters connected with the Planning Tribunal's report and recommendation was lodged in January 1982 but

these matters were disallowed. Finally Te Atiawa took a claim to the Waitangi Tribunal on matters relating to the proposed construction of the outfall and the tribunal deliberated during 1982 on the Manukorihi Marae at Waitara.

The Waitangi Tribunal's decision, in April 1983, recommended, amongst other things, that an outfall should not be constructed at Motunui. The Government set up a Task Force in July 1983 to look at treatment and disposal options for all the wastewater streams in the Waitara area and to recommend appropriate options. This work is still proceeding and in the meantime treated effluent from the commissioning phase of the Synthetic Fuels Plant is being discharged through the outfall at Waitara under the authority of the Synthetic Fuels Plant (Effluent Disposal) Empowering Act.

3.2 NZ Refining Company, Expansion of Refinery

A new wastewater treatment system and a new outfall were planned for the Marsden Point refinery expansion. The Company prepared an Environmental Impact Report and submitted it to the Commission for the Environment in June 1979. It was the Company's intention to review and modernise the total water handling and treatment system. However, the Environmental Impact Audit, released in November 1979, stated that further work would be required before details of the anticipated process water discharge rights could be finalised (Commission for the Environment, 1979). The issue of containment of oil spills was also addressed. The Company applied for a water right for the discharge of treated effluent into Whangarei Harbour in September 1981. The public notification of the application was found to be incorrect and on readvertising about twenty objections were received. The Northland Regional Water Board set up a Special Tribunal to hear this application and their hearings took 12 days in all, over a period from February to September 1983. A right to discharge treated effluent was issued to the Company in November 1983.

The NZ Refining Company lodged an appeal to the Planning Tribunal on the wording of several special conditions as well as correcting an error in the location of the discharge point. An appeal was also lodged by a member of the public who wanted, amongst other things, the discharge to be piped into the ocean at Bream Bay. The Planning Tribunal heard these appeals in April 1984 at which time the minor corrections to the special conditions were made and several grounds of appeal were withdrawn by both the Company and the local citizen.

3.3 New Plymouth

The debate over an acceptable sewage treatment system for New Plymouth started about 1967 and reached a significant point in 1984 with the commissioning of the carrousel plant and the associated 450 m ocean outfall. A major part of this debate was whether primary treatment and a 1600 m ocean outfall or secondary treatment and a 450 m outfall was the most acceptable option. The former option was preferred by the Department of Health as a cost-effective solution while the latter option was advocated by a local environmental group. In 1979 a water right for the former option was obtained but the issue was carried into the local body political arena and resulted in a change in emphasis to secondary treatment and a short outfall. The Council applied and was granted a water right to discharge secondary treated sewage effluent through a short (450 m) marine outfall from the eastern side of the Waikwakaiho River mouth in 1981.

Upon application to the Department of Health for subsidy for the construction of the plant and outfall, the New Plymouth City Council was informed that the Department had reservations on the necessity of the outfall in light of the proposed secondary treatment. Council were requested to consider the option of discharging effluent into the Waiwakaiho River before the subsidy was considered. An application to vary the water right was made in November 1981 and a Special Tribunal of the Taranaki Regional Water Board considered the application in July 1982. The variation to discharge into the Waikwakahio River was declined by the Tribunal in its decision of August 1982 so the ocean discharge of effluent remained and the subsidy was duly granted.

3.4 Green Island Borough

The Green Island Borough Council has discharged untreated sewage at about the low tide level on the Waldronville Beach for many years.

In 1981 the Borough's consultants, involved in preparing a new scheme for treatment and discharge, recommended to Council that a process of consultation and public involvement be adopted from the outset. This procedure was followed and used to assist in selection of the most appropriate outfall location and associated effluent quality. Public comment was invited through the local media and a number of submissions were received from interested groups and individuals. These included underwater diving clubs, surf clubs, commercial fishermen, and residents of the area.

Once the most appropriate scheme was selected (incorporating a 500 m ocean outfall and advanced primary treatment plant) further discussions were held with the interested groups and individuals to fine tune the proposal.

The treatment plant site of 6 hectares was required to be designated for such under the District Scheme provisions of the Town and Country Planning Act. The same procedure of keeping people informed (especially the adjacent landowners) was followed with the result that no objections to the change in designation were received and planning approval was given by the Silverpeaks County Council in 1980.

In April 1985 the required six water right applications were lodged with the Otago Regional Water Board with whom there had also been considerable liaison. The applications were backed by a comprehensive support document that discussed the proposed scheme and all the investigations undertaken. That document, together with copies of the applications, were also made available to interested parties and groups, and for public inspection at the time the applications were being made.

No objections were lodged to the applications, and after discussions between the Regional Water Board officers and Borough's advisors, the Rights were issued. No formal hearings were required.

4 WHY THE PROBLEMS?

From this small sample of ocean outfall case studies it is apparent that the water right procedure is a crucial one in planning for an ocean outfall. This procedure has the capability of not only fulfilling its function to have a water right application granted or declined but also of being a public forum for issues that are related to the application. These issues could encompass the level of treatment an effluent should receive before discharge and/or the location options for an ocean outfall. The Water and Soil Conservation Act 1967 does not provide for discussion of these issues because the water right application must be made for a given quantity of effluent to be discharged at a designated location.

Nevertheless members of the public may feel that inadequate discussion on options has preceeded the water right application and so the public forum of last resort is a water right hearing.

In the case of the Motunui outfall proposal the Water and Soil Conservation Act could not take the Maori cultural concerns, of the importance of their reefs as a source of kaimoana (seafood), into account when the outfall proposal was considered by the Planning Tribunal.

Neither does a water right hearing facilitate the planning of wastewater disposal on a regional basis, as is now happening for north Taranaki. Regional water boards have in the past been unable to fund the necessary studies that should precede many water right applications.

Although both town planning and water right procedures can help to balance the various concerns brought forward it has not always been possible to resolve issues through these procedures. Resolution has been provided for through the Waitangi Tribunal, in the case of the Motunui outfall proposal, and through the political process of local body elections in New Plymouth. There is no prospect of resolution being achieved under the Harbours Act procedure because there is no public participation and no rights of appeal.

At the water right hearing for the Marsden Point refinery expansion the Special Tribunal saw their task "to seek out facts on the application so as to enable (the Tribunal) to have sufficient information on which to reach a proper decision" (Northland Catchment Commission and Regional Water Board, 1983). To this end the tribunal requested the presence of technical experts as "Friends of the Tribunal" to assist in evaluation of the information. The individual objectors to this water right application faced difficulties in obtaining information with which to make their case to the Special Tribunal. Their contribution to the procedure was however commended both by the Special Tribunal and the Planning Tribunal (P. Tortell, Commission for the Environment, pers. comm.). More time was required due to the necessity of involving the Planning Tribunal in some minor word changes to special conditions of the granted water right. One objector withdrew 11 of his 15 points of appeal during the Planning Tribunal hearing because some issues were ruled as not being within the Tribunal's jurisdiction, and some were subsequently agreed between the Regional Water Board and the NZ Refining Company. The Company also withdrew one of its points of appeal.

The achievement of Green Island Borough in attracting no objections to its water right application is probably due to the extensive public information programme

undertaken over the last three years. User groups were consulted as to their preference for outfall location, initial investigations were explained, and people's concerns were listened to. Prior to the water right application being made, the user groups were again consulted, informed of the pending application and were provided with copies of the applications and support documentation.

The time taken to resolve the issue at New Plymouth, of whether primary treatment and a long ocean outfall was "better" than secondary treatment and a short outfall, was only partly addressed through the water rights procedure. The final resolution came not through statutory procedures but through the political process with the New Plymouth ratepayers prepared to pay for secondary treatment.

5 IMPROVEMENT OF PROCEDURES

There are two ways in which improvements can be sought with present procedures. The first is whether the use of the procedures can be improved and the second is whether the procedures themselves could be improved. Underlying the use of procedures to gain statutory approvals is the way in which the decision to proceed with an ocean outfall is made. If this is the "best solution" for a local authority or an industry, for the citizens, for water users, for recreational groups, and for environmental groups then it does seem there will be few delays in gaining the necessary approvals. If there is not general acceptance of an ocean outfall then it is likely that town planning and water right procedures will be used as an available public forum to debate the decision rather than these procedures being simply the vehicle for setting the technical details.

At present the Environmental Planning and Enhancement Procedures are the only formal procedures through which information on disposal options and the reasons for the choice of an option can be given and comment sought. Because sewage disposal is not usually the subject of an Environmental Impact Report where public involvement is part of the auditing procedure, local authorities could themselves produce an environmental assessment of the options and invite public comment before making the decision on an option. The time taken at this early stage to explain the financial and environmental implications of options could well result in time saved at the stage of applying for statutory approvals.

An alternative to using the Environmental Procedures to address options for disposal methods or locations would be to use an environmental mediation process. Such a process has been introduced in Ontario, Canada, and has been successfully used to find an acceptable interim disposal site for the domestic wastes of six adjoining municipalities. The Ontario Environmental Assessment Board was asked by Ontario's Minister for the Environment to appoint a mediator who, after 5 months of negotiations with individuals or deputations representing 14 different groups, produced a solution (Anon, 1984). In order for this process to be effective, the environmental information would still need to be made available to all the parties so that they can reach informed judgements as to the best course of action.

Public participation is provided in the present procedure under the Water and Soil Conservation Act to classify coastal waters. In this procedure the debate shifts to what uses of coastal water people want and hence what "quality" the waters can or should be. When the coastal waters are classified there is a clear management guideline as to the acceptability of a proposed effluent discharge and thus the debate shifts to technical and scientific opinions on the dilution and dispersion of the effluent and its effects on the receiving waters.

Public participation is also provided in the water rights procedure and town planning procedures where proposals are subject on appeal, to judicial review. The public must, as a last resort, be able to take their grievances to court. Because both of these procedures provide for public input, there could be scope for streamlining them by having a combined hearing. This has the advantage that the relationships between the approvals can be addressed rather than considering each approval in isolation.

There is also scope for encouraging all the authorising agencies to hold regular joint meetings to discuss progress in evaluating particular projects.

There are several changes to the Water and Soil Conservation Act that could be made to help resolve issues. The cultural concerns of Maori people regarding traditional fishing grounds and th° sacredness of water does need to be taken into account (Hughes, 1986). Because this cannot be done at present under the Act, the only recourse is to the Waitangi Tribunal.

There does need to be a way minor changes or corrections to water right conditions can be made without involving the sitting of the Planning Tribunal.

One solution would be to submit changes, agreed by all parties, for the written consent of the Planning Tribunal.

6 CHANGES TO PROCEDURES

It should be noted that there are some pending legislative changes that could influence the procedures required for future ocean outfalls.

The first is the consolidated Water and Soil Bill which is likely to be introduced into Parliament next year. There are some important relevant aspects in the Bill. First, statutory backing is to be given to water management plans which will include plans for the management of coastal waters. Second, the water classification system is likely to be changed to a system based on water uses. In the promotion of water management objectives cultural concerns would have to be taken into account.

7 FUTURE ACCEPTANCE OF OCEAN OUTFALLS

Community acceptance of an ocean outfall as the best disposal option can be influenced by many factors of which engineering considerations are only one part of the equation. The acceptance of a decision to proceed with an outfall is one of the keys to success of a proposal. A checklist of factors which may be helpful in the future is now given.

1 Previous history of disposal. If a community perceives that an ocean outfall will improve an unsatisfactory situation, such as shoreline discharge, then it may well be accepted. However, a malfunctioning existing outfall may cause a community to doubt the predicted good performance of a new outfall. Additional effort will be needed to demonstrate the the new outfall will operate satisfactorily.

2 Cultural concerns. There are many areas in New Zealand where seafood resources for the Maori people are very important.

3 The early release of information. The earlier that information is made available to the public and to local authorities the more likely that informed discussion on disposal options, locations and environmental implications can take place.

4 Adequate investigations. The information people require to assess an outfall proposal will often require detailed studies, e.g., of the existing

marine environment and predictions of how often diluted effluent will affect a bathing beach. If adequate time and resource are spent on these investigations initially, it could save much time and effort later on in a water right hearing. Early and continuing consultation with the regional water board is necessary when deciding on pre-outfall investigations.

5 Public relations. Making and maintaining contact with interested people or groups from an early stage in the planning of an outfall proposal is one of the most essential tasks to do. This is a combination of keeping people informed, inviting their comments and responding to their ideas. There may be times when a person or a group is implacably opposed to an ocean outfall and no amount of information, investigations or public relations is going to shift their view. In that case an independent procedure, like a water right, is one of the ways to balance the different concerns.

8 SUMMARY

A brief survey of some of the procedures encountered by ocean outfalls proposals is given in this paper. These procedural barriers are, however, only a part of the reason that ocean outfall proposals do not retain public acceptabilty as a viable disposal option. Another reason for non-acceptance can be the time taken between the concept/feasibility stage of a project and its construction. Often this time span is of the order of 15 years and the public forgets the reasons for embarking on the course of action. Progress on improving unsatisfactory coastal discharges may be seen by a community, or part of the community, as too slow. Changes in the financial climate also have their effect on outfall proposals.

Because each outfall proposal will have its own set of cultural, financial and environmental constraints it will be essential for future outfall proposals to identify these constraints early in the planning stage and to address them to the satisfaction of the community. The key requirements will be: early disclosure of information, the adequacy of initial investigations, continuing consultation with the public and expert agencies, and a decision on what is seen as an acceptable disposal method.

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ENGINEERING ASPECTS AND OPERATIONAL PROBLEMS

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1 INTRODUCTION

Operational problems are defined as those which initiate or exacerbate the aesthetic, environmental or public health problems due to an outfall not operating as designed. Problems arise because of:

a inadequate structural or hydraulic design;

b damage incurred during outfall installation; or

c unforseen operating conditions.

Any one of these three factors can result in a deterioration of the predicted water quality in the vicinity of the discharge. Outfalls into estuaries are generally shorter and together with the milder environmental conditions have given few engineering problems compared to outfalls along the open coast.

Sound design and marine construction experience are both needed in full measure to ensure success in outfall installation. Morris and Wilson (1975), Darnell (1984), Grace (1985) and Lumsden and Morris (1985) document important guidelines for those involved in outfall design and construction.

2 POOR OUTFALL DESIGN OR CONSTRUCTION

Structural design. An inadequate structural design will result in pipe cracks or joint failures either during pipe installation or service. The Waitara outfall has had substantial repairs to pipe cracks and joint problems, presumably incurred during installation (Morris and Associates, 1983). The Napier outfall had a major joint repaired at its midpoint during 1985, 12 years after its commissioning. That weakness may have arisen from the alignment problems in matching the two pipe sections during construction (Morris and Wilson, 1975).

Hydraulic design. The diffuser in particular must be designed to achieve a maximum initial dilution of the effluent for a wide range of flow rates. Poorly

designed diffusers will reduce dilutions and distribute port discharges unevenly along the diffuser. Proposals to improve the dilution performance of the Waitara outfall diffuser have been published (Wood, 1983; Bell and Williams, 1985).

3 OPERATIONAL DAMAGE

A comprehensive discussion of faults incurred by outfalls after their successful installation has been published by Grace (1985). He reports 35 documented problems internationally. In New Zealand documentation of problems is difficult to find, but Callaway (1985) collated some information on local outfalls including operational faults. The main problems in New Zealand have been:

i pipe breaks (either pipe cracking or joint failures);
ii diffuser burial (or part burial);
iii port blockage;
iv diffuser riser breaks.

Pipe breaks. Breaks known to occur in joints during the last 5 years were in outfalls at Napier and Waitara. These were probably caused by a combination of wave forces, littoral drift pressures, and sections of pipe being suspended due to sediment erosion. Sections of pipe suspension are reported to have occurred at Gisborne (Callaway, 1985) and at Waitara (Morris and Associates, 1983). The Gisborne outfall has not been affected by this occasional undermining. Shoreline recession, however, created structural problems at the Timaru outfall, which was one of the factors leading to its replacement.

Diffuser burial. Sediment movement has resulted in the partial burial of diffusers at Gisborne, Napier and Papamoa (Callaway, 1985). This results in a poorer dilution of the effluents, but no remedial action has yet been taken. There is scope for design improvements to protect the diffuser from burial in areas of mobile sediments (e.g., the mounting of the diffuser section on piles).

Port blockage. Ports can be either blocked by materials in the discharge or by marine fouling. Wood fibre has blocked the Whirinaki diffuser port risers (Morris and Wilson 1975) and the growth of mussels restricted the flow in the Napier outfall (C. Squire, Napier City Council, pers. comm.). Screen maintenance solved the first problem and enlarging the port size solved the second. The thermal outfalls for the power stations at New Plymouth and Marsden Point are cleared of mussels by periodically chlorinating the effluent.

Port riser breaks. The use of port risers is not a common practice in New Zealand (e.g., Whirinaki and Waimea outfalls). At Whirinaki marine traffic has severed the risers (R. Fullerton, Steven, Fitzmaurice and Partners, pers. comm.).

One further problem, not yet reported in New Zealand is the partial blockage of the diffuser, from causes other than diffuser burial. This can be caused by the deposition of sediment inside the diffuser due to sea water intrusion (carrying suspended sediment), or by deposition of solids from the wastewater. Good hydraulic design overcomes the salinity intrusion problem and regular maintenance minimises the deposition of wastewater solids.

4 CONCLUSION

Outfalls must be well designed, installed and maintained to be successful. There is a tendency for outfall operators to do too little in the area of inspection and preventative maintenance. Understandably, there is also a reluctance to document problems, but the availability of such information is useful (e.g., Grace, 1985). Some consultants are engaged to initiate and supervise regular inspection and maintenance of outfall systems (D.J. Chapman, Worley Consultants Limited, pers. comm.), but documentation is scarse.

Unless regular checks are made on outfall systems, their design performance characteristics cannot be confirmed. Public confidence in ocean outfalls could be restored and maintained if the inspection and maintenance information were available in engineering reports published to the standard of the scheme design documents.

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WORKSHOP DISCUSSION AND RECOMMENDATIONS

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1 INTRODUCTION

Following the presentation of the four position papers, M. Loutit, W. Bayfield and R. Weaver were invited to formally respond. This was followed by a general discussion. The substance of the three presentations and the contributions during the general discussion have been edited and collated under the three themes, procedural issues, environmental issues and engineering issues. An editorial commentary on the discussion is given, and a number of recommendations relating to planning, management and research requirements are presented.

2 WORKSHOP DISCUSSION

2.1 Procedural Issues

Public participation in outfall proposals. J. Boshier concluded in her position paper that the early release of information, particularly to the public, and an earnest effort in public relations is essential to the success of a coastal outfall scheme. She stressed the need for the communication to be a two way process. This point was well received by many of the workshop participants. P. Tortell and W. Bayfield emphasised the need for public involvement well before the water right hearings. P. Tortell emphasised that all of the important details should have been finalised at that stage. Two good examples of public consultation during the development of an outfall proposal are the schemes of Green Island Borough (J. Boshier, W. Bayfield) and Timaru City Council (G. Macdonald). Green Island Borough Council and its consultants initiated and guided the dialogue so successfully that a water right hearing was not even needed because there were no objections. At Timaru, the concurrent preparation of a preliminary classification of coastal waters by the South Canterbury Catchment Board provided a valuable framework for public discussion

on coastal water quality and outfall options. G. Macdonald suggested that all regional water boards should prepare preliminary classifications for their areas, but W. Bayfield thought the proposed management plans provided for under the Water and Soil Bill would provide for the same objectives.

There was some discussion on who should be responsible for initiating and guiding this type of dialogue with the public. J. Spier suggested it should be the local authorities (or presumably an industry if the outfall was a dedicated industrial one). W. Bayfield suggested that it should be the designers, while G. Macdonald felt it should be the regional water board.

Procedures for water rights. Several suggestions were made to improve situations encountered in the water right process. J. Fitzmaurice asked that regional water boards accept water right applications as being professionally prepared documents, make their assessment on these documents, and then advertise their intended decision. (Presumably objections would be received at that stage.) He felt this would result in a more direct process than the current practice where some water boards commission supplementary studies.
W. Bayfield called for more preliminary discussions between discharge proposers and board staff and also the earlier involvement of the public. I. Wood also called for preliminary meetings to discuss technical facts on which there is often scope for substantial agreement. The adversary situation in a water right hearing unnecessarily prolongs discussion of such technical information.

W. Bayfield suggested that regional water boards feel obliged to consider placing design and performance testing criteria on water right conditions.
J. Fitzmaurice advised that this is not necessary because current legislation provides sufficient powers to have modifications made to outfalls if required.

2.2 Environmental Issues

General. The position paper (Smith et al.) opened with the statement that carefully sited long sea outfalls are a satisfactory means of sewage disposal. The term satisfactory applied to biological, public health and aesthetic considerations. This view was challenged by M. Loutit, on the basis of her research and evaluation of the overseas literature. She claimed that environmental problems are likely to arise from the discharge of heavy metals, and that potential public health problems exist due to viral contamination of shellfish.

I. Wallis recommended that our attitude to marine waste disposal should accommodate the idea that some area of the coastline should be designated as being adversely influenced by coastal discharges with respect to some uses. This approach is similar to the designation of a 3 kilometre square area surrounding sewage treatment plants and a 2 kilometre buffer zone surrounding sludge disposal areas in Australia.

N. Burns suggested that one important objective for marine waste disposal should be to safeguard shellfish against contamination from sewage outfalls, that is, to design outfalls and associated treatment to ensure the achievement of this objective. In practice this would mean that the requirements for the acceptability of shellfish harvesting areas should be clearly defined. He added that this objective would then encompass the wish of the Maori people with respect to safeguarding their seafood resources. P. Tortell pointed out that this would also require that attention be given to the protection of the larval stages of the relevant shellfish, from contamination by heavy metals or other toxics, to ensure the natural replenishment of the shellfish beds by recruitment. This does suggest that better waste treatment may be necessary in some instances.

L. Thorstensen insisted that ultimately we must consider the question of the sensible allocation and wise use of resources, because that is ultimately the issue that will commend itself to politicians. He presented figures and comments on the comparative risks of drowning, being attacked by a shark, and contracting disease from bathing in a public swimming pool, and suggested that discussion of health risks due to viral contamination of shellfish, or possible improvements in treatment technology, emphasised matters of minor detail at the expense of the important central concern - that of cost-effective sewage disposal.

Maori cultural values were covered briefly in the position papers, (Smith et al., Boshier). The issue was also mentioned by M. Loutit, W. Bayfield and N. Burns. Early consultation with the local Maori people, along with similar consultations with the general public, is important when outfalls are being planned. M. Patrick raised the point that the Maori abhorrence of sewage in coastal waters is probably shared by many New Zealanders.

Biological. The position paper (Smith et al.) concludes that biotic effects due to non-toxic constituents in the waste are generally limited to several hundred

metres from ocean outfalls. In several estuaries receiving sewage discharges eutrophication, in the form of nuisance seaweed growths, has occurred and deoxygenation may be a problem in some others. The current discharge loads of heavy metals or other toxic substances are, however, presently so low as to give little cause for concern. M. Loutit insisted that since heavy metals are deposited on the sediments and subsequently are ingested and get into the food chain, they cannot be so readily dismissed. She emphasised that heavy metals are particularly detrimental to the embryonic and larval stages of many species. She pointed out that metals and toxic substances could affect the fish breeding grounds of economically important species (e.g., flatfish).

A. Hammond (West Germany) mentioned pollution problems in the Baltic Sea and J. Strating (Netherlands) in the Wadden Sea. It was acknowledged that much of the pollution was attributable to pollutants being discharged from rivers and land runoff. In highly populated areas, such as in West Germany, treatment is now provided for urban runoff, prior to its discharge into natural water courses.

Public Health. This topic generated considerable discussion. M. Loutit raised the issue of viral contamination of shellfish due to ocean outfalls, and the ineffectiveness of conventional waste treatment plants to deal with them. She called for a recognition of the potential problem and a willingness and funding to conduct surveys to determine the extent of viral contamination of marine sediments and shellfish in the vicinity of ocean outfalls. She conceded that there may be no problems, but no information is yet available to make a judgement on the matter. S. Clayton suggested focusing the discussion on two questions. Firstly the desirability of the objective of the non-contamination of shellfish by viruses, and secondly the design criteria to be considered to achieve this. M. Larcombe asked for comments from the microbiologists (Loutit, Austin & Lewis) on the need to standardise the test procedures for virus enumeration, the cost of such tests, who can conduct them and what the accepted criteria for viral contamination of shellfish are. M. Loutit said the tests were expensive, that a fair degree of standardisation had already been achieved in the methods used in the University of Otago laboratory, and emphasised that sampling techniques had to take account of the intermittent presence of viruses in sewage. F. Austin elaborated further that ideally the objective is to have shellfish without any detectable virus counts (PFUs) to be absolutely safe, and stressed that viruses remain viable in the sediments for a period of months and

can be remobilised by resuspension in the water column. He also concurred that monitoring would have to be conducted at intervals in recognition of the intermittent occurrence of viruses. Some practical points raised by M. Larcombe on the use of viral testing as a monitoring tool were not answered in detail. G. Fox recommended that as a first step a concerted effort be made to collate existing data available in New Zealand, on the health effects of recreational water use and shellfish consumption, and compare the situation with overseas findings. He felt this step should precede the funding of extensive research in this area. He also emphasised that many gastrointestinal infections have routes of transmission other than waterbourne ones (e.g., direct person to person contact). It is possibly as a consequence of these various transmission routes that there is no clear relationship between the microbial quality of discharges to recreational waters and the overall incidence of gastrointestinal infections in the community. K. Thomson mentioned that engineers should be giving the subject of viruses more consideration.

Aesthetics. W. Bayfield emphasised the need to deal with the aesthetic aspects and called for guidelines to help with this. I. Wallis suggested that milliscreening (largely pioneered in New Zealand) should be mandatory prior to discharge, thereby removing particulate matter, especially that which is non-biodegradable. K. Thomson pointed out that at the Clive outfall, where large quantities of particulate matter are discharged from the meat processing works, the only aesthetic problem is the occasional instance of fat deposits on the beach. He added that milliscreening would increase effluent disposal charges to the meat processors to an extent which could jeopardise their viability. K. Thomson noted, and J. Fitzmaurice inferred, that the decision to introduce milliscreening rests with the local community which has to pay for it.

2.3 Engineering Issues

Waste treatment and trade waste bylaws. M. Loutit suggested that the goal of engineers was to provide a minimum degree of treatment prior to discharge to coastal waters and called for a reassessment of sewage treatment practices in response to our knowledge of the effect of toxic substances and viruses on our environment. She added that current treatment methods concentrate only on reducing the organic matter and indicator bacteria (viz., coliforms). J. Fitzmaurice stated that the engineering profession generally exercised a much broader view, taking into account the impact of the discharge on the marine environment, the economics of the options and what the community can afford (for

local authority schemes). K. Thomson reiterated the importance of economic factors which may be relevant to the viability of some industries. He conceded, that some engineers (himself included) saw the installation of a long outfall as a means of sewage treatment. L. Thorstensen also emphasised the benefit of removing sewage, a potential health hazard, to sites remote from the public via long outfalls.

J. Spier pointed out that effective implementation of trade waste bylaws is a goal of interest to both groups (environmentalists and engineers). He added that waste streams are easier to treat at source and R. Weaver and K. Thomson confirmed this. R. Weaver raised the possibility of eliciting funds from trade waste charges to fund research on marine waste disposal.

Outfall inspection and maintenance. The position paper on engineering aspects (B. Williams) raised the question of inspection of the pipeline for its structural integrity, and the diffuser for its continued satisfactory performance in service. I. Wallis pointed out that because many New Zealand outfalls have been in use for some time thought should be given to inspection, and strategies developed for the early detection of impending failures.

3 COMMENTARY ON WORKSHOP DISCUSSION

The desirability of marine waste disposal was not questioned during the workshop. There was, however, a wide divergence of opinion on the level of effluent treatment that should be applied before discharge. This ranged from the suggestion that treatment should be to the highest possible level, to discharging untreated, raw effluent. The reality for the local authorities concerned is that they must strike a balance between the wise allocation and use of aquatic resources, protection of public health and the marine environment, and economic factors.

Public participation was seen by all as an essential step in developing a satisfactory outfall scheme. This will probably also apply in the future to maintaining public acceptance of existing schemes. The responsibility for the process was not resolved, but the discharger must obviously play a key role. The draft Water and Soil Bill, which provides for the preparation of 'management plans' by regional water boards, should provide a valuable framework for this dialogue. There was general agreement that water right proceedings could be substantially simplified by conducting discussions beforehand between all parties, including the public.

The discussion on the possible biotic effects of heavy metals and other toxic chemicals made mention of gross pollution that has occurred in Europe, and the effects that these substances can have on larval and juvenile fish and shellfish. Smith et al. found no evidence of such problems in New Zealand resulting from present discharges. However, this is no reason for complacency in the future and continuing surveillance of discharges and their effects is necessary. This is especially important where wastewaters contain potentially toxic substances.

The incidence and effect of viruses in the marine environment is clearly a contentious issue and one which can only be resolved with more information. The collation and publication of existing information was recommended in the position paper and endorsed during the workshop discussion. We see this as a necessary prerequisite before pursuing the microbiological research topics recommended below.

With a change in public expectations of outfalls, and possibly greater environmental awareness, there is a common desire for adverse aesthetic effects to be minimised. Techniques, such as milliscreening, are available to assist in this area, but the decision to implement this additional treatment appears to rest with the community affected.

As our outfalls age, inspection and maintenance will become more important. This is a topic which needs further study to evaluate the practicability of conducting inspections, and their required frequency. It is presumed that the Smith et al. position paper recommendation that shoreline discharges be discouraged was endorsed, since this was not challenged during the workshop discussion.

4 RECOMMENDATIONS

Based upon some of the recommendations presented in the position papers and the subsequent discussion there are a number of major recommendations which emerged from the workshop. They relate to planning, management and research requirements, and are seen as important in improving outfall planning and performance, ensuring continued satisfactory outfall waste disposal, and giving greater understanding of public health and environmental effects.

4.1 Planning and Management

The following recommendations are made.

1 That public consultation and participation are promoted by local authorities, consultants, regional water boards and any other party involved in the investigatory, design or assessment process for a coastal outfall.

2 That applicants for a water right in respect of a coastal discharge promote preliminary discussions with all relevant parties and groups prior to the formal water right hearing.

3 That shoreline discharges of untreated sewage along the coastline of New Zealand be actively discouraged.

4 That serious consideration be given to the promotion of the milliscreening (or equivalent) of wastewaters, currently being comminuted only, prior to discharge to the sea.

5 That effective implementation of trade waste bylaws be encouraged for wastewaters being discharged to the open sea or estuaries.

6 That regular inspection and maintenance of ocean outfalls be encouraged and effective strategies be developed to achieve this goal.

7 That regional water boards with coastal outfalls in their areas develop programmes to monitor these outfalls and publish their results on a regular basis. Monitoring efforts should include aesthetics.

4.2 Research

It is recommended that the following research topics be actively promoted.

1 The causal relationship between nutrient concentrations and algal growth in estuaries.

2 The effects on sediments and biota of toxic pollutants being discharged into partially enclosed water bodies (long-term, low-level monitoring is seen as being most appropriate).

3 To assess the validity of public fears of disease from swimming, and to put a perspective on the safety of shellfish consumption, relevant data should be collated and compared with overseas findings, and the results of the study be published.

Depending upon the outcome of research topic 3 (above), the following topics may also be studied.

4 The incidence of disease-producing organisms (especially viruses) in New Zealand shellfish.

5 The link between disease-producing organism concentrations in shellfish and sewage outfalls.

APPENDIX 1: LIST OF REGISTRANTS

Allsop, N.W.N.	Hydraulics Research, Wallingford, England
Austin, F.J.	Virus Research Unit, University of Otago
Bakx, R.	PO Box 4189, New Plymouth
Barnett, A.G.	Water Quality Centre, MWD, Hamilton
Bayfield, W.E.	Taranaki Catchment Commission
Bell, R.G.	Water Quality Centre, MWD, Hamilton
Boshier, J.A.	Commission for the Environment, Wellington
Buchan, S.	384 Rokeby Rd, Subiaco, Perth, WA6008, Australia
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Carver, D	PO Box 13006, Christchurch
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Fox, E.G.	MWD, Wellington
Fraser, G.	Mt Maunganui Borough Council
Gillie, R.D.	Dobrocky Seatech Ltd, Canada
Gunn, I.W.	Dept. Civil Engineering, University of Auckland
Hamanaka, K.I.	Kawazoe 4-4-7, Mimamiku, Sapporo 005, Japan
Hammond, A.	West Germany
Henwood, J.	Taranaki Harbour Board
Hinwood, J.B.	Dept. Mech. Eng., Monash University, Australia
Isaacson, M. de St Q.	Dept. of Civil Eng., Vancouver, Canada
Johnston, A.J.	Dept. Civil and Systems Eng., James Cook University, Townsville, Australia
Johnston, R.M.S.	Rangitikei-Wanganui Catchment Board
King, J.	City Engineers Dept., Dunedin City Council

Knudsen, M.	Dept. Civil Engineering, University of Canterbury
La Bonte, A.	1169 Highway A-1-A #311, Hillsboro Beach, Florida 33062, USA
Larcombe, M.F.	Bioresearches Ltd, Auckland
Lewis, G.D.	Microbiology Dept., University of Otago
Loutit, M.	Microbiology Dept., University of Otago
Macdonald, G.J.	Steven, Fitzmaurice and Partners Ltd, Christchurch
Marks, P.	Wellington City Council
Matthews, R.	Taranaki Catchment Commission
McCormack, M.	Ocean Routes (Aust) Pty Ltd, Australia
McLearie, D.D.	Binnie & Partners, Australia
Missen, H.	Wellington City Council
Murch, P.	Southland Harbour Board
O'Callaghan, R.	Wellington City Council
Patrick, F.M.	Taranaki Catchment Commission
Patten, F.	Northland Harbour Board
Provis, D.G.	Steedman Ltd, Australia
Pullar, V.	MacDonald Wagner Ltd, Australia
Rasmussen, N.	Commission for the Environment, Wellington
Reid, S	NZ Meteorological Service, Wellington
Robertson, B.M.	Otago Catchment Board
Robertson, B.	84 Bay St, Beauty Point, NSW 2088, Australia
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Smith, N.A.	Hutt Valley Drainage Board
Smith, R.	1 Montpelier Drive, Lower Plenty, Victoria 3093, Australia
Speir, J.	Hutt Valley Drainage Board
Squire, C	Napier City Council
Strating, J.	Delft Hydraulics Lab, The Netherlands
Taylor, N	Royds Sutherland McLeay Ltd, Christchurch
Thomson, P.	Marlborough Catchment Board
Thomson, A.K.	Hastings City Council
Thorstensen, A.L.	Dept of Health, Wellington
Tierney, B.W.	Timaru Harbour Board

Tortell, P.	Nature Conservation Council, Wellington
Treloar, P.D.	Lawson and Treloar Pty Ltd, Australia
Wallis, I.G.	Consulting Environmental Engineers, Australia
Weaver, R.J.	Timaru City Council
Webby, G.	Power Directorate, MWD, Wellington
Wescott, G.C.	Victoria College, Rusden Campus, 662, Blackburn Rd, Clayton VIC 3168, Australia
Whittaker, J.	MWD Central Labs, Lower Hutt
Wilkinson, F.	6 McLachlan Crs, Weetangera, ACT, Australia
Williams, B.L.	Water Quality Centre, MWD, Hamilton
Winoto, S.H.	Faculty of Engineering, National University of Singapore, Singapore
Wood, I.R.	Dept. Civil Engineering, University of Canterbury
Wright, B.	MWD, Head Office, Wellington

APPENDIX 2: REGIONAL WATER BOARDS WHICH WERE INVITED TO COMMENT ON THE WORKSHOP PROCEEDINGS

Auckland
Bay of Plenty
East Cape
Hauraki
Hawkes Bay
Marlborough
Nelson
North Cape
Northland
Otago
Rangitikei-Wanganui
South Canterbury
Southland
Taranaki
Wellington

WATER AND SOIL TECHNICAL PUBLICATIONS

1.	Liquid and waterborne wastes research in New Zealand, 1976. ($2.20)	1977
2.	Sampling of surface waters. ($2.20)	1977
5.	Late quaternary sedimentary processes at Ohiwa Harbour, eastern Bay of Plenty with special reference to property loss on Ohiwa. ($2.20)	1978
11.	The Waikato River: a water resources study. ($13.20)	1979
12.	A review of the habitat requirements of fish in New Zealand rivers. ($5.50)	1979
13.	The Ruahine Range: a situation review and proposals for integrated management of the Ruahine Range and the rivers affected by it. ($8.80)	1978
14.	A survey of New Zealand peat resources. ($11)	1978
15.	Effects of urban land use on water quantity and quality: an annotated bibliography. ($11)	1980
17.	Investigations into the use of the bacterial species *Bacillus stearothermophilus and Escherichia coli* (H2S positive) as tracers of groundwater movement. ($2.20)	1980
18.	A review of some biological methods for the assessment of water quality with special reference to New Zealand. Part 1. ($4.40)	1979
19.	The frequency of high intensity rainfalls in New Zealand, Part I. A. I. Tomlinson. ($8.80)	1980
20.	Regional flood estimation in New Zealand. ($11)	1982
21.	Coastal hazard mapping as a planning technique for Waiapu County, East Coast, North Island, New Zealand. ($8.80)	1981
22.	A review of some biological methods for the assessment of water quality with special reference to New Zealand. Part 2. ($4.40)	1981
23.	Hydrology of the catchments draining to the Pauatahanui Inlet. ($5.50)	1981
24.	Potential for contamination of the Heretaunga Plains aquifers. ($11)	1982
25.	Revised checklist of freshwater algae of New Zealand. Part 1. ($11)	1984
26.	Revised checklist of freshwater algae of New Zealand. Part 2. ($11)	1984
27.	Shoreline fluctuations and an assessment of a Coastal Hazard Zone along Pauanui Beach, Eastern Coromandel Peninsula, NZ. ($22)	1986
28.	Aquatic toxicity tests: comparative assessment of four acute tests and their potential application in N.Z.	in press

WATER AND SOIL MANAGEMENT PUBLICATIONS

1.	Regional planning and development. ($2.20)	1975
2.	Wetlands. ($2.20)	1975
5.	Forest operations guideline. ($2.20)	1978
6.	A guideline for the construction of access tracks and firebreaks. ($2.20)	1980
7.	A guideline to skifield development. ($2.20)	1980
8.	A wetlands guideline. ($5.50)	1982
9.	A water and soil guideline for mining. ($11)	1983
10.	A water and soil guideline for pipeline easements. ($4.40)	1985

Prices include G.S.T. and postage.