RUSSELL

WATER RESOURCES

NORTHLAND CATCHMENT COMMISSION

Technical Publication No. 1 987/3

December 1 987

This report should be referenced as:
Northland Catchment Commission 1 987. Russell Water Resources
Technical Publication No. 1 987/3

ISBN 0-90874 4-05-6

CONTENTS

Acknowledgements

The following Northland Catchment Commission staff contributed to this project and report.

T Phipps	- author, data collection and analysis
D Kokich	- data collection and analysis
C McLellan	- project design, drilling programme supervision
D Roke	- project design
P Freeman and D Kaiser	- bacteriological analysis
L Allan	- typing
D Brown	- draughting

Many other staff assisted with water sample collection and analysis, water level data collection and provided technical advice.

Mr P Hau and Ms S Hodge, staff of the Bay of Islands County Council carried out most of the fortnightly water level recording runs and some of the sample collection.

Northland Area Health Board provided the results of their tests of water supplies in the Russell area.

The drilling of the investigation bores was carried out by Kiwi Welldrillers, Northland Ltd, assistance with the pump tests was provided by Trigg Welldrilling Ltd.

The assistance given by the many landowners in the area who provided access onto their properties for water sample collection and water level measurements is greatly appreciated.

The funding of this project was provided by the National Water and Soil Conservation Authority (67%), Bay of Islands County Council (16.5%), and Northland Catchment Commission (16.5%).

UNITS

Area	m^2	= square metres
	ha	= hectares
	km^2	= square kilometres

$1\ km^2 = 100$ ha

1 ha $= 10{,}000\ m^2 = 2.47$ acres

Water Flow and Volume	l/s	= litres per second
	m^3	= cubic metres
	m^3/day	= cubic metres per day
	$1m^3$ = 1000 l	= 220 gallons

a flow of 1 l/s for 24 hours = 86.4 m^3/day

100 m^3/day = a flow of approximately 900 gallons per hour for 24 hours

Concentration (chemical)	mg/l	= milligrams per litre
	g/m^3	= grams per cubic metre

1mg/l = $1g/m^3$ = 1 ppm (parts per million).

RUSSELL WATER RESOURCES SURVEY

1 INTRODUCTION

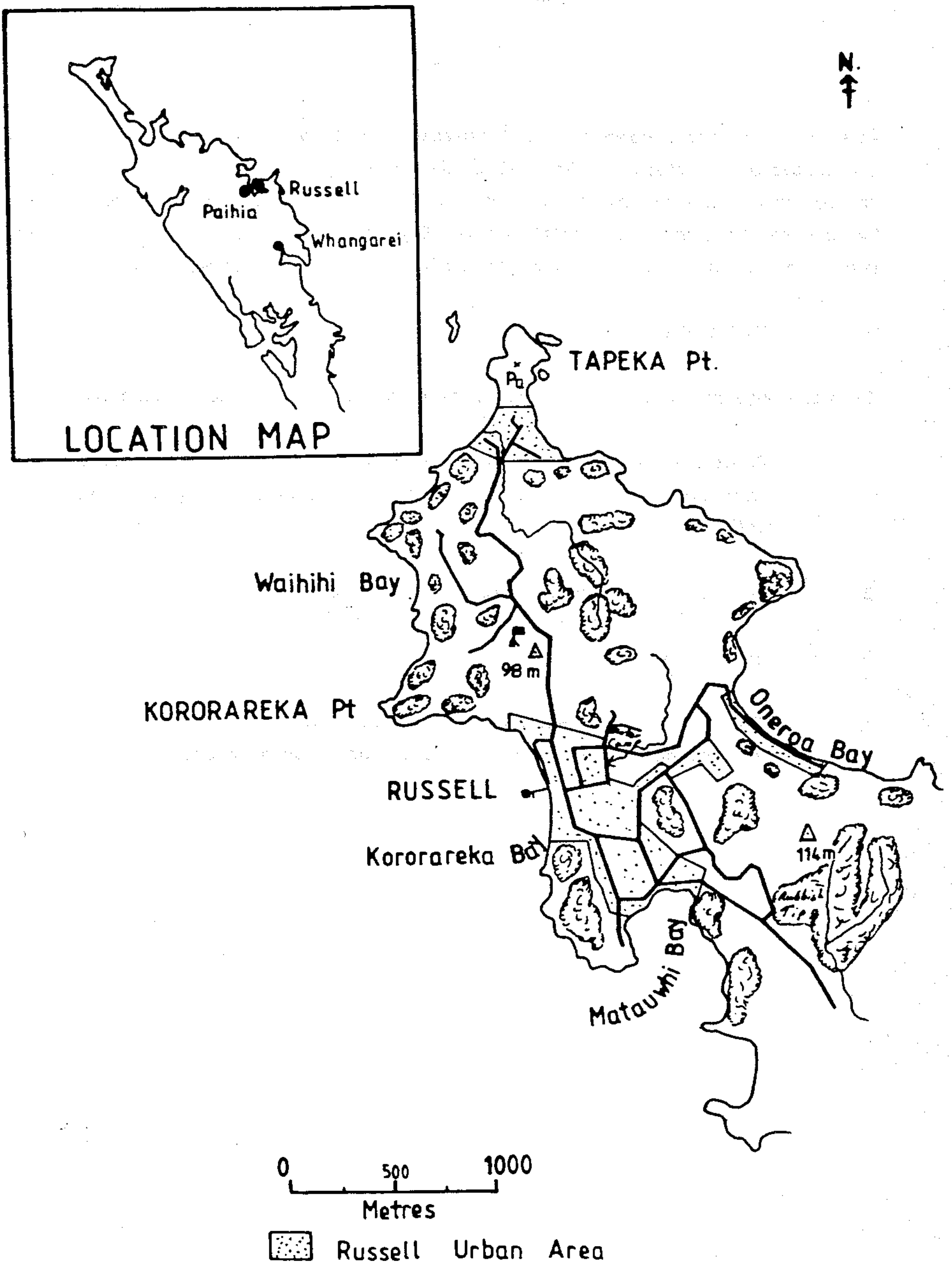
Russell is a coastal urban community located in the Bay of Islands (see Fig 1) and is thus part of one of New Zealands major tourist resort areas, catering to both local and overseas visitors. It has a permanent population of approximately 1050 (1986 Census). However in the summer holiday period the population increases to be in the order of 2000 (BOICC, 1982).

For sewage treatment the community, including most of the tourist accommodation and commercial facilities, rely on septic tank and soakage fields with some residences still using 'pit privies'. Most of the tourist accommodation, commercial premises, and public service buildings rely, particularly during summer, on groundwater taken from bores within the urban area for their water supply. A number of residences also use bore water to supplement roof catchment water supplies.

In 1982 the Bay of Islands County Council in conjunction with the Department of Health carried out a sanitary survey of the Russell urban area to locate and document the sewage disposal and water supply facilities. The Department of Health reported (Dept of Health 1982) to the BOICC that:

> "... the maps that have been drawn from this survey speak for themselves and present an alarming picture of wells used for domestic and public supply contaminated by sewage effluents, ..., and of streams discharging effluent from septic tanks and pit privies to the foreshore".

At about that time the Catchment Commission investigated and processed a number of Water Right applications to take water from bores in Russell Township. It was evident from those investigations that the groundwater resource was under significant pressure both in terms of the threat to water quality and sustainable water availability.



RUSSELL AREA - Localities

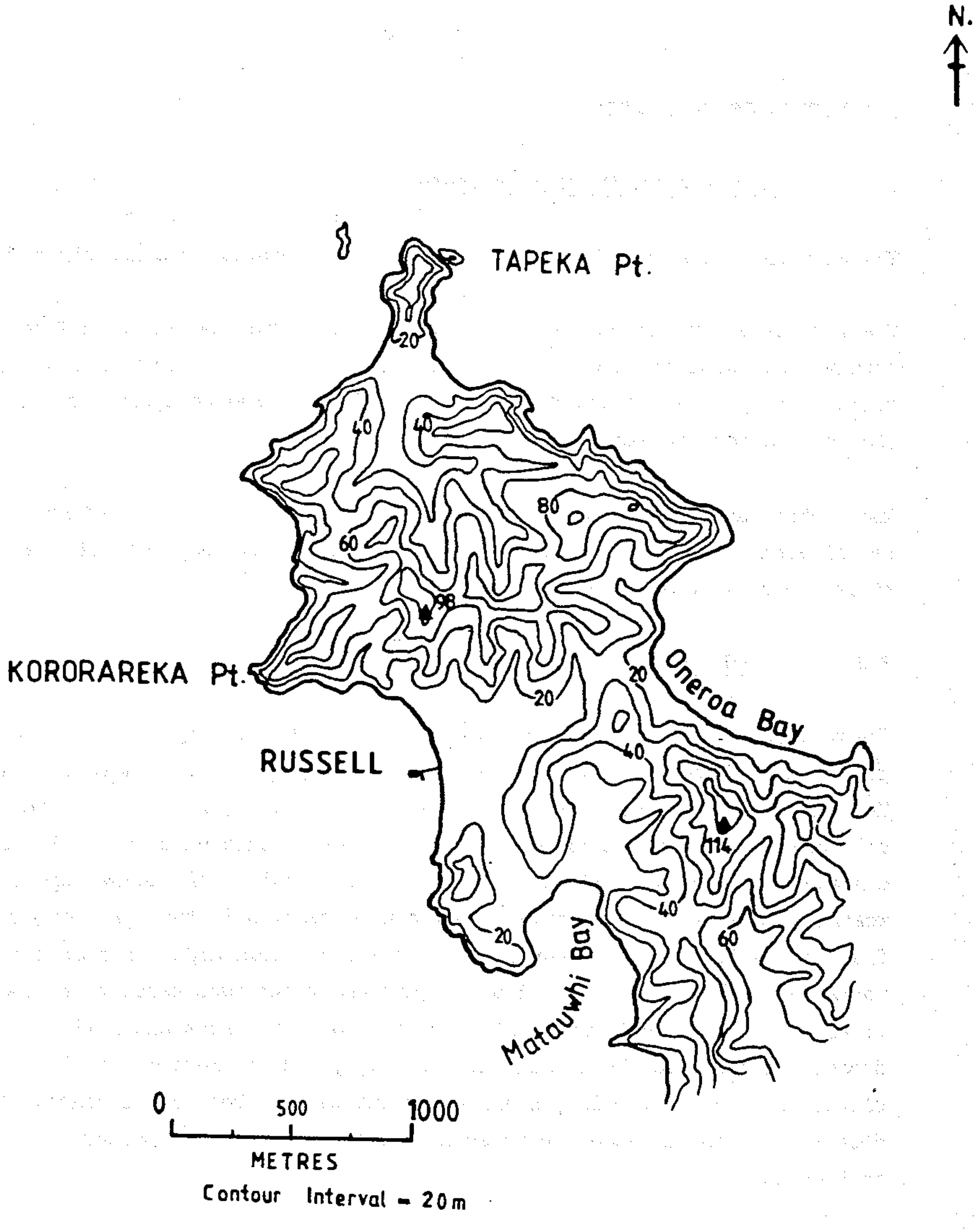
FIG. 1.

As a result of these concerns the Commission resolved to carry out an investigation to determine the quality and quantity of the groundwater resources in and around Russell township. The need for such an investigation was supported by both the Department of Health and the Bay of Islands County Council. A three year investigation programme was given final approval in August 1984.

2 OBJECTIVES

The main objectives of the Russell water resources investigation were to:

1. Determine the quality of the groundwater resources of the Russell area; particularly in relation to potential contamination by domestic effluent.
2. Estimate water availability from groundwater.
3. Estimate water demand.
4. Provide the Commission with information on which water resource management policies for the Russell area could be based.



RUSSELL AREA — Topography

FIG.

DESCRIPTION OF STUDY AREA

3.1 Locality and Physical Features

The main localities and features of the greater Russell area are shown in Fig 1.

The investigation was centred on the Russell township and Matauwhi Bay catchments. Russell township (Kororareka Bay) has a surface catchment area of approximately 0.62 km2 and Matauwhi Bay 0.61 km2. The topography of the general area can be seen in Fig 2.

The central and commercial area of Russell township occupies the terraced low relief area behind the fine gravel beach of Kororareka Bay and will be referred to as 'central Russell' in this report.

3.2 Geology

The predominant geology of the entire Russell area is Waipapa Group greywacke and greywacke with chert. The greywacke of the Waipapa Group is described (Kear and Hay, 1961) as relatively massive, locally contorted, jointed, indurated siltstones and rarer sandstones, in some areas containing chert. All the elevated and sloping land in the Russell area consists of deeply (up to 15 m) weathered greywacke. The only significant exception is the low lying relatively flat area underlying the central area of Russell township. This area has variable thicknesses, up to 15 m, of Quaternary stranded beach terraces (Ferrar et al 1925) in-filled swamps, alluvium and colluvial fans and fill. These deposits consist mainly of sequences of dirty fine to medium gravels, gravely clays, clays and some dirty sands along the terrace behind the beach. More details of this sequence can be seen from the bore logs in Appendix 1, discussed in Section 7.2.

3.3 Land Use

The area on which the investigation is centred is predominantly urban, commercial and residential. The eastern slopes of the Matauwhi Bay and northern slopes of the Russell township catchment are largely covered in mixed scrub and scattered trees.

3.4 Surface Drainage

There is no reticulated stormwater drainage system in the Russell or Matauwhi Bay catchments. The runoff from most building roofs is collected in tanks with the overflow going to ground soakage.

A stream/open drain system collects runoff from the three small gullies on the slopes on the north side of Russell. This then flows into a drain which runs through the northern half of the township, discharging to the sea at the north end of the beach. The runoff from some of the roads in the township which are curbed and channelled or have a roadside drain also flows to this drain.

Runoff from the eastern part of the Matauwhi Bay catchment enters the bay via a defined stream/drain at the eastern end of the beach. Small drains also discharge to the bay in the middle and at the western end of the beach.

3.5 Rainfall

The NZ Meteorological Service has a long daily rainfall record for Russell township (NZMS site A54211, NCC No 542101). The mean annual rainfall for this site for the period 1919-1986 (gaps 1933-40, 75-79) is 1364 mm, with a standard deviation of 260 mm. Monthly mean rainfalls for that period are given in Table 1. The monthly rainfall figures for the period of the investigation, January 1985 to July 1987 are given in Table 2.

From Tables 1 and 2 it can be seen that the period of investigation covers both a particularly wet and dry year; 1985 having the third highest rainfall of the 54 years of record examined and 1986 having the fourth lowest annual rainfall.

The first six months of 1987 were also particularly dry, having a total of only 348 mm, approximately 50% of the average rainfall for that period.

Table 1 Monthly Mean Rainfall (mm) for Russell for the period 1919-1986 (gaps 1933-40, 75-79). (NZMS site A54211, altitude: 2m)

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
mean	71	96	99	121	152	158	153	153	114	97	74	76	1364

range of annual rainfalls : 871 (1919) - 2444 mm (1956) SD 260 mm.

Table 2 Monthly Rainfall (mm) for Russell (NZMS site A54211) for the period January 1985-September 1987

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1985	61	212	171	214	199	139	164	184	114	128	110	123	1818
1986	223	140	20	29	157	65	92	130	131	86	30	45	1148
1987	39	10	63	160	40	36	169	125	100				

4 WATER USE

4.1 Introduction

For the purposes of this report water use has been divided into consumptive and non-consumptive uses. Consumptive uses are defined as those that physically consume water by removing some volume of it from the natural water source, and in Russell include domestic and public water supplies for local residents, visitor accommodation, shops, restaurants, offices, public facilities, school and irrigation of the bowling green. Non-consumptive uses are those that do not remove water and include ecological requirements, recreational uses, cultural and aesthetic value, and waste assimilation.

4.2 Existing Consumptive Uses

Most buildings in Russell have roof runoff collection tanks and most private residences rely on roof water for their water supplies. However most visitor accommodation, some restaurants, clubs and commercial facilities, the bowling green and some residences rely heavily on borewater particularly during summer. During dry summers a Russell Community Council bore is utilised for a water tanker delivery service to residents who run out of roof tank water.

Existing Water Rights are listed in Appendix 2, a summary of the Water Rights to take groundwater is given in Table 3.

Table 3 Summary of Water Rights to Take Groundwater

Russell Central	Quantity (m3/day)
motels, hotel	56
public supply, including : motor camp, public buildings, tanker supply service, fire brigade	100
bowling club irrigation & shop supply	4.5
Matauwhi Bay	
motel	6
domestic & shops	7
Long Beach public toilets	1.2
Tapeka Pt public toilets	2.3

Uses of groundwater other than those with Water Rights include : the primary school, three motels and approximately 85 residences (BOICC 1982) use supplementary or emergency bore water supplies. Of those residences with bores approximately 55 are outside central Russell.

Based on the water use data collected during the sanitary survey, current water rights and population, the estimated existing use of groundwater is :

peak usage-Russell urban area : 275 m3/day
peak usage-central Russell : 205 m3/day
off peak usage Russell : 60-120 m3/day
(most of which would be central Russell)

The peak groundwater usage figures represent usage during peak holiday periods, particularly where they coincide with prolonged dry spells. Off peak groundwater usage is more difficult to estimate. During periods of lower demand and relatively greater rainfall, rainwater collection systems are utilised by a number of premises which use bore water during peak use periods.

4.3 Potential Water Requirement

The potential total water requirements of the Russell urban area from all sources, have been estimated as follows :

4.3.1 Average demand for total Russell urban area : population x 225 litres/person/day : 1050 (1986 Census) x 0.225 = 236 m3/day

4.3.2 Peak summer holiday period : number of dwellings (including visitor accommodation) x peak number of residents per dwelling x 225 litres/person/day : 314 x 6.5 x 225 = 465 m3/day

4.3.3 Central Russell non-residential ie. tourist accommodation, camping ground, restaurants, clubs, commercial premises, public buildings, & school
estimated peak demand : 250 m3/day.
estimated off peak demand : 80-150 m3/day.

4.4 Non-Consumptive Uses

4.4.1 Ecological Requirements

The surface water courses in the Russell urban area have been modified by urban development to the extent that they are of low value as wildlife habitat. The ecological importance of the groundwater and surface waters is that they discharge to the coastal waters and therefore the quality of those discharging waters may directly effect the quality of coastal waters.

4.4.2 Cultural and Aesthetic Value and Recreation Uses

The attraction of the Bay of Islands, including Russell, to tourists and local residents alike are its aesthetic attributes, coastal marine based recreational activities and historical importance (both Maori and European) (Bay of Islands County Council, 1986). It is assumed that a public perception of largely uncontaminated natural water resources, particularly coastal, are a significant part of that attraction.

The waters of the rocky shoreline of Tapeka Point and adjacent areas were a traditional source of seafood for Maori people until the commencement of the Tapeka Point sewage outfall discharge (Department of Maori Affairs, 1986).

4.4.3 Waste Assimilation

In the Russell urban area the major non-consumptive use of the natural water resources, both surface flows and groundwater, is the assimilation of domestic effluent. Waste assimilation is a legitimate use of natural water recognised by the Water and Soil Conservation Act 1967. However such use may, and often does, conflict with other uses of the water. The use of coastal waters for domestic effluent disposal and assimilation is contrary to Maori cultural and spiritual value. The use and affects of the use of the water resource for waste assimilation are addressed in detail in Section 10.

5 GROUNDWATER RESOURCE ASSESSMENT PROGRAMME

The assessment of the groundwater resource involved :

1 The locating of existing bores and collection and examination of bore logs.

2 The drilling of investigation bores to allow the collection of geological, water level and water quality information and aquifer testing.

3 Regular groundwater level monitoring of both existing and investigation bores including the installation of a groundwater level recorder.

4 Pumping tests of investigation bores.

5 Periodic sampling of groundwater, drains and beaches, mainly for examination for coliform bacteria, as indicators of contamination by sewage.

6 SURVEY OF EXISTING WATER BORES

6.1 Number and Location

Existing water bores in the Russell urban area were located during the sanitary survey of the area and during a subsequent survey by NCC staff.

A total of 106 bores were located, 67 in the Russell township catchment and 51 in the Matauwhi Bay catchment. Welldrillers bore logs were obtained for 72 of those bores plus an extra 8 for bores in the Tapeka Point area. The logs often contain a rough location, depth and welldrillers estimate of working discharge.

The approximate location of these bores is shown on Fig 3. It is likely that there are some bores that were not located in this survey.

6.2 Bore Depths

Of the 80 bores of which the depths were known the depth distribution is as follows:

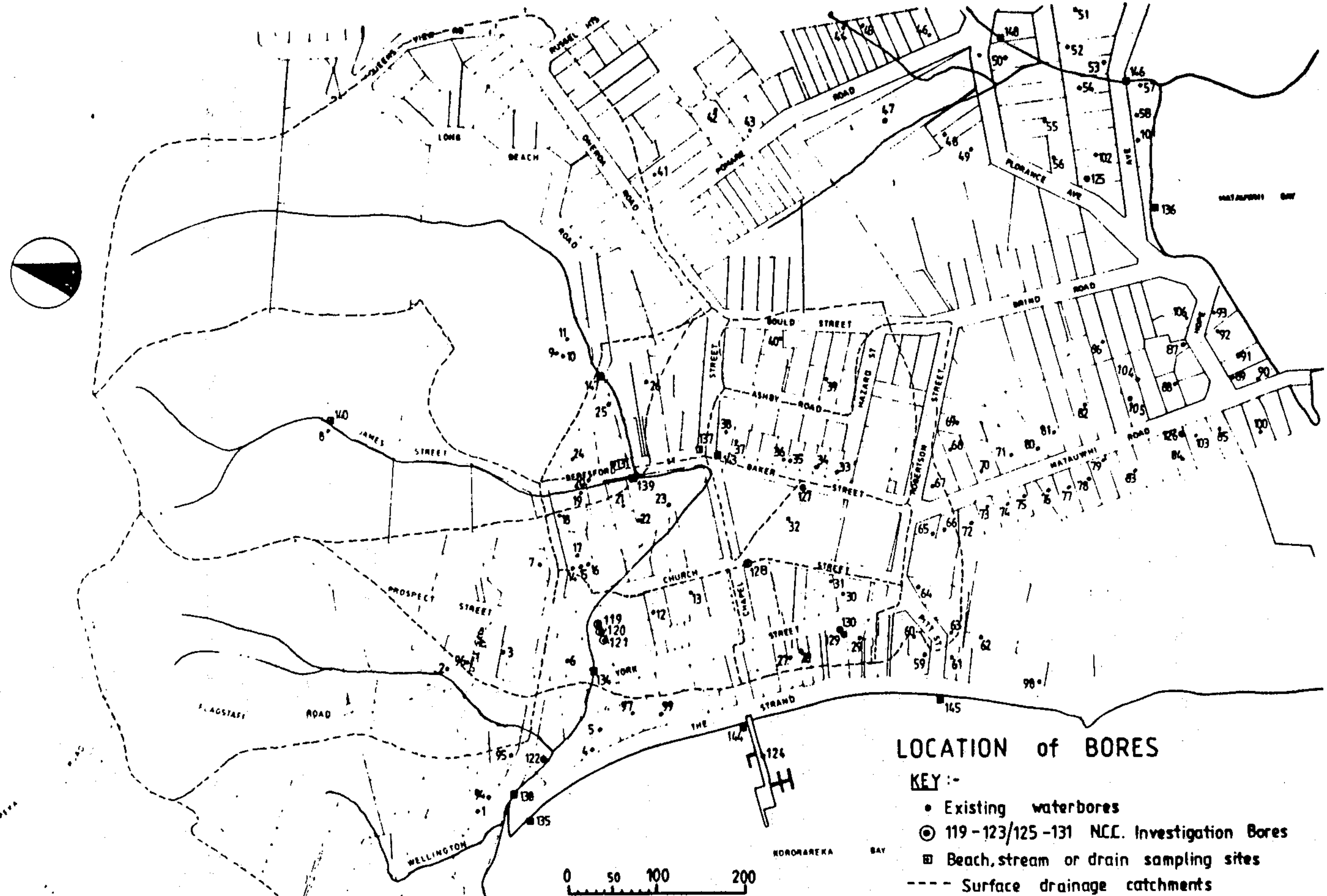
<10 m	10%
10-15 m	30%
15-30 m	50%
30-60 m	5%
>60 m	5%

Most of the bores are 75 mm or 100 mm in diameter

6.3 Bore Yields

Welldrillers estimates of the potential yield of individual bores were included on 58 of the welldrillers borelogs. The distribution of estimated yields is as follows:

<5	m3/day	5%
5-40	m3/day	75%
40-100	m3/day	15%
>100	m3/day	5%



LOCATION of BORES
KEY :-
• Existing waterbores
◉ 119 - 123/125 - 131 N.C.C. Investigation Bores
⊡ Beach, stream or drain sampling sites
---- Surface drainage catchments
0 50 100 200
Metres
KORORAREKA BAY
MATAUWHI BAY
THE STRAND
YORK
PROSPECT STREET
FLAGSTAFF ROAD
WELLINGTON
JAMES STREET
CHURCH STREET
CHAPEL
BAKER STREET
ASHBY ROAD
GOULD STREET
HAZARD ST
ROBERTSON STREET
MATAUWHI ROAD
BAIRD ROAD
FLORANCE AVE
BAY
POMARE
ROAD
OHEROA ROAD
LONG BEACH
PITT ST

FIG.

201318	Northland Catchment Commission		Reserve in Centre of Town, Russell	1702089	6097232		
201241	L Gardiner		Russell, Hope Ave	1702663	6096927		
201224	J Hotchkiss		Motel Russell	1702164	6096826		
201209	Duke of Marlborough Hotel		Russell	1701962	6097525		
201243	Eaves		Russell	1702663	6097027		
201320	Northland Catchment Commission		Matauwhi Bay Reserve	1702663	6097027		
201226	D Johnson		Baker St, Russell	1702163	6097325		
202120	C Watson		Florance Ave, Russell 33065	1702863	6096927	1702874	6096854 ~~609854~~
201211	Russell Town Board – old bore.		Tennis Courts	1701962	6097525		
201313	Northland Catchment Commission		Beside School, Russell	1702263	6097226		
201221	M O W		Russell	1702062	6097725		
201236	R Wilson		Russell	1702363	6097226		
201251	C Claason		Long Beach, Russell	1703162	6097428		
201206	T Dimmock		Tapeka Pt, Russell	1701858	6099024		
201315	Northland Catchment Commission		Church St, Russell	1702163	6097226		
201223	T Brooker		Russell	1702095	6097213		
201238	Fladgate		Russell 33021	1702363	6097226	1702020	6096899
201208	Duke of Marlborough Hotel		Russell 31717	1701962	6097525	1702861	6097800
201253	G Hitman		Long Beach, Russell	1703162	6097528		
201285	Body Corporation 115692		Main Rd, Russell	1701961	6097825		
201217	Russell Bowling Club			1701962	6097425		
201347	Northland Catchment Commission		Domain, Russell	1702096	6097453		
202131	P Paterson		Chapel St, Russell	1702562	6097427		
201202	B Taylor		Tapeka Point, Russell	1701758	6099024		
201219	A Allison		Russell House, Wellington St, Russell	1702062	6097625		
201234	Town Board – old bore.		Russell	1702261	6097826		
201249	R Weaver		Hope Ave, Matawhi Bay, Russell	1702764	6096827		
201204	J Smith		Tapeka Pt, Russell 31846	1701758	6099024	17 * NA	

2 1219 = 15.22 3.5 1230 Big Top 10 Holiday 201293. 1236. 32626

201210	Duke of Marlborough Hotel		Russell	1701962	6097525	1702172	6097534
202121	J Welch		Roberton Rd, Russell 32775	1702363	6097226		
201242	L Gardiner		Russell, Hope Ave	1702663	6096927		
201319	Northland Catchment Commission		Tapeka Point, Russell	1701958	6099124		
201227	D Gifford		Wellington St, Russell	1702162	6097425		
201212	H Waters		Wellington St, Russell	1701962	6097525		
201220	Recreation Grounds		Russell	1702062	6097725		
201314	Northland Catchment Commission		Beside Council Bore, Beresford St	1702262	6097526		
201237	Shaw		Russell 308182	1702363	6097226	1702017	6098955
201252	Bay of Islands County Council		Long Beach, Russell	1703262	6097428		
201205	Hendricksma		Rewa Place, Tapeka Pt, Russell 30761 ~~325~~	1701858	6099024	1702339	6097136
201316	Northland Catchment Commission		Boat Ramp, Keat St, Russell	1701963	6097580		
201222	Baker ? x3 ?		Russell	1702061	6097825		
201239	Russell School 201240		Russell	1702562	6097526	1702267	6097342
201207	M Marton ?		Russell	1701963	6097325		
201248	H Hooper		Oneroa Rd, Russell	1702662	6097427		
202115	Far North Council		Beresford St, Russell	1702462	6097426		
201233	King		Beresford St, Russell ~~31752~~	1702262	6097526		
202130	J Phillips		Church St, Russell ~~32164~~	1702163	6097325		
201346	Northland Catchment Commission		Domain, Russell	1702096	6097453		
201201	J McKathy		Tapeka Point, Russell	1701758	6099024		
201312	Northland Catchment Commission		Main Rd, Russell	1702264	6096826		
201218	D Woodcock 32156		Wellington St, Russell 32156	1702062	6097525		
202128	Lawson		Maiki Hill Rd, Russell	1701961	6097825	1702343	6096956
201235	Shortland Finance Ltd		Russell	1702364	6096926		
201250	R Clow Clowes ?		Hope Ave, Russell 30691	1702864	6096828		
201203	G Taulson		Tapeka Pt, Russell	1701758	6099024		
201198	Bay of Islands County Council - old bore		Tapeka Point, Russell	1701658	6099024		
202227	D Woodcock - Wellington St, Russell		" "	1702222	6097526		
202135	R Whitehead		Wellington St, Russell	1701861	6097924		
201245	H Hooper		Russell	1702662	6097427		
201228	M Shortland		James St, Russell	1702162	6097625		
202118	H Heine		Wellington St, Russell	1701762	6097724		
201213	P Taylor		Aroadia Lodge Russell	1701962	6097525		
209306	D Woodcock, Wellington Street, Russell		Wellington Street, Russell 30[illegible]	1702230	6097550		
201200	R Spriggs		Russell, Tapeka Point	1701758	6099024		
201247	H Hooper		Russell	1702662	6097427		
201230	N Harris		Matawhi Rd, Russell	1702263	6097026		
201348	Northland Catchment Commission		Domain Russell	1702096	6097453		
201215	E Fuller and Sons		Russell	1702063	6097325		
201286	Brambury			1701961	6097825		

~~1999~~
1991
2000

800 to
Dec -
140 per
f writer
. lake
approvals.
quantity -

Capham
Trust.
400
~~400~~.
1000 m3

1820201

101640

101644

WS_NUMBER	REQ_DETAIL	N3	LOC_DESC	XCOORD	YCOORD		
202230	Te Maiki Villas Ltd. - Flagstaff RoadRussell	n		1702062	6097725	1702043	6097742
202301	Triton Suites - 7 Wellington StreetRussellJill and Derek	n	front of Motel nth side driveway	1702180	6097572		
209210	J Phillips, 47 The Strand, Russell		47 The Strand	1701965	6097521		
209317	Mobil Oil NZ, The Strand, Russell		The Strand, Russell Wharf, One Monitoring	1701995	6097362		
209717	NRC, Huanui Reserve, Russell		Near picnic table	1702060	6097250		
202196	Annette McGreavy - 33 Rewa Street Tapeka PointBay of Isl	y	Bay of Islands	1701970	6098930		
202196	Annette McGreavy - 33 Rewa Street Tapeka PointBay of Isl	y	Bay of Islands	1701973	6098936		
202153	R Blomfield	y	York St, Russell	1702027	6097514		
202138	T Gilbert	y	Russell ~~32756~~	1702061	6098025		
202213	DoC - Russell	n	Workshop and Domestic 32756	1702364	6096826		
202183	Villa Helios - R &G Tuxford - 44 Du Fresne Place, Tapeka	n	30602	1701858	6099224		
202188	J Phillips - Chapel RoadRussel	n	No 2 behind the pub 32430/32544 / 32424	1702162	6097425		
202205	Winslow Grp Ltd Kevin Anderson - Russell Heights RdRussl	n	32292/32764/32268 32415 32416	1702962	6097428		
202192	Russel Bowling Club - Church St,Russel	n		1702262	6097426	1702151	6097540
202190	J Phillips - Church Street,Russell	n	Bore No 4 Behind shops	1702163	6097226		
209244	Antonio Pasquale, RPNZ properties Ltd, Long Beach Rd, Ru	n		1702810	6098127		
202195	Acadia Lodge - Matauwhi BayRussell	y		1702444	6096856		
202137	B Gibbs	n	Matauwhi Bay, Russell	1702864	6096528		
202204	Matauwhi Wharf Ltd - Matauwhi Rd Russell Slipway			1702064	6096626	1702345	6096623
202189	J Phillips - Pitt St,Russell		Infront of Kimberley Lodge No 3 bore cotta	1702063	6097125		
202217	D & S Biskind - 60 Tapeka Road Russell		?	1701660	6098424	1702518	6696120
202191	Russsel Bowling Club - Curch St,Russell		Russell	1702152	6097535		
201244	David H		Pamare Rd, Russell 32294	1702563	6097127	1702536	6097444
201229	E Coleman		Matawhi Bay Rd, Pussell 33163	1702264	6096826	1702363	6096750
201214	E Shorter		Russell	1701962	6097625		
201306	T Gilbert		Russell Motor Camp	1702261	6097926		
202134	G Sisterson		York St, Russell	1702062	6097425		
201246	H Hooper		Russell	1702662	6097427		
202117	Mrs Fraser - Wellington StRussell		Wellington St, Russell 31760	1701662	6097724	1701720	6097752
209337	Tim Dennis, 9 Baker Street, Russell		9 Baker Street, Russell	1702272	6097252		
201216	Holiday Enterprises Ltd		Russell, Chapel St	1702062	6097425		
201199	N Beattie		Rewa Place Tapeka Pt, Russell	1701761	6098124		
201293	Wilson		Russell	1702462	6097526		
201231	C Fenton		Matawhi Bay, Russell	1702263	6097026		
202179	Mills		Robertson Rd, Russell	1702163	6097126		
202123	J Gibb		Prospect St, Russell 31860	1702261	6097826	1702139	6097651
201317	Northland Catchment Commission		Reserve in Centre of Town, Russel	1702089	6097232		
201225	A Playle		Corner Baker St, Russell	1702163	6097325		
201240	Education Board		Russell School 32458	1702562	6097526	1702267	6097342
202108	W Hurri		Tapeka Point, Russell	1701858	6099124		

From the figures available there appeared to be no direct correlation between bore depth and yield. For example the bore with the highest reported yield of approximately 270 m3/day is 74 m deep, where as one 93 m deep bore apparently yields only 13 m3/day.

The bore yields indicated by the welldrillers relate to the capability of the individual bore over a short period and do not necessarily reflect the ability of the ground water resource to sustain those yields in the long term.

7 INVESTIGATION DRILLING

7.1 Drilling Programme

Twelve investigation bore holes were drilled in the investigation area in early 1985. Nine of the bores are in the central Russell area, two in the Matauwhi Bay catchment and one at Tapeka Point. The locations of the investigation bores is shown in Fig. 3.

The bore logs of the investigation bores are contained in Appendix 1. A summary of the main features of the bores is contained in Table 4 below.

The investigation bores varied from 5.5 to 35 m deep. Groundlevel at the bore sites was between 2.2 m and 3.5 m above mean sea level (m.a.m.s.l), except for the Beresford St. bore (No 131) at 5.1 m.a.m.s.l and the Baker St. (No 127) bore at 8.1 m.a.m.s.l.

At each site drilling continued until hard weathered or fresh greywacke was struck.

7.2 Interpretation of Borelogs

The borelogs of the investigation bores are given in Appendix 1.

The Interpretation of the geology from the borelogs supports the earlier description of the geology of the area given in Section 3.2.

The borelogs show that central Russell is a shallow basin containing mainly various thicknesses of dirty fine to medium gravels interbedded with clays and some vegetation. Fig 4 shows a diagrematic geological cross-section through the central Russell area perpendicular to the beach, as indicated by the investigation borelogs.

The logs for the two bores in the Matauwhi Bay catchment show shallower gravel deposits of less than 1.5 m depth with hard fresh greywacke also being struck at a shallower depth, 13 m, than in central Russell.

The bore drilled on the Tapeka Point Reserve showed no gravel deposit.

TABLE 4 Description of Investigation Bores

No	Name/Location	Depth (m)	Ground Level (m.a.m.s.l)	*Geology (depth-m)		Construction (depths-m)	
119	Tennis Courts-recorder, York St	11.3	2.39		mixed dirty gravels interbeded with clays	0.6-6.4 6.4-11.3	100mm steel casing 100 mm PVC screen 0.5 mm slots
120	Tennis Courts-middle, York St	5.5	2.25		mixed dirty gravels	0-5.5	100 mm slotted steel casing
121	Tennis Courts-far, York St	16.8	2.38	0-11 11-14.6 14.6-16.2 16.2-16.8	mixed dirty gravels interbedded with clays mud & vegetation weathered greywacke blue hard greywacke	0-14.6	100 mm steel casing
122	Boat Ramp, Kent St	8.2	3.48	0-5.7 5.7-8.2	interbeded dirty gravels and clays brown weathered greywacke	0-1.8 m 1.8-3.7	100 mm PVC casing 100 mm slotted PVC screen
123	Tapeka Point, reserve	11.2	2.45	0-11.2	weathered greywacke	0-4.8	100 mm PVC casing
125	Florence Ave, Matauwhi Bay reserve	13.3	2.32	0-1.3 1.3-12.2 12.2-13.3	mixed dirty gravels weathered greywacke hard blue greywacke	0-5.6	100 mm steel casing
26 / 126	Powell, Matauwhi Road	13.1	2.29	0-1.2 1.2-5 5-11.6 11.6-13.1	mixed dirty gravels clay-weathered greywacke weathered greywacke very hard greywacke	0-5.6	100 mm PVC casing
27 / 127	Upper School, Baker St	31.4	8.11	0-2.8 2.8-18.4 18.4-28 28-31.1	soil and dirty gravel weathered greywacke clay weathered greywacke rock hard blue greywacke	0-12.2	100 mm PVC casing
# / 128	Lower School, Chapel St	35.0	3.31	0-9.2 9.2-35	mixed dirty gravels weathered greywacke	[illegible]	[illegible]

Table 4 continued

No	Name/Location	Depth (m)	Ground Level (m.a.m.s.l)	Geology (depth-m)		Construction (depths-m)	
129	Hananui near, York St reserve	27.1	3.11	0-4	sands	0-8.5	100 mm steel casing
				4-7.5	mixed gravels	8.5-27.1	75 mm PVC screen 0.5 mm slots
				7.5-14	gritty clay & some vegetation		
				14-16	weathered greywacke		
				16-27.1	hard weathered greywacke		
130	Hananui for, York St reserve	8.5	3.17	as for 129 to 8.5 m		0-4	100 mm steel casing
						4-8	100 mm steel screeh 0.5 mm slots
131	Beresford St (north end)	31	5.10	0-14	mixed fine gravels	0-14	100 mm PVC casing
				14-31	weathered greywacke		

m.a.m.s.l - metres above mean sea level

*Geology - is a summary from welldrillers logs shown in Appendix 1.

Idealised Geological Cross-section of central RUSSELL running approximately East-West.

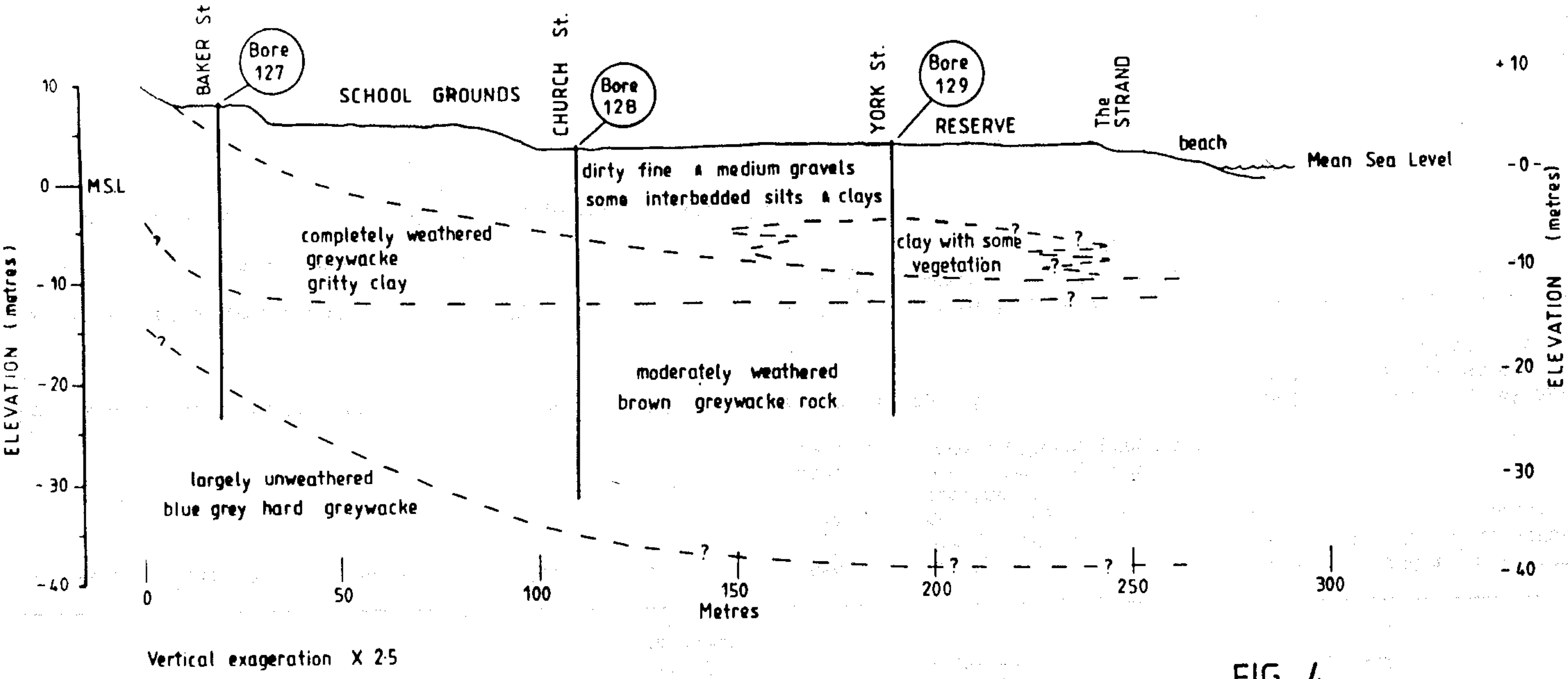


FIG. 4.

8 OCCURRENCE AND DISTRIBUTION OF GROUNDWATER

8.1 Aquifers Present

In this discussion an aquifer is considered to be a water-bearing unit which is distinct geologically, but not necessarily hydrologically from other water bearing units.

The examination of the borelogs of existing water bores and the investigation drilling findings indicate two main aquifers underlying the Russell township basin, and the possibility of a third. These are the upper gravel deposits, the weathered broken and fractured greywacke rock and thirdly the deeper unweathered fractured greywacke.

The gravel aquifer is limited in areal extent to the Russell Township basin, an area of approximately 13 ha. The gravel deposits contain discontinuous clay and mud layers.

The geological information indicates that the gravel aquifer is likely to be largely unconfined. In some areas however, lower portions may be confined or semi-confined by discontinuous layers of finer material. The weathered greywacke clay is likely to make the underlying weathered greywacke rock aquifer at least semi-confined.

8.2 Aquifer Hydraulic Characteristics

In general a dirty gravel aquifer such as that at Russell is highly permeable and allows relatively rapid movement of water both vertically and horizontally. The clay and mud layers or lenses will be relatively much less permeable and will limit vertical movement of water where they are present.

The downward movement of water from the gravel aquifer to the weathered and fractured greywacke will be limited by the relatively impermeable weathered greywacke clay zone.

Fresh greywacke rock is very fine grained and indurated with extremely low porosity. The movement and storage of water in the rock is entirely dependent on fractures. Zones with little fracturing will contain little water.

9 PUMP TESTS

9.1 Pump Test Programme

To further evaluate the hydraulic characteristics of the aquifers pump tests of a number of the investigation bores were carried out.

Pump tests have also been carried out on two bores in Russell in the course of Water Right investigations. A summary of the pump test findings is given in Table 5.

9.2 Discussion of Pump Test Results

For the purposes of this report discussion of the pump test results will be limited to more general comment rather than a detailed interpretation of each pump test. The detailed pump test data may be obtained from the Northland Catchment Commission.

The pump test results for bore No 120 penetrating the gravel aquifer shows that the rate at which water can flow through that material is moderately high although not as high as the theoretical values (Freeze and Cherry 1979) for clean gravel aquifers. The 5.5 m deep bore was capable of yielding a relatively high 200 m3/day in the short term. However because of the limited area of the gravel aquifer the long term sustainable yield from the aquifer may be significantly less.

The 10 minute pumping of the 16.8 m deep bore 121 did cause a significant 0.35 m drawdown in the 11.3 m bore 119 showing some direct hydraulic connection between the weathered greywacke and the overlying gravel deposits in that area.

In general the pump tests of the weathered greywacke 'aquifer', bores 16, 20, 121, 125, 126, 127, 129, 131, show moderate to very low hydraulic conductivities and transmissivities. The recovery of the water levels in those bores after pumping stopped was relatively slow indicating limited storage capacity within the aquifers. The pump tests show that bores taking water from the weathered greywacke aquifer will only provide moderate yields of 30 to 100 m3/day. Again the quantities that the bores were tested at do not necessarily represent long term sustainable yields.

TABLE 5 Summary Of Pump Test Data

Bore No	Name	Diam (mm)	Depth (m)	Casing (m)	Test time (hrs)	Discharge (m3/day)	Drawdown during test m.b.g.l (m.a.m.s.l)	Transmissivity (m2/day)	Hydraulic Conductivity (m/day)	Comments
120	NCC Tennis Court	100	5.5	full screen	3	198	1.27-2.22 (0.98-0.03)	176 148 R	27-32	gravel aquifer
121	NCC Tennis Court	100	16.8	14.6	10mins	4	1.21-13.5 (1.17- -11.12)	0.1 R	0.045	very low yield, weathered greywacke
127	NCC Upper School	100	31.4	12.2	23	118	5.84-7.43 (2.27-0.68)	58 85 R	3.02-4.43	possible boundary effect indicated
129	NCC Hananui	100	27.1	8.5	19	50	1.89-5.53 (1.22- -2.42)	12.7 11.8 R	0.63-0.68	weathered greywacke
131	NCC Beresford St	100	31	14	2.7	50	2.06-12.3 (3.04- -7.2)	8.8 5.4 R	0.32-0.52	weathered greywacke
20	Community Council Beresford St	100	60.1	?	24	94	3.06-18.13 (2.04- -13.03)	5.8 5.5 R 7.0 O	0.41-10	$S = 1.8 \times 10^{-3}$
16	Russell Bowling Club	100	33.5	21	21	22	0.81-7.6 (1.98- -4.81)	5.1 5.4 R	0.41	weathered greywacke
125	NCC Florence Ave Matauwhi Bay reserve	100	13.3	5.6	2.7	37	1.04-5.23 (1.28- -2.91)	170 71 R	9.2-22	weathered and fresh greywacke
126	NCC - Powell Matauwhi Rd	100	13.1	5.3	4	45	1.05-3.78 (1.24- -1.49)	45 15 R	1.9-5.8	weathered greywacke $S = 3 \times 10^{-4}$

Transmissivity calculated using $T = \frac{2.3\,Q}{4\Pi\,S}$ (Hazel, 1975 p81) R - recovery O - oservation bore

Hydraulic Conductivity calculated using $K = \frac{T}{b}$ where b = bore depth - casing length (ie. exposed 'aquifer' thickness)

No bore log is available for the Russell Community Council bore 20. The depth of casing is unknown and it is unclear as to which aquifer(s) the bore is open to. Pumping of that bore did cause a significant 3.3 m drawdown in bore 131 which is approximately 18 m away. Apart from the pump test of the Community Council bore there has been no pump test of any bore which may penetrate fracture zones in the unweathered greywacke.

10 WATER QUALITY AND CONTAMINATION

The possible contamination of groundwater, surface water, streams, drains, and beaches with domestic sewage effluent was the major issue prompting this investigation. The main type of contamination that is of concern is that by pathogenic (disease-causing) microorganisms (protozoa, bacteria and viruses) derived from human excreta. Such contamination presents a health risk when the water is used for water supplies, contact recreation or the collection of seafood.

The likelihood of contamination of groundwater or natural surface waters with pathogenic microorganisms has been assessed by two methods which can be covered under the headings of sanitary surveys and actual water quality measurements.

10.1 Sanitary Survey

The main objectives of a sanitary survey are to document in detail the existing sewage disposal and water supply facilities in a given area and to subsequently assess the survey results in terms of potential public health risks.

A detailed sanitary survey of the Russell area was carried out by BOICC and Department of Health in 1982. The survey involved the visiting of most properties in the area, locating and describing the sewage disposal and water supply facilities.

10.2 Results of Russell Sanitary Survey (BOICC, 1982)

Nearly all sewage treatment and disposal of sewage in the study area is by septic tank and tile drain soakage trench field. There were approximately 12 pit privies (long drops) still in use at the time of the survey. Two motels have extended aeration 'package' sewage treatment plants which discharge to evapotranspiration beds. One shop has a similar treatment plant but discharges to a soakage field. The Tapeka Point residential subdivisions has reticulated sewage collection and treatment which iscarried out in an extended aeration 'package' plant and discharge is to the sea via a sub-marine outfall. It is currently proposed to add tertiary treatment via a marsh to this system.

Observations by Commission, BOICC and NAHB staff and comment by local residents and contractors indicate that a significant number of the septic tank - soakage field systems have been 'modified' to facilitate more rapid soakage. This often involves the drilling of soakage holes in the soakage field, making holes in the bottom of the septic tanks and in at least one notable case having an open ended soakage field which drains to an open stormwater drain. All these practises speed effluent disposal but tend to significantly lessen the degree of treatment. This is particularly so in the case of the central area of Russell on the gravel deposits.

The sanitary survey shows that a significant number of soakage fields are immediately adjacent to open drains or within 50m of the beach. A number of bores which are used for water supplies for various public commercial and accommodation facilities are within 25m of soakage fields.

In summary the sanitary survey showed that the potential for contamination of water supplies, streams, open drains and the foreshore with domestic effluent is high. Water supply and effluent disposal facilities in Russell have not changed significantly since the sanitary survey was carried out in 1982.

10.3 Water Quality Measurements

The isolation and detection of pathogenic microorganisms in water is technically difficult, and prohibitively expensive. The presence and numbers of 'indicator organisms' which are relatively easily and quickly detected by simple laboratory tests are therefore used for assessing human faecal contamination of water, estimating the public health risk from contamination and setting water quality standards. Indicator organisms are bacteria which do not necessarily cause disease themselves, but whose presence indicates that pollution by human faecal contamination has occurred.

The most commonly used group of indicator organisms are the "coliform group" of bacteria. With the standard laboratory methods used the dominant organism isolated is Esherichia coli, an always present and usually nonpathogenic inhabitant of the human gut (Fenner 1981).

The presence of faecal coliform bacteria in a water sample indicates that pathogenic microorganisms could be present (but in much smaller numbers).

The presence of faecal coliform bacteria indicates degradation of water quality and a relative risk of disease transmission (Till, 1980).

The ratio of pathogens to indicator organisms in any contaminatd water and hence the risk to public health, is dependent on the prevalence of disease in the community contributing to those waters (Till, 1980). The significant tourist population is likely to increase the risk of the introduction of some exotic pathogen.

As part of this investigation and in order to assess the level of human faecal contamination of natural water samples from bores, surface drains/streams and sea water were collected and analysed for numbers of faecal coliform bacteria. The Northland Area Health Board as part of its regular programme of testing the water quality of public and commercial (motels, restaurants etc) water supplies measures faecal coliform bacteria numbers in Russell water supplies. However the samples collected by the NCC were from the natural water source, as close as possible to the source. Where as the NAHB sampling is mainly at the water use end of systems such as from kitchen taps.

10.4 Water Quality Standards and Guidelines

Both fresh and seawater of the Bay of Islands are classified under the water quality classification standards of the Water and Soil Act 1967 (W&S Act). The general objective of these classification standards is "to promote in the public interest the conservation and the best use of that water". The classifications standards are the minimum standard of water quality at or above which the 'classified' water shall be maintained. The detailed specifications of the Water & Soil Act water quality classification standards are listed in Appendix 3. The bacteriological specifications, which are of the most concern to this investigation, are given in Table 6.

The waters of Kororareka Bay (Russell beach) and Oneroa Bay (Long Beach) have an SB classification. The SB standard relates to water quality considered suitable for regular bathing. The waters of the remaining coastline surrounding Russell including Matauwhi Bay, Tapeka Point, and Pomare Bay have a higher SA classification standard which relates to water quality considered suitable for both the collection and cultivation of shellfish and bathing. The natural freshwaters of the Russell area have a D classified standard.

The Water Quality Criteria Working Party of the Water Resource Council (NWASCO, 1980) has recommended a series of revised classification standards. Those recommended classification standards have been included in the Draft Water and Soil Bill 1986. The detailed specifications of the standards relevant to this investigation are given in Appendix 4, and the bacteriological specifications of the standards are given in Table 6.

The NWASCA has recently (1987) given the NCC permission to review the Water Quality Classification of the Bay of Islands. Provided that the reclassification is within the framework of catchment management plan(s).

The NZ Department of Health guideline drinking water standard (NZDH, 1984) for untreated water entering a distribution system is that there be no faecal coliforms present.

Table 6 Water Quality Classified Standards - Bacterial Standards
(see Appendix 3 & 4 for full specifications of standards).

Class	Bacterial Standard	Water Use to be Protected
Water & Soil Conservation Act 1967		
SA	Based on not fewer than 5 samples taken over not more than a 30 day period, the median value of the total coliform bacteria content of the water shall not exceed 70 per 100 ml.	Consumption; cultivation of shellfish.
SB	Based on not fewer than 5 samples taken over not more than a 30 day period, the faecal coliform bacteria content of the water shall not exceed 200 per 100 ml.	Regular public bathing.
SC & SD	No specific bacterial standard.	
D (freshwater)	No specific bacterial standard	Stock water and general farm use.
Draft Water and Soil Bill 1986 (Recommended by Water Quality Criteria Working Party, (NWASCO 1980)		
CS	The median faecal coliform bacterial concentration shall not exceed 14 (MPN) per 100 ml based on a minimum of one water sample taken on each of 10 consecutive days when the risk of contamination is the greatest, and not more than 10% of the samples shall exceed 43 (MPN) per 100 ml.	Coastal water from which edible shellfish are regularly taken for human consumption or waters in which shellfish are cultivated or farmed.
CR	The median faecal coliform bacterial concentration shall not exceed 200 per 100 ml based on a minimum of one sample taken on each of five separate days over not more than a 30 day period; nor shall more than 10% of samples taken on separate days during any 30 day period exceed 400 faecal coliform per 100 mls.	Coastal water for regular public bathing purposes.
W (freshwater)	The median faecal coliform bacteria concentration shall not exceed 2000 per 100 ml based on a minimum of one water sample taken on each of five separate days over not more than a 30 day period; nor shall more than 10% of samples taken on separate days during any 30 day period exceed 4000 faecal coliforms per 100 ml.	Water for a source for public water supply or for the preparation and processing of food for sale for human consumption where treatment at least equivalent to flocculation, filtration, and disinfection could be reasonably expected.

10.5 Sampling Programme

Water samples were collected from 20 existing water supply bores, 11 NCC investigation bores, 9 drain/stream sites and 4 beach sites. These sites are shown in Fig 6.

The sampling programme was designed on the basis of:

1. the number of samples that could reasonably be collected and returned to the laboratory for initial processing, on the same day,

2. ease of access to sampling point and in the case of bores the closeness of sampling point to the bore ie. taps at bore head prefered,

3. willingness of bore owner to have sampling carried out.

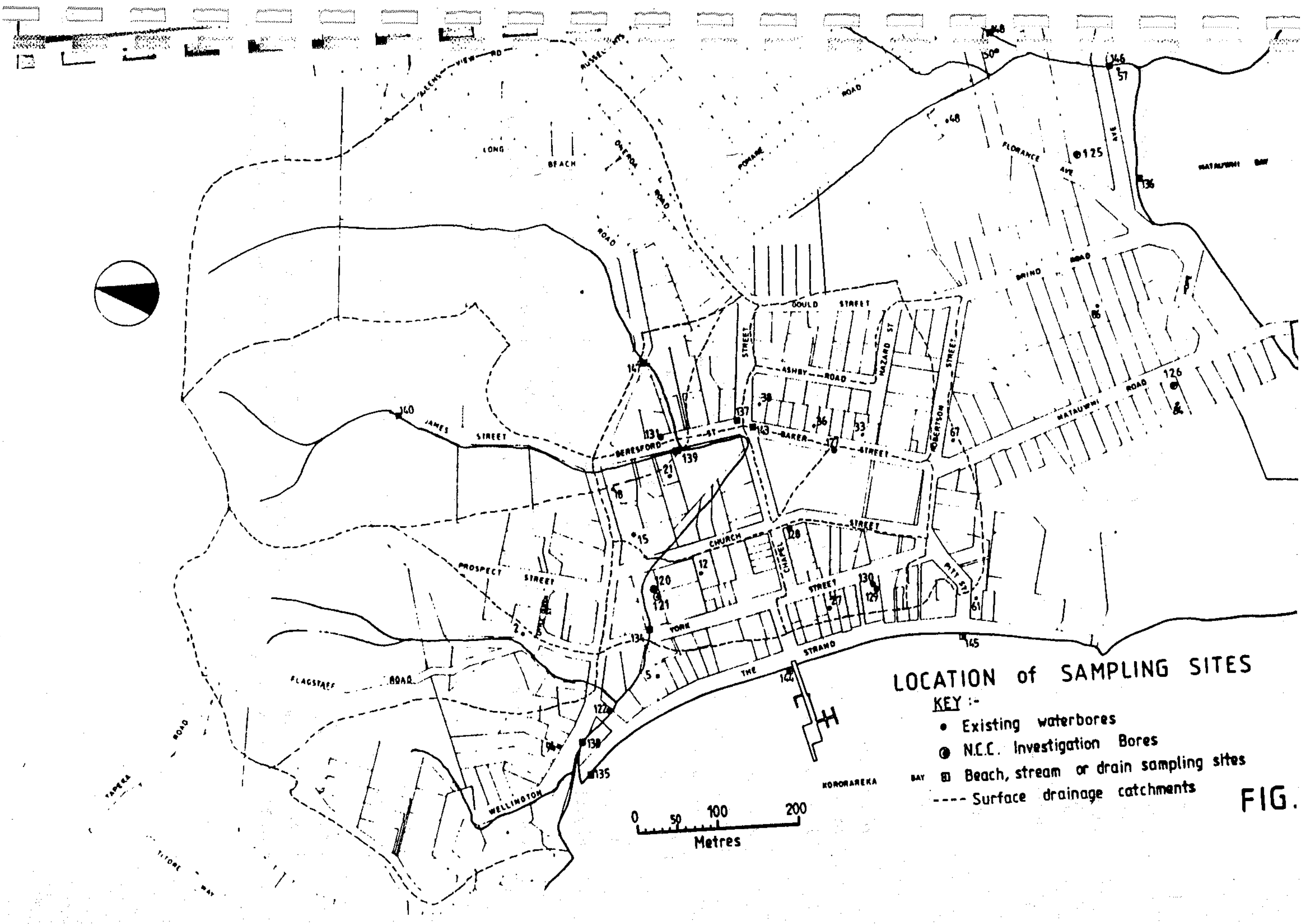
Unfortunately information on bore construction were not available for many of the bores sampled.

Sampling was carried out on 30 occasions between October 1984 and January 1987. Not all sites were sampled on each occasion. All but 6 of the sampling runs took place during the late spring and summer between November and February. In total 510 borewater, 115 drain and stream and 56 beach (seawater) samples were collected for faecal coliform counts.

Total coliform counts were also carried out on 282 of the samples from the 20 existing water supply bores during the period October 1984-March 1985.

10.6 Results of NAHB Sampling

The NAHB sampling and testing of public and commercial (motels, restaurants etc) water supplies showed significant evidence of faecal contamination. For example, for the period January 1985 to November 1986 144 water samples were collected, from 20 public or commercial water supplies and of those samples almost 25% contained faecal coliforms. Faecal coliforms were found in at least one sample from each of 11 of the 22 premises from which samples were taken. The Department



LOCATION of SAMPLING SITES

KEY :-

- • Existing waterbores
- ◉ N.C.C. Investigation Bores
- ▣ Beach, stream or drain sampling sites
- ---- Surface drainage catchments

FIG.

of Health guideline for safe drinking-water supplies (Department of Health, 1984) is that there be no faecal coliforms present. As a result of the detection of faecal coliforms in water supplies a number of commercial premises and tourist facilities have been required to install chlorination systems to treat their water supplies. However there are still a significant number of unchlorinated supplies.

10.7 Results of Faecal Coliform Counts

10.7.1 Units/Methods

All faecal coliform (FC) and total coliform (TC) results are expressed in terms of numbers of organisms per 100 ml of sample as determined by standard (APHA-, 1985) membrane filter or MPN methods.

Results shown as '<' (less than) a certain number indicate that the numbers of FC or TC are below the detection limits of the method employed, at the sample dilution rate used. Any results of that nature are treated as a negative result, ie. contains no FC, for the purpose of data summaries and discussion.

In some of the borewater samples the water was discoloured or contained significant amounts of suspended material which effectively prevented the accurate determination of low FC counts using the membrane filter method, which was used in the early stages of this project.

10.7.2 Borewater

A summary of the results of the faecal coliform counts of the 510 borewater samples taken is given in Table 7.

Faecal coliforms were found in 91 (18%) of the bore water samples. Of the 34 individual bores sampled, faecal coliforms were found in at least one sample from each of 21 (62%) bores.

Table 7 Summary of Faecal Coliform Results from Borewater Samples.
Number of Samples in Given Range.

Bore No	Depth (m)	n	<	1-10	10-100	100-1000	>1000	total +ve	median (no./100ml)	max (no./100ml)
				Faecal coliforms (no./100 ml) (number of samples in range)						
02		30	14	5	4	4	3	16	2	2400+
05		22	22					0	<	<
12	well	15	8		6	1		7	<	310
14		2	2					0	<	<
15	well	25	15	5	2	2	1	10	<	2630
18		20	19			1		1	<	400
20	60	2	2					0	<	<
21	30	26	25	1				1	<	4
27		14	14					0	<	<
33	<13	22	21	1				1	<	8
36	<18	25	25					0	<	<
38		16	16					0	<	<
46	41	3	3					0	<	<
48		15	15					0	<	<
49		1	1					0	<	<
50		13			4	4	5	13	580	TNTC
57	<13	22	17	3	1		1	5	<	TNTC
61		29	27	1		1		2	<	350
67	<24.3	28	27	1				1	<	9
74	7.9	12	11		1			1	<	30
83		3	2	1				1	<	2
84		16	14	1	1			2	<	50
86	33	12	12					0	<	<
94		17	11	3	3			6	<	44
120	5.5	13	6	3	2		2	7	4	2400+
121	16.8	14	14					0	<	<
122	8.2	13	2		4	5	2	11	200	TNTC
123	11.2	11	10	1				1	<	3
125	13.3	10	9	1				1	<	4
126	13.1	12	12					0	<	<
128	35	11	11					0	<	<
129	27.1	14	13	1				1	<	2
130	8.5	13	11	1	1			1	<	13
131	31	10	8	2				2	<	10
34		510	419 (82%)	31 (6%)	28 (5%)	18 (4%)	14 (3%)	91 (18%)		

n = total number of samples

TNTC = too numerous to count

< = 'less than' - indicates that with the method and dilution used no faecal coliform organisms were found.

A number of the samples counted as containing no faecal coliforms contained levels of total coliforms which indicate that faecal coliforms would have been present in the samples.Of the 282 samples for which total coliforms were measured 119 (42%) had total coliform levels of greater than 1/100 ml and 60 (21%) had greater than 100/100 ml (see Table 8). Of the 20 bores from which samples were analysed for TC 18 (90%) bores had at least one sample which had a TC level of greater than 1/100 ml and 15 (75%) which had at least 3 samples with a level of greater than 1/100 ml.

Although the incomplete nature of the data set prevents any rigorous statistical analysis it appears that, as might be expected, shallow bores and wells are in general more likely to be contaminated. It would be expected shallow bores in the gravel aquifers or those with faulty casing that allowed water from the upper aquifer to enter, would have a greater risk of contamination from septic tank and soakage field effluent. Septic tank effluent is typically warmer than the natural groundwater, hence less dense, tending to float and flow along the top of the groundwater (Gibbs, 1986). Of the twelve NCC investigation bores the only two that consistently had positive faecal coliform results were the 5.5 m bore 120 and the 8.2 m bore 122. Both those bores are shallow, penetrate and have screens set in the shallow gravel aquifer. The investigation bores which are cased through the soil and upper aquifer show much less contamination.

Table 8 Summary of Total Coliform Results from Borewater Samples. Number of samples in a given range

Bore No	Depth (m)	n	<	1-10	10-100	100-1000	>1000	total +ve	median (no./100ml)	max (no./100ml)
				Total Coliform (no/100 ml) (number of samples in range)						
02		16	11		1		4	5	<	7800
05		17	14	1	2			3	<	92
12	well	15			1	3	11	15	1300	TNTC
15	well	15	4	3	3	3	2	11	12	TNTC
18		16	4	1	3	5	3	12	166	2900
21	30	13	10	1	2			3	<	72
27		14	14					0	<	<
33	>13	12	11	1				1	<	4
36	>18	16	16					0	<	<
38		15	14		1			1	<	50
46	41	3				2	1	3	250	5250
48		14	12	1		1		2	<	26[illegible]
50		13				2	11	13	4800	TNTC
57	<13	15		1	6	6	2	15	200	TNTC
61		17	14	3	0			3	<	4
67	24.3	17	14	1	2			3	<	100
74	7.9	12	9	1		2		3	<	1000
84		16	2	8	6			14	6	88
86	33	12	11	1				1	<	2
94		14	3	4	5	2		11	10	384
20		282	163 (58%)	27 (9.5%)	32 (11.3%)	26 (9.2%)	34 (12%)	119 (42%)		

n = number of samples

TNTC = too numerous to count

< = 'less than' - indicates that with the method and dilution used no coliform organisms were found.

Table 9 Summary of Faecal Coliform Results from Drain and Stream Samples

Site NO	Location	n	<	Faecal Coliforms (number per 100 mls) 1-14 (number of samples in range)	14-200	200-2000	2000-4000	4000 +	max (no./100ml)	median (no./100ml)
134	York St	31	1		7	13	3	7	32000	1100
137	Ashby St	2					1	1	9660	-
138	Kent St	10	1			4	4	1	3600	1975
139	Beresford St	10	1	1	2	3		3	15700	1300
140	James St	10	2		3	4	1		2400+	150
143	Baker St	3	1					2		
146	Hope Ave	8	1		1	4	1	1	TNTC	1560
147	Longbeach Rd	29	3	1	13	10	1	1	10000	200
148	Florence Ave	4			1	2		1	TNTC	-
		108	10	2	27	40	11	17		
			(9%)	(2%)	(25%)	(37%)	(10%)	(16%)		

n = total number of samples for each site

TNTC = too numerous to count

< = 'less than' - indicates that with the method and dilution used no faecal coliform organisms were identified.

10.7.3 Drains/Streams

A summary of the faecal coliform results from samples taken from the main drains/streams running through Russell and Matauwhai Bay is given in Table 9. The table lists the numbers of samples from each site that contained numbers of faecal coliform within a certain range. The results show that the drains are subject to significant contamination much of the time. The data set is not sufficient to provide statistical comparisons of season or flow conditions. However the samples which had the highest faecal coliform counts were collected on two separate occassions, once during and once immediately after heavy rain, suggesting a flushing out of contaminated groundwater.

Shortly after the completion of the sampling programme it was discovered that there was at least one heavily used septic tank soakage field with a piped discharge into the main drain in the central Russell area. A dye test carried out on another major septic tank soakage field system showed that effluent from that system also entered the main drain.

10.7.4 Beaches

A summary of all the FC results for foreshore seawater samples collected since 1976 is given in Table 10. The numbers of samples with faecal coliform counts falling within ranges relating to water quality classification standards are given in Table 11. Again the data set is insufficient to evaluate the differences between tides, weather conditions, seasons or years. However the samples which had consistently the highest faecal coliform counts were collected on a day after heavy rain, ie. 64 mm on 3 December 1985. The relatively high counts in the foreshore samples coincided with some of the highest recorded counts in both the drain samples and samples from bores in the gravel aquifer. This indicates that the high faecal coliform counts are a result of the flushing of domestic effluent from the soakage fields, and pits etc. through the gravel aquifer to the drains and foreshore.

Table 10 Faecal Coliform Numbers in Foreshore Seawater Samples

Site: 135 - Russell - north end

year	n	range	>200/100 ml
1976	10	1-94	0
1977	9	1-120	
1978	9	1-68	0
1981	5	1-36	0
1982	10	2-56	0
1983	4	4-24	0
1984	4	1-96	0
1985	5	1-520	1
1986	6	5-49	0
1987	4	2-126	0

Site: 145 - Russell - southern end

year	n	range	>200/100 ml
1976	-		
1977	9	1-108	0
1978	9	1-160	0
1981	5	1-440	1
1982	10	1-1264	1
1983	6	5-20	0
1984	4	2-236	1
1985	5	2-515	1
1986	5	2-170	0
1987	4	2-172	0

Site: 144 - Russell - mid

year	n	range	>200/100ml
1980	5	2-436	2
1985	3	2-390	1
1986	7	2-560	2
1987	4	2-270	1

*Site: - Matauwhi Bay

year	n	range	>200/100 ml
1980	5	1-180	0
1982	10	2-152	0
1983	4	10-914	3
1984	4	6-596	1
1986	4	4->2400	2
1987	4	2-1000	1

* Samples taken from various sites on the Matauwhi Bay foreshore.

Table 11 Faecal Coliform Numbers in Foreshore Seawater Samples (10/84 to 1/87)

No	Site Location	n	<	Faecal Coliforms (numbers per 100 mls) 1-14	14-200	200-400	400-2000	>2000	max (no./100ml)	median (no./100
					(number	of	samples)			
135	Russell - north end	14	2	5	6	0	1	0	520	20
144	Russell - wharf	14	1	4	5	3	1	0	560	53
145	Russell - end Pitt St	12	2	4	5	0	1	0	515	125
136	Matauwhi Bay	9	0	3	3	1	1	1	72400	33

n = total number of samples

< = not detected at dilution used, assumed to be 0.

These results indicate that the Russell foreshore sea water quality often falls below the bacterial requirements of the standard (see 'CS' standard, Appendix 4) considered suitable for coastal water from which edible shellfish are regularly taken or waters in which shellfish are cultivated or farmed (see Table 6). Although total coliform counts were not carried out, as required to determine compliance with the current SA classification, water that does not meet the CS classification faecal coliform standards is unlikely to meet SA classification.

On a small but significant number of occasions, the faecal coliform counts exceeded 400 faecal coliforms/100 ml and would therefore fall below the bacterial requirements of the standard considered suitable for regular public bathing (class CR, see Table 6). However based on the limited sampling carried out to date the Kororareka Bay (Russell beach) foreshore water quality would generally comply with the existing SB classificiation. If sampling was to be carried out on consecutive days after significant rainfall events it is likely that the SB standard would not be met due to the flushing out of effluent.

10.8 Chemical Analysis of Groundwater Samples

The results of chemical analysis of groundwater samples taken during the investigation are given in Table 12.

The main features of the chemistry of the samples collected are that:

- they had a low to moderate concentration of total disolved solids (as measured by conductivity),
- low pH, except for site 121,
- high iron concentrations.

In relation to the use of the groundwater for domestic and communal water supplies the samples show that the groundwater quality generally falls outside the Health Department recommended drinking water quality guidelines (NZDH, 1984) for pH and iron and to a lesser extent manganese (see Table 13). However those guideline figures are based on aesthetic quality requirements related to taste, turbidity, discolouration and corrosiveness rather than health criteria. Treatment of the water to increase the pH and reduce the iron and manganese concentrations would render the groundwater suitable for communal water supply in those respects.

Table 12 Chemical Analysis of Groundwater Samples
(all units g/m3 unless otherwise stated)

Site No Location	120 Tennis Court	121 Tennis Court	127 School Baker St	129 Hananui (near)	131 Beresford St (NCC)	20 Community Council Beresford St
Date Sampled	9/3/87	9/3/87	9/3/87	9/3/87	9/3/87	5/3/86
pH	6.12	7.33	6.05	6.23	5.50	
Conductivity (ms/m)	22.1	55.7	22.8	27.2	18.9	34.5
Chloride	40.4	62.8	50.8	50.8	44.4	44.0
Sulphate	14.6	10.2	9.6	14.8	5.3	
Bicarbonate (HCO_3^-)	33.6	231.8	27.5	49.3	14.4	
Sodium	24.8	39.6	34.4	35.6	27.2 *	37
Potassium	2.08	4.28	4.20	5.60	2.24	2.8
Calcium	5.8	46.7	1.8	3.8	2.0	21.0
Magnesium	4.4	14.1	4.5	5.3	2.3	6.6
Iron (total)	12.40	4.26	3.00	1.82	0.34	5.50
Manganese (total)	0.17	0.14	0.07	0.03	0.09	0.24
Silica (SiO_2) (molybdate reactive)	25.0	41.6	51.6	63.0	33.7	
total alkalinity ($CaCO_3$)	27.5	190.0	22.5	40.4	11.8	
total hardness ($CaCO_3$)	32.7	174.8	22.9	31.4	14.7	79.7

Table 13 pH, Iron, Manganese - Drinking Water Standards for NZ
(NZDH, 1984) Aesthetic Quality

	Unit	Highest Desirable	Excessive	Undesirable Effect that may be produced
pH	range	7.4-8.5	7.0-8.5	corrosion and scale, unsatisfactory disinfection
Iron	g/m3	0.1	1.0	taste, turbidity, discolouration, deposits, growth of iron bacteria
Manganese	g/m3	0.05	0.5	taste, turbidity, discolouration, deposits in pipes

10.9 Conductivities of Groundwater and Surface Drain Samples

The conductivity of the water is proportional to its ionic concentration (the amount of disolved salts in the water), the higher the ionic concentration the greater the conductivity.

The conductivities of bore and surface drain water samples measured during this investigation are given in Table 14.

In general the conductivities of the bore water samples were low to moderate for natural fresh water and typical of groundwater from the type of geology present. However samples from bore No. 27 had elevated conductivities which are an indication of seawater intrusion into the aquifer. That bore is approximately 31 m deep 35 m from the beach and was drilled in about 1940. No other bores close to Russell beach show any indication of seawater intrusion at this stage. Conductivity measurements were made during the pump test of the NCC investigation bore No. 129, which is 27.1 m deep and situated 50 m from the beach and 75 m south of bore No. 27. The bore was pumped for 19 hours at a rate equivalent to 50 cubic metres per day, during which time the conductivity stayed at approximately 25 mS/m. Other bores to show indications of seawater intrusion were the NCC bore No. 123 situated on reserve close to Tapeka Pt beach, with conductivities between 185 and 239.4 mS/m, and bore No. 57 a shallow (<13 m) bore approximtely 35 m from Matauwhi Bay Beach and a few metres from the tidal creek at the eastern end of the beach.

The conductivities of the surface drain waters was generally within the same range as the groundwaters with some lower conductivities being recorded during and after rainfall.

Table 14 Conductivities of Groundwater and Drain Samples
(mS m^{-1} @ 25 degrees Celcius)

Site No	n	conductivity range
Bores		
02	18	23.4 - 30.8
05	17	19.4 - 23.9
12	12	59.4 - 72.0
15	12	22.8 - 30.8
18	12	25.8 - 32.5
21	17	21.7 - 25.4
27	12	121.3 - 565.0
33	13	21.5 - 26.7
36	16	28.9 - 43.3
38	15	26.0 - 34.5
44	1	
46	3	37.5 - 40.8
48	13	25.0 - 31.4
50	12	31.9 - 39.1
57	16	31.6 - 138.6
61	19	48.5 - 63.5
67	17	20.5 - 32.8
74	9	24.3 - 26.1
84	13	19.6 - 23.2
86	10	23.7 - 26.9
94	15	24.8 - 27.8
120	6	18.2 - 27.4
121	6	30.2 - 40.5
122	6	18.2 - 25.1
123	6	185 - 239.4
125	1	35.3
126	5	22.8 - 24.5
128	6	25.1 - 28.5
129	6	25.1 - 42.2
130	6	23.3 - 29.6
131	3	21.7
Drains		
134	18	11.9 - 49.3
138	2	19.4 - 24.5
139	2	16.0 - 23.9
140	2	16.5 - 21.7
147	15	21.1 - 32.5
148	5	6.8 - 20.9

n = number of samples

11 GROUNDWATER LEVELS - PIEZOMETRIC CONTOURS

11.1 Groundwater Level Monitoring Programme

The static water levels (ie. natural, unpumped water levels) in a number of existing water bores and in the NCC investigation bores were measured manually, generally fortnightly, for the period October 1984 to February 1987. A groundwater level recorder was installed on NCC Bore No. 119, Tennis Courts, York Street, on 28 March 1985. That bore is 11.3 m deep and is screened through the lower part of the gravel aquifer.

Table 15 shows a list of the highest and lowest water levels measured in the bores monitored. Many of the lowest levels measured were not static water levels as they were subject to pumping drawdown. As the bores are of various depths the water levels represent the piezometric head from both the gravel and the weathered greywacke aquifers, and in one or two cases the unweathered greywacke. Also some bores have insufficient or corroded casing and/or the annulas between the casing and drill hole is not grouted to prevent downward leakage from overlying aquifers. This means that the water levels measured may be a composite of the piezometric head in more than one aquifer.

11.2 Piezometric Contours

The bore heights were levelled relative to mean sea level so that water levels could be compared and inferred piezometric contours drawn. Groundwater flows from high to low piezometric heads and in a direction perpendicular to the piezometric contours.

Figure 6 shows the highest water levels recorded in the bores, most of which occurred in the winter and spring of 1985. Inferred piezometric contours have been drawn from these. The piezometric countours form a pattern similar to the topographic contours, with the main direction of flow being toward the beaches.

Table 15 Range of Water Levels in Russell Bores (9/84-2/87)

Bore No	Water Levels high-low (m.b.g.l)	high-low (m.a.m.s.l)	range (m)
1	1.740-4.320*	3.440 - 0.860	2.580
12	1.200-1.665	1.530 - 1.065	0.465
14	0.740-3.410*	2.190 - 0.480	2.670
15	0.560-4.970*	2.510 - 1.900	4.410
16	0.520-7.700*	2.270 - 4.91	7.180
18	2.600-5.980*	4.640 - 1.26	3.380
19	1.560-4.330	3.790 - 1.02	2.77
21	1.070-5.515*	4.390 - 0.055	4.445
22	0.325-4.020*	2.915 - 0.780	3.695
36	5.600-9.47*	3.170 - 0.700	3.870
38	3.230-4.315	3.730 - 2.645	1.085
48	0.370-3.010*	2.300 - 0.34	2.640
49[1]	1.175-1.515	1.975 - 1.635	0.340
50[1]	0.380-0.745	1.910 - 1.545	0.365
51[1]	F -0.535	+2.42 - 1.885	
57	0.600-2.400*	1.12 - 0.68	1.800
59	1.010-3.840*	3.18 - 0.350	2.830
61	2.16 -4.070	2.43 - -0.52	1.910
63	0.920-5.020*	4.03 - -0.070	4.100
69	18.47-21.355*	3.1 - 0.125	2.885
83	0.300-8.627*	2.950 - 5.377	8.327
84	0.525-2.020	1.865 - 0.370	1.495
89	0.690-2.940	1.070 - 1.180	2.25
94	0.970-4.940*	4.260 - 0.304	3.956
97[1]	3.010-4.400*	0.930 - -0.460	1.390
102	0.380-1.980	1.54 - -0.060	1.600
120	0.590-1.500	1.66 - -0.75	0.91
121	0.800-2.290	1.58 - -0.09	1.49
122	0.910-3.060	2.57 - -0.420	2.990
123	0.654-4.010	1.895 - -1.470	3.365
125	0.610-1.860	1.71 - -0.460	1.250
126	0.570-2.560	1.72 - -0.270	1.990
127	5.010-7.101	3.100 - 1.100	2.000
128	1.040-3.870	2.27 - -0.560	2.830
129	1.000-3.820	2.11 - -0.71	2.820
130	1.100-3.000	2.07 - 0.17	1.900
131	1.010-4.760	4.090 - 0.34	3.75

m.b.g.l - metres below ground level

m.a.m.sl - metres above mean sealevel

* - water level which was most likely effected by pumping, other low reading may also have been effected by pumping.

49[1] - Readings do not cover full time period.

F - Flowing artesian

RUSSELL

MAXIMUM GROUNDWATER LEVELS; INFERRED PIEZOMETRIC CONTOURS & DIRECTION of GROUNDWATER FLOW.

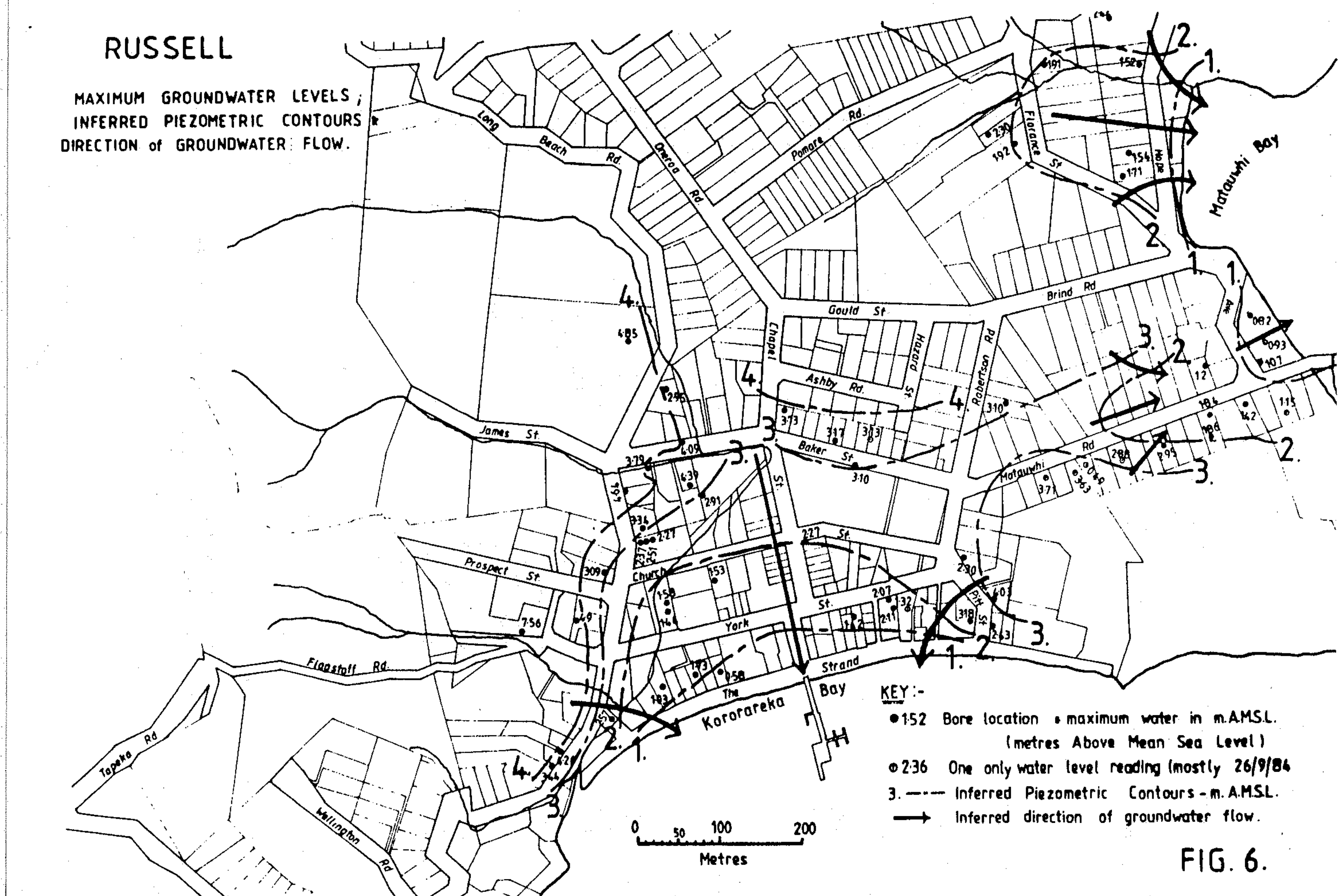


FIG. 6.

In the Russell situation the determination of the lowest natural groundwater levels is difficult because so many of the bores are being pumped or are affected by others being pumped during the periods when groundwater levels are at their lowest.

However it is evident that the water levels in bores in the central Russell township, the Matauwhi Bay foreshore and the lower part of Matauwhi Bay Road drop below mean sea level, see Table 15.

Water levels during pumping may be several metres below mean sea level as can be seen from the levels for bores No 16 and 83 and the maximum drawdowns that occurred during pump tests (see Table 5). Any piezometric levels lower than 1 m below mean sea level are also below mean low water spring (m.l.w.s).

11.3 Tidal Effect on Water Level

The water level in NCC bore no 119 (recorder) was significantly affected by the tide. The tidal range at Russell is 2 m between Mean High Water Spring (M.H.W.S) and Mean Low Water Spring (M.L.W.S) and 1.5 m between MHW Neap and MLW Neap. The tide related movement recorded in bore no 119, which is approximately 130 m from the shore was between 0.25 and 0.45 m per tidal cycle. An example of this tidal water level change can be seen in Figure 7. Also plotted is a trace of the water levels for the same period with the tidal movement removed (using DETIDE, MWD 1986).

Water level changes through a tide, from high to low, were measured in the NCC investigation bores on 6 November 1987. The range of water level changes are shown in Table 16.

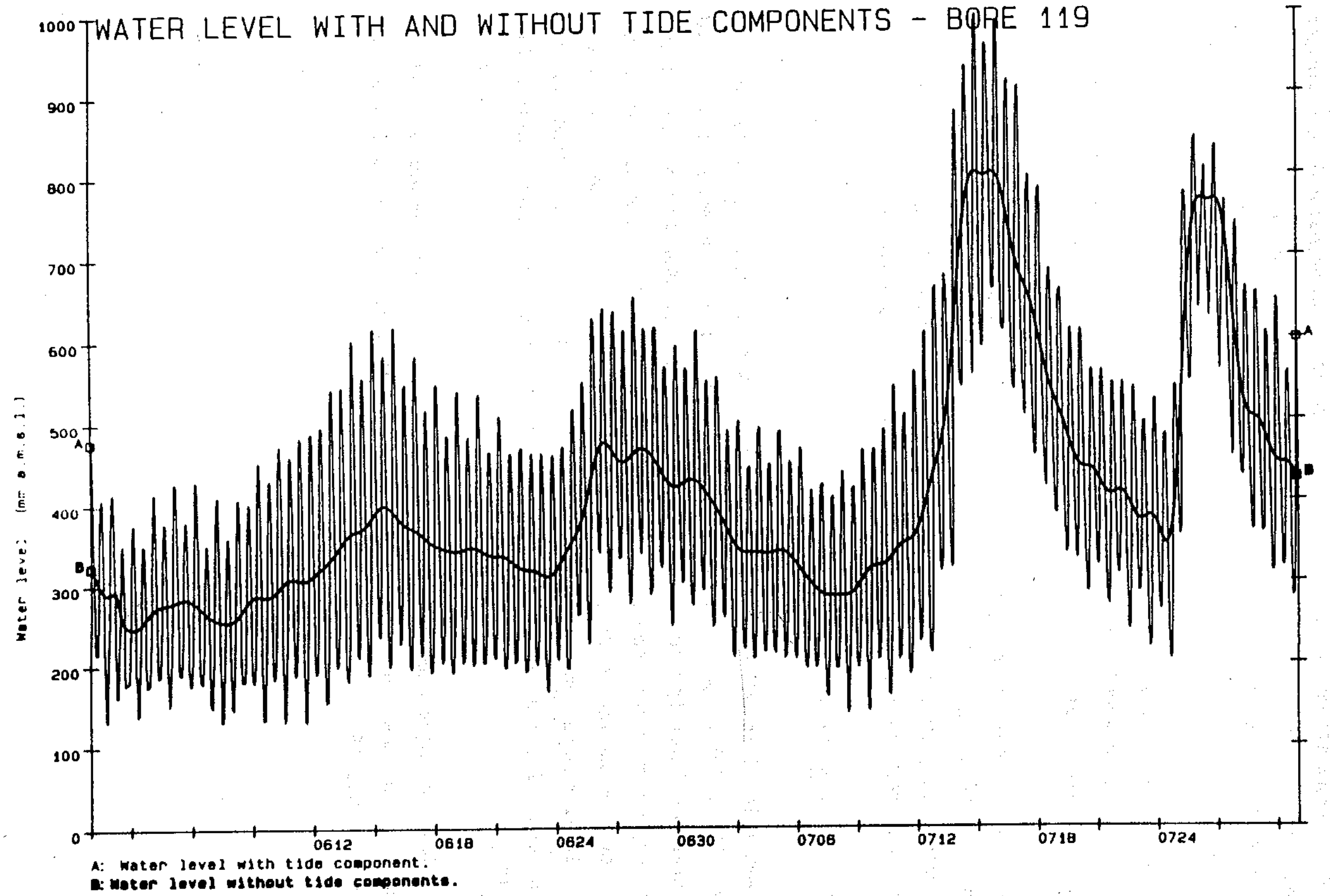

WATER LEVEL WITH AND WITHOUT TIDE COMPONENTS - BORE 119
Water level (mm a.m.s.l.)
1000
900
800
700
600
500
400
300
200
100
0
0612
0618
0624
0630
0706
0712
0718
0724
A
B
A: Water level with tide component.
B: Water level without tide components.

FIG. 7.

Table 16 Water Level Changes in Investigation Bores between high and low tide on 6 November 1987

Bore No	Depth (m)	Distance from Shoreline (m)	Water Level Change (m)
119 (recorder)	11.3	130	0.325
120	5.5	127	0.030
121	16.8	125	0.090
122	3.7	35	0.070
125	13.3	70	0.010
127	31.4	225	0.0
129	27.1	60	0.140
130	8.5	60	0.040
131	31.0	310	0.020

From these results it can be seen that the tidal effect is most pronounced in bore 119 (recorder). The reaction of the water level in bore 119 indicates that the lower of the two gravel aquifers at that site, through which the bore is screened, has an hydraulic connection with the sea and is semi-confined or confined. The changes in water levels in the shallower gravel aquifer, as represented by bores 120, 122 and 130 were only 10% to 20% of those in 119. The shallow aquifer is unconfined and would not be expected to be affected by the tide to the same extent as the confined aquifer. The water levels in the lower weathered greywacke aquifer, as represented in bores 121, 125 (Matauwhi Bay), 127, 129 and 131 changed from 0 to 0.14 m through the tide. The water level in bore 129, the closest to the shoreline of those in the weathered greywacke showed the largest movement. The weathered greywacke aquifer is most likely confined in places, but largely semi-confined and because of its relatively low transmissivity has a relatively poor hydraulic connection with the sea.

12 SEAWATER INTRUSION

12.1 General

In a situation like Russell where coastal aquifers come in contact with the sea under natural conditions fresh groundwater is discharged to the sea. However with abstraction of groundwater the seaward flow of groundwater will be decreased and even reversed, allowing seawater to enter and move inland in the aquifer.

The natural seaward flow of groundwater and the fact that seawater is more dense than freshwater means that seawater entering a coastal aquifer forms a wedge under the freshwater. If the piezometric head and seaward groundwater flow are reduced landward and or upward movement of the seawater interface may be induced. Seawater intrusion can be induced in unconfined, semi-confined or confined aquifers. The interface between the fresh and seawater may be diffuse and its position move in response to natural recharge events or prolonged dry spells.

The naturally slow rate of groundwater flow, the density difference between fresh and seawater and the flushing required, means that once seawater intrusion and contamination has occurred it can take a long time (years) to remove naturally and be difficult and expensive to remedy artificially.

Methods for controlling seawater intrusion include: reduction of pumping, modifying pattern of pumping, use of artificial recharge bores or basins establishment of a pumping trough parallel to the shoreline using a line of pumping wells or construction of an artificial subsurface barrier. (Freeze and Cherry 1979, Hazel 1975).

12.2 Seawater Intrusion at Russell

The relatively small areal extent of the aquifers, piezometric heads that are close to mean sea level, pumping water levels that fall below sea level and existing indications of seawater intrusion all indicate a high that the potential for sea water intrusion at Russell.

The shallow gravel aquifers of central Russell, Kororareka Bay catchment, occupy an area of only approximately 13 ha and are approximately 260 m wide, from the shoreline inland. The surface area of the total Kororareka Bay catchment, which is likely to coincide with the surface area of the weathered greywacke aquifer which underlies the gravels and forms the surrounding slopes, is approximately 62 ha. These relatively small catchment areas mean that recharge of the aquifers is very limited, and that the quantity of water flowing through the aquifers to the sea will also be small.

The water level data collected shows that even when the groundwater levels were at their highest the piezometric head was only 1 m to 2 m above mean sealevel in bores along the foreshore in both Kororareka and Matauwhi Bays. Water levels recorded during pump tests and the lower levels recorded in water supply bores were generally below mean sea level. Pumping water levels were often below mean low water neap. This indicates that during periods when groundwater abstractions are at their greatest, which normally coincide with prolonged dry spells when groundwater levels would naturally be at their lowest in Russell, there will be very little flow of fresh groundwater to the sea. It is likely under those conditions that there would be an inland movement of the freshwater/seawater interface.

Given that the freshwater heads are close to and sometimes below mean sea level and the seawater contamination detected in Bore No 27 indicate that the freshwater/seawater interface is in the vicinity of the shoreline.

13 GROUNDWATER AVAILABILITY - 'SAFE YIELD'

13.1 Definition of 'Safe Yield'

For the shallow gravel aquifers and the weathered greywacke aquifers of the Russell area the maximum amount of groundwater that is physically available for abstraction over any given period is equivalent to the sum of the amount of water stored in the aquifer plus the volume of water entering the aquifers as recharge from rainfall during that period.

However the taking of groundwater in quantities in excess of the quantity of recharge is in effect groundwater 'mining'. The 'mining' of groundwater from the aquifers at Russell would cause a general lowering of the water levels and piezometric levels and a reduction in freshwater flow to the sea. This in turn would result in the eventual loss of the resource through seawater intrusion inland into the aquifer and drawing the water levels down to such an extent that pumping would be impractical. Damage to the physical structure of the aquifer (eg. compaction of gravels) causing permanent reduction in the water - bearing capability of the aquifers, and also land subsidence may also result.

The 'safe yield' of the gravel and weathered greywacke is therefore the amount of water that can be taken without 'mining' the groundwater and causing such undesirable effects. The 'safe yield' must therefore be limited by the volume of water entering the aquifers as recharge from rainfall.

13.2 Groundwater Recharge

Recharge of the gravel and weathered greywacke aquifers is from rainfall that falls within the surface catchment boundaries. There is no recharge of these aquifers from outside of the surface catchments.

Recharge occurs by direct infiltration of rainfall or stormwater runoff from roads, other sealed areas and roofs, and by infiltration from septic tank soakage fields.

The recharge of the groundwater by rainfall can be estimated using water balance calculations.

13.3 Water Balance

To estimate the recharge from rainfall for the Russell area a soil moisture/water budget type model (Fenemor, 1985) was used. The model estimates daily groundwater recharge from rainfall and evapotranspiration. The model is based on the following water balance.

$$R_i = (P_i . Q) - E_i - D_{i-1}$$

where R_i = groundwater recharge on day i (R>0)

P_i = rainfall

Q = percentage of Pi that leaves the catchment during and shortly after rain as surface runoff in drains and streams.

E_i = actual evapotranspiration on day i

D_{i-1} = soil moisture deficit calculated from P_{i-1} and E_{i-1} with $0 < D_i <$ (Field capacity - wilting point).

For the Russell calculations daily rainfall from Russell (NZMS site A54211) was used. Daily potential evapotranspiration is estimated by using daily raised pan evaporation data from Kerikeri (site 531901) multiplied by a pan factor of 0.7. Actual evapotranspiration occurs at the potential rate until available soil moisture becomes limiting. At that stage a choking function is applied which reduces actual evapotranspiration to zero when the soil moisture deficit reaches 1.2 times the water holding capacity.

This type of model is designed for extensive alluvial (or similar) aquifers from which there is little or no surface runoff and therefore surface runoff is generally ignored. However for the Russell gravel aquifer there are significant sealed areas and some surface drains which lead to some relatively quick losses of a proportion of rainfall during and immediately after rainfall by both surface runoff and rapid subsurface flow to drains.

Hence a surface runoff quickflow loss, Q, has been included in the model. No measurements of surface runoff losses have been made at Russell however. Values for Q have been estimated from runoff data from other catchments in Northland. For the purposes of this report estimates of recharge of the gravel aquifer have been given for various values of Q. Table 17 gives calculations of annual recharge for various values of Q for the years 1984-86. Two different values of soil water holding capacity have also been used: 50 mm and 100 mm. As discussed in Section 3.5 1985 had the third highest annual rainfall of the 54 years of record examined while 1986 had the fourth lowest. It is therefore likely that the recharge figures for 1985 and 1986 will be close to maximum and minimum figures respectively and that 1984 will be close to the average.

Given the recharge figures in Table 17 and that the surface area of the gravel aquifers is approximately 13 ha the annual recharge of the gravel aquifers is likely to lie in the range 39 000 to 124 000 m3 with an average figure of approximately 56 000 m3.

Recharge is not spread evenly throughout the year, as can be seen from the monthly estimates given in Table 18. There may be several months in any year particularly in the October to March period during which little or no recharge occurs. The small areal extent and total storage volumes of these aquifers means that the groundwater resource of the shallow aquifers will be vulnerable to depletion during prolonged dry spells. Fig. 8 gives a plot of the water levels measured in NCC bores No 120 and 121 and estimated recharge for the period April 1985 to August 1987. Bore 120 is screened in the upper part of the gravel aquifer and 121 in the weathered greywacke at the same site. The pattern of estimated recharge fits well with the measured water levels.

Table 17 Recharge of Gravel Aquifers at Russell. Calculated using a water balance model (see Section 13.3 for explanation and assumptions).

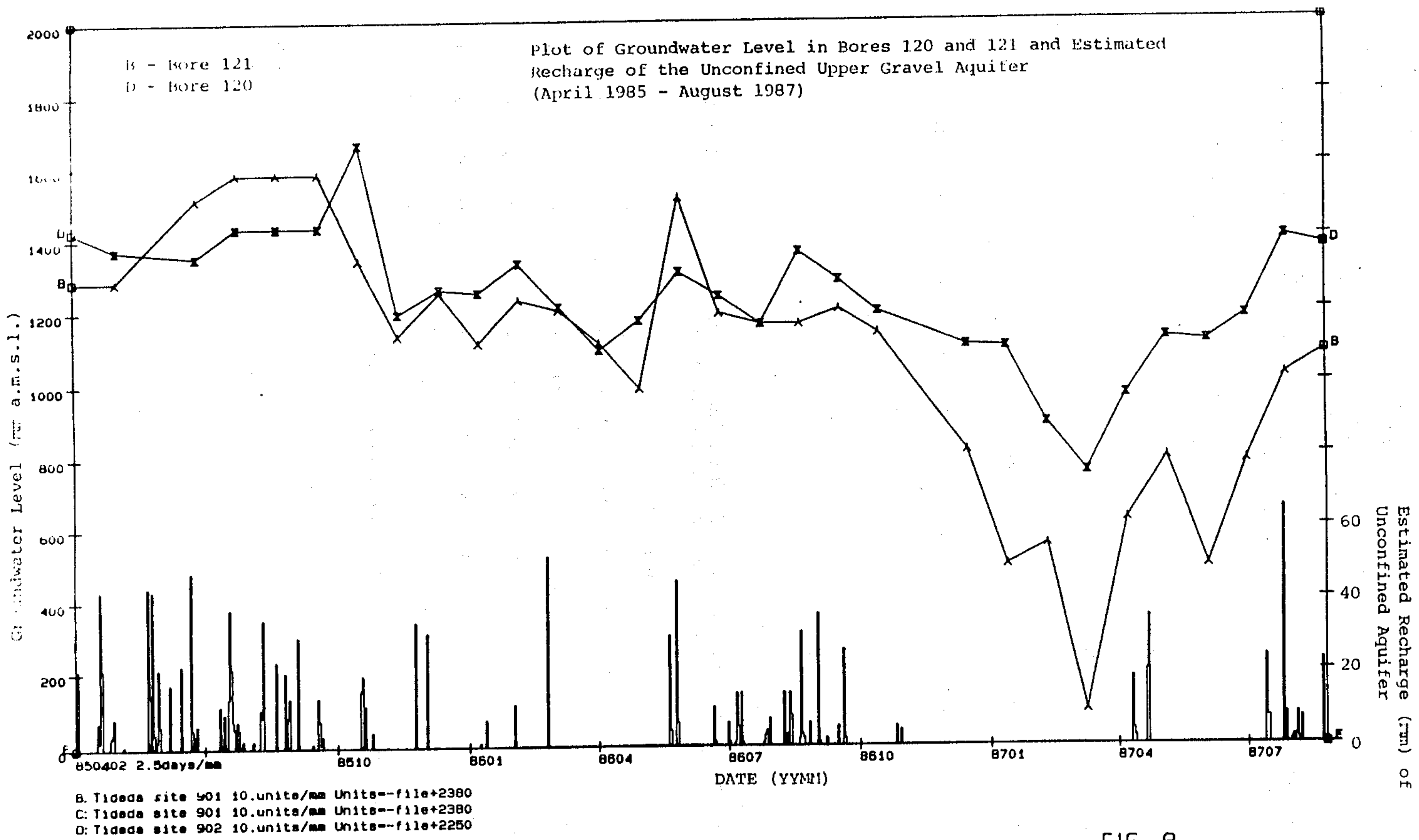
Year	Total Rainfall for year (mm)	Soil Water Holding Capacity (mm)	Runoff-Quickflow (% loss)	Groundwater Recharge for year (mm)
1984	1314	50	20	379
		50	*	481
1985	1818	50	20	777
		50	*	941
1986	1148	50	20	301
		50	*	389

* runoff - quickflow : <20mm/day rainfall : 10%, 20-80 mm/day : 20%, >80 mm/day : 40%.

Table 18 Monthly Recharge of the Gravel Aquifer(s) at Russell Calculated using a Water Balance Model (see Section 13.3 for explanation and assumptions)

Year	Total Rainfall for year (mm)	*Recharge (mm)												
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Tot[illegible]
1984	1314	0	0	71	7	63	42	88	111	67	0	0	32	41[illegible]
1985	1818	0	94	79	125	135	101	119	119	55	49	34	31	94[illegible]
1986	1148	8	63	0	0	85	17	51	84	72	9	0	0	38[illegible]
1987		0	0	0	79	0	0	112	76	44				

* runoff quickflow : <20mm/day rainfall : 10%, 20-80 mm/day : 20%, >80 mm/day : 40%.



Plot of Groundwater Level in Bores 120 and 121 and Estimated Recharge of the Unconfined Upper Gravel Aquifer (April 1985 - August 1987)
B - Bore 121
D - Bore 120
2000
1800
1400
1200
1000
800
600
400
200
0
60
40
20
0
Estimated Recharge (mm) of Unconfined Aquifer
850402 2.5days/mm
8510
8601
8604
8607
8610
8701
8704
8707
DATE (YYMM)
B. Tideda site 901 10.units/mm Units=-file+2380
C: Tideda site 901 10.units/mm Units=-file+2380
D: Tideda site 902 10.units/mm Units=-file+2250

FIG. 8.

There may be some additional but relatively smaller quantities of water entering the gravel aquifer from infiltration of runoff from the surrounding weathered greywacke slopes.

13.4 Recharge of Weathered Greywacke Aquifer

The predominant clay and clay loam soils of the weathered greywacke slopes have a considerably lower infiltration capacity than do the soils overlying the gravel aquifer. Suface runoff is therefore a more significant factor in the water balance and groundwater recharge proportionally less. Studies of weathered greywacke catchments elsewhere in New Zealand have estimated groundwater recharge in those catchments to be in the order of 1 to 5% of annual rainfall (Dr RA Petch, WVA, pers com). For the Russell area this would give an annual recharge of between 10 and 90 mm. For the Kororareka Bay catchment, with a surface area of approximately 62 ha, the annual recharge would be in the order of 6200 to 56000 m3. For the 61 ha Matauwhi Bay catchment annual recharge would be in the order of 6000 to 55000 m3.

13.5 Groundwater Availability vs Use

From the preceeding discussion the 'safe yield' of groundwater from the gravel and weathered greywacke aquifers at Russell has been estimated at between 45000 to 180000 m3/year, with an average of 75000 m3/year. With an additional 6000 to 55000 m3/year being the 'safe yield' from the Matauwhi Bay catchment.

Due to the potential for seawater intrusion (see Section 12) and its possible long term effects it is considered that the 'safe yield' used for water allocation purposes should be the estimated figure for a dry year rather than an average figure or that for a wet year.

The lower figure given for 'safe yield' for Russell is 45000 m3/year which, if spread evenly throughout the year equates to approximately 123 m3/day. That for the Matauwhi Bay catchment would be approximately 20 m3/day.

The existing uses of groundwater use in Russell (see Section 4.1) has been estimated at an off-peak usage of between 60-120 m3/day up to a peak usage of 275 m3/day. The potential total water requirement for the Russell urban area (see Section 4.2) is estimated at an average demand of 235 m3/day to a peak demand of 465 m3/day.

From these figures it can be seen that existing groundwater usage is close to, and at peak usage above the estimated 'safe yield' and that the total water requirements of the Russell urban area are significantly greater than the estimated 'safe yield' of the gravel and weathered greywacke aquifers.

14 ALTERNATIVE WATER SOURCES

14.1 Introduction

Given that the gravel and weathered greywacke aquifers cannot in the long term supply the water requirements of urban Russell a brief discussion of alternative water sources is given below.

The alternative water sources can be covered under the following headings:

- roof runoff collection
- deeper groundwater
- runoff collection dams
- stream flow.

14.2 Roof Runoff Collection

Roof runoff collection is a source of water which is already utilised by most premises in Russell. However roof runoff collection cannot supply the full water requirements of most premises. Average households of 3 to 5 people require approximately 180-250 m3 of water per year. That would include garden watering and vehicle washing. Obviously self imposed watering, vehicle washing, toilet flushing and other restrictions will reduce the household water requirement. A roof runoff collection system comprising 95 m2 of roof and a 22.5 m3 (5000 gal.) tank would be capable of providing between one third and one half of that requirement depending on rainfall quantity and pattern for the year. For tourist accommodation facilities the proportion of the water requirement that could be supplied from roof water is lower.

14.3 Deeper Groundwater

At this stage there has been little investigation of the potential of the unweathered greywacke as a water supply source. As discussed in Section 8.2 water is only found in significant quantities in unweathered greywacke in fracture zones.

To date only a few bores have been drilled to any significant depth into the unweathered greywacke. The Commission has welldrillers borelogs which give indications of the bore production capabilities for only three such bores in the Russell urban area (see Section 6.3). The deepest bore at 93 m deep apparently only yielded 0.5 m3/hour whereas one at 74 m deep yielded approximately 11 m3/hour and 41.5 m deep bore approximately 20 m3/hour (480 m3/day).

Although the welldrillers estimates of the capabilities of the latter two bores look promising when compared to the estimated water requirements for Russell, the ability of the bores and the resource to sustain those yields in the long term has not been investigated. Details of the quality of the deeper groundwater are as yet unknown.

If those estimated yields were sustainable and the quality adequate groundwater from fracture zones in the unweathered greywacke could provide the water requirements of the Russell urban area.

14.4 Runoff Collection Dams

Surface runoff from the weathered greywacke soils of the catchments surrounding Russell could be expected to be in the order of 500-700 mm, or 5000-7000 m3/ha, per year. This runoff could be collected in storage dams to provide a public water supply to Russell. To provide for the total water requirement of the Russell urban area (see Section 4.2), at an average demand of 240 m3/day or 87600 m3/year a catchment area of approximately 17 ha would be required. A dam with a usable water volume of approximately 25000 m3 (say 75m x 75m x 4.5 m) would be required to provide 100 days supply at average demand or 50 days at peak demand during a prolonged period of little or no rainfall. Such a dam would have been able to supply Russells water requirements through the very dry spell experienced over the 1986/87 summer and dry winters of 1986 and 1987.

A stereoscopic examination of aerial photographs of the Russell peninsula and a site visit showed that there are several catchments close to Russell (within 2 km) which have some potential for siting runoff collection dams.

14.5 Stream Flow

There are no streams on the Russell peninsula that sustain a flow that is sufficient to contribute significantly as a public water supply source, without the use of a dam. It may however be feasible to supply Russell from some more distant stream flow source as part of a larger water supply scheme.

14.6 Conjunctive Use

The conjunctive use of two or more sources may be required to provide the potential water requirements for Russell.

15 SUMMARY AND CONCLUSIONS

15.1 Water Quality

15.1.1 The results of a 1982 Bay of Islands County Council/Health Department survey of both water supply and sewage disposal facilities in the Russell urban area showed that there is a high potential for contamination of water supplies, streams, open drains and the foreshore with domestic effluent.

15.1.2 Northland Area Health Board testing of water used in public and commercial premises (motels, restaurants etc) has shown significant evidence of faecal contamination.

15.1.3 Faecal coliform bacteria were found in at least one sample from each of 21 of 34 bores sampled in the Russell area.

15.1.4 Faecal coliform bacteria counts showed that the open drains in the Russell urban area are subject to significant contamination from domestic effluent.

15.1.5 On a small but significant number of occasions (given the limited sampling carried out) faecal coliform numbers in foreshore seawater samples from Kororareka and Matauwhi Bays fell outside the standard considered suitable for regular public bathing (CR classification). However the results indicated that the Kororareka Bay foreshore water quality would generally comply with the existing SB classification except during and for several days after significant rainfall.

15.1.6 Chemical analysis of samples of groundwater from the gravel and weathered greywacke aquifers showed iron and manganese concentrations which may cause aesthetic problems, such as bad taste, turbidity, discolouration and corrosion, if the water is used untreated for domestic water supply.

15.2 Geology

15.2.1 Examination of existing geological information and investigation drilling showed that the low lying relatively flat area of Russell township consisted of variable sequences of up to 15 m of dirty fine to medium gravels, gravely clays, clay and some dirty sands, overlying up to 15 m of weathered greywacke, overlying unweathered greywacke. All the hillslopes surrounding Russell are formed of weathered greywacke overlying fresh greywacke.

15.3 Seawater Intrusion

15.3.1 The relatively small areal extent of the aquifers, piezometric heads that are close to mean sea level, pumping water levels that fall below sea level and existing indications of seawater intrusion all indicate a high potential for seawater intrusion into the aquifers at Russell.

15.4 Water Availability

15.4.1 Both the overlying gravel deposits and the weathered greywacke contain usable quantities of groundwater, and are the aquifers currently used for most water supply bores in Russell.

15.4.2 Water availability from the gravel and weathered greywacke aquifers of the Russell area is limited by the small areal extent and volume of those aquifers, and by the potential for seawater intrusion into those aquifers.

15.4.3 It is estimated that the safe yield from the gravel and weathered greywacke aquifers of the Kororareka Bay Catchment area is between 45000 and 180000 m3/year and 6000–55000 m3/year for the Matauwhi Bay catchment.

15.4.4 Due to the potential for seawater intrusion into the aquifers and the uncertainties involved in the estimations of 'safe yield' it is considered that allocations of water from those aquifers to consumptive uses should be limited to the lower estimates of safe yield, until such time as the limits of the resource become more accurately defined.

15.4.5 Existing groundwater usage in the Russell urban area is estimated to be close to and at peak usage exceeds the lower estimate of the 'safe yield' of the gravel and weathered greywacke aquifers. The estimated total water requirements of the Russell urban area are significantly greater than the estimated 'safe yield'.

15.5 Alternative Sources of Water

15.5.1 Roof runoff collection provides a significant source of water for private residences. However for most households roof runoff alone is not capable of supplying the full water requirements.

15.5.2 Groundwater from the underlying unweathered greywacke may provide a significant source of water. However there has been very little investigation of that potential resource to date.

15.5.3 Surface runoff collection and storage in dams is a potential source of water for Russell. There are several catchments close to Russell which have some potential for the siting of runoff collection dams.

16 RECOMMENDATIONS

Based on the information contained in this report the following recommendations are made regarding the management of the water resources of Russell.

16.1 Water Quality Standards

Water quality standards that are considered to be achievable and consistent with the various water uses to be protected should be set for the natural waters of the Russell area as follows:

16.1.1 Water quality standards for the natural coastal waters of the Russell area which are consistent with a general perception of a largely uncontaminated natural resource and compatible with regular public bathing and the gathering of seafood.

16.1.2 Water quality standard for surface freshwaters whereby the flow of freshwater into the sea does not compromise the coastal water quality standard.

16.1.3 Water quality standard for groundwater consistent with the use of groundwater for domestic and public water supply, where minimal treatment could be expected.

16.1.4 That the proposed water quality standards be based on the water quality classification standards of the Draft Water and Soil Bill 1986 and the existing classified standards.

16.1.5 To achieve the recommended water quality standards, and by implication water quality suitable for the uses described above, it is recommended that the current individual septic tank/soakage field based sewage treatment and disposal system be replaced by a reticulated sewage collection and centralised treatment system(s) of an appropriate design.

16.2 Water Availability and Allocation

16.2.1 That no further allocations of groundwater from the gravel and weathered greywacke aquifers, beyond existing uses be made and that a more efficient use be made of that resource via a suitably monitored community water supply.

16.2.2 That investigations into alternative water sources, in particular runoff collection and storage dams and groundwater from deeper unweathered greywacke be encouraged.

16.3 Implementation of Resource Management Recommendations

16.3.1 That a resource management plan setting out the Commissions goals, policies and method of implementation be prepared for the Russell area.

However given that at this stage such management plans have no direct statutory backing, statutory backing must come from the use of the water right and water right monitoring system, adoption of water and land use management recommendations in the Bay of Islands County Council District Scheme and with the use of any other statutory consent powers available to the Commission.

16.3.2 That monitoring of the resource be continued at a level sufficient for the effectiveness of the resource management to be assessed.

REFERENCES

APAH et. al. 1985: Standard Methods for the Examination of Water and Wastewater (16th Ed.) APHA, AWWA, WPCF.

BOICC 1982 : Russell Sanitary Survey; unpublished results (NCC File No 600.10.4).

BOICC 1986 : Statement of Proposed Objectives and Policies for Review of District Scheme. Bay of Islands County Council, May 1986.

Dept of Health 1982: report to BOICC regarding results of Russell Sanitary Survey - unpublished (NCC File No 670.1.6)

Dept of Maori Affairs 1986: evidence given on behalf of Dept of Maori Affairs at the NCC Tribunal Hearing of Water Right application 928 (BOICC, to discharge treated domestic effluent, Tapeka Point) (NCC File No 928).

Fenemor A 1985: The Water Balance Models for Calculating Rainfall Recharge to Groundwater. Water and Soil Science Centre, Christchurch, MWD. Report No WS 982.

Fenner F 1981: Microbiological Pollution of Groundwater in Proceedings of the Groundwater Pollution Conference - Perth, WA 19-23 Feb 1979. Australian Water Resources Council Conference Series No 1. p333-355.

Ferrar HT 1925: The Geology of the Whangarei - Bay of Islands Subdivision, Kaipara Division. NZ Geological Survey Bull. ns. 27.

Freeze RA & Cherry JA 1979: Groundwater. Prentice-Hall Inc.

Gibbs M 1987: The Evaluation of Groundwater Contamination by Lake and Seashore Urban Developments in: Proceedings of the Groundwater Chemistry Workshop 18-20 August 1986; ARARWB Thechnical Publication No 41.

Hazel CP 1975: Groundwater Hydraulics. Australian Water Resources Council.

Kear D & Hay RF 1961: Geological Map of New Zealand 1:250000 (1st Ed.) Sheet 1, North Cape. DSIR, Wellington.

MWD 1986: DETIDE a computer programme to remove the effects of the ocean tide from a set of water level data. Water and Soil Science Centre, Christchurch, MWD.

NWASCO 1980: The Report of the Water Quality Criteria Working Party: National Water and Soil Conservation Organisation - unpublished.

NZDH 1984: Drinking Water Standards for New Zealand. New Zealand Department of Health.

Till DG 1980 : Public Health - Water Microbiology Criteria : report by DG Till Chief Bacteriologist, National

GLOSSARY

Aquifers - a permeable water-bearing formation through which water moves under natural conditions and yields water to wells at a sufficient rate to be a practical source of water supply.

Aquifer Test or Pumping Test - a field procedure in which water is pumped from a well in the aquifer to be tested at a measured rate while observing the drawdown in other wells nearby, to calculate the aquifer characteristics.

Artesian - confined aquifer water which is under sufficient pressure to rise above ground surface when penetrated.

Confined - water which is isolated from above and below by impermeable layers is called confined water, or water of a confined aquifer.

Dirty Gravel - gravel formation that contains a significant amount of fine (clay, silt and sand) material.

Drawdown - the lowering of static water level by pumping.

Evapotranspiration - combination of evaporation due to drying and transpiration due to utilisation of soil moisture by plants.

Greywacke - dark grey indurated siltstone and sandstone.

Hydraulic conductivity (Permeability) (K) - a measure of a material's ability to transmit water: the value of K is dependent on the size, number and interconnectedness of the inter-granular pore spaces within the material.

Hydraulic Gradient - the change in piezometric head (or pressure) per unit distance in a given direction.

NZMS - New Zealand Meteorological Service.

Piezometric - piezometric pressure or piezometric surface or piezometric level is the height of the static water level above the aquifer surface. In an unconfined aquifer the piezometric surface coincides with the water table, while in a confined aquifer at a level in equilibrium with atmospheric pressure (static water level in an open well penetrating the confined aquifer).

Piezometric Contour - lines of equal piezometric pressure.

Porosity - ratio of the total volume of pore spaces in a material to its total volume.

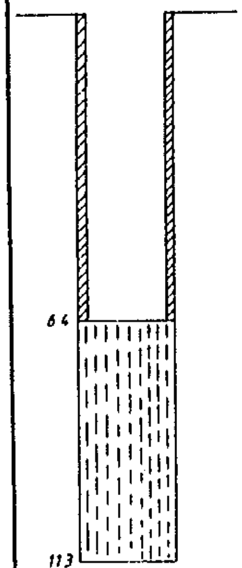
Recharge	- the addition of water to the zone of saturation; also, the amount of water added.
Runoff	- that part of rainfall flowing to surface streams.
Semi-confined aquifer	- an aquifer overlain by a semi-pervious layer which has a relatively low, though measurable, permeability.
Static Water Level	- the level of water, or head, in an open bore which is unaffected by pumping.
Transmissivity (T)	- the rate of flow of groundwater under a unit hydraulic gradient through a cross section or unit width and extending through the full thickness of saturated aquifer.
Unconfined aquifer	- a completely saturated permeable formation which has a free water table.
Weathering	- the in-situ physical disintegration and chemical decomposition of rock materials at or near the earths surface.
Well Screen	- a filtering device used to keep sediment from entering a water well.
Well Yield	- the volume of water discharged from a well or bore.

Appendix 1

Geological and Construction Logs

for NCC Russell Investigation Bores

SITE NAME / No *Domain Recorder* 119 Tennis Court
LOCATION *York St, Russell*
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0		*Loose dirty gravels*		*100 mm galvanised casing*
5		*Medium gravels*		
		Marine muds	6.4	
10		*Mixed gravels interbedded with clays*		*Slotted PVC 20 Thou inch.*
11.3			11.3	*YIELD: 6.5 l/min @ 11m drawdown*

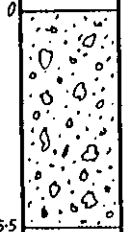
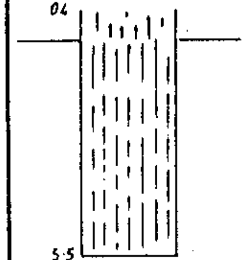
Driller *Kiwi*
Drill Type *Rotary*
Start: *31.1.85*
Finish *31.1.85*

NORTHLAND CATCHMENT COMMISSION

PROJECT:

FIGURE No.

SITE NAME / No *Domain, middle.* 120 Tennis Court – middle
LOCATION *York St, Russell*
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0		*Fine to medium dirty gravels*	0.4 	*100 mm slotted galvanised*
5.5			5.5	*YIELD 115 l/min 5.5m drawdown*

Driller: *Kiwi*
Drill Type: *Rotary*
Start: *31.1.85*
Finish: *31.1.85*
Logged by: *Driller*

NORTHLAND CATCHMENT COMMISSION

PROJECT: RUSSELL GROUNDWATER

FIGURE No

SITE NAME / No. Domain, Far 121 Tennis Court
LOCATION York St, Russell.
MAP REFERENCE

SCALE (m)	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0	Loose dirty mixed gravels	0.5	100 mm Galvanised Casing
	Medium gravels		
5	Marine muds		
	Mixed gravels with interbedded clays		
10			
	Marine mud and vegetation		
15	Brown weathered greywacke	14.6	YIELD: 3 l/min @ 16m drawdown
16.8	Blue greywacke		Uncased

Driller: Kiwi
Drill Type: Rotary
Start: 31·1·85
Finish: 31·1·85
Logged by: Driller

NORTHLAND CATCHMENT COMMISSION

PROJECT:

FIGURE No.

SITE NAME / No. 122 Boat Ramp
LOCATION Kent St, Russell.
MAP REFERENCE

SCALE (m)	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0	Top soil	0.5	
	Light yellow clays		100 mm PVC
	Dirty medium gravels	1.8	Slotted PVC 20 Thou inch
	Dirty fine gravels	3.7	
	Brown clays & vegetation		
5	fine gravels		
	Brown weathered greywacke		
8.2			YIELD: Blew hole dry with air

Driller: KIWI
Drill Type: Rotary
Start: 16·1·85
Finish:

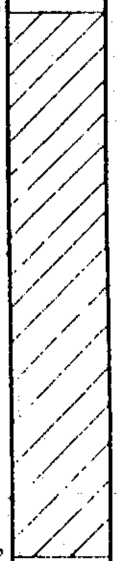
NORTHLAND CATCHMENT COMMISSION

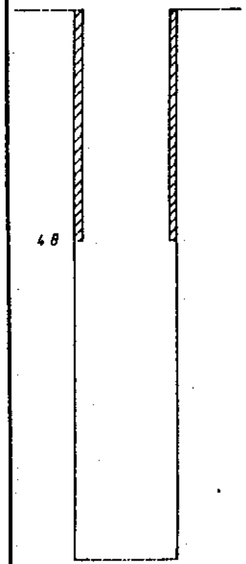
PROJECT:

FIGURE No

SITE NAME / No 123 *Tapeka Point*
LOCATION *Russell*
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0				100mm PVC
4.8			4.8	
5		Weathered greywacke very broken		Uncased
10				
11.2				YIELD: 83 l/min @ 11.2m drawdown





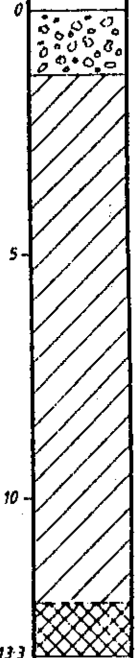
Driller: *Kiwi*
Drill Type: *Rotary*
Start: *Jan '85*
Finish
Logged by

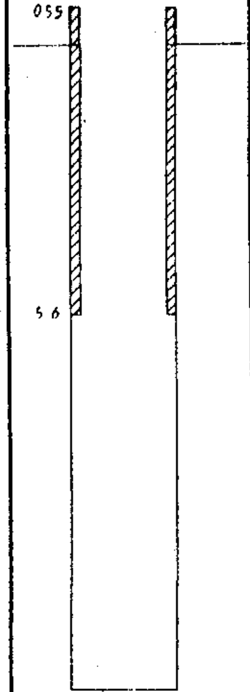
NORTHLAND CATCHMENT COMMISSION

PROJECT:
FIGURE No.

SITE NAME / No. 125 *Matauwhi Bay Reserve*
LOCATION *Florence Ave, Russell*
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0		Mixed dirty gravels	0.55	100mm galvanised casing
5		Weathered greywacke	5.6	Uncased
10				
13.3		Blue greywacke		YIELD 27 l/min





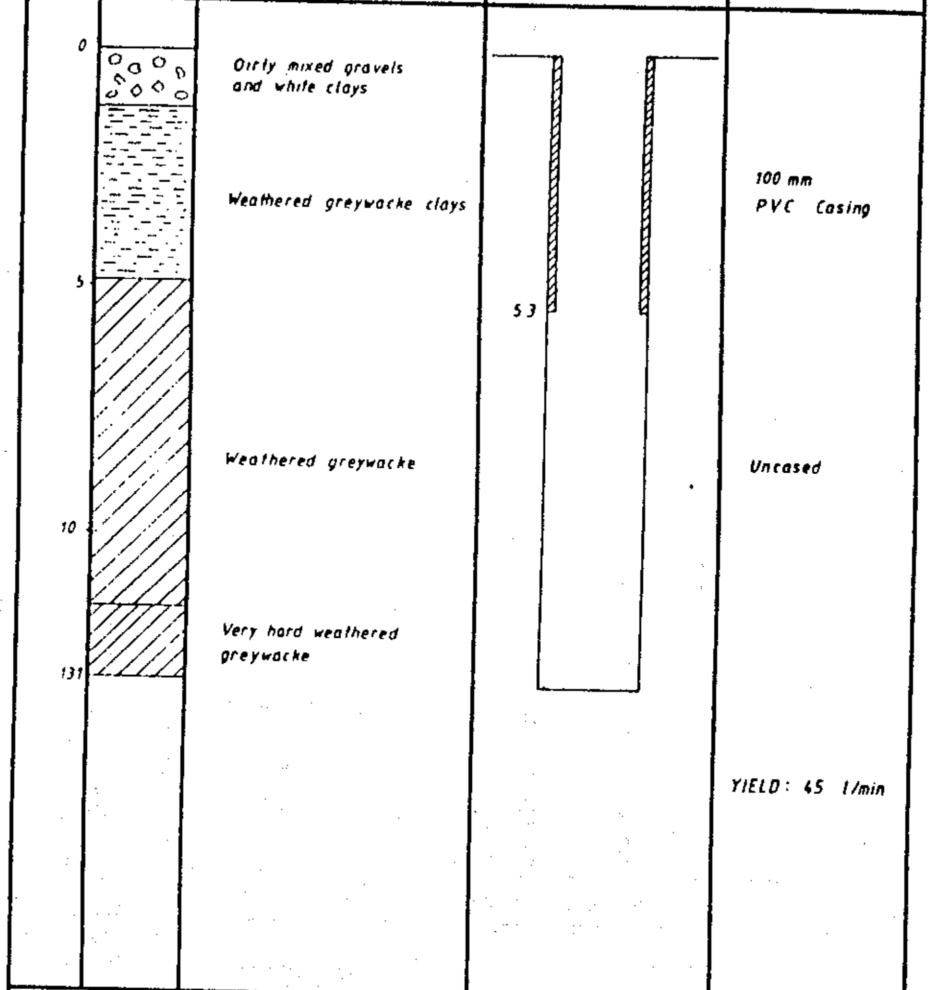
Driller: *Kiwi*
Drill Type: *Rotary*
Start: *Jan 85*
Finish:
Logged by: *Driller*

NORTHLAND CATCHMENT COMMISSION

PROJECT: *RUSSELL GROUNDWATER*
FIGURE No

SITE NAME / No 126 *Powell*
LOCATION *Matauwhi Rd, Russell.*
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS



Driller *Kiwi*
Drill Type *Rotary*
Start *8 1 85*
Finish *8 1 85*
Logged by *Driller*
Drawing No

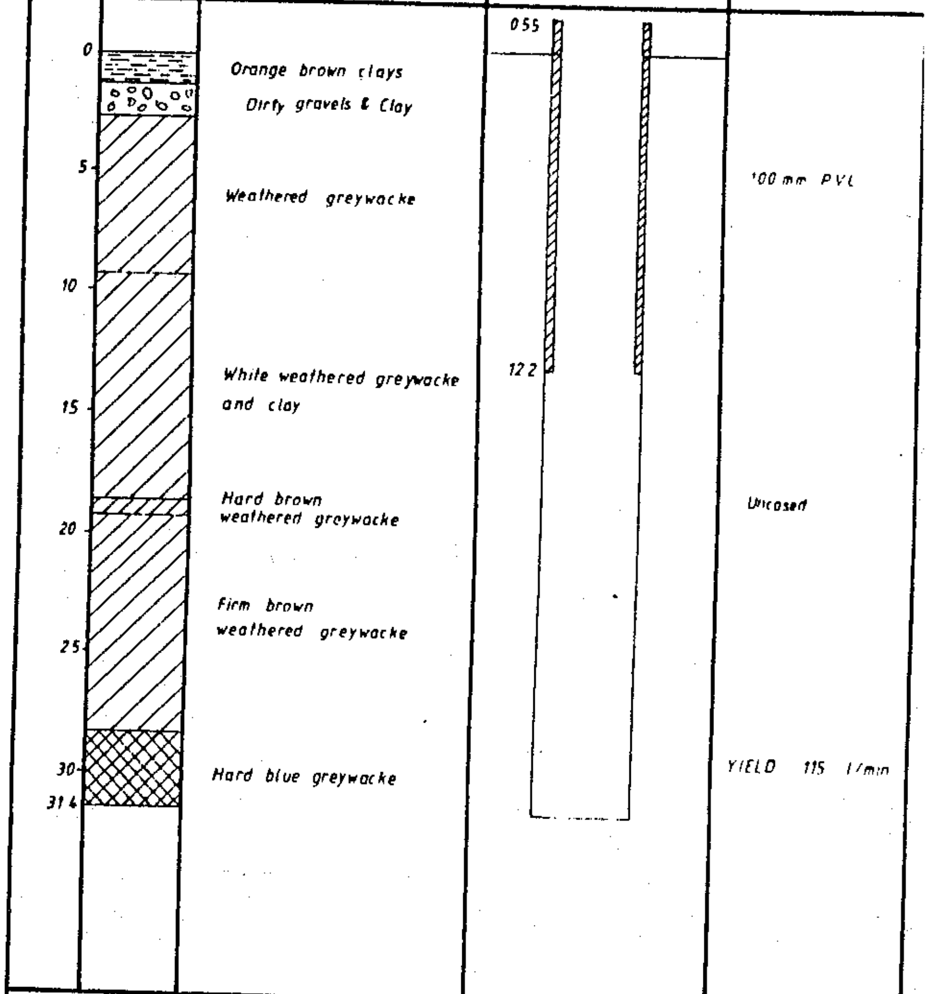
NORTHLAND CATCHMENT COMMISSION

PROJECT: *RUSSELL GROUNDWATER*

FIGURE No.

SITE NAME / No 127 *Upper School*
LOCATION *Baker St, Russell.*
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS



Driller: *Kiwi*
Drill Type: *Rotary*
Start: *9·1·85*
Finish: *9·1·85*
Logged by: *Driller*

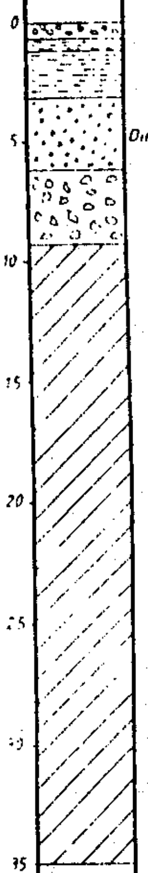
NORTHLAND CATCHMENT COMMISSION

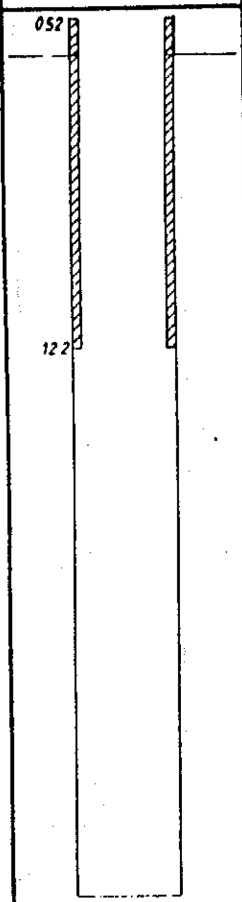
PROJECT: *RUSSELL GROUNDWATER*

FIGURE No

SITE NAME / No. 128 *Lower School*
LOCATION *Chapel St, Russell.*
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0		Yellow & brown dirty gravels Black clays Grey clays	0.52	
5		Dirty fine loose gravels Dirty medium gravels		100 mm PVC
10			12.2	
15				Uncased
20		Weathered greywacke		
25				YIELD: 4 l/min
30				
35				





Driller: *Kiwi*
Drill Type *Rotary*
Start: *14·1·85*
Finish

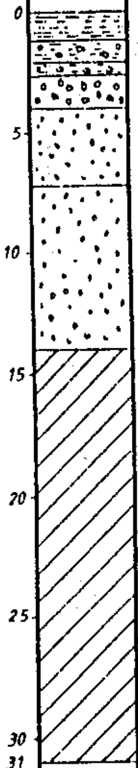
NORTHLAND CATCHMENT COMMISSION

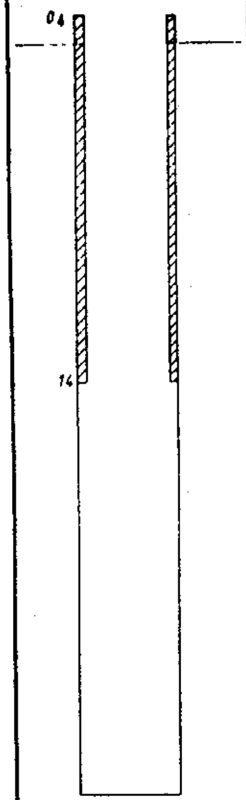
PROJECT:

FIGURE No.

SITE NAME / No. 131 *Beresford St*
LOCATION *Russell*
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0		Yellow clays Brown clays & gravels Blue silty clays & gravels Blue gravel	0.4	
5		Fine gravels		100 mm PVC
10		Dirty brown fine gravels	14	
15				
20		Weathered greywacke		Uncased
25				
30				YIELD: 30 l/min
31				





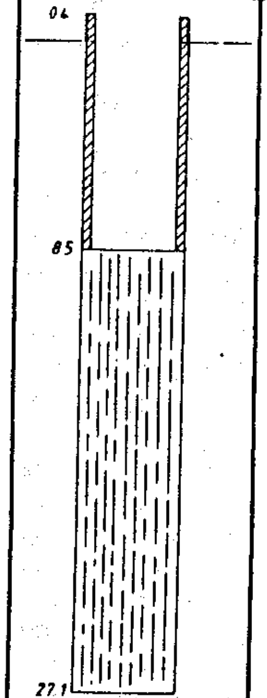
Driller: *Kiwi*
Drill Type: *Rotary*
Start: *11·1·85*
Finish:

NORTHLAND CATCHMENT COMMISSION

PROJECT:

FIGURE No

SITE NAME / No 129 Hananui Lodge, nearest to motel
LOCATION York St Russell
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0		Fine sands Black coarse sands Brown coarse sands Blue & grey fine sands	 0.4	
5		Medium gravels Gravels & marine mud Medium gravels Gravels Gravels & clays	8.5	100mm galvanised casing
10		Weathered greywacke clays		
15		Marine mud Marine mud & vegetation Weathered greywacke		75mm PVC 20 Thou
20		Hard greywacke		
25				
27			27.1	YIELD 42 l/min

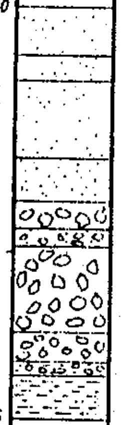
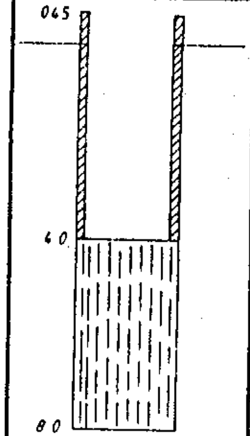
Driller Kiwi
Drill Type Rotary
Start 17 1 85
Finish
Logged by Driller

NORTHLAND CATCHMENT COMMISSION

PROJECT:

FIGURE No

SITE NAME / No. 130 Hananui Lodge, farthest from motel
LOCATION York St, Russell.
MAP REFERENCE

SCALE (m)	GRAPHIC LOG	GEOLOGICAL LOG	BOREHOLE CONSTRUCTION	COMMENTS
0		Fine sands Black sands Brown sands Blue & grey sands	 0.45	100 mm galvanised casing
5		Medium gravels Gravels & marine mud Medium gravels	4.0	Slotted galvanised 20 Thou
8.5		Gravels Gravels & clays Weathered greywacke clays	8.0	YIELD: 55 l/min

Driller: Kiwi
Drill Type: Rotary
Start: 22·1·85
Finish:

NORTHLAND CATCHMENT COMMISSION

PROJECT:

FIGURE No.

Appendix 2

Exisitng Water Rights - Russell Urban Area

WR No	St	Name	Catchment	m3/d	Type	Purpose	Exp. Date
3537		BOICC	Kororareka Bay	22	UNDE	Fire Brigade Use and Public Supply	30/04/93
1694		Morton HR & Montgomery HA	Kororareka Bay	1	UNDE	Water Supply to Shop	30/04/90
909		Flagstaff Homestead	Kororareka Bay	6	UNDE	Motel and Domestic	30/04/96
911		Marlin Lodge	Kororareka Bay	1.1	UNDE	Private Water Supply	30/04/97
3730		Bambury B	Kororareka Bay		DISC	Discharge Treated Sewage	30/04/90
3731		Bambury B	Kororareka Bay		DISC	Discharge Stormwater	30/04/90
1885		Bay of Islands Maritime	Kororareka Bay		DISL	Discharge Septic Tank Effluent	30/04/90
2330	E	Muller JH & OJ	Kororareka Bay		DISL	Discharge Treated Effluent	30/09/87
3146		Young W	Kororareka Bay	6	UNDE	Emergency Supply for Hotel	30/04/89
4200		Hananui Lodge Motel	Kororareka Bay	1.7	UNDE	Motel Water Supply	30/04/97
970	E	BOICC	Kororareka Bay	9	UNDE	Public Water Supply	30/04/86
3763	A	Andersen KR	Kororareka Bay	11	UNDE	Hotel & General Commercial	
3845	A	BOICC	Kororareka Bay		DISC	Control Floodwaters	
4410	A	BOICC	Kororareka Bay		DISL	Discharge Septic Tank Effluent	
912	E	Willowbridge Services	Kororareka Bay	2.5	UNDE	Private Water Supply	30/04/86
2547	A	Andersen KR	Kororareka Bay	30	UNDE	Water Supply for Hotel	
1695		BOICC	Kororareka Bay	27	UNDE	Motor Camp Water Supply	30/04/90
3536		BOICC	Kororareka Bay	50	UNDE	Fire Fighting & Public Supply	30/04/93
2767	A	Spcialised Finishes	Kororareka Bay		DISC	Discharge Treated TA	
3729		Bambury B	Kororareka Bay	6	UNDE	Domestic Supply	30/04/93
3024	A	Russell Bowling Club (Inc)	Kororareka Bay	4.5	UNDE	Irrigation Bowling Green	
1616		Shortland Finance Ltd	Matauwhi Bay	3	UNDE	Domestic Needs	30/04/90
[illegible]		Motel Russell	Matauwhi Bay	6	UNDE	Domestic & Motel	30/04/90
930		David H	Matauwhi Bay	4	UNDE	Domestic Water Supply	30/04/06
2336	E	Motel Russell (Hotchkiss)	Matauwhi Bay		DISC	Discharge Treated Sewage	30/09/87
3572		Colenso N	Matauwhi Bay T		DAM	Dam & Discharge Stormwater	30/04/90
822		BOICC	Oneroa Bay	1.2	UNDE	Public Toilet Water	30/04/95
928		BOICC	Tapeka Pt		DISC	Discharge Treated Domestic Effluent	30/06/91
671		BOICC	Tapeka Pt T	2.3	UNDE	Public Toilet	30/04/95

St - Status : A - Application E - Expired

Type : UNDE - totake from a bore DISC - discharge DISL - discharge to ground

APPENDIX 3. Water Quality Classification Standards Water and Soil Conservation Act 1967

Section 26c
(p. 20-133, *ante*).

[SCHEDULES

[FIRST SCHEDULE

STANDARDS FOR CLASS A WATERS

The waters shall in all respects be maintained in their natural state, and no waste shall be permitted to enter them.

[SECOND SCHEDULE

STANDARDS FOR CLASS B WATERS

The quality of Class B waters shall conform to he following requirements:
(a) The natural water temperature shall not be changed by more than 3 degrees Celsius:
(b) The acidity or alkalinity of the waters as measured by the pH shall be within the range of 6.0 to 8.5 except when due to natural causes:
(c) The waters shall not be tainted so as to make them unpalatable nor contain toxic substances to the extent that they are unsafe for consumption by humans or farm animals, nor shall they emit objectionable odours:
(d) There shall be no destruction of natural aquatic life by reason of a concentration of toxic substances:
(e) The natural colour and clarity of the waters shall not be changed to a conspicuous extent:
(f) The oxygen content in solution in the waters shall not be reduced below 6 milligrams per litre:
(g) Based on not fewer than 5 samples taken over not more than a 30-day period, the median value of the faecal coliform bacteria content of the waters shall not exceed 2,000 per 100 millilitres and the median value of the total coliform bacteria content of waters shall not exceed 10,000 per 100 millilitres.
(h) *Repealed by s. 30(a), 1973 No. 24.*

[THIRD SCHEDULE

STANDARDS FOR CLASS C WATERS

The quality of Class C waters shall conform to the following requirements:
(a) The natural water temperature shall not be changed by more than 3 degrees Celsius:
(b) The acidity or alkalinity of the waters as measured by the pH shall be within the range 6.5 to 8.3 except when due to natural causes:
(c) The waters shall not be tainted so as to make them unpalatable, nor contain toxic substances to the extent that they are unsafe for consumption by human or farm animals nor shall they emit objectionable odours:
(d) There shall be no destruction of natural aquatic life by reason of a concentration of toxic substances:
(e) The natural colour and clarity of the waters shall not be changed to a conspicuous extent:
(f) The oxygen content in solution in the waters shall not be reduced below 6 milligrams per litre:
(g) Based on not fewer than 5 samples taken over not more than a 30-day period, the median value of the faecal coliform bactoria content of the waters shall not exceed 200 per 100 millilitres.
(h) *Repealetd by s. 30(b), 1973 No. 24.*

[FOURTH SCHEDULE

STANDARDS FOR CLASS D WATERS

The quality of Class D waters shall conform to the following requirements:
(a) The natural water temperature shall not be changed by more than 3 degrees Celsius:
(b) The acidity or alkalinity of the waters as measured by the pH shall be within the range of 6.0 to 9.0 except when due to natural causes:
(c) The waters shall not be tainted so as to make them unpalatable nor contain toxic substances to the extent that they are unsafe for consumption by farm animals, nor shall they emit objectionable odours:

(d) There shall be no destruction of natural aquatic life by reason of a concentration of toxic substances:
(e) The natural colour and clarity of the waters shall not be changed to a conspicuous extent:
(f) The oxygen content in solution in the waters shall not be reduced below 5 milligrams per litre.
(g) *Repealed by s. 30 (c), 1973 No. 24.*

[FIFTH SCHEDULE

STANDARDS FOR CLASS SA WATERS

The quality of Class SA waters shall conform to the following requirements:
(a) The natural water temperature shall not be changed by more than 3 degrees Celsius:
(b) The natural pH of the waters shall not be changed by more than 0.1 unit and at no time shall be less than 6.7 or greater than 8.5:
(c) There shall be no destruction of natural aquatic life by reason of a concentration of toxic substances nor shall the waters emit objectionable odours:
(d) The natural colour anl clarity of the waters shall not be changed to a conspicuous extent:
(e) The dissolved oxygen content in solution in the waters shall not be reduced below 5 milligrams per litre:
(f) Based on not fewer than 5 samples taken over not more than a 30-day period, the median value of the total coliform bacteria content of the waters shall not exceed 70 per 100 millilitres.
(g) *Repealed by s. 30 (d), 1973 No. 24.*

[SIXTH SCHEDULE

STANDARDS FOR CLASS SB WATERS

The quality of Class SB waters shall conform to the following requirements:
(a) The natural water temperature shall not be changed by more than 3 degrees Celsius:
(b) The natural pH of the waters shall not be changed by more than 0.1 unit and at no time shall be less than 6.7 or greater than 8.5:
(c) There shall be no destruction of natural aquatic life by reason of a concentration of toxic substances nor shall the waters emit objectionable odours:
(d) The natural colour and clarity of the waters shall not be changed to a conspicuous extent:
(e) The dissolved oxygen content in solution in the waters shall not be reduced below 5 milligrams per litre:
(f) Based on not fewer than 5 samples taken over not more than a 30-day period, the median value of the faecal coliform bacteria content of the waters shall not exceed 200 per 100 millilitres.
(g) *Repealed by s. 30 (e), 1973 No. 24.*

[SEVENTH SCHEDULE

STANDARDS FOR CLASS SC WATERS

The quality of Class SC waters shall conform to the following requirements:
(a) The natural water temperature shall not be changed by more than 3 degrees Celsius:
(b) The natural pH of the waters shall not be changed by more than 0.1 unit and at no time shall be less than 6.7 or greater than 8.5:
(c) There shall be no destruction of natural aquatic life by reason of a concentration of toxic substances nor shall the waters emit objectionable odours:
(d) The natural colour and clarity of the waters shall not be changed to a conspicuous extent:
(e) The dissolved oxygen content in solution in the waters shall not be reduced below 5 milligrams per litre:
(f) *Repealed by s. 30 (f), 1973 No. 24.*

[EIGHTH SCHEDULE

STANDARDS FOR CLASS SD WATERS

The quality of Class SD waters shall conform to the following requirements:
(a) There shall be no destruction of natural aquatic life by reason of a concentration of toxic substances, or an altered acidity or alkalinity as measured by the pH, or a rise in temperature caused by the pollutant:
(b) There shall be no fouling of fishing grounds
(c) The natural colour and clarity of the waters shall not be changed to a conspicuous extent
(d) *Repealed by s. 30 (g), 1973 No. 24.*

Appendix 4 Water Quality Classification Standards
Draft Water & Soil Bill 1986

Section 140

SECOND SCHEDULE

Part I

Water-use classes and standards of water quality for water other than coastal water. Where appropriate the symbol X may be added to the class to denote that the water concerned is sensitive to nutrient enrichment.

CLASS G WATER (Being water for general use purposes)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius and shall not exceed 25 degrees Celsius.

(b) The pH of the water shall be within the range 6.0-9.0 units.

(c) The water shall not be tainted or polluted so as to make it unpalatable or unsuitable for consumption by farm animals, or unsuitable for irrigation.

(d) The water shall not emit an objectionable odour.

(e) There shall be no substantial adverse effects on the aquatic community by reason of pollutants.

(f) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(g) There shall be no visible oil or grease films or conspicuous floatable or suspended materials.

(h) The concentration of dissolved oxygen shall exceed 5 gram per cubic metre.

(i) There shall be no excessive slime growths as a result of organic substances.

Where the water condition does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.

CLASS R WATER (being water for regular public bathing)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius and shall not exceed 25 degrees Celsius.

(b) The pH of the water shall be within the range 6.5-9.0 units.

(c) The water shall not be tainted or polluted so as to make it unpalatable or unsuitable for consumption by humans or farm animals, or unsuitable for irrigation.

(d) The water shall not emit an objectionable odour.

(e) The aquatic community shall not be adversely affected by reason of pollutants.

(f) Aquatic organisms shall not be rendered unsuitable for human consumption by accumulation of excessive concentrations of pollutants.

(g) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(h) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(i) The median faecal coliform bacteria concentration shall not exceed 200 per 100 millilitres based on a minimum of one water sample taken on each of five separate days over not more than a 30 day period; nor shall more than 10% of samples taken on separate days during any 30 day period exceed 400 faecal coliforms per 100 millilitres.

(j) The concentration of dissolved oxygen shall exceed 5 gram per cubic metre.

(k) There shall be no undesirable biological growths as a result of pollutants.

Where the water condition does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.

CLASS S WATER (Being water protected for an outstanding special purpose of a scenic, scientific, or recreational character, such use being specifically designated in a water conservation order or the Schedule of Protected Waters or water used as a source of public water supply where treatment equivalent to only disinfection could be reasonable expected)

The quality of the natural water shall not be significantly altered in those characteristics which have a direct bearing upon the suitability of the water for the specific uses or values designated.

CLASS W WATER (being water for a source for public water supply or for the preparation and processing of food for sale for human consumption where treatment at least equivalent to flocculation, filtration, and disinfection could be reasonably expected.)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius and shall not exceed 25 degrees Celsius.

(b) The pH of the water shall be within the range 6.5-9.0 units.

(c) The water shall not be tainted or polluted so as to make it unpalatable or unsuitable for consumption by farm animals, or unsuitable for irrigation.

(d) The water shall not emit an objectionable odour.

(e) There shall be no substantial adverse effect on the aquatic community by reason of pollutants.

(f) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(g) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(h) The median faecal coliform bacteria concentration shall not exceed 2000 per 100 millilitres based on a minimum of one water sample taken on each of five separate days over not more than a 30 day period; nor shall more than 10% of samples taken on separate days during any 30 day period exceed 4000 faecal coliforms per 100 millilitres.

(i) The concentration of dissolved oxygen shall exceed 5 gram per cubic metre.

(j) There shall be no undesirable biological growths as a result of pollutants.

(k) The concentration of ammonia-nitrogen shall not exceed 0.2 gram per cubic metre.

Where the water quality does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.

CLASS F WATER (Being water specially protected for fish spawning purposes)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius ad shall not exceed 25 degrees Celsius. For salmonid spawning water during the spawning season the water temperature shall not exceed 13 degrees Celsius.

(b) The pH of the water shall be within the range 6.0-9.0 units, and within that range the maximum change shall not be greater than 1.0 unit.

(c) The water shall not be tainted or polluted so as to make it unpalatable or unsuitable for consumption by humans or farm animals, or unsuitable for irrigation.

(d) The water shall not emit an objectionable odour.

(e) There shall be no adverse effect on the aquatic community by reason of pollutants.

(f) Aquatic organisms shall not be rendered unsuitable for human consumption by accumulation of excessive concentrations of pollutants.

(g) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(h) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(i) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

(j) There shall be no undesirable biological growths as a result of pollutants.

Where the water condition does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.

Part II

Water-use classes and standards of water quality for coastal water. Where appropriate the symbol X may be added to the class to denote that the water concerned is sensitive to nutrient enrichment.

CLASS CD WATER (Being limited open coastal water made available primarily for waste discharge purposes)

(a) There shall be no conspicuous oil or grease; or conspicuous floating or suspended waste materials.

(b) The aquatic life shall not be substantially adversely affected by reason of toxic substances.

CLASS CE WATER (Being estuarine coastal water with a substantial freshwater component for general use purposes)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius.

(b) The pH of the water shall be within the range 7.0-8.8 units and within that range the maximum change shall not be greater than 0.5 units.

(c) The water shall not emit an objectionable odour.

(d) There shall be no substantial adverse affects on the aquatic community by reason of pollutants.

(e) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(f) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(g) The concentration of dissolved oxygen shall exceed 5 gram per cubic metre.

(h) There shall be no fouling of fishing grounds.

Where the water condition does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.

CLASS CG WATER (Being enclosed or inshore coastal water for general use purposes)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius.

(b) The pH of the water shall be within the range 7.5-8.8 units and within that range the maximum change shall not be than 0.5 units.

(c) The water shall not emit an objectionable odour.

(d) There shall be no substantial adverse effects on the aquatic community by reason of pollutants.

(e) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(f) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(g) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

Where the water condition does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.

CLASS CO WATER (Being open coastal water for general use purposes)

(a) The water shall not emit an objectionable odour.

(b) There shall be no substantial adverse effects on the aquatic community by reason of pollutants.

(c) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(d) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(e) There shall be no fouling of fishing grounds.

Where the water condition does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.

CLASS CP WATER (Being coastal water protected for an outstanding special purpose of a scenic, scientific, cultural, or recreational character, such use being specifically designated in a water conservation order or the Schedule of Protected Waters or under the Marine Reserves Act 1971.

The quality of the water shall not be significantly altered in those characteristics which have a direct bearing upon the suitability of the water for specific uses or values designated.

CLASS CR WATER (Being coastal water for regular public bathing purposes)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius.

(b) The pH of the water shall be within the range 7.5-8.8 units and within that range the maximum change shall not be greater than 0.3 units.

(c) The water shall not emit an objectionable odour.

(d) The aquatic community shall not be adversely affected by reason of pollutants.

(e) Aquatic organisms shall not be rendered unsuitable for human consumption by accumulation of excessive concentrations or pollutants.

(f) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(g) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(h) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

(i) The median faecal coliform bacteria concentration shall not exceed 200 per 100 millilitres based on a minimum of one water sample taken on each of five separate days over not more than a 30 day period; nor shall more than 10% of samples taken on separate days during any 30 day period exceed 400 faecal coliforms per 100 millilitres.

Where the water condition does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.

CLASS CS WATER (Being coastal water form which edible shellfish are regularly taken for human consumption or waters in which shellfish are cultivated or farmed)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius.

(b) The pH of the water shall be within the range 7.8-8.4 units.

(c) The water shall not emit an objectionable odour.

(d) The aquatic community shall not be adversely affected by reason of pollutants.

(e) Aquatic organisms shall not be rendered unsuitable for human consumption by accumulation of excessive concentrations of pollutants including excessive numbers of faecal organisms or pathogenic organisms.

(f) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(g) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(h) The median faecal coliform bacterial concentration shall not exceed 14 MPN (Most Probable Number) per 100 m millilitres based on a minimum of one water sample taken on each of 10 consecutive days when the risk of contamination is greatest, and not more than 10% of the sample shall exceed 43 MPN per 100 millilitres.

(i) The concentration of dissolved oxygen shall exceed 80% of the saturation concentration.

Where the water condition does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.

CLASS CO WATER (Being open coastal water for general use purposes)

(a) The water shall not emit an objectionable odour.

(b) There shall be no substantial adverse effects on the aquatic community by reason of pollutants.

(c) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(d) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(e) There shall be no fouling of fishing grounds.

CLASS CP WATER (Being coastal water protected for an outstanding special purpose of a scenic, scientific, cultural, or recreational character, such use being specifically designated in a water conservation order or the Schedule of Protected Waters or under the Marine Reserves Act 1971.

The quality of the water shall not be significantly altered in those characteristics which have a direct bearing upon the suitability of the water for specific uses or values designated.

CLASS CR WATER (Being coastal water for regular public bathing purposes)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius.

(b) The pH of the water shall be within the range 7.5-8.8 units and within that range the maximum change shall not be greater than 0.3 units.

(c) The water shall not emit an objectionable odour.

(d) The aquatic community shall not be adversely affected by reason of pollutants.

(e) Aquatic organisms shall not be rendered unsuitable for human consumption by accumulation of excessive concentrations or pollutants.

(f) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(g) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(h) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

(i) The median faecal coliform bacteria concentration shall not exceed 200 per 100 millilitres based on a minimum of one water sample taken on each of five separate days over not more than a 30 day period; nor shall more than 10% of samples taken on separate days during any 30 day period exceed 400 faecal coliforms oer 100 millilitres.

CLASS CE WATER (Being estuarine coastal water with a substantial freshwater component for general use purposes)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius.

(b) The pH of the water shall be within the range 7.0-8.8 units and within that range the maximum change shall not be greater than 0.5 units.

(c) The water shall not emit an objectionable odour.

(d) There shall be no substantial adverse affects on the aquatic community by reason of pollutants.

(e) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(f) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(g) The concentration of dissolved oxygen shall exceed 5 gram per cubic metre.

(h) There shall be no fouling of fishing grounds.

CLASS CG WATER (Being enclosed or inshore coastal water for general use purposes)

(a) The natural water temperature shall not be changed by more than 3 degrees Celsius.

(b) The pH of the water shall be within the range 7.5-8.8 units and within that range the maximum change shall not be than 0.5 units.

(c) The water shall not emit an objectionable odour.

(d) There shall be no substantial adverse effects on the aquatic community by reason of pollutants.

(e) The natural colour and clarity of the water shall not be changed to a conspicuous extent.

(f) There shall be no visible oil or grease films or conspicuous floating or suspended waste materials.

(g) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

Where the water condition does not comply with these requirements, no action shall be permitted which will cause the water condition to deviate further from compliance with these requirements.