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A SURVEY OF
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PEAT RESOURCES

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ERRATA

Water and Soil Technical Publication No. 14, 1978.

Abstract Para 4 Line 2
For million read billion.

Page 7 4.3 Survey Report

Include under a: These are relatively small peats regarded as having no immediate significance to water and soil management problems.

Page 7, 4.4 Explanation of Report Nomenclature.

Include under Maps: "Maps for Sweetwater, Whangamarino/Island Block, Hauraki, Ohinewai, Orini, Kainui, Komakorau, Kaituna, Rukuhia, Moanatuatua and Awarua Plain — Seaward Moss swamps are contained in the map envelope.

Page 26 Include:

Location

This is part of an extensive area of very wet swamp which lies west of the Waikato River, from Mercer south to Huntly. The area investigated is to the east and south of Meremere, and south almost to Te Kauwhata (See also 6. Ohinewai).

Waikato Valley Authority district.

Classification

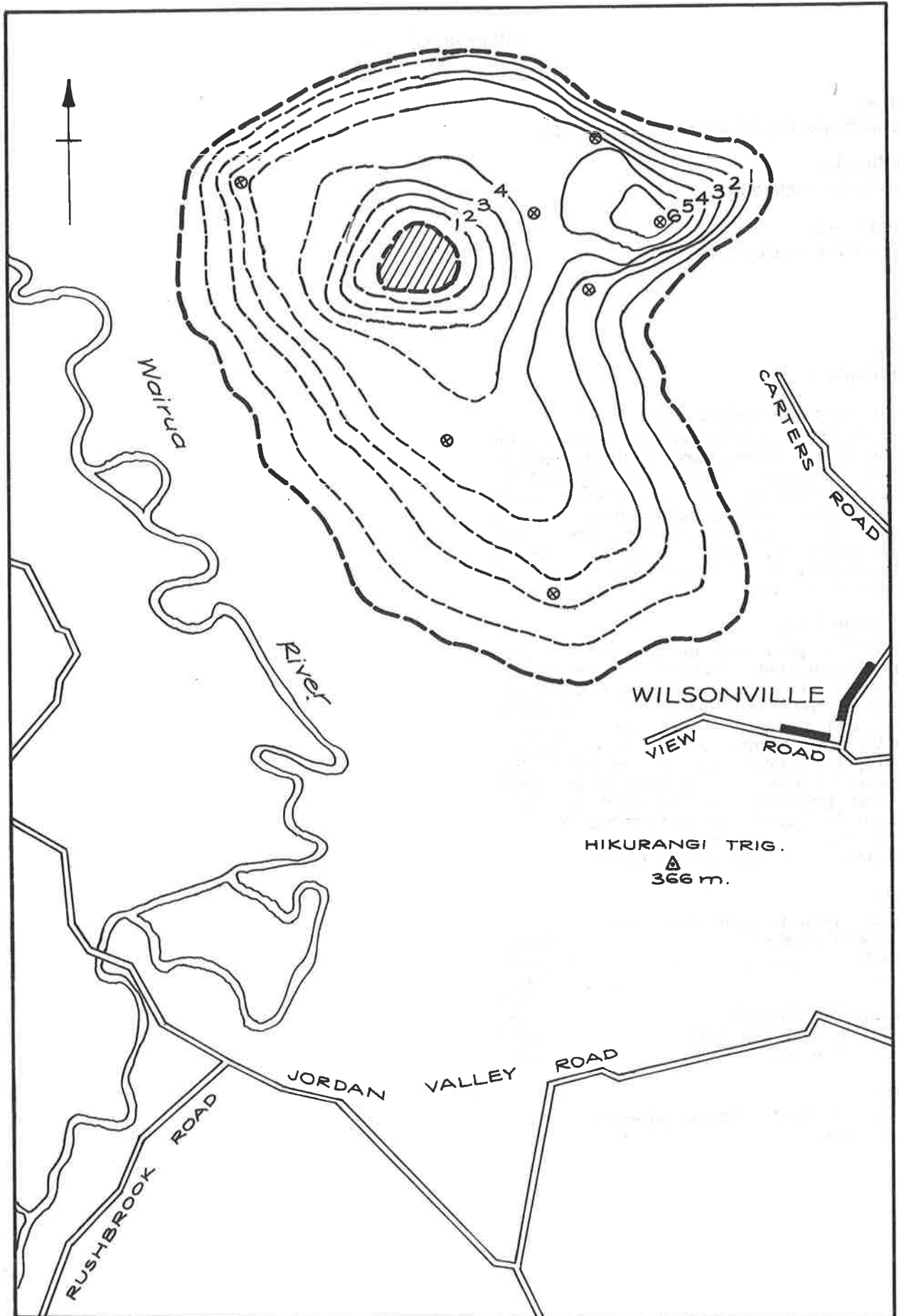
Mesotrophic, but with some oligotrophic characteristics.

Page 76 Title is:

OHINETAMATEA

Page 116 Scale of Castledowns map is:

Scale 1 : 50 000



HIKURANGI 2

SCALE, 1 : 25 000

Water & soil technical publication, no. 14 (1978)

2

3 km

A SURVEY OF NEW ZEALAND
PEAT RESOURCES

BY A. DAVOREN

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UNIVERSITY OF WAIKATO,
WITH CONTRIBUTIONS FROM K. THOMPSON,
UNIVERSITY OF WAIKATO.

A SURVEY OF NEW ZEALAND PEAT RESOURCES

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Ministry of Works and Development, Hamilton**

Water and Soil Technical Publication No 8, 1978.

ABSTRACT

In July 1976 the Soil Conservation and Rivers Control Council requested a survey of peat resources. The request required the definition of peat locations, extent, type and amount to provide information for guiding management policy in the various regions where alternative uses of the peat resources have to be balanced.

The field work, comprising mapping of peat boundaries, probing for depth and sampling for identification of plant remains, was carried out between November 1976 and March 1977.

Sixty seven peatlands in the North and South Islands were investigated. Peatlands on Stewart and Chatham Islands and the region west of the main divide between Palmerston North and Wellington were not surveyed. However sources of information for these are noted in the report.

Peats investigated cover an estimated 1400 km² and have a volume in excess of 300 million m³. Most were oligotrophic in character. A small number were mesotrophic. There were no true eutrophic swamps although a few classified as mesotrophic had some eutrophic characteristics. All showed evidence of man's influence such as drainage and development, burning or merely grazing by stock.

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PREFACE

Peatlands in New Zealand have been used in the past mainly for dairy and sheep farming. The special nature of the peat was recognised only in the extra work and expense entailed in developing the land — in providing adequate drainage and special fertiliser requirements, the difficulties in attempting to work the land with conventional machinery, the drying out of the surface material, coping with the drastic shrinkage after draining and so on.

Lately there has been a growing awareness, perhaps engendered by overseas practice, that peatlands may be too valuable to be used only for growing fodder for sheep and cattle and that other uses may have an equal or even greater claim — horticultural crops for example. But then there are those who would hold that large areas of the remaining undeveloped peatlands should be left undisturbed as great sponges to control runoff of water into rivers or to serve as wildfowl feeding and nesting places or as scientific reserves where their largely unique vegetation can be preserved. Others again would wish to mine the peat for use as horticultural material or for extracting various chemical products or even as a possible source of energy.

In the face of these competing and conflicting claims the task of deciding the most appropriate use for individual peat deposits becomes a daunting one especially when it is realised that the decision to use the peat for one particular purpose may well mean that it cannot be used for any other. Furthermore any disturbance of part of a peat deposit is very likely to affect not only the whole deposit but neighbouring farmlands and rivers as well. It is important therefore, that as much factual information as possible be available before final decisions are made.

With this in mind the Chairman of the Soil Conservation and Rivers Control Council asked the University of Waikato to undertake a survey of New Zealand's peat resources to determine, as far as possible, where peat occurs, in what quantities and of what kind. The information was to be summarised in report form and produced as quickly as possible.

A great deal of information about peat already existed in published bulletins and papers but a great deal more lay in unpublished reports and maps held by Government Departments and local bodies. The council undertook to arrange for this material to be made available but in almost every case the data supplied were insufficient for the needs of the survey. For example the excellent maps of the general soil survey of New Zealand give the location and a reasonable indication of the area of almost every peat deposit in New Zealand and the accompanying bulletins (Soil Bureau Bulletins 5 and 27) give information about the composition of the near-surface peat but nothing about the thickness of the deposits. The Department of Lands and Survey, Drainage Boards and Catchment Authorities have all, at various times, prepared maps of individual peat bogs and some of these show the depths of peat but invariably they lack information about the composition of the peat.

It soon became obvious that field work would be necessary to supplement the existing data.

A meeting of people selected because of their interest and expertise in different aspects of peatlands was held in Hamilton in August, 1976. The group consisted of Prof. J. D. McCraw (Convener); Prof. H. S. Gibbs, Dept of Earth Science, University of Waikato, Dr M. L. Leamy, Soil Bureau, D.S.I.R.; Mr K. Thompson, Dept of Biological Sciences, University of Waikato Mr F. C. C. H. van der Elst, Ruakura Agricultural Research Centre; Miss P. M. Bates, Rukuhia Soil Research Centre and Mr A. Davoren of the Water and Soil Division of the Ministry of Works and Development who acted as Technical Secretary.

The group decided on a simple classification for peats, the kind of information to be collected and the sampling procedures and patterns. It was reluctantly agreed that only sufficient information to satisfy the needs of the survey could be collected owing to the short time available. So requests to collect samples for radiometric dating, pollen analyses, volcanic ash studies and other very worth while investigations had to be turned down because the careful collection of the required samples would involve too much time and the use of specialised equipment. It was also decided that whereas probing to the bottom of a bog to establish the thickness of peat was a very necessary part of the programme, collection of samples for identification and classification of the peat would be undertaken only to a depth of 3-5 metres. It was reasoned that the large amount of extra time required to sample to greater depths would not be justified by the value to the survey of the extra information obtained.

Simple probes and samplers were designed and constructed with emphasis on ease of repair, maintenance and assembly. It is essential that equipment subjected to constant, hard field use should be capable of repair in isolated places such as country garages and that it should be capable of quick and easy assembly in the cold, wet and dirty conditions prevailing during the sampling of peat bog. Complicated equipment requiring many easily-lost or misplaced tools or delicate manoeuvring with cold, peat-covered hands is out of place on such a survey. Samplers, based on the so-called "Aberdeen" sampler used by the Peat Survey of Scotland (described by P. C. Jowsey in *The New Phytologist*, vol. 65 (2): 1966), were constructed in the University

workshops. Because they were designed to be discarded at the end of the survey they were constructed from tubing normally used for motor car exhaust pipes instead of the more usual stainless steel. They were, in fact, still in good working order when the survey was completed.

Mr Davoren undertook the collection of information held by Catchment Authorities, Drainage Boards, private firms and individuals and Government Departments. Much of this was mailed on request but Mr Davoren visited a number of institutions throughout the country to assist in the search for information. When it was all assembled he assessed the kind and quantity of information still needed to satisfy the requirements of the survey.

A group of students were then given initial training on the peatlands near Hamilton and as they gained confidence and experience were sent further afield. Initially they worked in pairs but where personnel were made available to the survey by Catchment authorities the students acted as team leaders and at some stages as many as four teams were in the field at the one time. Mr Davoren was constantly on the move organising the logistics, carrying out reconnaissance ahead of the survey parties and then assisting with the actual field work. As the field men gained experience they were able to identify most of the plants making up the surface vegetation and also many of the plant remains in the peat. Where they were uncertain samples were sent for identification to Mr K. Thompson and Dr E. O. Campbell.

Field work was completed during the autumn of 1977 and then the Peat Group now augmented by Mr G. E. Orbell of Soil Bureau, D.S.I.R. and Dr N. T. Moar of Botany Division, D.S.I.R., decided on the form and layout of the report. Mr Davoren has prepared the report drawing information from field men's notes as well as from the data assembled from other sources. The maps, including those of individual peat deposits were also prepared by Mr Davoren assisted by draughtsmen of the Ministry of Works and Development.

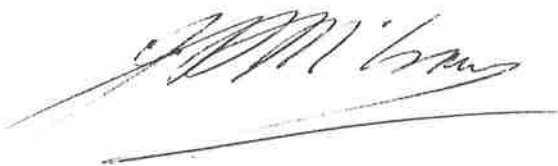
We are well aware of the inadequacies of this survey. Constant decisions had to be made weighing time and expense in extending the field work against the value of any extra information gained. Consequently a number of peat deposits were not visited. These fell into several categories:—

- (a) Where there was reason to believe that a large number of small deposits, lying in a similar environment, were similar in composition then only a sample was surveyed. The numerous small bogs in the far north were dealt with in this way as were the widespread patches of blanket peat on the uplands of Otago and Southland.
- (b) A number of deposits were difficult of access without special transport. For example, to reach the blanket peats of Fiordland would have required a major expedition; the very wet bogs in parts of Westland and along the lower course of the Waikato River could only be reached by boat.
- (c) The deposits of Stewart Island, Chatham Islands and the west coast of Wellington have already been covered by recent surveys.

It was kept in mind that the information gained during this reconnaissance would probably be valid for only a limited number of years and that if fuller information were required from a particular deposit then this would be obtained by a detailed survey of the individual deposit.

The preparation of a comprehensive bibliography of peat in New Zealand is underway (supported by the National Water and Soil Organisation) and it is hoped that this will be available as a separate publication in the near future. For this reason the large number of published and unpublished reports that were consulted during the preparation of this report are not acknowledged individually apart from a few major references which are listed in appropriate places in the body of the text.

It remains to express the thanks of the Convener and the Group to the innumerable individuals and organisations who readily co-operated in supplying information for this survey, to the field workers who bore the brunt of the unpleasant part of the work and to Mr Davoren who has toiled mightily over the past eighteen months.



J. D. McCRAW, Professor of Earth Sciences.

FOREWORD

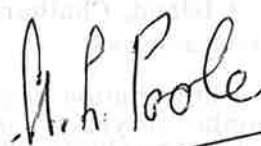
New Zealand, a temperate country experiencing high rainfalls, with mountains and many naturally flooding rivers has a varied range of swamps and bogs. Some of these are extensive — the more familiar Hauraki Swamp covers nearly 240 km² — many are small and the high mountains contain numerous bogs interspersed with a variety of other communities of vegetation.

Some of these swamps and bogs have gone through marked changes having been subjected to grazing animals, frequent fires, drainage and protection from flooding. The lowland swamps, occupying the floodplains of rivers, have been the most affected as a consequence of their conversion to agriculture. But the mountain bogs have also been greatly changed by fire, and domestic and wild animal stocking. They have become drier and less efficient as water storage areas. Some of the shallower lowland swamps have been so successfully converted to high producing pastures or cropping that they are unrecognisable as swamps. Others are only retained in agricultural production through controlled drainage and maintenance of water tables.

All swamps and bogs are of concern to Catchment Authorities. Some of the highest yielding agricultural areas in the country are swamps and are now protected by the river flood control schemes designed and operated by the Authorities. Many of these schemes — as the swamps are more intensively developed and drained — require pumping, the design and maintenance of which the Catchment Authorities are involved in. Water tables are more finely controlled.

During the past few years there has been a marked increase in the use of peat for horticultural purposes. It has to be won from swamps and in doing so levels are altered, thus affecting drainage. In this way, neighbouring land or stream and river flood protection schemes can be affected. The winning of peat must therefore be controlled by having regard to surrounding areas, drainage and flood protection schemes.

There is a detailed knowledge of some swamps and bogs, but no broad survey has been available to date. This survey fills the gap and gives us a clearer knowledge of our peat resources which are rapidly being converted.



**Chairman
Soil Conservation and Rivers
Control Council**

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INTRODUCTION

Although a great deal is now known about the distribution and characteristics of northern temperate peats, this report represents the first systematic attempt to catalogue the peat resources of any region in the Southern Hemisphere.

1. The World Peat Resources

1.1 Peatland Research

In 1966 the International Biological Programme and the International Union for the Conservation of Nature and Natural Resources agreed to co-sponsor a programme to develop co-operation in the management and conservation of peatlands for scientific research and education and for the protection of their wildlife. This programme was called *Project Telma*, and it mainly consisted of cataloguing the resources, together with anything that was known about them. The programme did not cover the tropics or the Southern Hemisphere, but even so, many of the data, and particularly those relating to chemistry, hydrology and utilization, now published on European, Russian and North American peats, are of considerable relevance to the management of our New Zealand peat resources. It is a pity that this information has not been more readily accessible, although organisations concerned with peatland utilization have in most cases not looked for it. As pointed out in the preface, we intend to make this literature more widely available in New Zealand by publishing, in the near future, an annotated bibliography.

The International Peat Society (Head Office in Helsinki) has done a great deal to co-ordinate peat research in northern temperate regions, and has five permanent commissions dealing with various aspects of classification and utilization. Many countries have established national peat research bodies, for example, the United Kingdom has the Mires (=Peatlands) Research Organisation; Canada has the Muskeg Research Institute.

1.2. Global distribution of peatlands

There are some 3 million km² of peatlands in the world. This compares with about 14 million km² of arable land, some of which is peatland but most of which is not. About 5% of the land surface of the U.S.S.R. is peat covered, but this represents some 65% of the total global peat resources. The tiny country of Finland is second with 12% of the world's resources and achieves this distinction through having one third of its land area covered by peat. New Zealand is no more than sixteenth in the league table of world peat resources, having only 0.05% of the total deposits covering 0.7% of the country's land surface. Some 10 northern temperate countries boast in excess of 10,000 km² of peatland, although the contribution of the Southern South America states is not known. There are extensive tropical peatlands associated with mangrove swamps and in regions subject to exceptionally high rainfall (e.g. Indonesia), but most of the global peat resources are restricted to the temperate zones.

2. Peatland types

2.1 Terminology

A good account is given in Taylor, N.H. & Pohlen, I.J. (1962) *Soil Survey Method*. Soil Bureau Bull. 25, D.S.I.R., so the notes here will be brief.

Peat will form wherever the substrate is more or less permanently waterlogged and supports a dense vegetation cover. In other words, because the rate of oxygen diffusion through a waterlogged substrate is very low, aerobic decomposition processes are suppressed to a level which is quite inadequate to dispose of the accumulating dead plant material. Peat, therefore, is the partially decomposed remains of plants (and, to a very much lesser extent, animals), mixed with varying proportions of mineral matter. It is normal to consider deposits with organic contents in excess of about 50% as peat, and 20-50% organic matter as 'organic soil'. Peat may be either *sedimentary* (deposited under water, as in true swamps) or *sedentary* (built up by plants *in situ*, as in bogs and fens). In their typical forms, these two peats are usually quite easy to distinguish and, of course, they have quite different properties. Sedimentary peats are highly decomposed, colloidal, often pulpy or jelly-like, and usually without obvious structure. *Dy* and *gyttja* are recognised subtypes: the former is deposited by lakes charged with humic colloids and the latter is formed from sedimented algae. Both may be mixed with the remains of swamp plants and may then be called *swamp dy* or *detritus gyttja*.

Peatlands may be either *ombrogenous* (water supply entirely from rainfall) or *soligenous* (rainfall supplemented by moving groundwater), although various transitions are also encountered. Ombrogenous types are usually called *bogs*, have low nutrient status (i.e. are *oligotrophic*) and low pH (usually less than 5). Soligenous peatlands are collectively called *fens* (*swamps* are here considered as a category of fen), have medium to high nutrient status (*mesotrophic* to *eutrophic*) and pH levels ranging from about 5.5 to 9. All sedimentary peats are eutrophic or mesotrophic; sedentary peats may form in peatlands of any trophic status.

Wetland is a generic term embracing *swamp*, *peatland* and *marsh* as well as open water bodies. True swamps are characterised by leads of standing water during all or part of the year and they usually, but not always, lay down peat. The colloquial use of the term *swamp* to mean *peatland* can thus be rather misleading. Peatlands always deposit organic material; marshes typically never do so.

Both ombrogenous and soligenous mires are represented in New Zealand. Most of the former can be covered by two categories: *raised bogs* (= *high moor*) occur in lowland areas with moderately high and reliable rainfall distributed throughout the year. They are characterised by a domed cross-section which is maintained by faster peat accumulation in the centre (here, the water-table is consistently higher, aeration of

the peat less pronounced and decomposition processes minimised). Around the periphery, the dome slopes very abruptly (the *rand*) into a mesotrophic stream or swampy area (the *lagg*).

Blanket bog is the second common type of ombrogenous peatland. It characterises the cooler, higher-rainfall upland areas and the subantarctic islands. Peat accumulates wherever vegetation grows, and covers even sloping surfaces (the German term, *terrainbeddeckenmoor*, is very appropriate). Although raised bogs are often over 12 metres deep, blanket peats are typically less than 1m in depth, since plant growth is restricted by lower temperatures.

There are other types of ombrogenous peatland in New Zealand, such as the *valley bog* and the *terrace bog*. The former can often be regarded as a 'potential raised bog', and the latter has affinities with both raised bog and with *transition bog* (a type intermediate between bog and fen).

Because groundwater influenced by base-rich limestone rock is uncommon in New Zealand, there are no extensive areas of eutrophic fen, comparable with those in East Anglia (U.K.) or the Everglades (U.S.A.). On a world scale, not only would the large sedge swamps of Westland classify only as mesotrophic, but also relatively few of the smaller New Zealand fens could be awarded eutrophic status. However, it is conventional to employ the full trophic scale in any national classification, so that quite a number of the raupo swamps would enter the eutrophic category here. Furthermore, practically all New Zealand soligenous mire (= *low moor*) are true swamps, so that the latter term will be used throughout this report. However, it is as imprecise to refer to bogs as 'swamps' as it is to call forest 'bush'.

In practice, most extensive peatlands are complexes of different mire types: blanket bogs have mesotrophic *flushes* along drainage channels (a type of *topogenous* mire: the nutrient status of rainwater is raised if it flows along the ground between topographic barriers); raised bogs are bounded by mesotrophic *laggs*, where peat grades into mineral soil; concave low-moor peatlands often incorporate areas of bog where the peat surface has grown beyond the influence of base-rich groundwater. Moreover, most oligotrophic peatlands, other than blanket bog, have developed from earlier soligenous ones (for example, restiad bog from kahikatea swamp). Consequently, peat profiles taken from two similar types of peatland can be quite different, and two profiles taken from the same peatland can also be quite distinct from each other.

The vegetation of peatlands is dense only because the water supply is never restricted. The species diversity, on the other hand, is very low, because the roots of all peatland plants must be adapted to tolerate an anaerobic environment. Bog plants must also be able to tolerate very low nutrient conditions and pH values which may fall below 3.5. Because of this additional constraint, bogs support even fewer

plant species than fens.

2.2. Classification

Peatlands may be classified upon the basis of their vegetation, physical structure, chemistry, water relations, peat types, or even upon their economic importance. Naturally, the most explicit classification would incorporate information from all of these categories, and it is usually convenient to build this up from a primary subdivision into eutrophic, mesotrophic and oligotrophic types. All of the ombrogenous peatlands then fall into the oligotrophic category, and fens classify as mesotrophic or eutrophic. Structure (e.g. domed, blanket, concave) can then be used to split the categories further and, lastly, the peatlands can be referred to a particular vegetation type.

By far the most important acid-peat-forming plant, worldwide, is *Sphagnum*, of which there are probably about 50 species. Although many New Zealand bogs are also dominated by this moss, here it is the restiad rush *Calorophus minor*, unique to New Zealand, which is the most frequently encountered peat-former. Both plants are excellent 'sponges', although in *Sphagnum* this property is due to densely packed leaves and large empty leaf cells, whereas the water-holding capacity of *Calorophus* is attributable to its dense mat of aerial roots.

Fen peats (the American term *muck* is less precise) are much more variable in composition and may be formed from grasses, sedges, reeds, mosses, or trees. An abbreviated inventory of peat types illustrates an approach to classifying peatlands which is quite independent of the physico-chemical system outlined above:

A. Sedentary peats	Examples
(i) moss peats	<i>Sphagnum, Dicranoloma</i>
(ii) herb peats	
(a) grass peats	<i>Danthonia, Chionochloa</i>
(b) sedge peats	<i>Carex</i>
(c) reed peats	<i>Typha, Phormium</i>
(d) rush peats	<i>Schoenus, Baumea</i>
(e) restiad peat	<i>Calorophus/Sporodanthus</i>
(f) fern peats	<i>Gleichenia</i>
(g) cushion bog peats	<i>Oreobolus</i>
(iii) wood peats	kahikatea, bog pine
B. Sedimentary peats	
(i) Dy	<i>Typha</i> swamp, lake peat
(ii) gyttja	

Peats containing multiple dominants are called moss/herb, sedge/rush, etc. Note that terms used in the first column of the above peat classification may be misleading unless the dominant plants can be identified; for example, both of the moss peat examples given are to be found on oligotrophic mires, but rich fens in Europe may be dominated by mosses such as *Drepanocladus*, *Paludella* or *Campylium*. In addition, the surface vegetation of a peatland may be quite different from that comprising peat below the surface. The following is intended as a guide to the classification of New Zealand peatlands on the basis of their living vegetation cover:

1. Raupo-type swamps: All of the mesotrophic fen type and dominated by *Typha angustifolia* (=raupo, bulrush).

(a) Raupo swamps: Dominated by *Typha*, *Baumea* (a spikey, *Juncus*-like rush) and *Carex* species (sedges).

(b) Flax swamps: Dominated by *Phormium tenax* (flax). In fact, flax is usually associated with raupo swamps, but only grows in the drier parts. The almost-pure flax swamp is a derivative of the raupo brought about by drainage and cultivation of the flax.

(c) Nigger-head swamp: Dominated by the sedge *Carex secta*, but closely related to raupo swamps. There are many examples of transitional types between the two. Many Westland swamps are *Carex* dominated, and are often associated with kahikatea (*Podocarpus dacrydioides*).

(d) Montane swamps: *Typha* is the characteristic plant, but manuka (*Leptospermum scoparium*), *Baumea*, *Schoenus* and *Phormium* are also present. The type often grades into montane bog.

2. Bogs: About 110 angiosperm species are recorded for New Zealand bogs, but 25 of these are endemic to Stewart Island.

(a) Shrub Bog: There is a lowland type with manuka, cabbage tree (*Cordyline australis*) and *Sphagnum* which intergrades with the raupo swamp type, depending upon the extent of groundwater flow. Under wetter, more acid conditions, the cabbage tree is eliminated and the umbrella-fern (*Gleichenia dicarpa*) and the restiad *Calorophus minor* are present. Under the wettest and most acid conditions, the manuka also disappears from this type, although a *Dracophyllum* species often replaces it (see *Calorophus* bog, below). Shrub bog may dominate almost any topographic type of oligotrophic peatland: raised bog, bogs in valleys or depressions, bogs on terraces or even bogs on the flat tops of hills.

The name 'pakihī' is given to any open space (typically flat, although the level ground may be on a terrace or a hill-top or in a valley or hollow) in Westland beech forest. They are characterised by gleyed podsols but, where edaphic conditions are sufficiently wet, peats develop from the *Gleichenia/Calorophus/Sphagnum* manuka vegetation type, with *Baumea*, *Schoenus*, *Oreobolus*, the red tussock-grass *Chionochloa rubra* and *Dracophyllum spp* usually associated.

(b) *Calorophus* bog: Grades into shrub bog. The *Gleichenia/Calorophus/Sphagnum* type is the commonest peatland type in New Zealand, and is found at both high and low altitude throughout both islands. The proportions of the three characteristic plants vary greatly, and, in the South Island, the moss *Dicranoloma billardieri* may also be an important component. Most raised bogs are of the *Gleichenia/Calorophus/Sphagnum* type, and many pakihīs contain areas dominated by *Calorophus* bog.

(c) Restiad bogs: Dominated by the restiad rushes *Sporodanthus traversii* (over 2 metres in height) and *Calorophus minor*. In their best developed form, *Sphagnum* is absent and *Gleichenia* is rare. Restiad bogs are not found below 38° latitude; they grade into manuka shrub-bog as conditions become drier.

(d) Blanket bogs: Exclusively upland or cool temperate in distribution, and restricted in New Zealand to the cooler, wetter areas of Fiordland, Southland and Otago mountain tops and Stewart Island. *Sphagnum* is locally common throughout, but most of the peat comprises roots of the snow tussocks (particularly red tussock) and *Dracophyllum*. As the climate becomes drier, blanket bog grades into red tussock grassland and then into *Poa caespitosa/Festuca novae-zelandiae* tussock grassland in the driest upland areas.

Cushion bog, characterised by the hummock-forming species *Oreobolus*, *Donatia novae-zelandiae*, *Gaimardia setacea* and others, is common at higher altitudes in the southern South Island. Where it covers large areas, it may be considered as a type of blanket bog, but its coverage is usually much more restricted. *Chionochloa* is still a characteristic component.

In this survey, where peat deposits have been described from blanket bogs, they mostly refer to deeper topogenous peats in gullies or flushes or to miniature raised bogs in hollows or on level ground.

3. Utilisation of peat and peatlands

3.1. Utilisation overseas

Peat can be a more valuable commodity than many people realise. Ironically, it is often at its most valuable when it is *in situ* and unmodified. Nevertheless, peat mining has developed into a considerable industry in some countries. Most mined peat is derived from *Sphagnum* moss, the 'peat moss' or 'moss peat' of horticulture. Its value as a soil conditioner (it is not a fertiliser) depends upon its high water-holding capacity (up to 10 times, weight for weight), upon its high base-exchange capacity (for retention of nutrients in the soil), its high thermal capacity and fibrous nature (improves soil structure and insulating properties) and upon its high organic content (a good substrate for beneficial soil microbes). The world market in this product is dominated by the U.S.S.R. (96%) and Eire (2%). The Russian production figure represents 80 million tons of peat, 90% of which is 'milled.' Milling involves scratching the surface inch of the peat surface (after removing the vegetation), turning it to allow aeration and drying, then harvesting and bagging. The method is used in New Zealand.

Good peat moss may also be compressed into boards with a high insulating capacity, and over 100,000m² of these are produced annually in Russia. Poorer grades of peat (more highly humified) can be compressed into briquettes

with the same insulating properties. A further application of compressed peat is in the manufacture of biodegradable pots for horticulture. This development was pioneered in Norway and now several hundred millions are made annually throughout the world.

Peat is still used as a domestic fuel in remote areas of some European countries, and Russia now fuels at least 70 power stations mainly with milled peat.

Like coal, peat may also be processed to yield a chemical harvest. Peat is rich in carbohydrates, and the Soviet Union has pioneered the commercial utilisation of these compounds for yeast cultivation and the production of ethyl alcohol, furfural, etc. Waxes, resins, bitumens and oils may also be extracted from some types of peat and again the U.S.S.R. is extracting such chemicals on a commercial basis.

The world peat harvest is in excess of 100 million tonnes each year, and this far exceeds the rate of accumulation (estimated maximum of 3 tonnes per hectare per year). Oxidation due to other forms of peatland exploitation (see below) further widen the deficit.

The other major use for peatlands is crop cultivation, which may mean agriculture, horticulture or forestry. The U.K. Forestry Commission has planted large areas of shallow blanket peats with Sitka spruce, but the deeper peats are not suitable for tree growth. Many peatlands of the world, mainly fens, have been reclaimed for agricultural purposes, but management of reclaimed peatlands is not as straightforward as it was once thought to be.

Once the natural vegetation has been removed, peat growth stops. Once the water table has been lowered, peat decomposition starts.

The Fen District of south-eastern England and the Everglades region of the south-eastern United States, are only two examples of places where agricultural development of fen peats has been intensive for a long time.

To an agriculturalist, all peat soils, and particularly bogs, have major nutrient deficiencies but, with heavy fertilisation and adequate drainage, peat soils can give exceptionally high crop yields. However, a price must be paid in that accelerated decomposition rates might lower the surface by as much as 10-20cm per year. Maize, for instance, not only has a particularly high nutrient requirement, but also promotes much more peat oxidation than do perennial crops such as pasture. One reasonable estimate puts the current global annual carbon dioxide production from the oxidation of peatlands and organic soils about equal to that released per annum from fossil fuels.

Peatlands play a critically important role in regulating water flow into drainage systems. A similar service is performed by watershed forests. Examples can be taken from all over the world to illustrate the flood-peak problems which

are liable to occur in rivers which have lost peatland 'sponges' in their catchments.

Burning of blanket bog to improve grazing potential, coupled with gross over-stocking, is a very common cause. The upper reaches of the South African Orange River has been severely damaged in this way, as have many of the upland moors in Great Britain. Subsequent erosion is rapid, so that even the chemical characteristics of the rivers may change. Erosion and flash-flooding, as well as increased biological oxygen demand, dissolved chemical levels, turbidity and aquatic weed growth, are also common features of swamp and peatland reclamation schemes. Water engineers found it necessary to remove canals installed to improve water-flow through the Everglades Swamps in Florida, as flash-flooding peaks reached dangerous levels. 50% of the agricultural peatlands around Florida's Lake Okeechobee will cease to be productive by the year 2000 because erosion has removed all the peat. Similar problems are experienced in the English Fen District and Dutch polders, where water-tables in productive land can only be maintained by pumping water uphill into drainage canals. In addition, developers in all of these regions, and in others such as the Central African swamps, have encountered the problem of over-drainage and irreversible drying out. Drain depths and spacings are critically important in good peatland management, since once peat has dried out completely its structure is destroyed and cannot be recovered by re-wetting.

Finally, there is the scientific value of peatlands. Project TELMA would not have been conceived if this aspect had not been considered important. Peatlands are 'stress' environments for plants and animals. Plants in particular must possess major structural and physiological adaptations in order to survive, and a great deal of valuable information on adaptive mechanisms remains to be gleaned from such habitats. There are therefore, in addition to aesthetic and recreational reasons, powerful scientific justifications for conserving representative peatland ecosystems in different parts of the world. Peatlands also hold a key to past climates and vegetation patterns. Examination of recognisable plant fragments, particularly pollen grains, in the profile can enable scientists to construct for entire regions, vegetation and climatic histories extending back many thousands of years.

3.2. Utilisation in New Zealand

Compared with European countries, the New Zealand peat industry started late and built up slowly, so that, even in the recent past, this country has imported most of its requirements for horticultural peat. Demand is increasing rapidly and peat is a very bulky material to transport, so local peat mining operations have been greatly expanded in recent years, and there is an apparent need for yet further expansion. Since most of our deeper bogs are dominated by *Calorophus*, resources of the preferred horticultural grade of *Sphagnum* deposit are quite

limited. *Calorophus* peat is mined on Moanatuatua Bog in the Waikato Basin, and has satisfactory properties for many horticultural purposes. However, its lack of structure places it at a disadvantage in comparison with *Sphagnum cristatum* peats. Regulations usually require peatland on which mining operations have been completed to be left in a condition suitable for some sort of agriculture, but legislation is apparently imprecise and it is sometimes unclear who should be ultimately responsible for the conversion. Other problems are that mining may expose uncultivable horizons in the profile, lower the surface below the useable drainage line, or expose 'stick layers' of manuka (*Leptospermum scoparium*) or bog pine (*Dacrydium colensoi*). Stick layers are frequently encountered close to the surface in New Zealand bogs, they are expensive to remove and sometimes overlies peat deposits less suitable for mining purposes.

Peat is not used as a fuel in New Zealand, nor has it been used as a source of chemicals. However, Chatham Island peats are known to contain extractable quantities of waxes. It is doubtful if our peat reserves are large enough to permit extraction for fuel or chemicals without interfering with other uses of peatlands.

A high proportion of New Zealand peatlands are used for agricultural purposes, or are affected in some way by agriculture. Upland sheep grazing in the South Island and dairy farming in the Waikato region are but two examples which utilise, respectively, blanket bogs and restiad bogs.

In the Waikato area in particular there is now a rapidly growing interest in the cultivation of cash crops on peat. Some of these enterprises have been highly successful, and some, still at the development stage (such as blueberries), are likely to be very rewarding in the future. However, many have been less than satisfactory, owing either to ignorance or disregard of the essential principles of peatland management, or to lack of financial backing, or both. Peatlands are inherently much more difficult to manage than mineral soils, although they can be expected to provide high yields when under good management. Indeed, many peats of the northern North Island are considered to be excellent substrates for high-intensity horticulture, and by choosing suitable crops and directing production towards export markets, the potential for development in this field must be considerable.

Farmers in New Zealand have discovered, as did their counterparts overseas before them, the importance of carefully controlled drainage systems. Even when under perennial grass, peatlands in the Waikato often shrink and oxidise by up to 5 or 6 centimetres per year, and much higher loss rates have been recorded for peatlands under horticulture. In order to maintain agricultural production, peatlands must also be supplied with heavy top-dressings of fertilisers and corrective applications of lime (to lessen acidity) and some trace elements (to avoid plant and animal deficiency symptoms). It

should be noted that most of the well-known peatland farming regions of the world use fens; the farmers of New Zealand are, for the most part, reclaiming acid, oligotrophic bogs, which are more difficult.

The other side-effects of peatland reclamation have also been encountered here: higher flood peaks and nitrate levels in rivers, increased erosion, explosive weed growth in drainage ditches. However, there is a good short-term (Say 100 years for the best-managed land) future for New Zealand peatland agriculture, provided that we share our expertise, heed the experiences of others, and continue to improve our techniques.

The importance of peatlands as 'sponges' regulating water-flow to rivers was mentioned in the previous section. All Catchment Boards in New Zealand are well aware of the problems which can result from, for instance, burning and over-grazing of upland peat-covered catchments. There is thus an undeniably good case for complete conservation of mountain-top blanket bogs in Southland and Otago, because, even after 'improvement' this land is still, at best, marginal for grazing purposes.

One of our best examples of flood control by peat deposits is the huge raised bog on the Hauraki Plains. The maximum elevation of this peatland is 6.5m A.S.L. and, without its assistance, it would probably be extremely difficult and expensive to prevent the Waihou and Piako Rivers from coalescing.

Buildings are often erected on peatlands and roads and railways are sometimes laid over them. No-one would suggest that peatlands are useful for these purposes, but they are certainly used when other substrates are not available (as, for instance, in the urban expansion of Hamilton). The instability of peat substrates requires buildings to be either 'floated' on the surface or to be anchored by piles driven through to mineral ground. Rates of shrinkage and oxidation must be predicted and rates of water penetration and sub-surface water flow may also be needed. As with peatland agriculture, the technology involved in building on peat is much more complex than that required for construction on mineral soils.

The scientific study of peatlands has not progressed as far in New Zealand as it has in Europe and in North America. Although much of the published overseas work is relevant here, there are many unique features of New Zealand mires and future investigations are likely to be very rewarding. However, many scientists are becoming greatly concerned that, due to accelerating exploitation, some of our peatland types may be within sight of extinction. Greater conservation effort is undoubtedly needed.

Finally, although the last two sections of this Introduction have outlined most of the potential uses for peat and peatlands and drawn attention to many of the hazards of peatland exploitation,

the purpose of this report is to provide a basis for management decisions, and not to make specific recommendations. However, it is in order to observe that 'conservation' is a legitimate and quite respectable use of peatlands. Many of our peatlands have already been reclaimed, some well and some badly, and many more will be developed in the future, some, perhaps, as a result of this report. However, once the natural vegetation has been removed, peatlands become a strictly limited resource.

It is therefore important that they be managed wisely, bearing in mind that some peatlands are just as valuable to us in their natural condition as are others under intensive development.

Keith Thompson
University of Waikato.

4. Peat Resources Survey

4.1 Survey History

Surveys of peatlands were undertaken to determine peat depth, surface and subsurface levels as early as the 1920's e.g. Hauraki 1928, Moanatuatua 1932. The purpose of these surveys was to provide information for land development activities such as drainage, roading and subdivision. Various Committees dealt with the development of particular swamp blocks e.g. the Peat Committee concerned with the development of the Ruku block on Rukuhia.

The Inter-departmental Peat Committee, established in December 1962, mainly considered drainage and flood protection problems, but did recognise the need for studies to "distinguish the peat areas as distinct from the light alluvial soils of the plains. . ." In 1971 concern was expressed by the Committee "over the general lack of information concerning peat reserves in N.Z., and an enquiry was to be made of the Director of Water and Soil as to the possibility of a survey being carried out". A year later the Moanatuatua Peat Reserve Board resolved to send letters to selected Government departments requesting that an investigation be carried out to determine the extent, quantity and composition of peat areas and their value as a natural resource.

In 1975 the Waikato Valley Authority was requested by the National Water and Soil Conservation Organisation to co-ordinate a "comprehensive appraisal and evaluation of the agricultural and horticultural potential of the Waikato peat lands". The report was completed in 1976 and comprised a catalogue and assessment of existing water and soil and land-use data. It showed that much was known about agricultural and potential agricultural use, but very little information was available regarding other aspects of peat development.

At the Interdepartmental Peat Committee meeting in July 1976, Dr Mitchell, Research Director, Water and Soil Division, Ministry of Works and Development, reported that at the

request of the Soil Conservation and Rivers Control Council a "detailed study was to be undertaken on a national basis, on what our physical peat resources were". The information contained in the eventual report would be to provide a basis on which to make management decisions.

4.2 Survey Methods

1:250,000 soil maps were used to identify the major peat deposits. Other peatlands brought to attention because of a specific use or reason were also investigated.

The survey involved mapping the peat boundary, probing for peat depth, and sampling to a depth of 3-5m to identifying the plant remains in the peat, and subsequently classifying the swamp.

a. The mapping of the peat boundary was carried out by field observations (where the swamp was developed) or from aerial photographs (where the swamp was undeveloped).

b. Probing for peat thickness was carried out manually by plunging a 9.5mm diameter steel rod probe, screwed together in metre lengths, through the peat until basement was struck. A builder's bit on the end of the probe sampled the basement material for field identification. The number and density of probings varied from one per 0.5 - 0.8km² for large swamps such as Komakarau, to one per 0.2 - 0.4km² for smaller swamps. For areas comprising a number of small pockets of peat, a range of peat thicknesses were recorded.

c. Samples for identification were taken at approximately half the probe sites, using a simplified Aberdeen-type peat borer. Samples were described and macro-remains identified in the field, and representative samples retained for laboratory identification.

Access to probe and sample sites was by farm tracks and by foot on developed peats, and by foot on undeveloped peat swamps.

In addition to the above, other characteristics observed and noted were:

a. Depth of mineralisation or soil development, especially on developed and drained peats;

b. mineral additions (especially important in the mesotrophic and eutrophic peats) layers or lenses of sand or silt, and volcanic ash beds;

c. depths of logs, timber, twig layers and root mats;

d. surface vegetation (especially species on undeveloped peatlands) and landuse;

e. the depth of the standing water, especially on undeveloped peats;

f. degree of decomposition, using the Von Post (VP) scale, of the samples taken for identification.

4.3. Survey Report

The report details the findings from the field survey and incorporates some existing data. Each peat swamp or area of peat is dealt with separately in detail. Not all peatlands were investigated, important omissions were:

a. The peat areas south of Palmerston North and west of Levin.

b. The coastal peats of western Wellington, which are described in:—

Harris, W.F. 1968. Peat Classification by Pedological Methods, applied to Peats of Western Wellington, N.Z. *DSIR Bulletin 189*.

Moar, N.T. 1952. A Botanical Survey of a Peat Area between Raumati South and Paraparaumu *New Zealand Journal of Science Technology A33* (5): 78-89.

Moar, N.T. 1953. Vegetation and Peat of a Small Mire at Plimmerton, North Island, N.Z. *New Zealand Journal of Science Technology A34* (6): 479-86.

1954. Peat Profiles Whareroa Block, Paekakariki N.Z., *New Zealand Journal of Science Technology A36* (3): 221-231.

c. Stewart Island, covered in a Soil Survey and various botanical studies.

d. Chatham Island, detailed in the Soil Survey and an investigation of the peats for wax extraction.

e. Peatlands of Fiordland. It was hoped that this report would contain some information on nutrient, ash, and carbon contents of peats (particularly the surface layers), but it has not been possible to complete the analyses within the time available.

4.4 Explanation of Report Nomenclature

Title

The peatland is titled by the locally accepted name. Where such a name did not exist a geographical title is adopted.

Maps

a. North and South Island maps. These show the peatlands investigated in the course of the survey and are numbered from north to south.

b. Peat Isopach Maps. These show the points of equal peat depth within the raw peat boundary and the survey sites.

c. Peatland Maps. These show the peat boundary and the survey sites only. NOTE: The peat boundary shown in both (b) and (c) signifies the boundary between the raw peat, whatever its classification, and any mineralised or oxidised peat which may surround the swamp.

Peat isopach and peatland maps should not be used to accurately determine peat depths. The maps merely indicate trends.

Descriptive Text

a. Location. A brief description of the location of the peat swamp or area giving the distance in kilometres (only approximate) from a principal town, the map reference of the northernmost point of the swamp, unless otherwise stated, and the Catchment Board or Commission district the swamp is within.

b. Classification. A simple classification, based upon plant remains identified in peat samples, was adopted for the survey.

Eutrophic; *Typha spp.*, *Phormium spp.*, *Carex secta*. No true eutrophic peats were found in New Zealand although some have eutrophic characteristics.

Mesotrophic; *Carex spp.*, *Baumea spp.* Oligotrophic; high moor and blanket types. The high moor species are dominated by the restiad *Calorophus minor*, *Gleichenia dicarpa*, and/or *Sphagnum spp.* The blanket peats are dominated by *Sphagnum spp.* and cushion plants such as *Donatia novae-zelandiae*, *Celmisia spp.* and *Oreobolus spp.*

c. Present Status. Three categories were used to describe the present status of peats:

Active; in natural state and still supporting native peat-forming species.

Degenerating; because of development or mismanagement, loss of water, mineralisation or oxidation, and shrinkage that is now occurring in the peat. The degenerating class is subdivided into agricultural, whether arable or pastoral; mining for horticultural use; and misuse or mismanagement such as burning or over draining.

Regenerating; usually in burned-over areas where the native peat forming species are colonising the swamp surface again.

d. Area and Volume. The approximate area of the swamp within the boundary is given in km² and the volume in million m³. The area is not given for the alpine and sub-alpine peats, nor for those swamps whose full extent was not mapped. Volumes are not given where there are many small pockets of peat, or where there is an irregular subsurface combined with insufficient depth probes.

e. Surface Vegetation and Landuse. The surface vegetation and landuse were described at each survey site. The description given is an assessment of the typical cover.

f. Peat Composition. A description of the species identified from field and laboratory examination. Any profiles described are composite representative profiles of a particular peat type. Only for the larger peat swamps are more

than one peat profile described.

The Von Post Scale (referred to in the text as VP) is used to describe the degree of decomposition of moist peat layers from: Harris, W. F. 1968: Peat Classification by Pedological Methods, applied to Peats of Western Wellington, No. 8. D.S.I.R. Bulletin 189.

- VP 0 Pulp-free peat. Yields only clear colourless water when squeezed. A quantity of wet peat is squeezed in the hand.
- VP 1 Almost pulp-free peat. Yields a clear weak yellow-brown water.
- VP 2 Very weakly pulp-charged peat. Distinctly turbid brown water. No peat substance passes between the fingers. Residue somewhat mushy.
- VP 3 Weakly pulp-charged peat. Strongly turbid water. No peat substance passes between the fingers. Residue somewhat mushy.
- VP 4 Moderately pulp-charged peat. Very turbid brown water. Some peat substance escapes between the fingers. Residue mushy.
- VP 5 Strongly pulp-charged peat. About half the peat escapes between the fingers. Residue strongly mushy.
- VP 6 Very strongly pulp-charged peat. About two-thirds of the peat escapes between the fingers. Residue consists mainly of resistant remnants such as root fibres, wood, etc.
- VP 7 Almost completely pulp-charged peat. Almost all of the peat escapes between the fingers.
- VP 8 Completely pulp-charged peat. The whole mass passes between the fingers. No plant structure of any kind recognisable.

Note: Terms used to describe the degree of decomposition and the equivalent VP values are:

Poorly decomposed = VP 0-3.

Moderately decomposed = VP 4-6.

Well decomposed = VP 7-8.

g. Highest Point and Outfall level. Where data are available (usually from Catchment Authorities) the highest point and ground level at the outfall in metres above sea level (unless otherwise stated) are given.

h. Climate. Data from a climate station considered to represent the climate of the peatland are given.

i. General. Additional sources of information such as scientific papers and reports, and other uses such as flood ponding and wildlife reserves are noted under this heading.

4.5. Key to Common Names and Synonyms of Plants Mentioned in Text

blackberry — *Rubus fruticosus*

bracken — *Pteridium aquilinum*

flax — *Phormium tenax*

gorse — *Ulex europaeus*

kahikatea — *Podocarpus dacrydiodes*

manuka — *Leptospermum scoparium*

rush — *Juncus spp.* and *Baumea spp.*

sedge — *Carex spp.*

Gleichenia dicarpa now *Gleichenia circinata*

Podocarpus dacrydiodes now *Dacrycarpus dacrydiodes*

Calorophus minor (formerly *Hyperloaena lateriflora*) now *Empodisma minus*.

4.6. Acknowledgements

Assistance was received from many organisations and authorities, and a number of individuals without whose assistance the survey work could not have been completed:

a. Ministry of Works and Development, especially Hamilton and Dunedin District, and the Invercargill and Greymouth Residency offices.

b. Catchment Authorities, especially Waikato Valley Authority, Otago Catchment Board, and Southland Catchment Board who all contributed staff and vehicle assistance.

c. The innumerable farmers, without whose co-operation many peat areas would not have been accessible.

d. K. Thompson of University of Waikato, for invaluable assistance in botanical identification of both surface vegetation and remains within the peat.

e. N. Moar, Botany Division, D.S.I.R., for supplying very useful peat borehole data.

f. P. Marsh, D. McLean, R. Salter and C. Nichols, the untiring field workers employed especially for the survey.

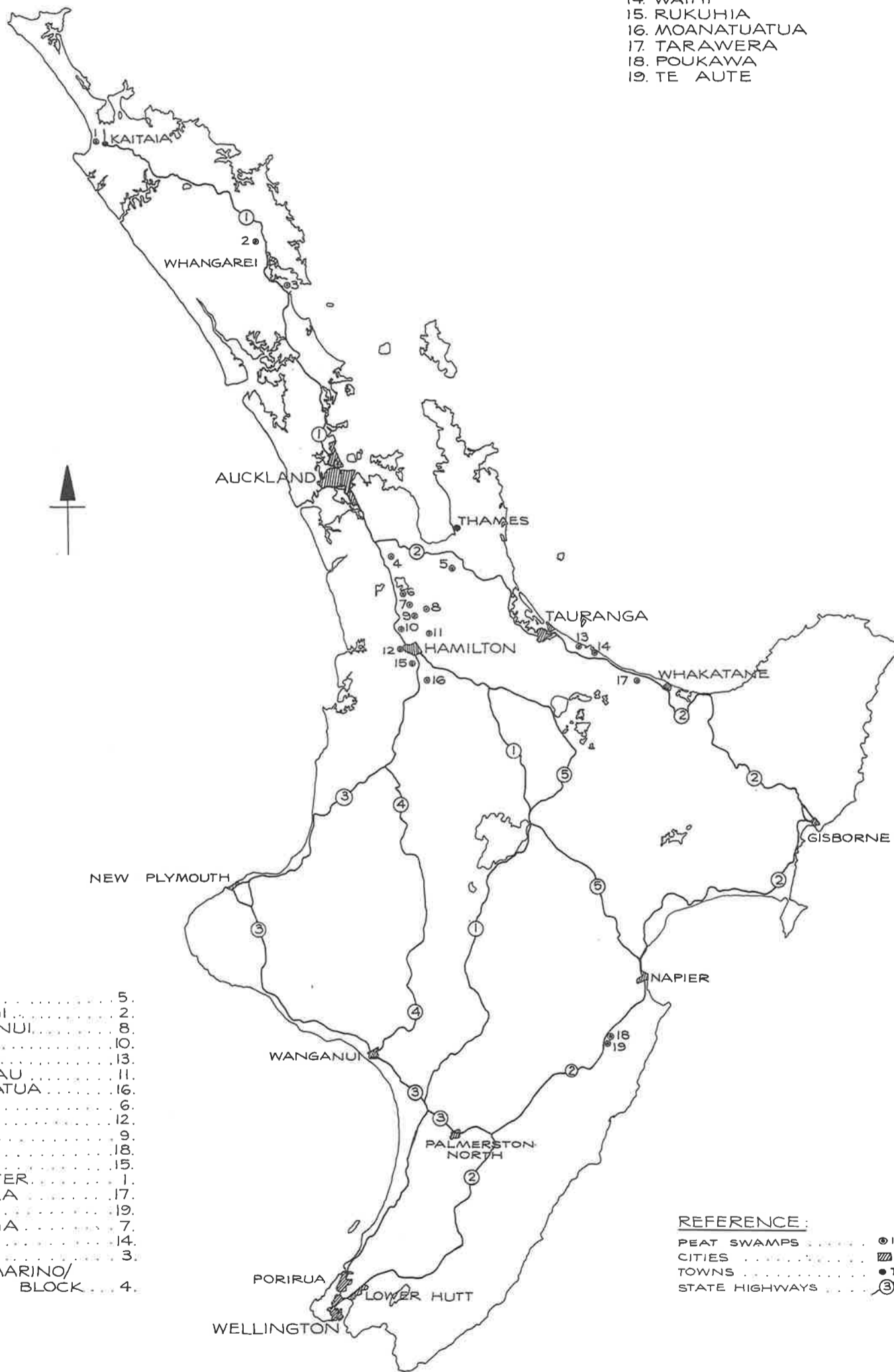
<u>REFERENCE</u>	
ROADS.....	
RAILWAYS.....	
TOWNSHIPS.....	
POWER LINES.....	
PEAT BOUNDARY.....	
DEPTH CONTOURS.....	
SAMPLE POINTS.....	
COAST LINE.....	
CLAY ZONE.....	

KEY TO ALL MAPS

	.....ASH BEDS, ALLUVIAL LAYERS
	.....SAND OR SILT
	.....RESISTANT ROOT MATS
	.....WOOD OR TIMBER
	.....LAPILLI
	.....STUMPS
	.....CHARCOAL FRAGMENTS
	.....CHARCOAL LAYER
	.....SPHAGNUM LAYER
	.....BASEMENT
	.....CLAY, SILT & SANDS
	.....GRAVELS

KEY FOR PEAT PROFILES

1. SWEETWATER
2. HIKURANGI
3. WAIPU
4. WHANGAMARINO/ISLAND BLOCK
5. HAURAKI
6. OHINEWAI
7. TE MIMIHA
8. HOE O TAINUI
9. ORINI
10. KAINUI
11. KOMAKARAU
12. OHOTE
13. KAITUNA
14. WAIHI
15. RUKUHIA
16. MOANATUATUA
17. TARAWERA
18. POUKAWA
19. TE AUTE



- * HAURAKI 5.
- * HIKURANGI 2.
- HOE O TAINUI 8.
- KAINUI 10.
- KAITUNA 13.
- KOMAKARAU 11.
- * MOANATUATUA 16.
- * OHINEWAI 6.
- OHOTE 12.
- ORINI 9.
- POUKAWA 18.
- * RUKUHIA 15.
- SWEETWATER 1.
- TARAWERA 17.
- TE AUTE 19.
- TE MIMIHA 7.
- WAIHI 14.
- WAIPU 3.
- * WHANGAMARINO/
ISLAND BLOCK 4.

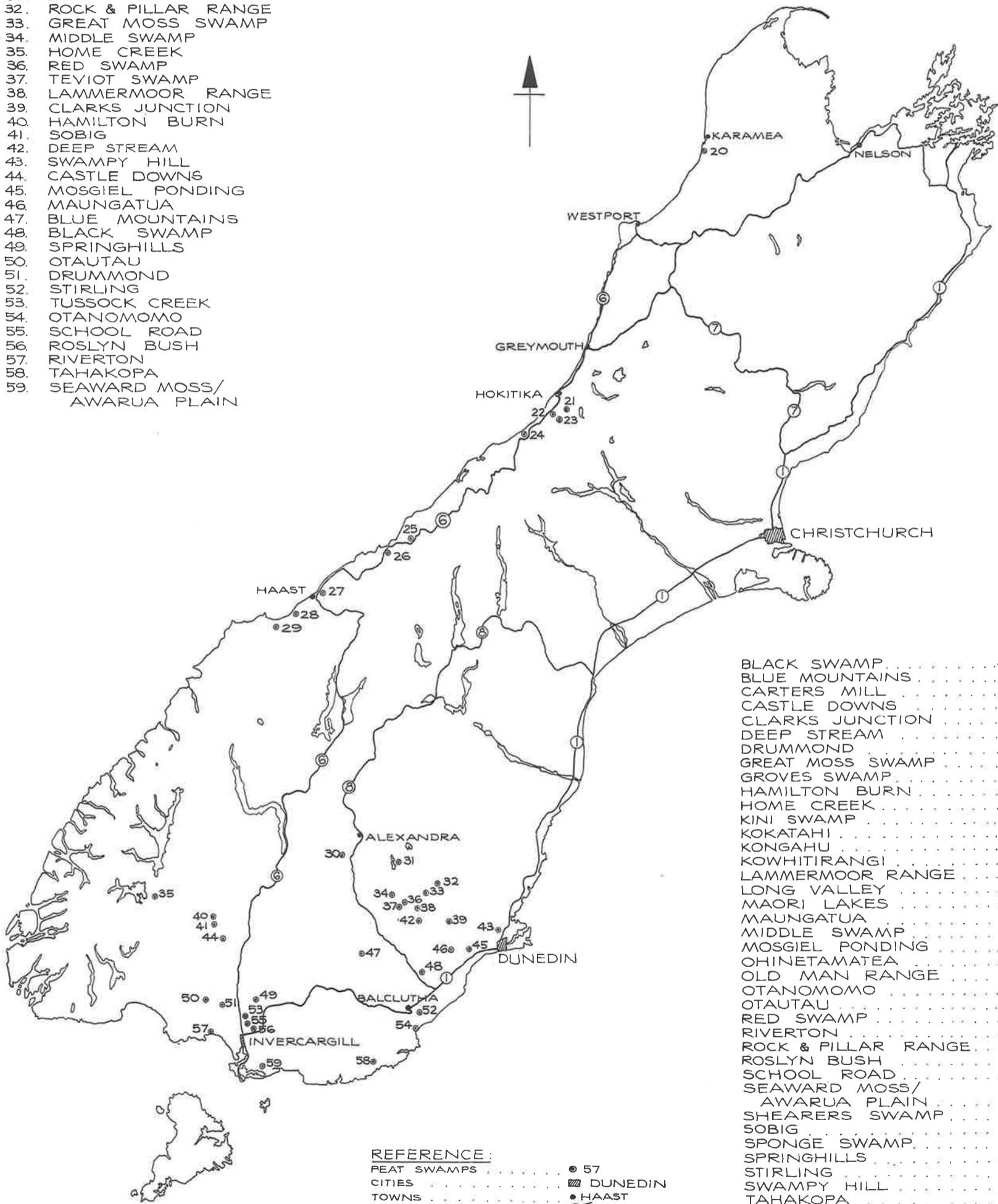
- REFERENCE:
- PEAT SWAMPS ● 17
 - CITIES ▨ HAMILTON
 - TOWNS ● THAMES
 - STATE HIGHWAYS ③

NORTH ISLAND LOCATION MAP

Water & soil technical publication no. 14 (1978)

SCALE, 1:3 000 000 0 50 100 150 200 Km

20. KONGAHU
21. KOKATAHI
22. GROVES SWAMP
23. KOWHITIRANGI
24. SHEARERS SWAMP
25. OHINETAMATEA
26. KINI SWAMP
27. MAORI LAKES
28. CARTERS MILL
29. SPONGE SWAMP
30. OLD MAN RANGE
31. LONG VALLEY
32. ROCK & PILLAR RANGE
33. GREAT MOSS SWAMP
34. MIDDLE SWAMP
35. HOME CREEK
36. RED SWAMP
37. TEVIOT SWAMP
38. LAMMERMOOR RANGE
39. CLARKS JUNCTION
40. HAMILTON BURN
41. SOBIG
42. DEEP STREAM
43. SWAMPY HILL
44. CASTLE DOWNS
45. MOSGIEL PONDING
46. MAUNGATUA
47. BLUE MOUNTAINS
48. BLACK SWAMP
49. SPRINGHILLS
50. OTAUTAU
51. DRUMMOND
52. STIRLING
53. TUSOCK CREEK
54. OTANOMOMO
55. SCHOOL ROAD
56. ROSLYN BUSH
57. RIVERTON
58. TAHAKOPA
59. SEAWARD MOSS/
AWARUA PLAIN



- | | |
|-------------------------------|----|
| BLACK SWAMP | 48 |
| BLUE MOUNTAINS | 47 |
| CARTERS MILL | 28 |
| CASTLE DOWNS | 44 |
| CLARKS JUNCTION | 39 |
| DEEP STREAM | 42 |
| DRUMMOND | 57 |
| GREAT MOSS SWAMP | 33 |
| GROVES SWAMP | 22 |
| HAMILTON BURN | 40 |
| HOME CREEK | 35 |
| KINI SWAMP | 26 |
| KOKATAHI | 21 |
| KONGAHU | 20 |
| KOWHITIRANGI | 23 |
| LAMMERMOOR RANGE | 38 |
| LONG VALLEY | 31 |
| MAORI LAKES | 27 |
| MAUNGATUA | 46 |
| MIDDLE SWAMP | 34 |
| MOSGIEL PONDING | 45 |
| OHINETAMATEA | 25 |
| OLD MAN RANGE | 30 |
| OTANOMOMO | 54 |
| OTAUTAU | 50 |
| RED SWAMP | 36 |
| RIVERTON | 57 |
| ROCK & PILLAR RANGE | 32 |
| ROSLYN BUSH | 56 |
| SCHOOL ROAD | 55 |
| SEAWARD MOSS/
AWARUA PLAIN | 59 |
| SHEARERS SWAMP | 24 |
| SOBIG | 41 |
| SPONGE SWAMP | 29 |
| SPRINGHILLS | 49 |
| STIRLING | 52 |
| SWAMPY HILL | 43 |
| TAHAKOPA | 58 |
| TEVIOT SWAMP | 37 |
| TUSOCK CREEK | 53 |

- REFERENCE:**
- 57 PEAT SWAMPS
 - DUNEDIN CITIES
 - HAAST TOWNS
 - Ⓢ STATE HIGHWAYS

SOUTH ISLAND LOCATION MAP

1. SWEETWATER

Location

8km west of Kaitaia behind the dunes bordering
Ninety Mile Beach (N9:727793).
Northland Catchment Commission district.

Classification

Mesotrophic, but with some oligotrophic
characteristics.

Present Status

Degenerating, agricultural.

Area

56.2km².

Volume

285 million m³.

Surface Vegetation and Landuse

Most of the swamp has been developed for
agriculture, with small areas still covered by low
manuka. Most of the agricultural land is in
pasture, much with manuka, gorse, rushes,
bracken fern, blackberry and other weeds. Small
areas are used for arable crops such as potatoes,
and an area north and south of Spains Road and
immediately east of Kunicichs Road is a N.Z.
Forest Service Pine nursery.

Climate

Kaitaia Airport Climate Station.

Mean annual rainfall 1430mm

Distribution all year,
but higher
falls April-
September

Fogs 21 days

Mean annual temperature 15.3°C

Mean January temperature 18.9°C

Mean July temperature 11.4°C

Peat Composition

The peat is generally black, well decomposed and contains few recognisable plant remains. Mineral additions vary in amount throughout the profile.

Mineralised peat. Some areas had 0.2-0.3m of gleyed silt overlying raw peat.

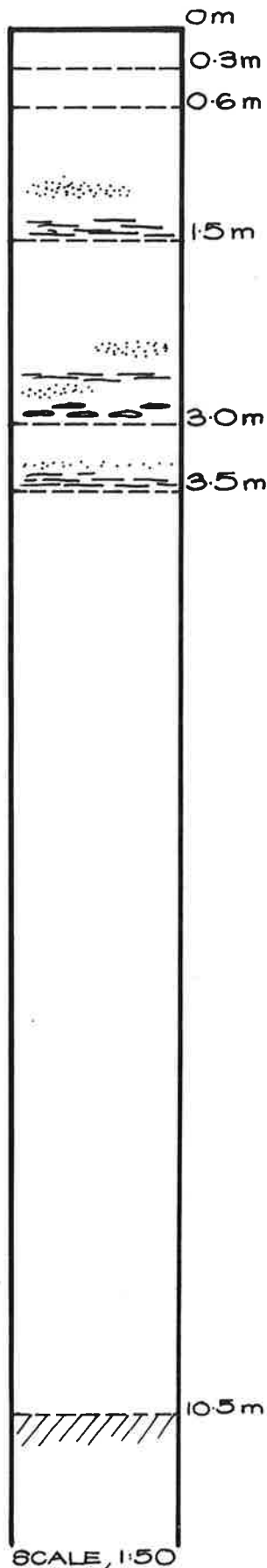
Gleichenia dicarpa, *Calorophus minor*, *Cladium spp.* some *Schoenus brevifolius*, woody roots and wood fragments. Well decomposed, VP 7-8 with some sand or silt lenses.

Gleichenia dicarpa, *Calorophus minor*, *Cladium spp.*, variable amounts of woody roots and wood fragments. Well decomposed, VP 7-8, with some sand or silt lenses.

Resistant layer common at 3.5m. Usually a black, fibrous peaty sand.

Large fern roots common below 3.0m.

Generally grey or brown clay, with some brown sands.



2. HIKURANGI

General

Four major pockets of peat west of Hikurangi Township of varying thickness. Only deposits 2, 3, 4 were investigated. Northland Catchment Commission district.

Hikurangi 2

Location

20km north of Whangarei and west of Hikurangi (N20:767165)

Classification

Oligotrophic, high moor.

Present Status

Degenerating, agricultural.

Area

6.35km², although about 3.5km² or 55% is covered by up to 1m of alluvial silt.

Volume

16.8 million m³.

Surface Vegetation and Landuse

The entire swamp has been developed for agriculture. Most of the land is in pasture, with blackberry, gorse and rushes. Kahikatea and manuka stumps are common. The centre of the swamp is dominated by a sandstone outcrop (shown on thickness map).

Peat Composition

The peat is composed of *Calorophus minor*, *Cladium spp.*, some *Schoenus brevifolius*, some *Gleichenia dicarpa*, some woody roots and wood fragments. The peat is well decomposed and black, with V P values of 6-7. Woody obstructions were struck between 2.0 and 3.0m. The peat basement is blue-grey or brown clay, and in parts a brown silty sand.

Climate

Whangarei Hospital Climate Station.

Mean annual rainfall 1597mm
Distribution even
Frosts 6 days
Fogs 8 days
Mean annual temperature 16.1°C
Mean January temperature 20.8°C
Mean July temperature 10.4°C

General

The area is used for ponding flood waters from the Wairua River.



Hikurangi 3

Location

21km north-west of Whangarei (N20:700144).

Classification

Oligotrophic, high moor.

Present Status

Degenerating, agricultural.

Area

7.7km².

Volume

11.6 million m³.

Surface Vegetation and Landuse

Almost the entire swamp has been developed for agriculture, with a small area centred about the 7 metre thickness contour still covered by manuka, bracken fern, gorse, blackberry, some flax and grasses. All this agricultural land is in pasture, with rushes, blackberry, gorse, low manuka and some bracken fern. The manuka and blackberry is in places very dense and difficult to penetrate.

Peat Composition

Much of the peat was mineralised to 0.2m. Samples taken show the peat to be composed of moderately decomposed (VP 5-6) *Cladium spp*, *Schoenus brevifolius*, *Calorophus minor*, *Gleichenia dicarpa* and woody roots and fragments (probably *Leptospermum scoparium*). A resistant, woody layer was present at 2.0-2.5m. Below this, the mineral content and proportion of woody roots and fragments of the peat increase (although the peat still dominated by rush species). The peat is underlain by blue or white gleyed clays with a high organic content.

Climate

Whangarei Hospital Climate Station

Mean annual rainfall 1597mm

Distribution even

Frosts 6 days

Fogs 8 days

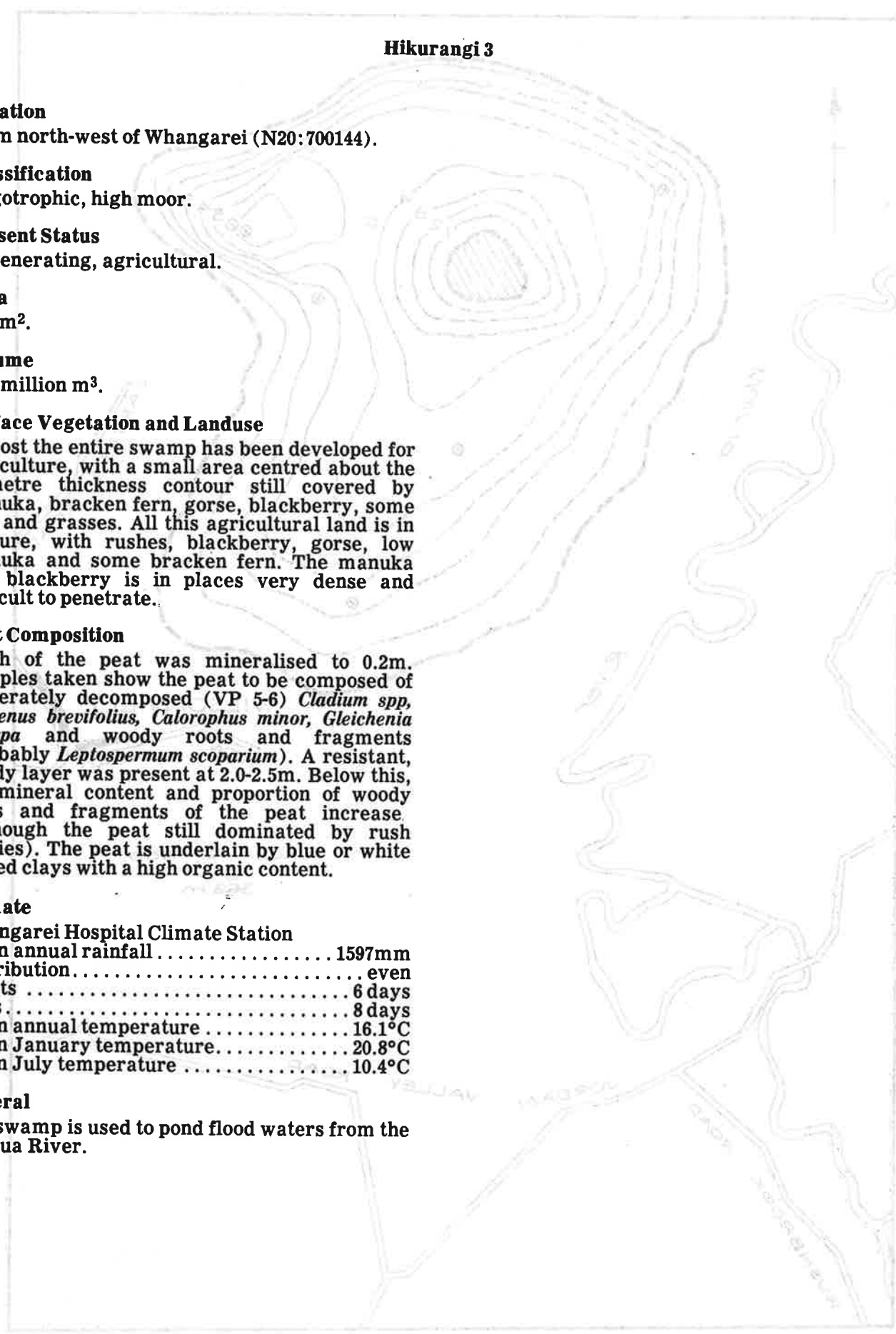
Mean annual temperature 16.1°C

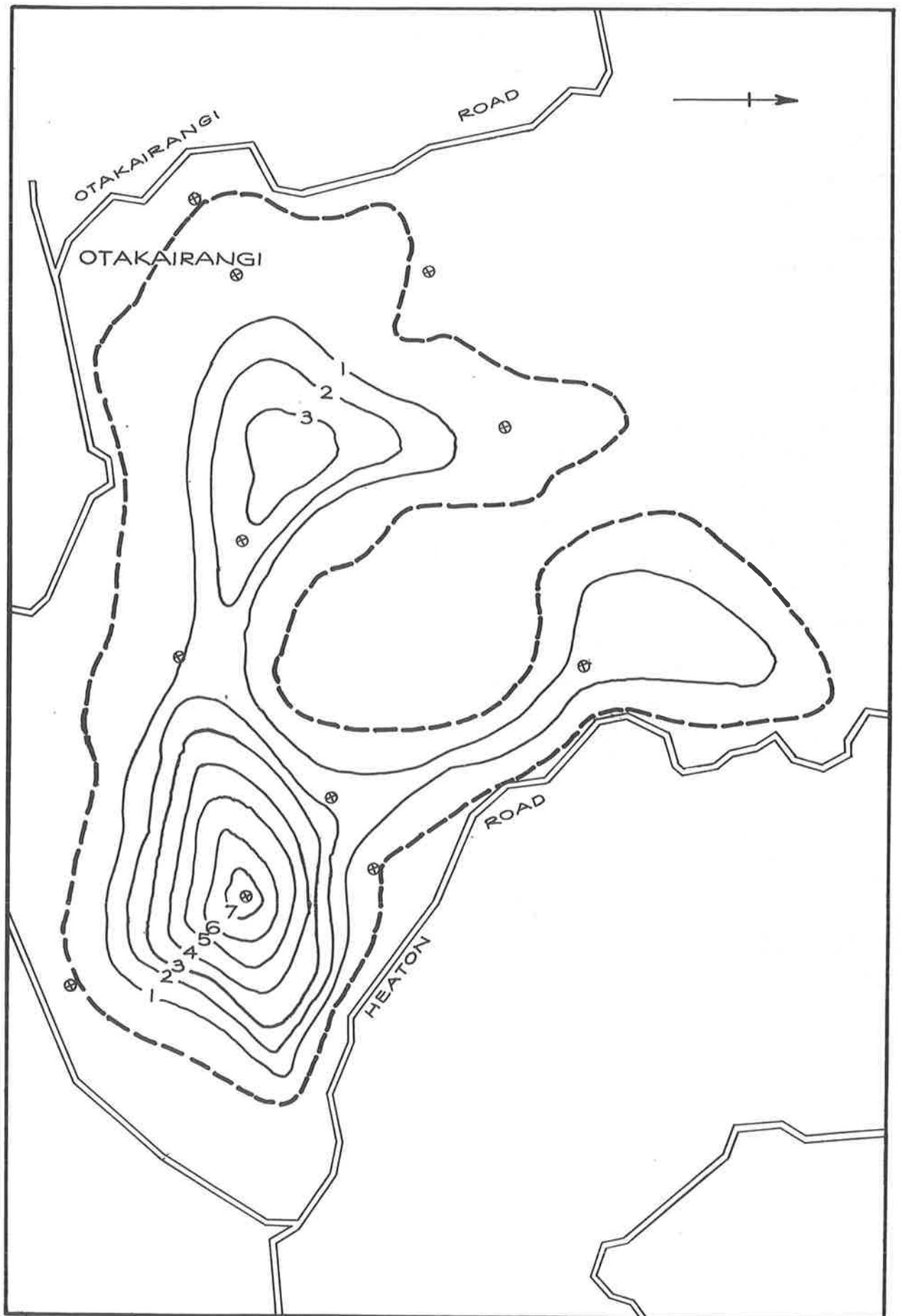
Mean January temperature 20.8°C

Mean July temperature 10.4°C

General

The swamp is used to pond flood waters from the Wiarua River.





HIKURANGI 3

SCALE, 1:25 000

Water & soil technical publication no. 14 (1978)

2

3km

Hikurangi 4

Location

14km north-north-west of Whangarei
(N20:760097).

Classification

Oligotrophic, high moor.

Present Status

Degenerating, agricultural.

Area

11.1km².

Volume

21.7 million m³.

Surface Vegetation and Landuse

Most of the swamp has been developed for agriculture, although a small area in the northern part is still covered by *Gleichenia dicarpa*, *Leptospermum scoparium*, *Baumea teretifolium*, with some exotic grasses. A small part is used to crop maize. The rest is in pasture some with blackberry, manuka stumps and debris, rushes, and some low manuka.

Peat Composition

The peat is dominated by rush species with woody roots. Much of the peat is mineralised to 0.2-0.3m. From 0.3-1.5m the peat is dominated by rush species i.e. *Calorophus minor*, *Cladium spp.*, with *Leptospermum scoparium* and some *Gleichenia dicarpa*. Below this the peat is composed of rush species, with occasional woody roots. The peat is underlain by a blue, green or brown clay.

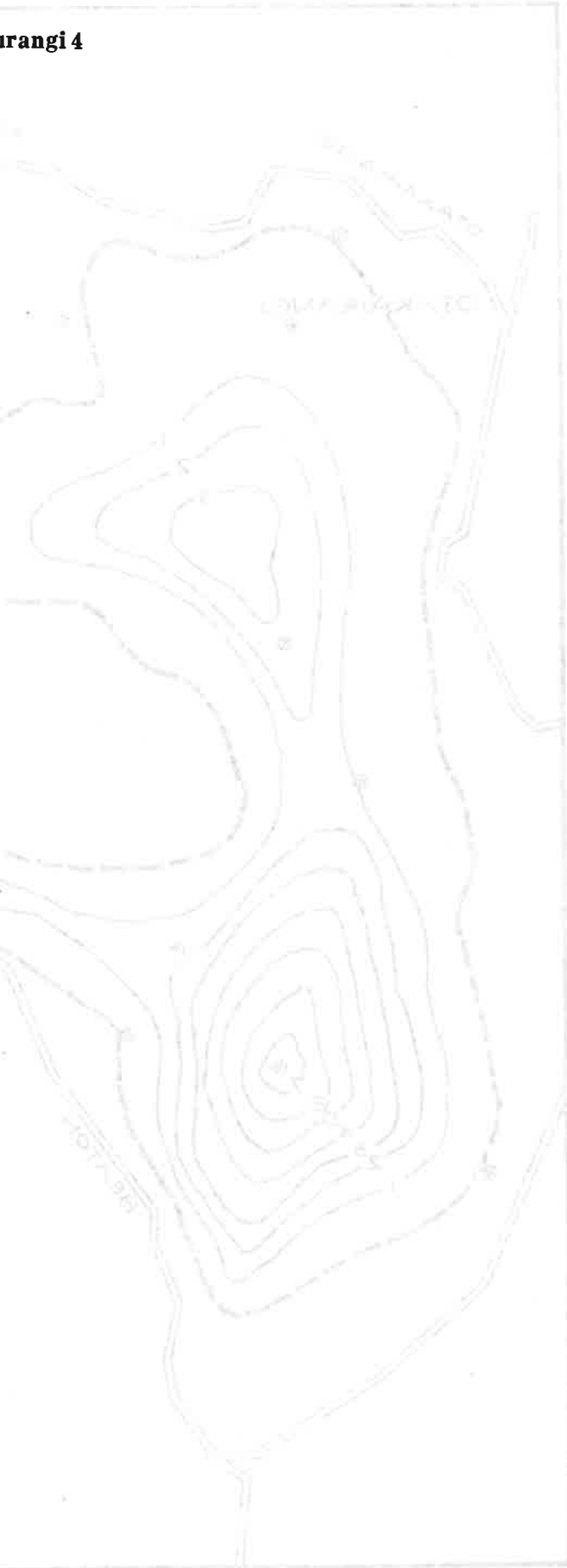
Climate

Whangarei Hospital Climate Station

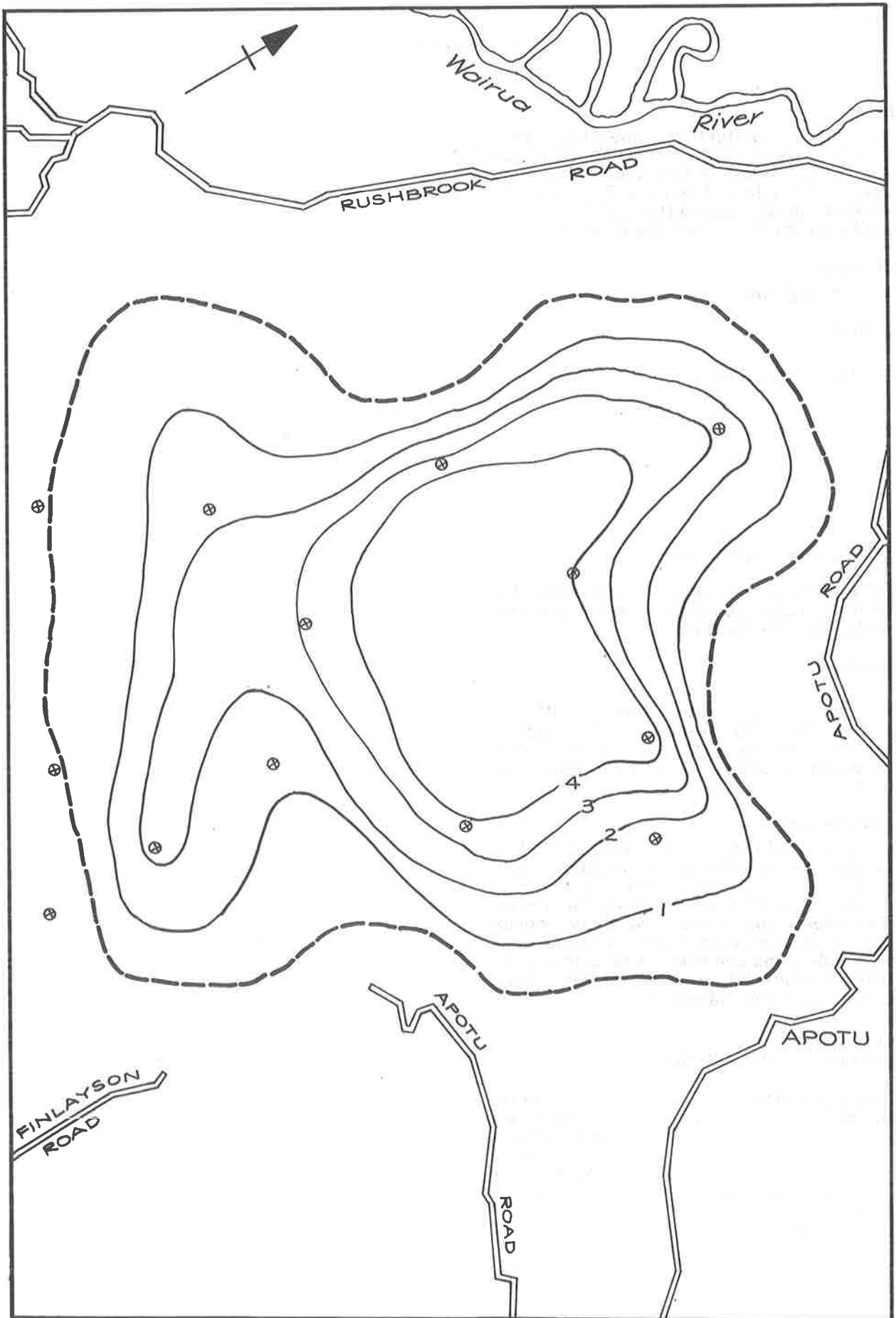
Mean annual rainfall	1597mm
Distribution	even
Frosts	6 days
Fogs	8 days
Mean annual temperature	16.1°C
Mean January temperature	20.8°C
Mean July temperature	10.4°C

General

The swamp is used to pond flood waters from the Wairua River.



HIKURANGI 4



HIKURANGI 4

SCALE, 1 : 25 000 0 1 2 3 km
Water & soil technical publication no. 14 (1978)

3. WAIPU

Location

A small, almost completely mineralised peat swamp, 4.5km west of the Marsden Point Oil Refinery (N24:958838). It lies behind the sand dunes along the edge of Bream Bay and the southern shore of Whangarei Harbour. Northland Catchment Commission district.

Classification

Oligotrophic, high moor.

Present Status

Degenerating, agricultural.

Area

7.9km².

Volume

9.8 million m³.

Surface Vegetation and Landuse

The entire swamp is in pasture, primarily for dairy farming. On some small areas wood debris and stumps litter the surface.

Peat Depth

The peat is generally very shallow with approximately 50% of the swamp having a depth of less than 1.0m. The deepest peat (up to 3.5m) is centred about McEwen Road-Pyle Road intersection.

Peat Composition

The peat is very black, well decomposed (VP 7-8), with few recognisable plant remains. Up to 0.5m of peat is mineralised, and to a depth of 1.5m the peat is dominated by *Gleichenia dicarpa*, with *Calorophus minor*, *Schoenus brevifolius*, woody roots and wood fragments. Variable proportions of mineral additions are present throughout the peat, which is underlain by a brown peaty sand or in places by a brown sandy clay.

Climate

Marsden Point Climate Station.

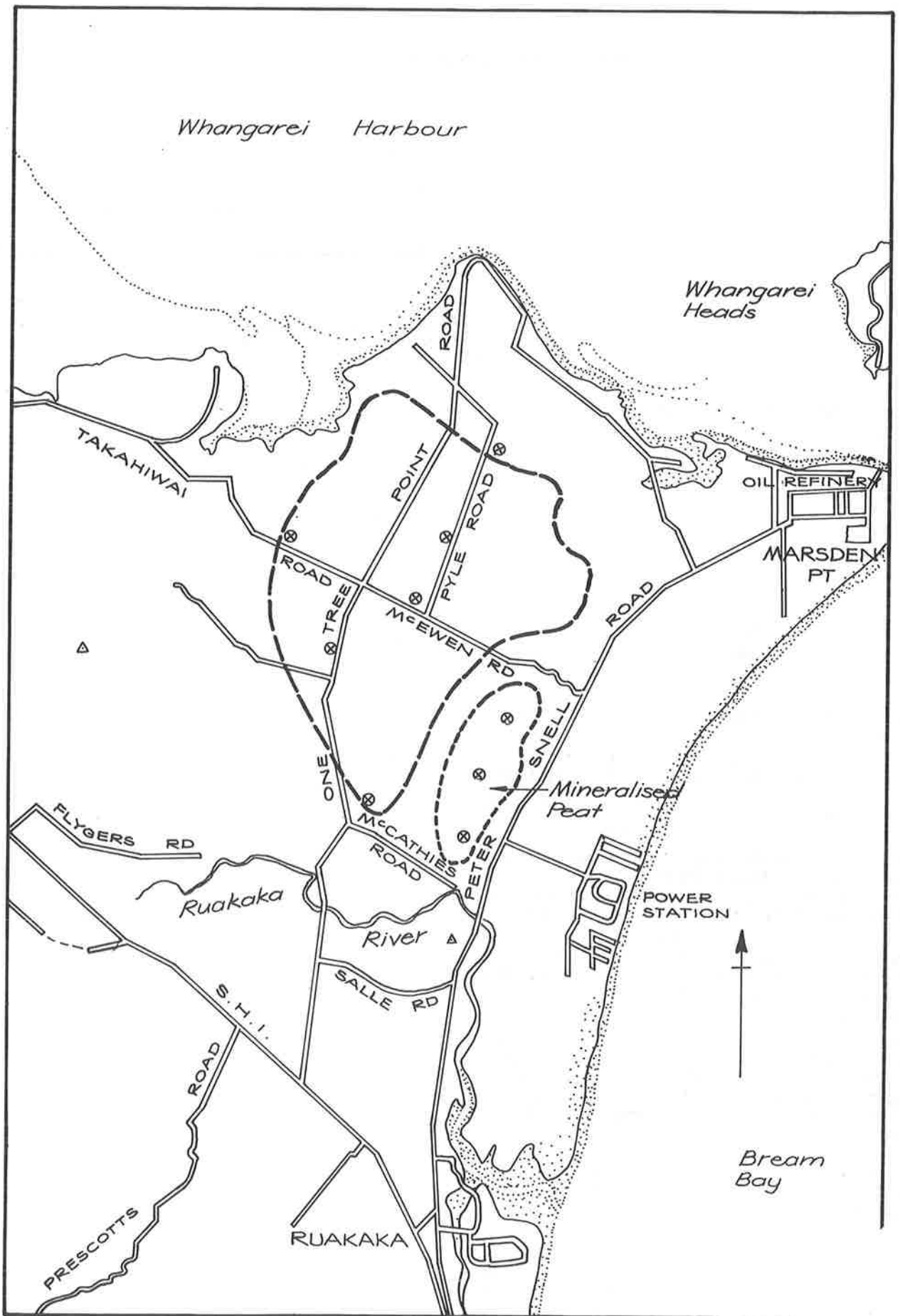
Mean annual rainfall 1500mm

Distribution even but with
heavier falls
April to
September

Mean annual temperature 16.9°C

Mean January temperature 21.5°C

Mean July temperature 11.8°C



WAIPU

In the

4. WHANGAMARINO - ISLAND BLOCK

Outfall Level

Whangamarino River (N52:577067) - 3.85m.

Climate

Maramarua Forest Climate Station.

Mean annual rainfall 1271mm
Distribution even
Frosts 39 days
Fogs 24 days
Mean annual temperature 14.3°C
Mean January temperature 18.1°C
Mean July temperature 10.1°C

Present Status

Active, with small fringe areas developed for agriculture.

Area

The swamp area investigated covers 70.6km².

Volume

No estimate of volume has been made owing to insufficient sampling sites and the irregularity of the subsurface.

Surface Vegetation and Landuse

The pattern of surface vegetation and landuse is shown in Fig. 1. The types are detailed below.

Type 1: Very small areas of pasture with rushes and some sedges.

Type 2: Overback deposits from the Whangamarino River and mineral additions from surrounding hills have increased the mineral content, and the introduced willow *Salix atrocinacerea* and manuka are common.

Type 3: Frequent flooding by the Whangamarino River and to a lesser extent the Maramarua River, has resulted in a peaty loam soil with sedges and *Salix atrocinacerea* extensively intermixed with pasture grasses.

Type 4: Increased mineral content in the peat, and extensive drainage has allowed the invasion of manuka at the expense of the native peat vegetation.

Type 5: The most extensive area of the peat swamp and is covered by *Calorophus minor*, *Eleocharis sphacelata*, *Cladium teretifolium*, *Baumea rubiginosa*, *Gleichenia dicarpa*, *Leptospermum scoparium*, *Phormium tenax* and some *Sporodanthus traversii*.

The water table is very high all year. The vegetation tends to form rafts with open water between.

Peat Depth

In areas covered by rush species the peat varies in depth from 1.0-7.5m, and in the Reao Arm. Close to the Whangamarino River and the surrounding hills, the peat is less than 1.5m deep.

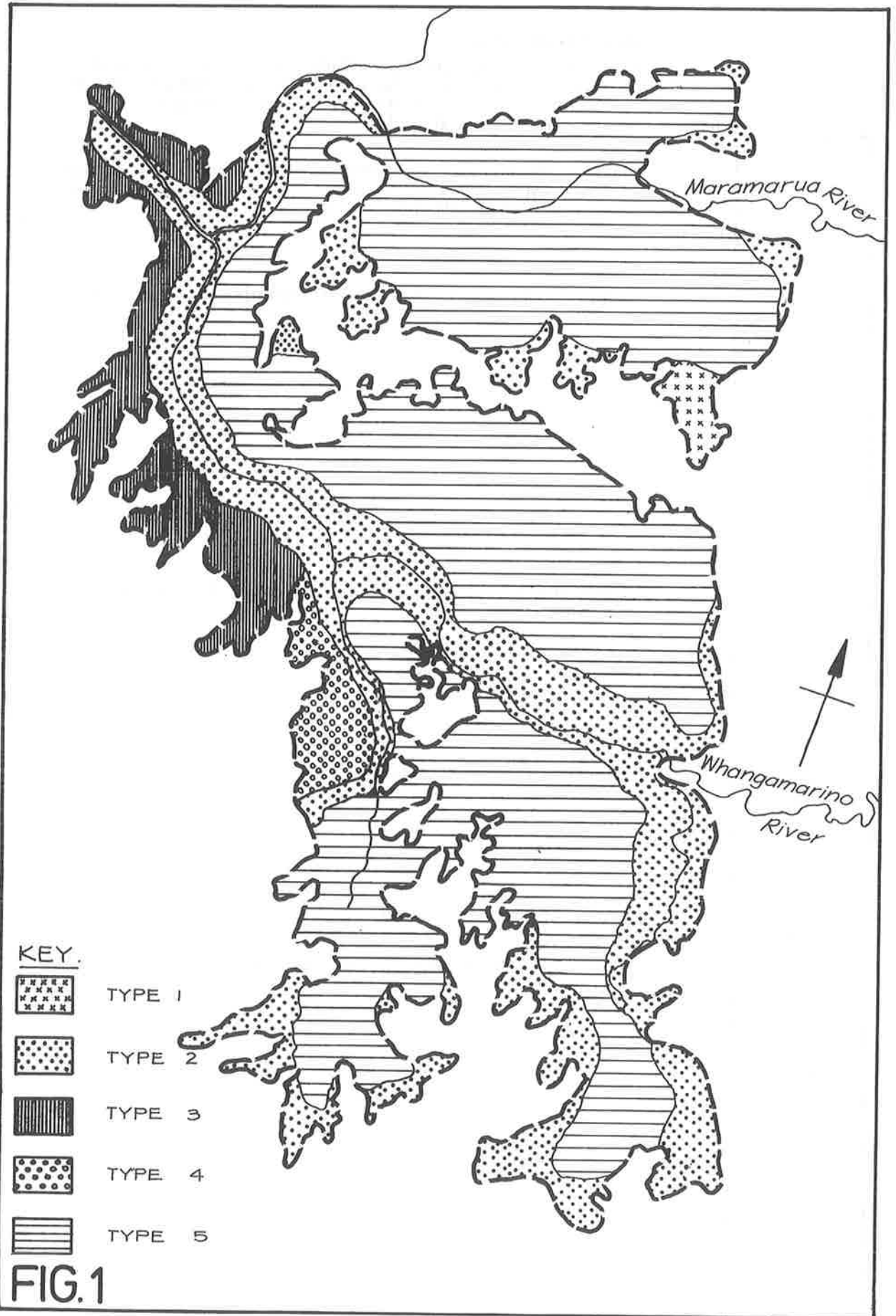
Highest Point

Reao Arm (N52:652952) - 7.15m.

General

The swamp is used to pond flood waters from the Maramarua, Whangamarino and Waikato Rivers. It is an important water fowl habitat.

Some data have been obtained from: Fry, R. G. 1976 "Peat of the Reao Arm." Unpublished MSc thesis, University of Waikato Library.



**WHANGAMARINO ISLAND BLOCK
SURFACE VEGETATION & LAND USE**

Water & soil technical publication no. 14 (1978)

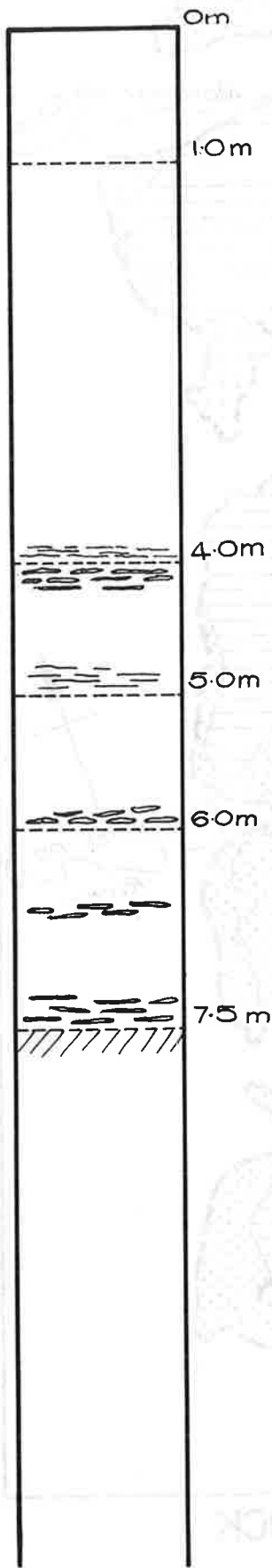
SCALE, 1 : 63 360

Peat Composition

Only the area covered by rushes, and to a lesser extent that covered in manuka, show true raw peat profiles. The other areas have considerable mineral additions, or are interbedded alluvial silts and peaty silts.

Calorophus minor (up to 80%), *Cladium teretifolium*, *Gleichenia dicarpa*, *Schoenus brevifolius*, and some *Leptospermum scoparium*.
Very wet and raw, VP 3-4.

Below 1.0 peat very wet, more decomposed and difficult to sample.



Resistant, difficult to penetrate root mats of *Gleichenia dicarpa* common.

Wood common at most depths.

Wood common above base.
Blue, blue-grey or grey clay or silty clay.

SCALE, 1:50

5. HAURAKI

Location

15km west of Thames and 35km north west of Paeroa (N48:940125).
Hauraki Catchment Board District.

Classification

Oligotrophic, high moor.

Present Status

Part is degenerating, agricultural (mainly in the fringe areas of the swamp); part is degenerating, mined (a small area in the centre of the northern dome); part is active (the extensive southern dome).

Area

238.5km².

Volume

1018 million m³.

Surface Vegetation and Landuse

The vegetation and landuse types are shown in Fig. 2.

Type 1: Mainly pasture, with small areas used to crop maize. It comprises the fringe and shallower areas of the swamp and those areas with good road access.

Type 2: Mainly pasture with manuka, blackberry, gorse, rushes, willows (close to the rivers) and some bracken fern. It surrounds the two domes.

Type 3: The area still covered by restiad species and is subdivided into two groups.

- (a) northern dome: As a result of extensive drainage of surrounding peat, the dome is covered by dense *Leptospermum scoparium* up to 4.5m high, some *Calorophus minor* (usually close to drains), dense bracken fern, blackberry and gorse. Some small areas have *Baumea teretifolium*, *Sporodanthus traversii*, *Gleichenia dicarpa*, and occasional mounds of *Sphagnum spp.*
- (b) southern dome: This is relatively unaffected by surrounding drainage. A 20-30m band of dense, tall manuka (3-4m), which is probably the result of surrounding drainage and development, surrounds the dome. The dome is characterised by a near surface water table; "islands" of *Sporodanthus traversii* and *Leptospermum scoparium* are surrounded by *Calorophus minor*, *Baumea teretifolium*, *Gleichenia dicarpa*, *Epacris pauciflora*, some low manuka, *Sphagnum spp.* (occasionally as cushions) and other moss species. Close to the Piako River, where the mineral content of the peat is higher the vegetation is *Phormium tenax*, *Juncus articulatus*, grasses, with some dense *Sphagnum* cushions.

Highest Point

Near N52:953061 approximately 6.5m. At the north end approximately 5.5m.

Outfall Level

The swamp has many outfalls, which drain into the Piako or the Waitakaruru River (see thickness contour map), e.g.

Awaiti Canal, which drains into the Piako River, has a low tide level at approximately mean sea level at its outfall.

Pouarua/Maukoro Canals, which drain into the Waitakaruru River, have an outfall level at approximately mean sea level

Climate

Ngatea Climate Station.

Mean annual rainfall 1112mm
Distribution evenly over

121 raindays

Frosts 52 days

Fogs 32 days

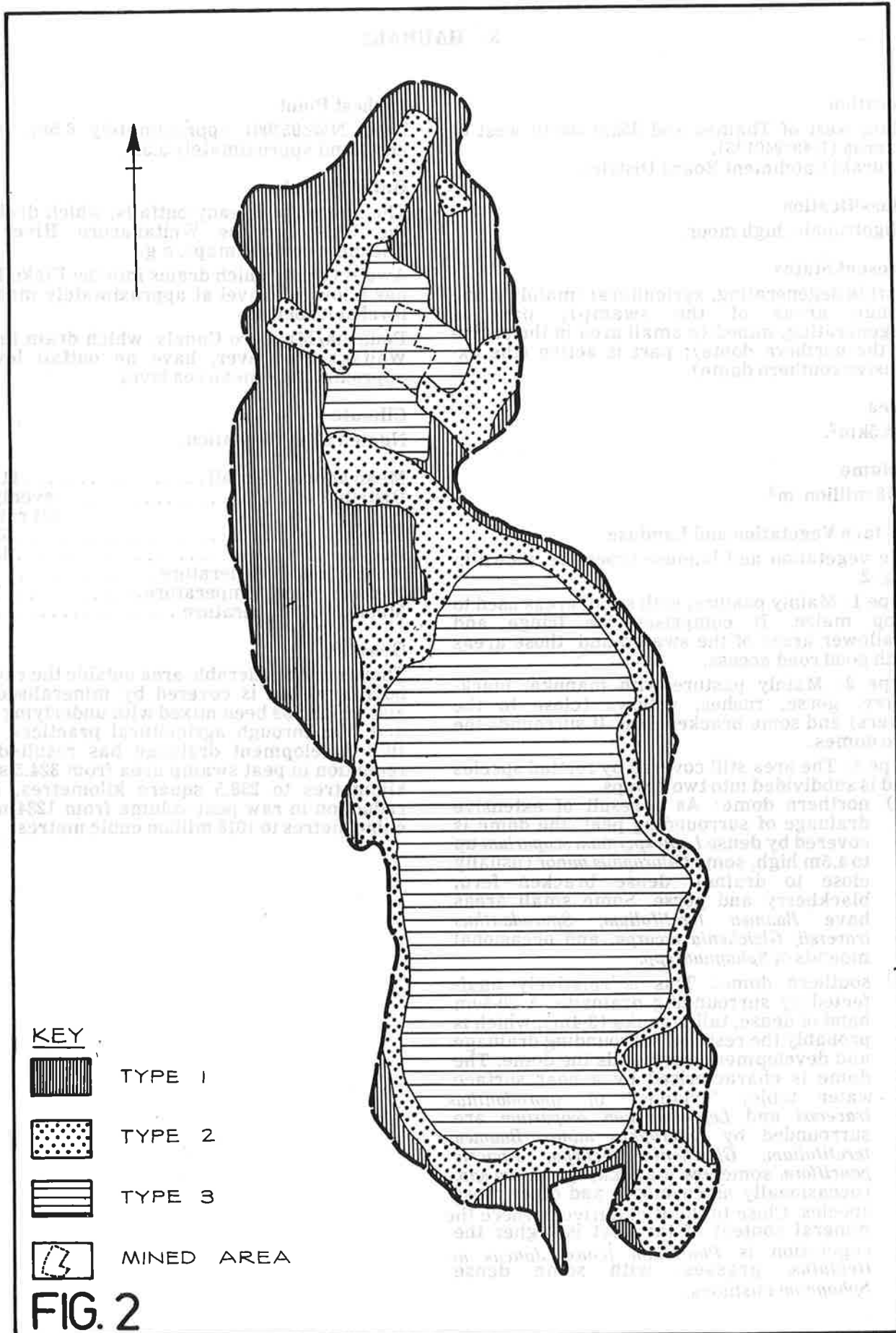
Mean annual temperature 13.4°C

Mean January temperature 17.9°C

Mean July temperature 8.7°C

General

There is a considerable area outside the raw peat boundary that is covered by mineralised peat and which has been mixed with underlying sands and silts through agricultural practices. Since 1928 development drainage has resulted in a reduction in peat swamp area from 324.5 square kilometres to 238.5 square kilometres, and a reduction in raw peat volume from 1234 million cubic metres to 1018 million cubic metres.

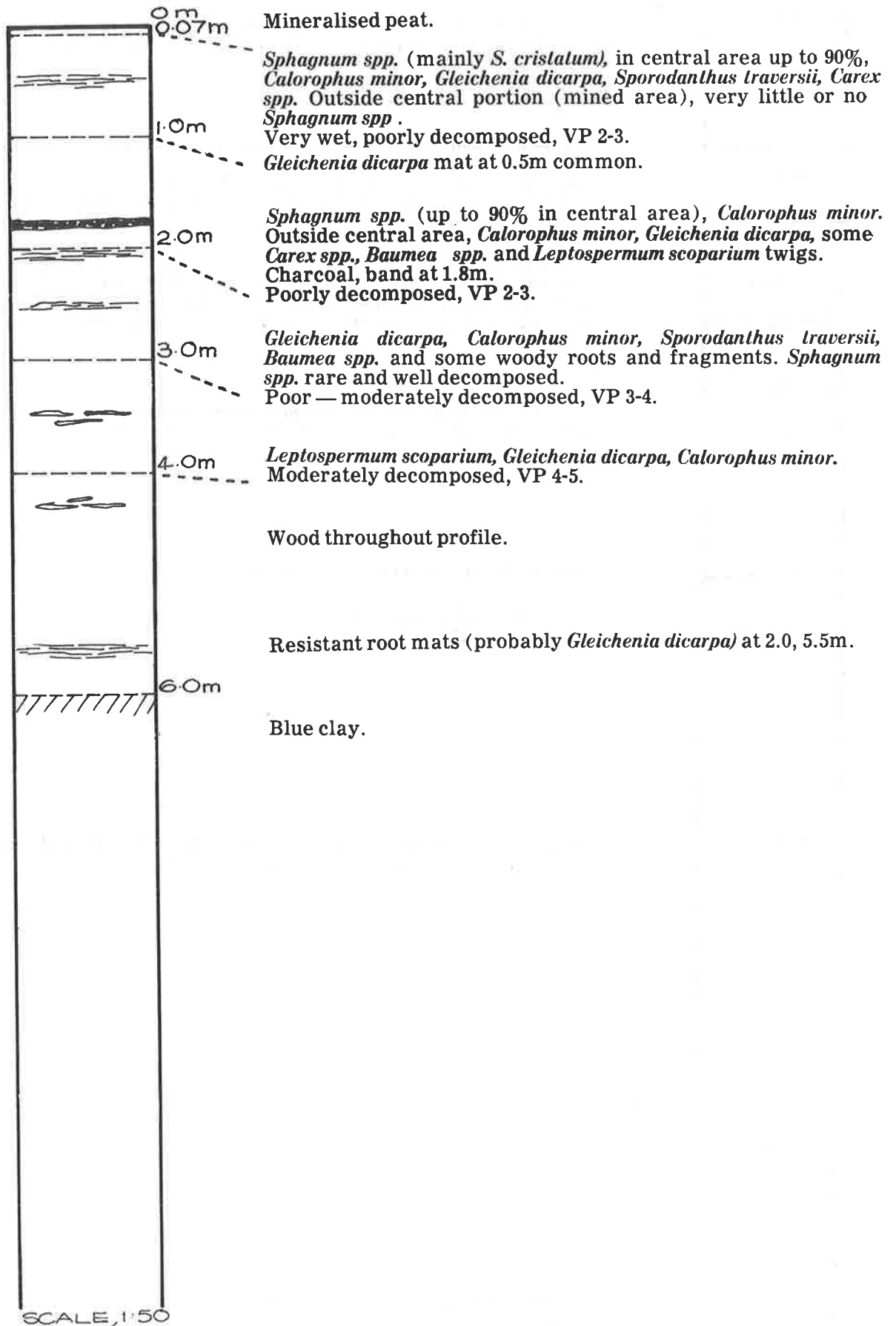


HAURAKI SURFACE VEGETATION & LAND USE

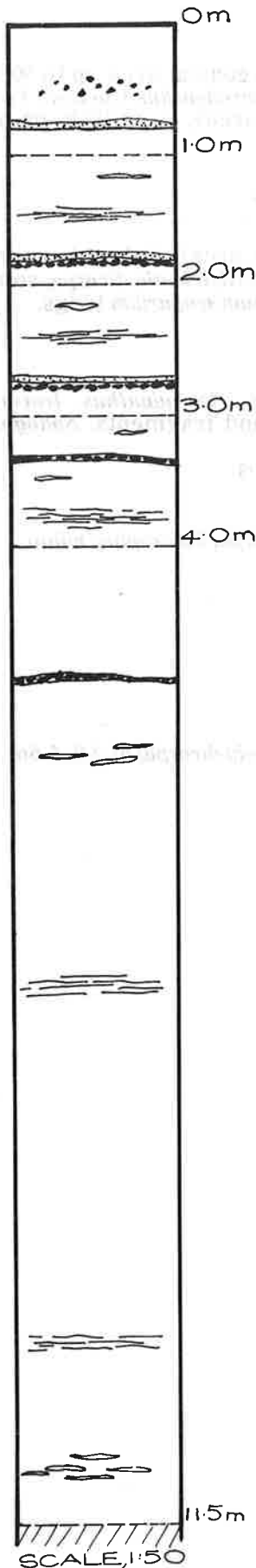
Water & soil technical publication no. 14 (1978)

SCALE, 1 : 139 000

Peat Composition
1) Northern Dome



ii) Southern Dome



Very wet, difficult to sample. *Calorophus minor*, *Baumea* spp., *Sphagnum* spp., *Gleichenia dicarpa*, and wood twigs and fragments.

Charcoal, poorly decomposed, VP 2-3.
Tephra (?) layer at 0.8m.

Calorophus minor (up to 80%), some *Sphagnum* spp. (moderately decomposed), *Baumea* spp., *Sporodanthus traversii* and wood.

Very wet, charcoal, poorly to moderately decomposed, VP 3.
Sandy layer (pumiceous lapilli ?) at 1.8m often with charcoal immediately below.

Baumea spp. (up to 70 - 80%), some *Calorophus minor*, *Sporodanthus traversii*, *Gleichenia dicarpa* and woody roots and fragments.

Very wet, slushy, moderately decomposed, VP 5-6.
Pumiceous tephra 0.15m thick at 2.75m, often with charcoal immediately below.

Gleichenia dicarpa, some *Calorophus minor* and *Baumea* spp.
Very slushy, moderately to well decomposed, VP 6.

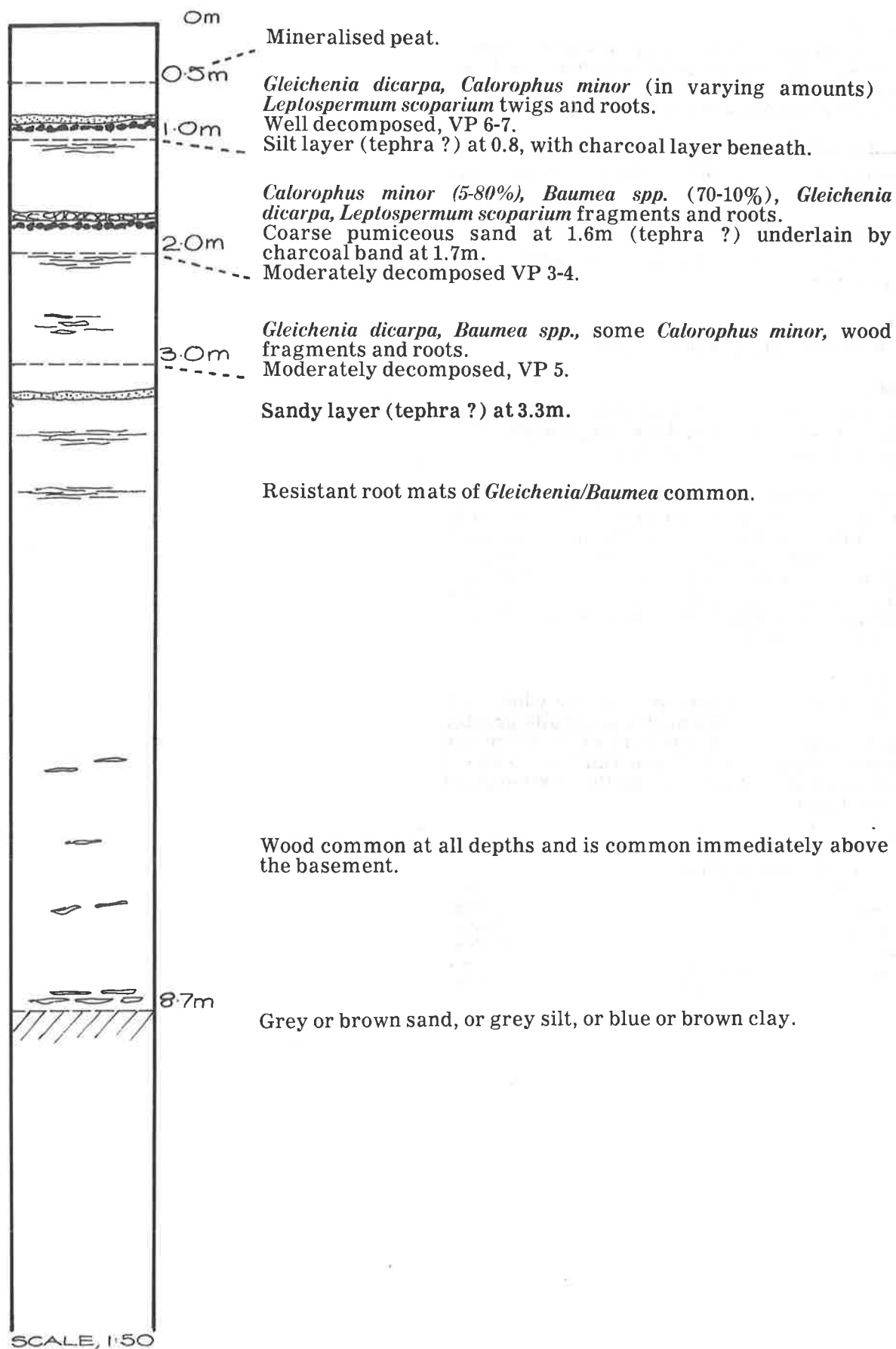
Bands of charcoal common down to 5m.

Wood throughout profile.

Resistant, difficult to penetrate root mats of *Gleichenia/Baumea* or *Gleichenia/Calorophus* common throughout profile.

Grey or blue-grey sand, or green or grey silt, or blue or brown clay.

iii) Developed Peat Profile



6. OHINEWAI

Location

The area investigated is 11km north of Huntly, east of SH 1 and on the southern shores of Lake Waikare. Waikato Valley Authority district.

Classification

Mesotrophic, but with some oligotrophic characteristics.

Present Status

Degenerating, agricultural, but with small active areas.

Area

The area surveyed covers 15.0 km².

Volume

No estimate of volume was made owing to insufficient sample sites and the irregularity of the subsurface and peat distribution.

Surface Vegetation and Landuse

Most of the swamp is developed for agriculture. It is mainly in pasture with rushes and some manuka debris. A few small areas are used to crop maize. Small patches are covered by *Leptospermum scoparium*, *Calorophus minor*, *Eleocharis sphacelata*, *Gleichenia dicarpa*, and some *Baumea teretifolium*.

Peat Depth

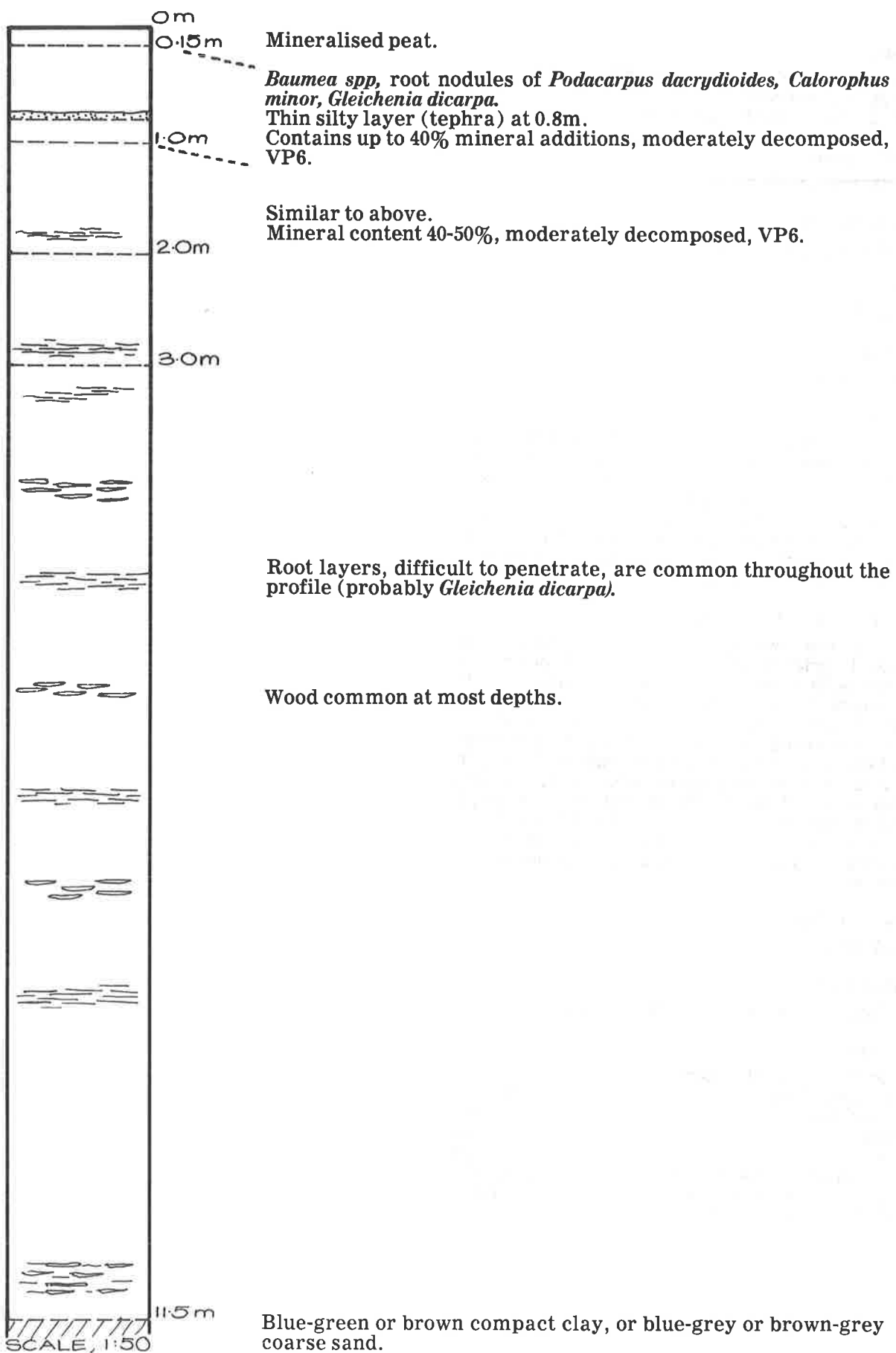
Except in the lobes close to Ohinewai where it is less than 1.5m deep, the peat is generally greater than 5.0m deep. Peat depths of 8.0 — 11.5m are common, especially between Ohinewai-Tahuna Road and Frost Road, and to the north-east of Balemi Road.

Climate

Maramarua Forest Climate Station.

Mean annual rainfall	1271mm
Distribution	even
Frosts	39 days
Fogs	24 days
Mean annual temperature	14.3°C
Mean January temperature	18.1°C

Peat Composition



7. TE MIMIHA

Location

10km north-east of Huntly (N52:753810), but most is on sheet N56.
Waikato Valley Authority district.

Classification

Oligotrophic, high moor.

Present Status

Degenerating, agricultural.

Area

11.1 km².

Volume

60 million m³.

Peat Depth

The peat, although varying in depth from 1.0 - 12.0m is deepest about midway down Kneebone Road. For the eastern three sites along Kneebone Road and to the north of these, peat thicknesses greater than 9.0m were recorded. Between the swamp, Kneebone Road and Welch Road depths are 1.5 - 3.0m, whereas the northern lobe has depths of 1.0 - 2.0m.

Surface Vegetation and Landuse

Most of the swamp has been developed for pastoral agriculture; Land recently broken in is littered with manuka debris and stumps. Stands of manuka remain along drains and farm races. A small area about midway down Kneebone Road is covered by dense manuka, blackberry, bracken fern, gorse and some rushes. Owing to drainage, few native peat species are now active in this area. In the northern extremity, a small stand of kahikatea have roots about 1.0m above the present peat surface, which suggests the peat has shrunk by this amount, as a consequence of drainage.

Highest Point

N56:782778 - 24m.

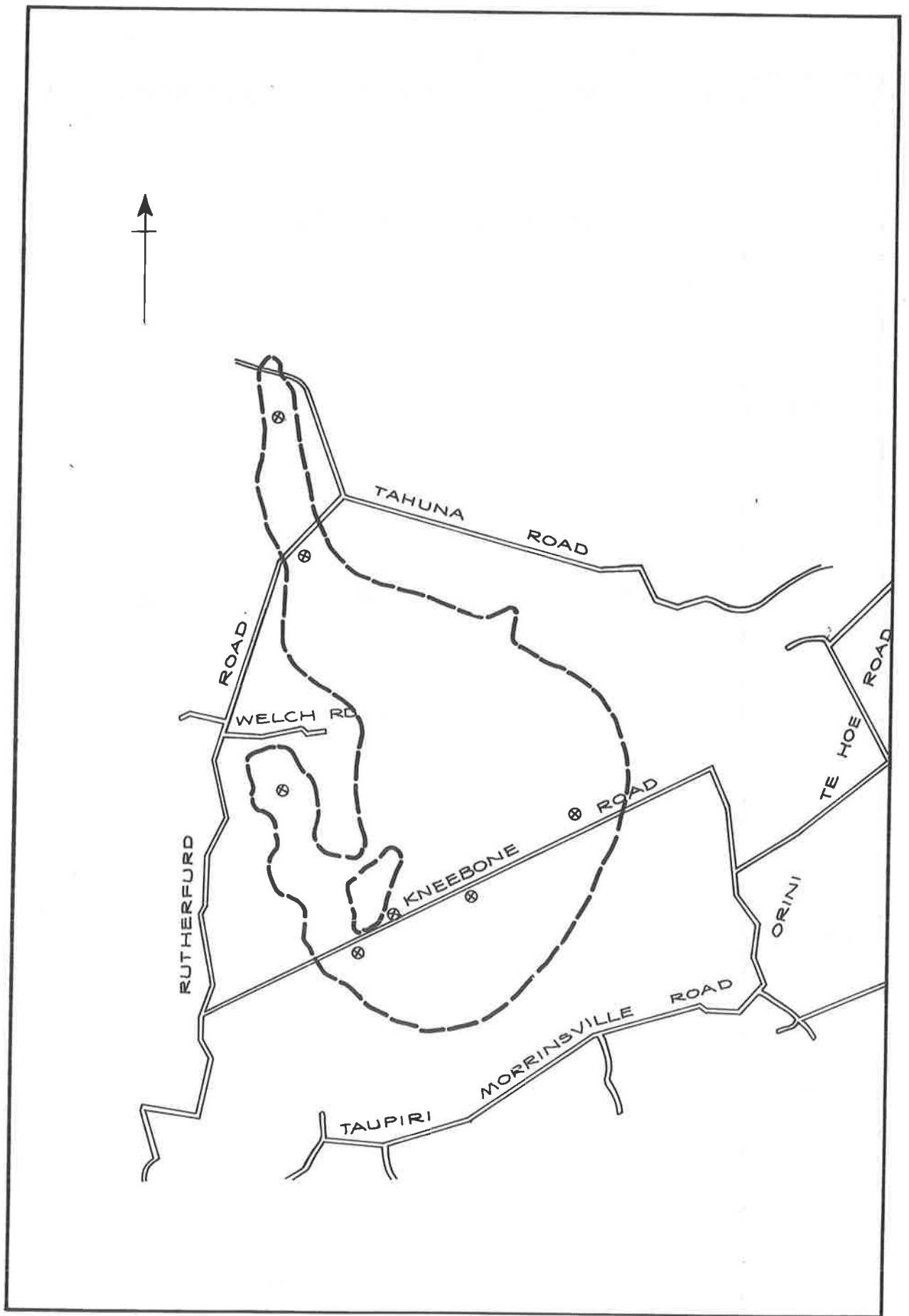
Outfall Level

Te Mimiha Drain (N56:760754) — 13.5m.

Climate

Ruakura Climate Station

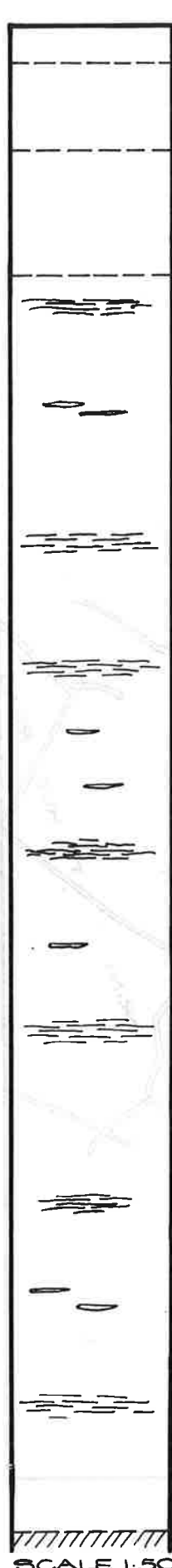
Mean annual rainfall	1197mm
Distribution	even
Frosts	49 days
Fogs	29 days
Mean annual temperature	13.0°C
Mean January temperature	17.3°C
Mean July temperature	8.1°C



TE MIMIHA

SCALE, 1:50 000

0 1 2 3 4 5 6km
Water & soil technical publication no. 14 (1978)



0m
 0.3m
 1.0m
 2.0m
 12.0m

Peat Composition

In north and western lobe the peat is very dry and mineralised up to 1.0m.

Mineralised peat.

Dense *Gleichenia dicarpa*, *Calorophus minor*, raw, VP 3-4.

Frequent almost impenetrable root mats of *Gleichenia dicarpa*.

Occasional wood fragments.

Large brown rhizomes (sedge ?) at base.

Coarse - medium, brown, grey and occasionally peaty pumiceous sand.

SCALE 1:50

8. HOE-O-TAINUI

Location

22km north-east of Taupiri (N56:901782). The swamp is locally referred to as Northern or Cryers Swamp. Waikato Valley Authority district.

Classification

Oligotrophic, high moor.

Present Status

Degenerating, agricultural.

Area

14.5 km².

Volume

64.5 million m³.

Highest Point

N56:873740 - 28.2m.

Outfall Levels

Northern Outlet Drain (N56:853772) - 18.4m.
Murchies Drain (N56:847757) - 19.3m.

Climate

Ruakura Climate Station.

Mean annual rainfall 1197mm

Distribution even

Frosts 49 days

Fogs 29 days

Mean annual temperature 13.0°C

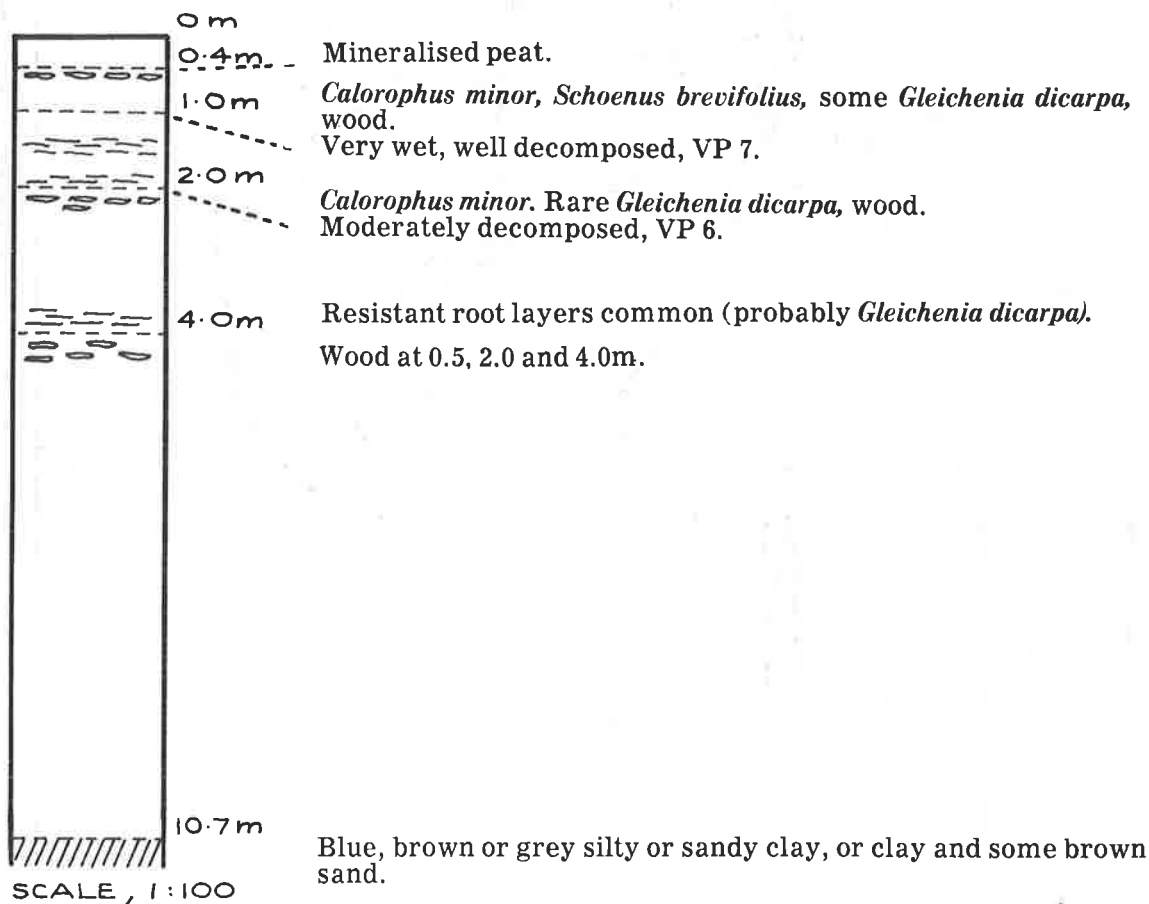
Mean January temperature 17.3°C

Mean July temperature 8.1°C

Surface Vegetation and Landuse

Almost the entire swamp has been developed for pastoral agriculture. A small area in the centre of the swamp (end of Flaxmill Road) is covered with dense manuka, blackberry and bracken fern. A small area is used to crop maize and potatoes. Much of the central swamp has recently been developed for pasture and is littered with stumps and wood debris.

Peat Composition



9. ORINI

Location

3.5km north-east of Taupiri (N56:755725).
Waikato Valley Authority district.

Classification

Oligotrophic, high moor.

Present Status

Degenerating, agricultural.

Area

14.7 km².

Volume

59.8 million m³.

Surface Vegetation and Landuse

Most of the swamp (approximately 85%-90%) is developed for pastoral agriculture. Some of the pasture has small manuka, rushes, gorse and bracken fern present. Small areas are used to crop maize. In the central part of the swamp, about Uapoto Road, there is a small patch covered by dense manuka, with *Calorophus minor*, *Drosera spp.*, and *Gleichenia dicarpa*.

Highest Point

N56:778696 - 24.4m.

Outfall Level

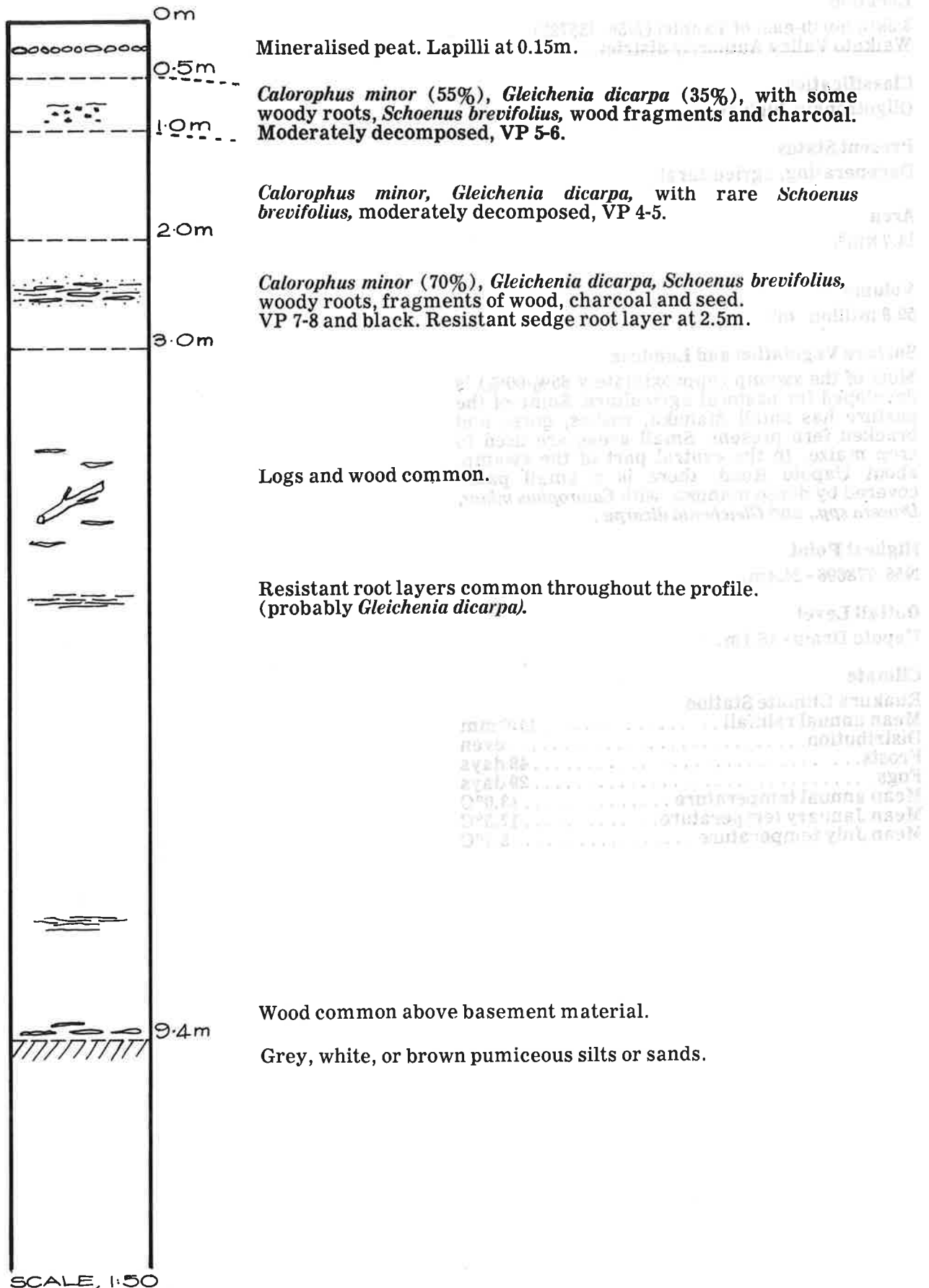
Uapoto Drain - 15.1m.

Climate

Ruakura Climate Station

Mean annual rainfall	1197mm
Distribution	even
Frosts	49 days
Fogs	29 days
Mean annual temperature	13.0°C
Mean January temperature	17.3°C
Mean July temperature	8.1°C

Peat Composition



10. KAINUI

Location

3.5km south of Taupiri and 6km north-east of Ngaruawahia (N56:716645). Waikato Valley Authority district.

Classification

Oligotrophic, high moor.

Present Status

Degenerating, agricultural.

Area

14.2km².

Volume

18.8 million m³.

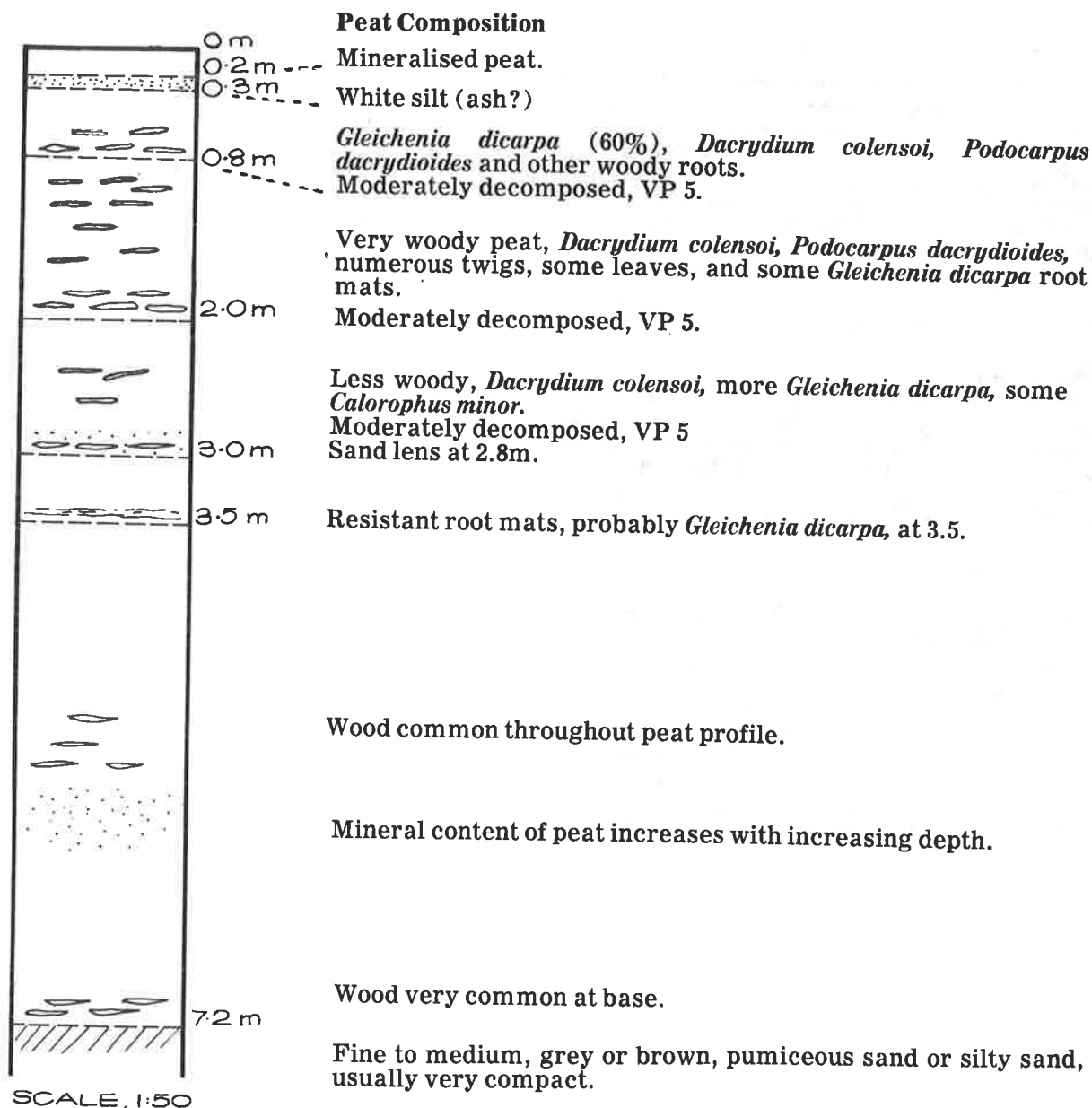
Surface Vegetation and Landuse

The entire swamp is developed for agriculture. Most is pasture, some with rushes, gorse, low manuka (especially along drains and farm races) and blackberry present. The rest of the swamp is used to crop maize and potatoes. Many areas are littered with wood debris and stumps.

Climate

Ruakura Climate Station.

Mean annual rainfall 1197mm
 Distribution..... even
 Frosts..... 49 days
 Fogs..... 29 days
 Mean annual temperature 13.0°C
 Mean January temperature..... 17.3°C
 Mean July temperature 8.1°C



11. KOMAKARAU

Location

27km north of Hamilton and 12km north-east of Taupiri (N56:802745), although most lies within 15-20m north and east of Hamilton.

The swamp lies within the boundaries of two catchment board districts; about 75% lies within the Wakato Valley Authority district, and about 25% within the Hauraki Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Degenerating, agricultural.

Area

216.3km².

Volume

504.7 million m³.

Surface Vegetation and Landuse

Almost the entire swamp has been developed for agriculture, although there are some small isolated areas, e.g. approximately 1 square kilometre to the immediate north-east of Valentine/Woodland Road intersection, which is covered by dense manuka, blackberry, bracken fern and some gorse. The greatest area of the agricultural land is in pasture, a small proportion of which has rushes, small manuka, some gorse, and other weeds present. A small area is used to crop maize and potatoes.

Highest Points

These are located in the eastern sector of the swamp, e.g. 47.0m at N56:913504 — (this point lies outside the raw peat boundary, but is on mineralised peat); 41.6m at N56:937583; 40.2m at N56:935641 — the highest point in area controlled by the Hauraki Catchment Board.

Outfall Levels

- (i) Short, steep outfalls to the south-east into the Waitakururu Stream, e.g. N56:963603.
- (ii) The longer, principal outfalls from the swamp, i.e.
Central Drain, (N56:820628) — 27.0m;
Komakarau Drain, (N56:828595) — 26.8m;
Eastern Outlet Drain, (N56:878700) — 24.5m) Mangahaumia Stream, which leaves the swamp at N56:985674, and at its confluence with the Piako River (N56:028710; has a level of 5.2m; Ten Foot Drain (N56:791716); Lake Drain (N56:811740)

Climate

Ruakura Climate Station.

Mean annual rainfall 1197mm
Distribution even
Frosts 49 days
Fogs 29 days
Mean annual temperature 13.0°C
Mean January temperature 17.3°C
Mean July temperature 8.1°C

General

The area to the north-east of Piako Road is locally referred to as Woodlands Swamp, whereas the western portion is called Komakarau Swamp — although there is no physical boundary between the two areas.

Sand ridges were common close to the surface, and in some places protrude through the peat, especially in the Valentine Road/Seifort Road area.

12. OHOTE

Location

8km west of Hamilton (N65:703483).
Waikato Valley Authority district.

Classification

Mesotrophic.

Present Status

Degenerating, agricultural.

Area

6.4km².

Volume

11.5 million m³.

Surface Vegetation and Landuse

Most of the swamp is in pasture for dairying; the rest is used for maize cropping.

Highest Point

25m.

Outfall Level

15.5m.

Climate

Rukuhia Climate Station.

Mean annual rainfall 1252mm

Distribution..... evenly over
135 raindays

Frosts..... 29 days

Fogs..... 29 days

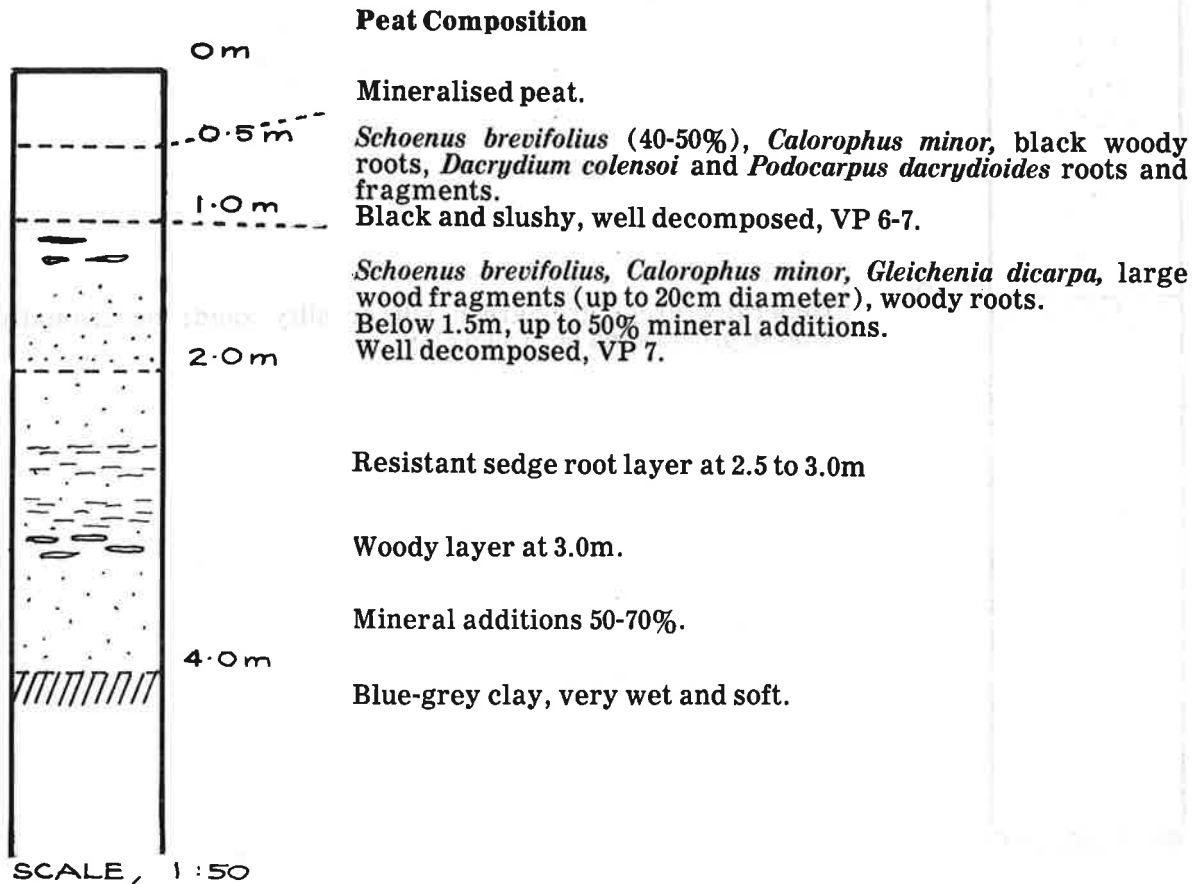
Mean annual temperature 13.6°C

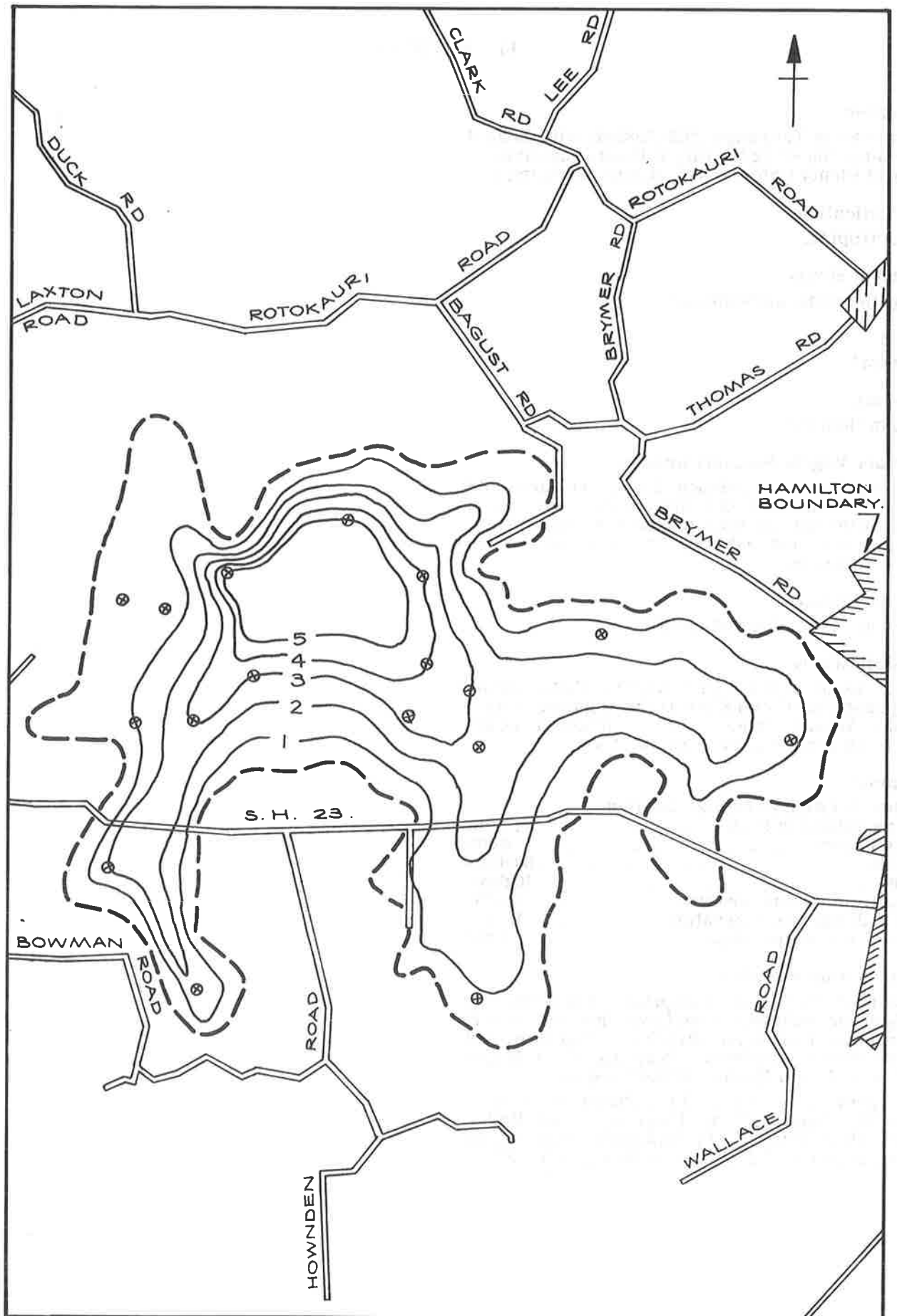
Mean January temperature..... 18.0°C

Mean July temperature 9.0°C

General

Ohote is a Water and Soil Division, Ministry of Works and Development regional catchment. Data including rainfall, runoff and groundwater levels are held in MWD District Office, Hamilton.





OHOTE

SCALE, 1 : 25 000

Water & soil technical publication no. 14 (1978)

2

3 km

13. KAITUNA

Location

11km east of Tauranga (N58:758558) lying behind the sandhills along the Bay of Plenty coastline. Bay of Plenty Catchment Commission district.

Classification

Mesotrophic.

Present Status

Degenerating, agricultural.

Area

35.4km².

Volume

92.5 million m³.

Surface Vegetation and Landuse

The swamp is developed for agriculture, and most is in pasture. Stumps, timber debris and logs litter the surface in some areas, rushes, blackberry, and cabbage tree are common in some pastures.

Highest Point

7.5m at N67:785488 and 758497.

Outfall Levels

Bells Road drain 1.6m; Kopura Canal 2.0m; Raparapahoe Canal 2.3m; Ohineangaanga Canal 2.6m; Waiari Stream 2.6m; Diagonal Drain 1.1m. All drain into the Kaituna River.

Climate

Tauranga Airport Climate Station.

Mean annual rainfall	1348mm
Distribution	even
Frosts	60 days
Fogs	10 days
Mean annual temperature	14.0°C
Mean January temperature	18.5°C
Mean July temperature	9.2°C

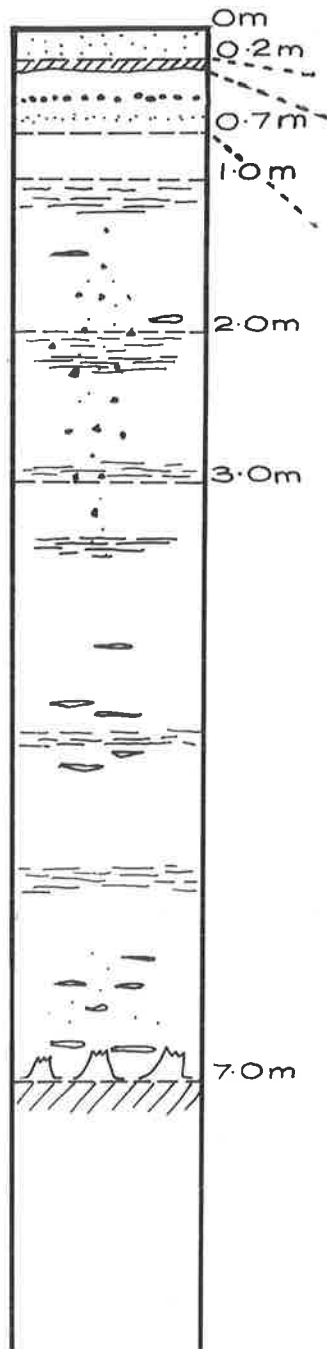
Source of information

The Kaituna Swamp comprises approximately 55% of the lowlands of the Lower Kaituna River. Information has been taken from : Bay of Plenty Catchment Commission "Kaituna River Major Scheme: Lower Kaituna River" report.

Campbell, E.O.; Heine, J.C.; Pullar, W.A. 1973: Identification of Plant fragments and Pollen from Peat Deposits in Rangitaiki Plains and Maketu Basins. *N.Z. Journal of Botany* 11:317-30.

Peat Composition

The upper part of the peat contains numerous ash beds, the uppermost of which have, through agricultural practices, been intermixed with the peat. Below this the peat is well decomposed and plant remains are fragmented.



SCALE, 1:50

0m
0.2m
Mineralised peat, dry, sandy texture as result of mixing of Tarawera and Kaharoa Ashes into the peat.

0.7m
Coarse white silty layer, Taupo Pumice.

1.0m
Some twiggy layers of *Podocarpus dacrydioides* and *Laurelia novae-zelandiae*, but mainly *Cortaderia toetoe*, *Baumea complanata*, *B. rubiginosa*, some *Gleichenia dicarpa*, and occasional *Calorophus minor*. Some charcoal, well decomposed, VP 6-7. Gritty fragments (tephra?) at 0.4 and 0.6 metres.

2.0m
3.0m
Below 0.7m peat is fibrous and is predominantly *Gleichenia dicarpa*, *Baumea complanata*, *B. rubiginosa*, *B. huttoni*, *B. teretifolia*, with some *Cortaderia toetoe* and *Calorophus minor*. Charcoal is common, well decomposed, VP 6-7.

Twiggy, woody, root mats of *Gleichenia dicarpa*, *Laurelia novae-zelandiae*, and *Podocarpus dacrydioides* at 1.0-1.2, 2.0-2.2, 2.8-3.0 metres.

Wood and woody roots common throughout peat.

7.0m
Stumps and/or logs above basement (probably *Laurelia novae-zelandiae* or *Podocarpus dacrydioides*).

Grey-brown, or brown medium sands.

14. WAIHI

Location

30km east-south-east of Tauranga (N68:942478).
Bay of Plenty Commission district.

Classification

Mesotrophic.

Present Status

Degenerating, agricultural.

Area

23km².

Volume

18.5 million m³.

Surface Vegetation and Landuse

The swamp is developed for pastoral agriculture.

Some pasture has rushes present.

Peat Depth

The deepest peat (2.0-2.5m) is in the west between Tainui and Kaikopu Roads. Much of the peat is less than 1.0m deep, especially east of the Wharere Canal.

Climate

Tauranga Airport Climate Station.

Mean annual rainfall 1348mm

Distribution even

Frosts 60 days

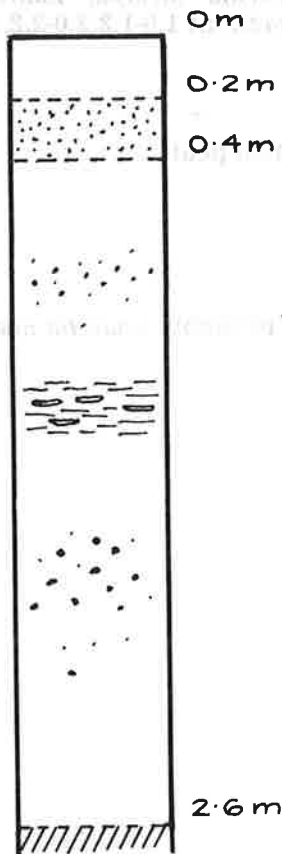
Fogs 10 days

Mean annual temperature 14.0 °C

Mean January temperature 18.5 °C

Mean July temperature 9.2 °C

Peat Composition



0-0.2 m Mineralised peat, peaty loam texture resulting from mixing with ash beds by agricultural practices.

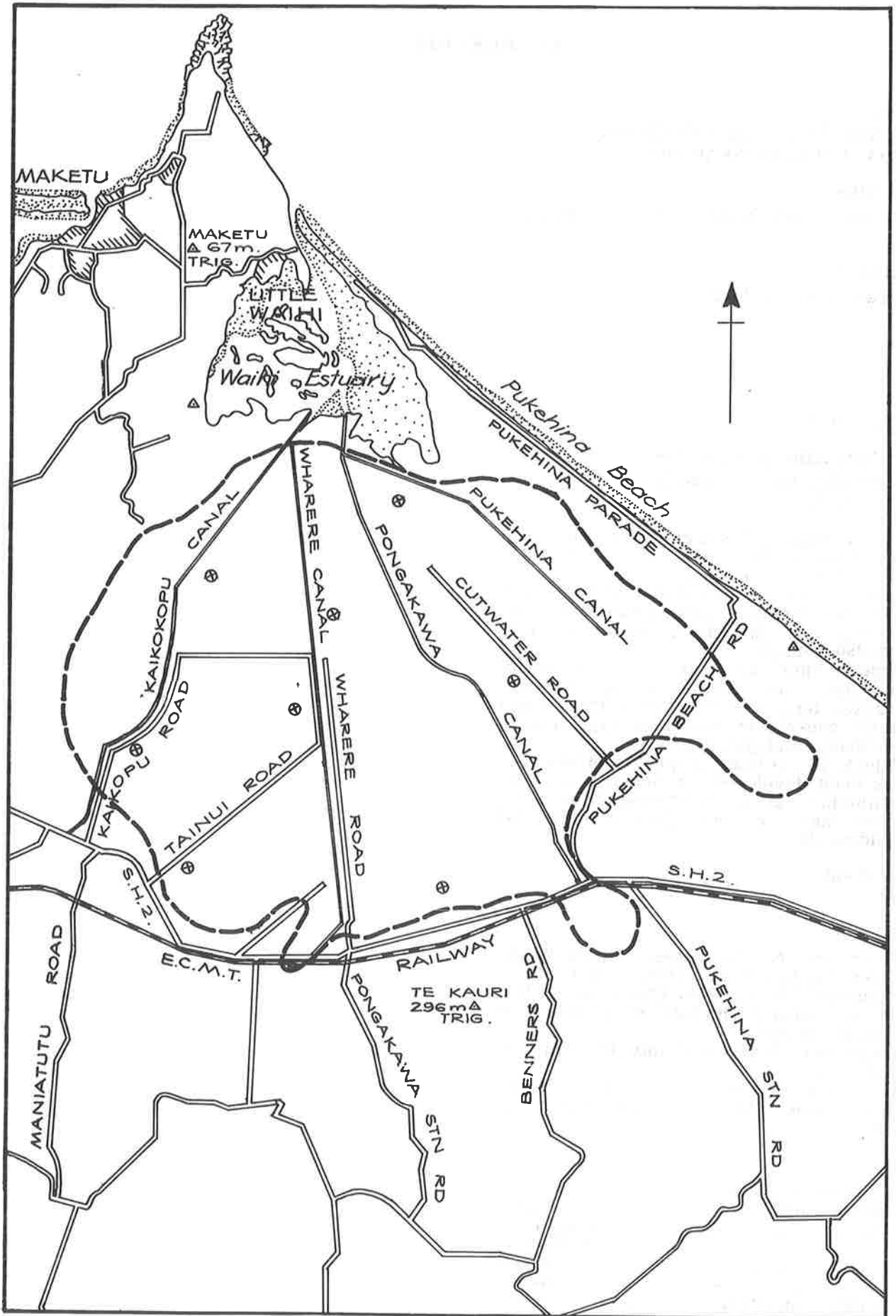
0.2-0.4 m White medium pumiceous sand (Taupo Pumice).

0.4-1.5 m *Baumea* spp., *Gleichenia dicarpa*, some *Calorophus minor* and *Cortaderia toetoe*. Wood fragments and charcoal common. Plant remains are very fragmented. Peat is well decomposed, VP 7.

1.5-2.6 m Twigggy, woody layer at 1.5m — most probably *Gleichenia dicarpa*, *Laurelia novae-zelandia*, and *Podocarpus dacrydioides*.

Below 2.6 m Grey or brown medium sand.

SCALE, 1:25



WAIHI

SCALE, 1 : 50 000

Water & soil technical publication no. 14 (1978)

4 5 6 km

15. RUKUHIA

Location

3.5km south of Hamilton (N65:758456).
Waikato Valley Authority district.

Classification

Oligotrophic, high moor, with mesotrophic fringes.

Present Status

Degenerating, agricultural.

Area

64.2km².

Volume

344.9 million m³.

Surface Vegetation and Landuse

The principal vegetation and landuse types are shown in Fig. 3.

- (i) Type 1: Most of this area is in pasture with occasional rushes. Some small areas are used for maize cropping.
- (ii) Type 2: Pasture with extensive rushes, and some low manuka, gorse, blackberry, and bracken fern. Manuka stumps and debris are also common.
- (iii) Type 3: Small areas, which as a result of drainage, are dominated by manuka, bracken fern, and in damper areas some small pockets of *Sphagnum spp.*, *Baumea teretifolium* and ground mosses.
- (iv) Type 4: The greatest proportion of this area has been developed for housing, and the remaining area, bordering Kahikatea Drive, has been developed as industrial building sites.

Highest Point

53.5m

Outfall level

- (i) Those that drain to the west into the Waipa River, e.g. Koromatua Stream, N65:736425; Mangahia Stream, N65:727358 and 730353, the latter arm of which drains directly from Lake Mangahia.
- (ii) Those that drain east into the Waikato River, e.g. Mystery Creek, N65:817338; Mangakotukutuku Stream, N65:787423 and 803415.

Climate

Rukuhia Climate Station.

Mean annual rainfall 1252mm
Distribution evenly over
135 raindays
Frosts 29 days
Fogs 29 days
Mean annual temperature 13.6°C
Mean January temperature 18.0°C
Mean July temperature 8.0°C

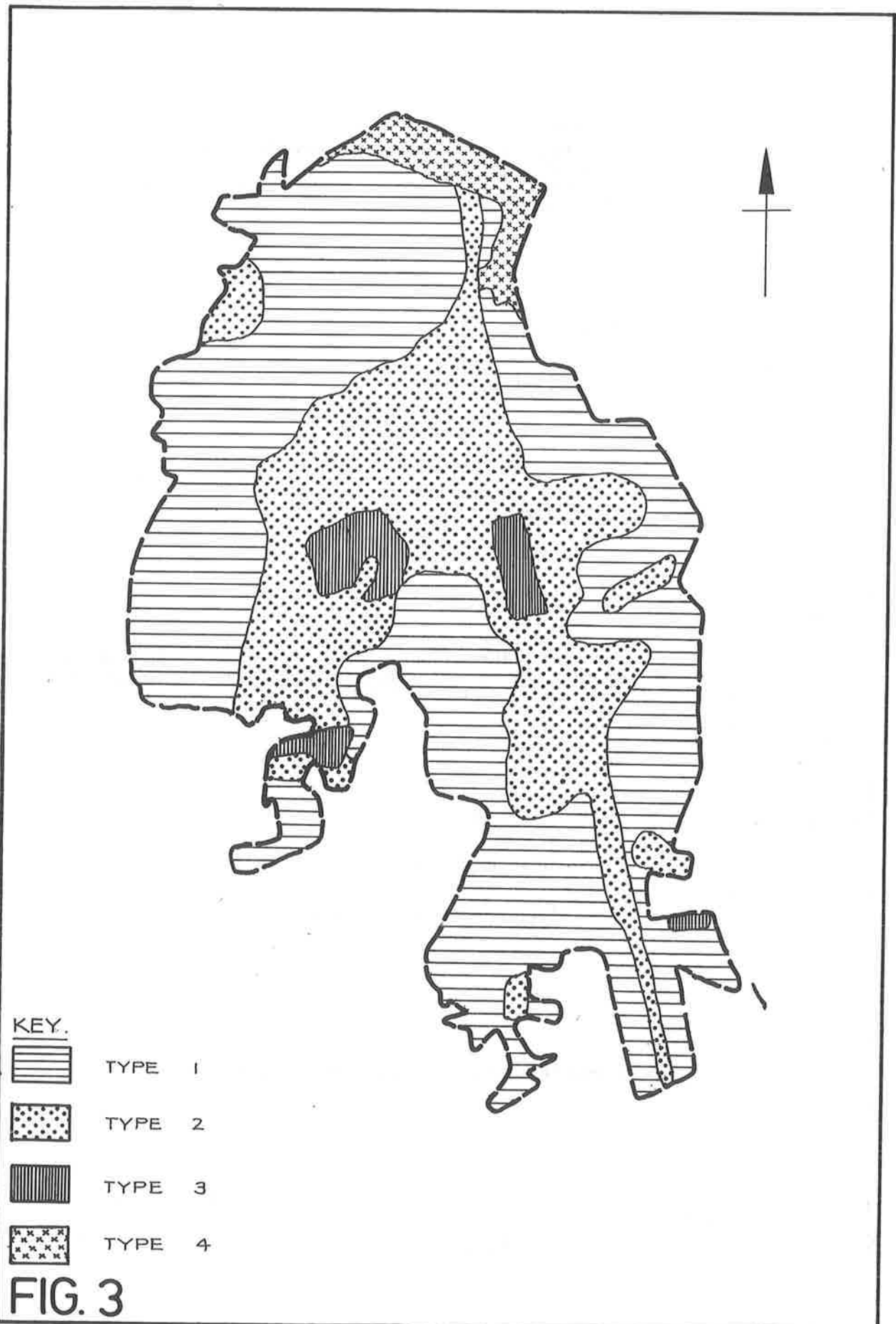


FIG. 3

**RUKUHIA
SURFACE VEGETATION & LAND USE**

SCALE, 1 : 47 900

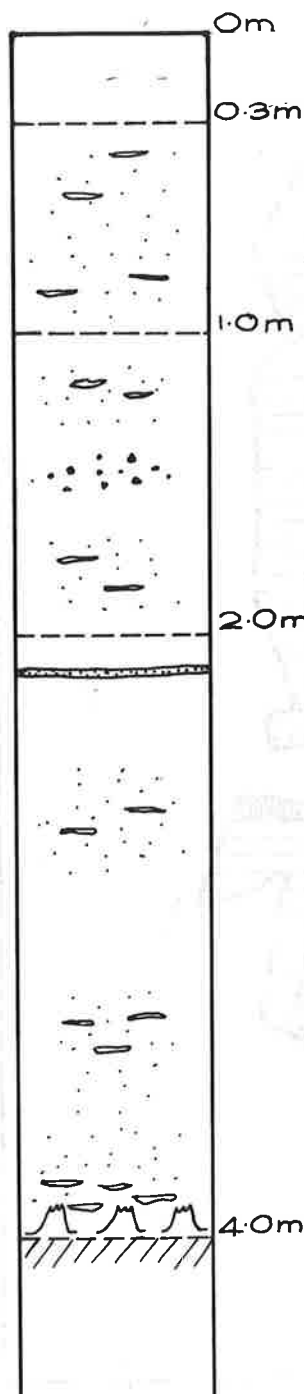
Water & soil technical publication no. 14 (1978)

Peat Composition

The composition of the peat can be divided into two:
the dome peat;

the peat of fringe areas, areas in southern lobes, and areas about the peat lakes.

Margin Peat



Mineralised peat

Schoenus brevifolius, *Baumea teretifolium*, *Dacrydium colensoi* twigs and leaves, other wood.

High mineral content, remains very fragmented, charcoal fragments, well decomposed, VP 7.

Schoenus brevifolius, *Baumea teretifolium*, *Dacrydium colensoi*, twigs and roots, other wood, some *Colorophus minor* and *Gleichenia dicarpa*. Remains very fragmented, high mineral content (up to 40%), well decomposed, VP 6-7.

Grey-green tephra (?) at 2.2m.

Fine pumiceous layers (tephra ?) down to 2.7m.

Mineral content increases with depth.

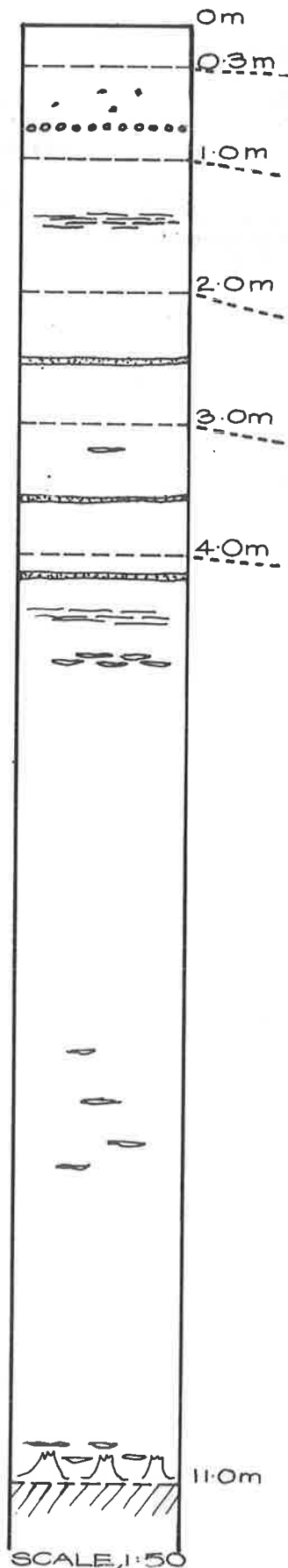
Predominantly wood peat, difficult to penetrate.

Stumps of *Podocarpus dacrydioides* and other wood at base.

Blue-green, very wet, pumiceous silt.

SCALE, 1:25

Dome Peat



Mineralised peat

Calorophus minor, *Gleichenia dicarpa*, *Schoenus brevifolius*.
Charcoal as fragments and bands.
Moderately decomposed, VP 5-6.
Pumice lapilli (Taupo Pumice) at 0.7 - 0.8m.

Calorophus minor, *Gleichenia dicarpa*, some *Schoenus brevifolius*,
some *Leptospermum scoparium* roots and fragments.
Charcoal present as fragments and bands.
Baumea teretifolium/*Schoenus brevifolius* root mat at 1.5m.
Moderately decomposed, VP 4-5.

Calorophus minor, *Gleichenia dicarpa*, *Schoenus brevifolius*, *Leptospermum scoparium* roots and fragments.
Well decomposed, VP 6.
Thin tephra (?) layer at 2.5m.

Calorophus minor, *Gleichenia dicarpa*, *Schoenus brevifolius*, seed
from *Baumea teretifolium*, some wood (unidentified).
Charcoal fragments.
Well decomposed, VP 6-7.
Tephra (?) layer at 3.5m.

Tephra (?) layer at 4.2m.

Resistant root mats of *Gleichenia dicarpa* or sedges throughout.

Wood common through profile.

Wood and stumps common above basement.

Light grey pumiceous silt, or coarse pumiceous silt, or occasionally brown clay.

16. MOANATUATUA

Location

15.5km south-east of Hamilton and 8.5km west of Cambridge (N65:882335).
Waikato Valley Authority district.

Classification

Oligotrophic, high moor, with mesotrophic margins.

Present Status

Degenerating, agricultural, although small areas are active.

Area

84.7km².

Volume

346.8 million m³.

Surface Vegetation and Landuse

The principal vegetation and landuse types are shown in Fig. 4.

- (i) Type 1: Predominantly pasture with occasional rushes. Some small areas are used for maize cropping.
- (ii) Type 2: Land in pasture with rushes, small manuka, gorse, and bracken fern; land recently broken in and littered with manuka stumps and debris; and small areas regenerating after burning.
- (iii) Type 3: The area covered by natural species, but dominated by manuka where development and drainage have influenced the peat. The vegetation comprises *Calorophus minor*, *Gleichenia Dicarpa*, *Baumea teretifolium*, *Drosera binata*, *D. spathulata*, *epacris pauciflora*, some *Sporodanthus traversii*, some low *Leptospermum scoparium*, and the liverwort *Goebelobrym unguicululum*. Close to drainage, there is taller, dense manuka and bracken fern. On open drain sides and damp ground the liverwort *Marchantia tabularis* is growing. A small area west of Wallace Road north is mined for domestic peat.

Highest Point

75.0m

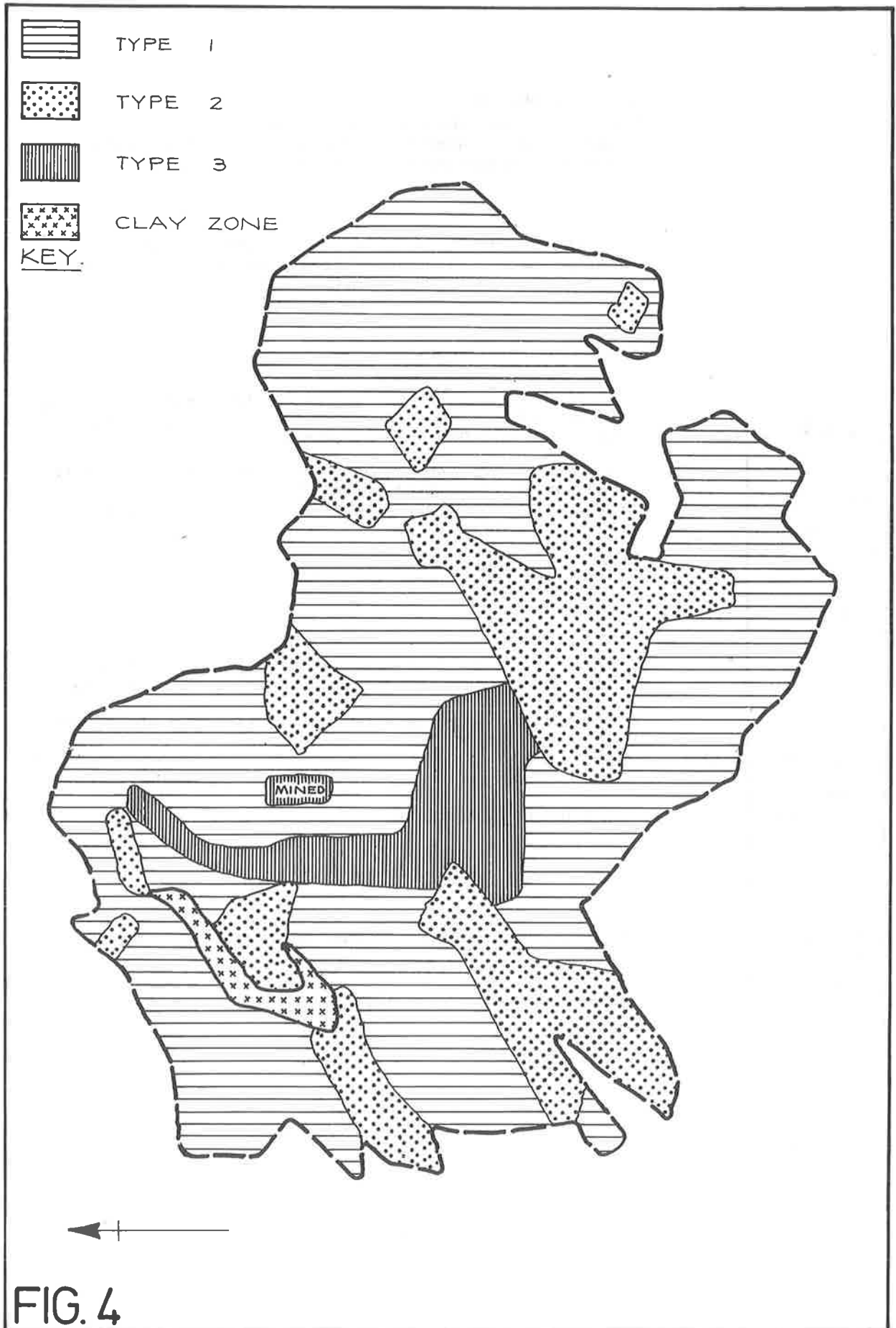
Outfall Level

- (i) Mangapiko Stream which flows into the Waipa River, and drains the southern and much of the eastern part of the swamp. The major drains flowing to the Mangapiko Stream leave the peat at N65:875246 and 899227.
- (ii) Outlets which drain into Mystery Creek and the Mangawhero Stream. These drain the northern and western parts of the swamp.

Climate

Rukuhia Climate Station.

Mean annual rainfall 1252mm
Distribution evenly over
135 raindays
Frosts 29 days
Fogs 29 days
Mean annual temperature 13.6°C
Mean January temperature 18.0°C
Mean July temperature 8.0°C



MOANATUATUA
 SURFACE VEGETATION & LAND USE

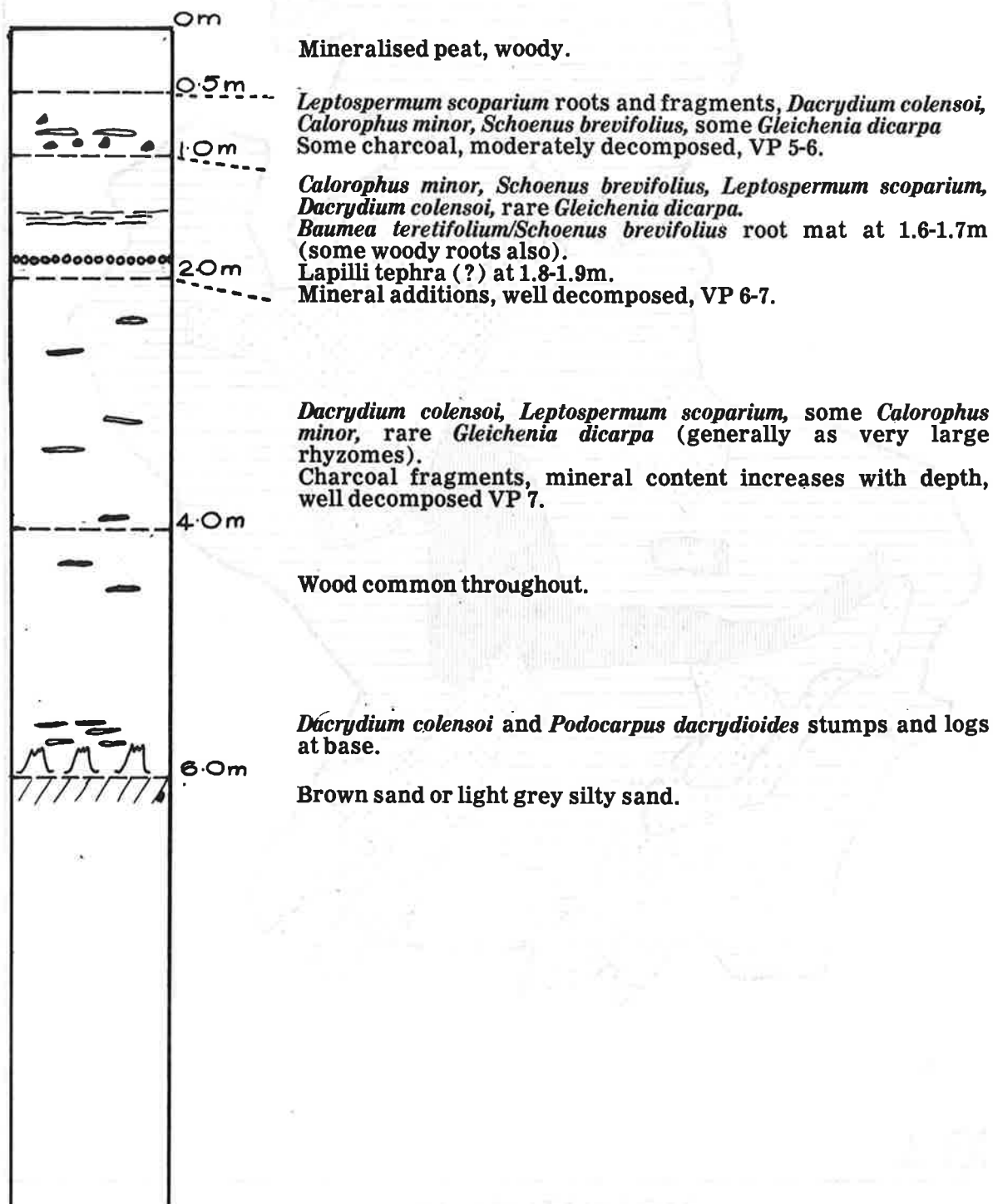
Water & soil technical publication no. 14 (1978)

Peat Composition

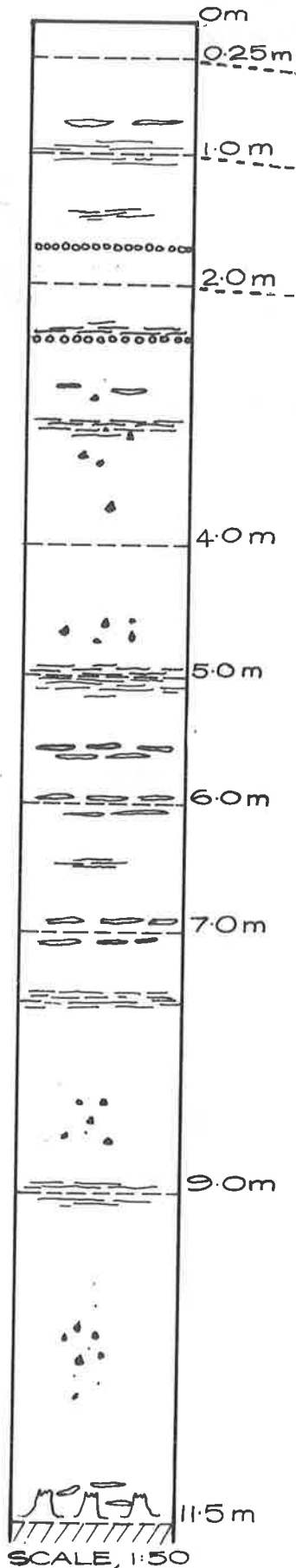
The peat is divided into two major types.

- i) higher nutrient species, found on the lagg or fringe areas;
- ii) low nutrient species as found on the dome area.

i) **Lagg Peat** The peat is mixed and occupies the marginal drainage areas in the north and south, and areas around lakes which occupy re-entrants against the western hills.



ii) Central or dome peat



Mineralised peat.

Calorophus minor, *Gleichenia dicarpa* (large rhizomes 0.5-1.0cm in diameter) *Schoenus brevifolius*, some wood (*Leptospermum scoparium* up to 1-2cm diameter), well decomposed, VP 6-7. Fibrous *Gleichenia dicarpa* mat at 0.9-1.0m.

Calorophus minor, *Gleichenia dicarpa*, some *Schoenus brevifolius*, very wet and decomposed *Leptospermum scoparium* fragments. Charcoal fragments and bands, well decomposed, VP 6-7. *Gleichenia dicarpa* (with some woody roots) at 1.6-1.7m. Lapilli tephra (?) at 1.7-1.8m.

Calorophus minor, *Gleichenia dicarpa*, *Schoenus brevifolius* (large rhizomes), some *Leptospermum scoparium* fragments, Wood content increased 2.5-3.2m. *Gleichenia dicarpa/Schoenus brevifolius* root mats at 2.3 and 3.0m. Charcoal fragments and bands, well decomposed, VP 6-7. Thin gritty layer at 2.4m (tephra?).

Root mats (*Gleichenia/Schoenus*) difficult to penetrate at 5.0, 6.5, 7.5, 9.0m.

Woody layers at 5.5, 6.0 and 7.0m.

Charcoal common throughout profile.

Stumps and/or logs common above basement.

Brown sand or grey sandy silt.

17. TARAWERA

Location

20km west of Whakatane (N68:225328).
Bay of Plenty Catchment Commission district.

Classification

Mesotrophic.

Present Status

Degenerating, agricultural.

Area

30km².

Volume

18.5 million m³.

Surface Vegetation and Landuse

Almost the entire swamp has been developed for pastoral agriculture. Some pasture has rushes present, and stumps and logs are common. A small area in the south (south of lagoons) is covered by manuka, flax, grasses and some rushes.

Peat Depth

The deepest peat occurs west of the Tarawera

River (1.0-1.7m). Elsewhere it is generally 0.2-0.5m thick.

Climate

Whakatane Climate Station.

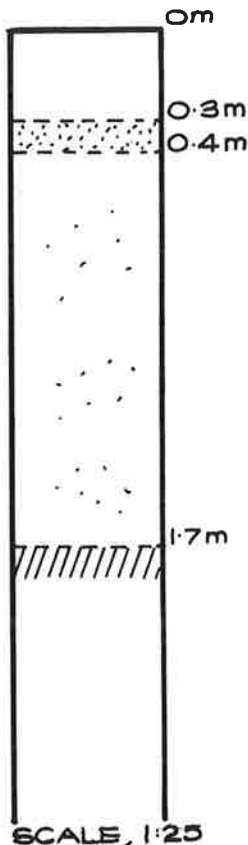
Mean annual rainfall 1304mm
Distribution even
Frosts 10-15 days
Fogs rare
Mean annual temperature 14.1°C
Mean January temperature 18.6°C
Mean July temperature 9.2°C

Source of Information

Information on the Tarawera swamp is contained in the Bay of Plenty Catchment Commission: "Rangitaiki River Major Scheme" report.

Peat Composition

The 0-0.3m mineralised peat has a silty texture resulting from the mixing of the Tarawera and Kaharoa Ash into the peat by agricultural practices.

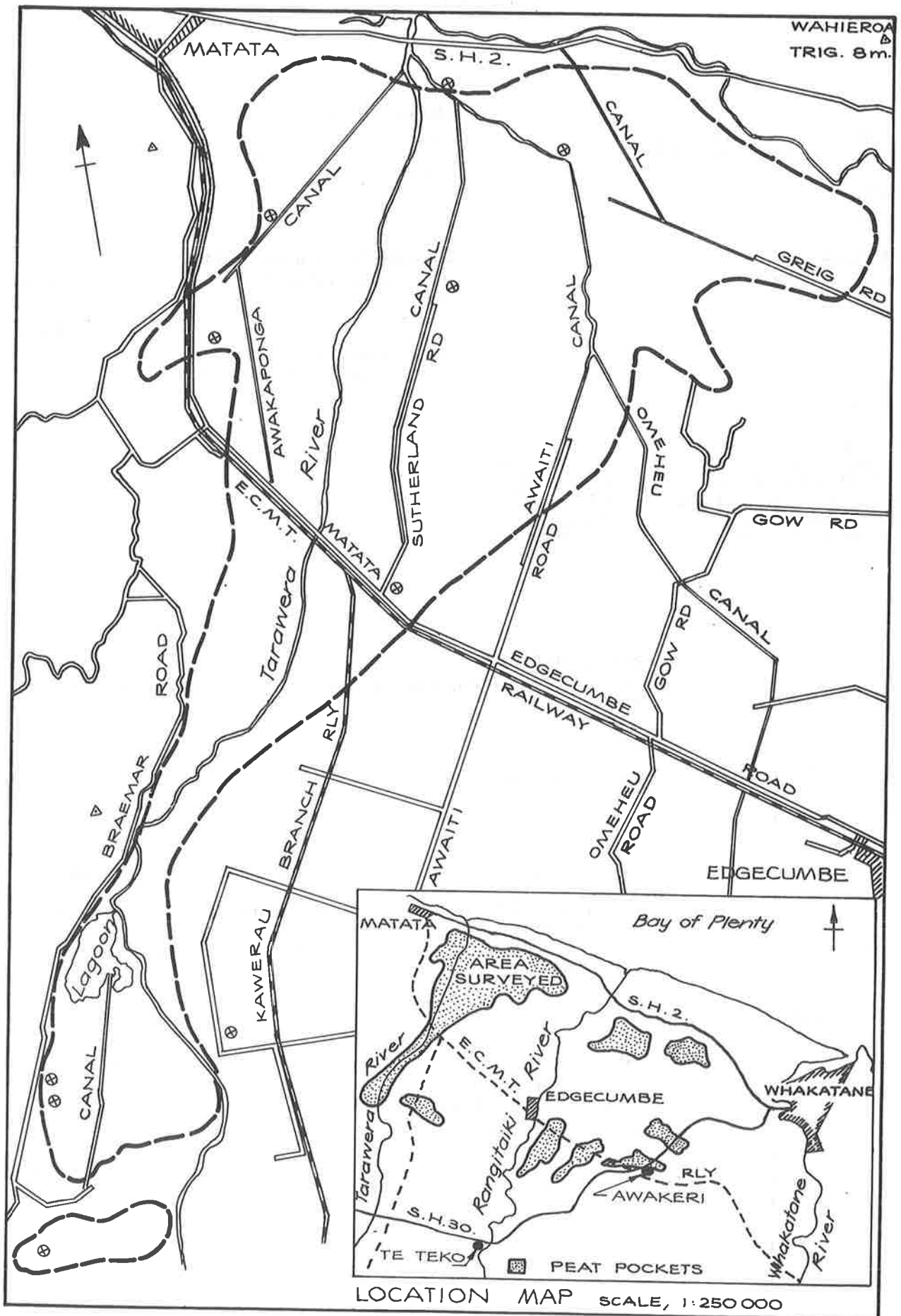


Mineralised peat.

Coarse white pumiceous silt (Taupo Pumice).

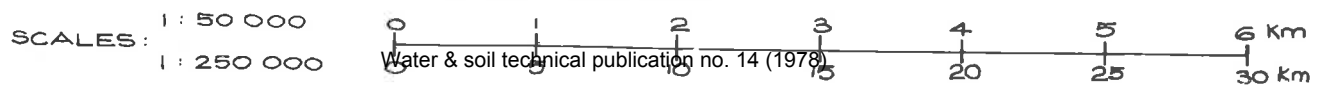
Baumea spp., some *Calorophus minor* and *Cortaderia toetoe*.
Very few recognisable plant remains and very fragmented.
Peat dry and well decomposed, VP7.
Some charcoal and gritty in places.

White or grey-brown medium sand.



TARAWERA

SCALE 1:50 000



18. POUKAWA

Location

17km south-west of Hastings (N141:142062).
Hawkes Bay Catchment Board district.

Classification

Eutrophic.

Present Status

Degenerating, agricultural.

Area

8.9 km².

Volume

25.2 million m³.

Highest Point

31m

Outfall Level

N141:142049 - 29m.

Climate

Waipukurau Climate Station.

Mean annual rainfall 824mm

Distribution even

Frosts 62 days

Fogs 9 days

Mean annual temperature 12.1°C

Mean January temperature 17.1°C

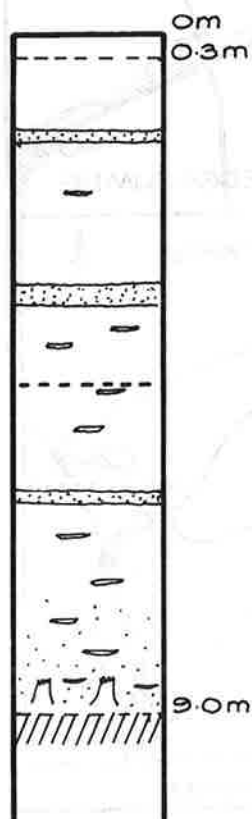
Mean July temperature 6.9°C

Surface Vegetation and Landuse

Most (approximately 90%) of the swamp is drained and developed for pastoral agriculture. A small area around Lake Poukawa is still covered by *Baumea* spp., some *Phormium tenax* close to the water's edge, and some *Calorophus minor*.

Peat Composition

Water table at 0.15m close to lake, but up to 1.2m away from lake margins.



Dry mineralised peat.

Baumea spp., *Typha angustifolia*, some *Phormium tenax* and *Calorophus minor*.

Mineral layers (tephra? or lake sediments) some charcoal close to surface.

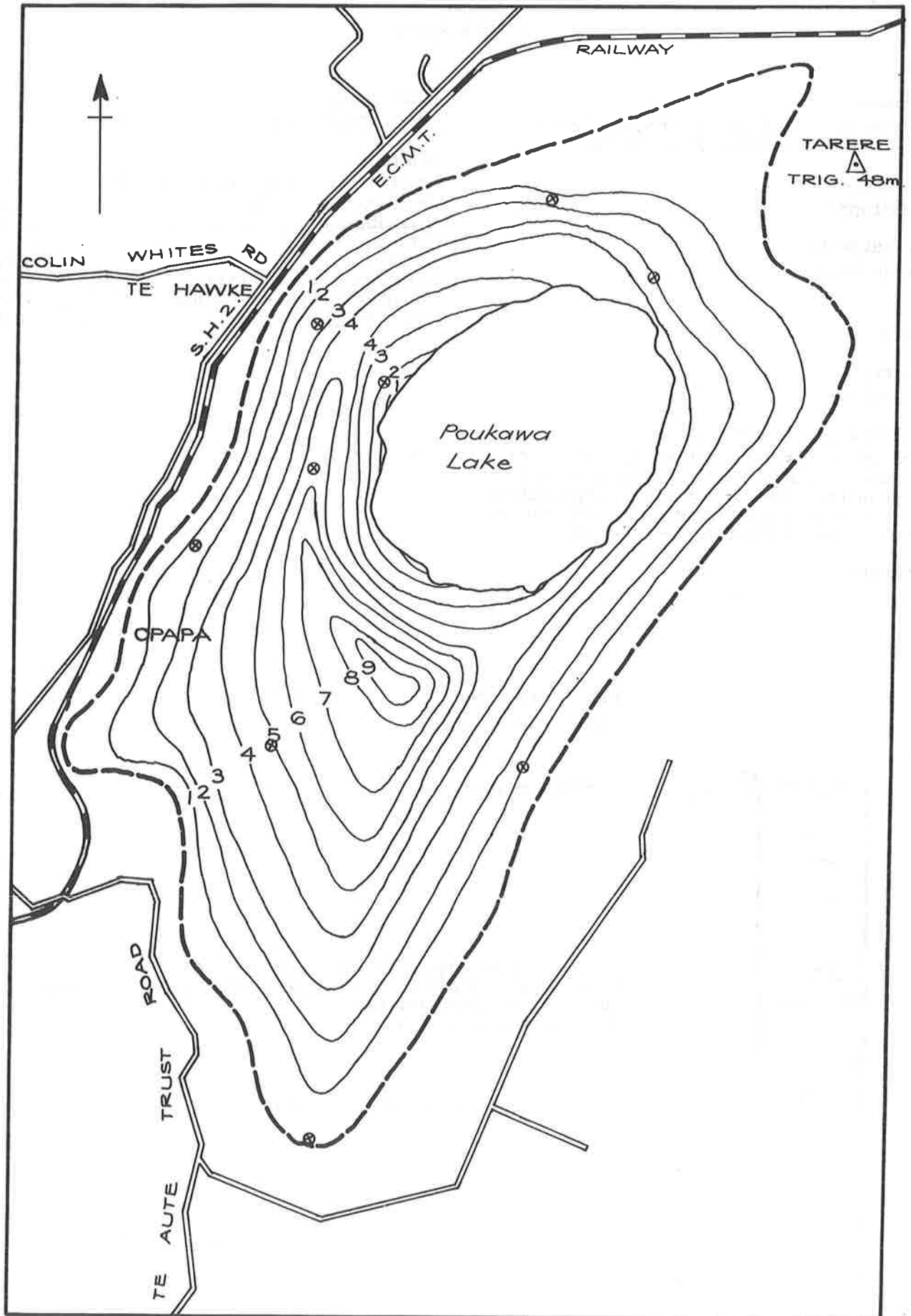
Plant remains very fragmented, well decomposed, VP 6-7. Some wood.

Baumea spp., *Calorophus minor*, some *Typha angustifolia* and *Phormium tenax*.

Wood very common, and stumps and/or logs common immediately above basement.

Silt layers (tephra? or lake sediments?), well decomposed, VP 7.

White or green silt or fine silty sand.



POUKAWA

19. TE AUTE

Location

26km south-west of Hastings (N141:075984).
Hawkes Bay Catchment Board district.

Classification

Mesotrophic.

Present Status

Degenerating, agricultural.

Area

4.6 km².

Volume

16.5 million m³.

Surface Vegetation and Landuse

Most of the swamp is developed for pastoral agriculture, but a small area is only partially developed with *Baumea spp.* and *Calorophus minor* still present. Stumps and timber debris are common over much of the developed land.

Highest Point

88m.

Outfall Level

N141:079947 - 86m.

Climate

Waipukurau Climate Station.

Mean annual rainfall 824mm

Distribution even

Frosts 62 days

Fogs 9 days

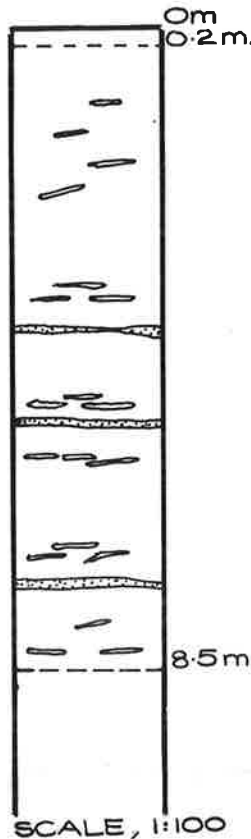
Mean annual temperature 12.1°C

Mean January temperature 17.1°C

Mean July temperature 6.9°C

Peat Composition

Water table 0.2 - 0.5m.

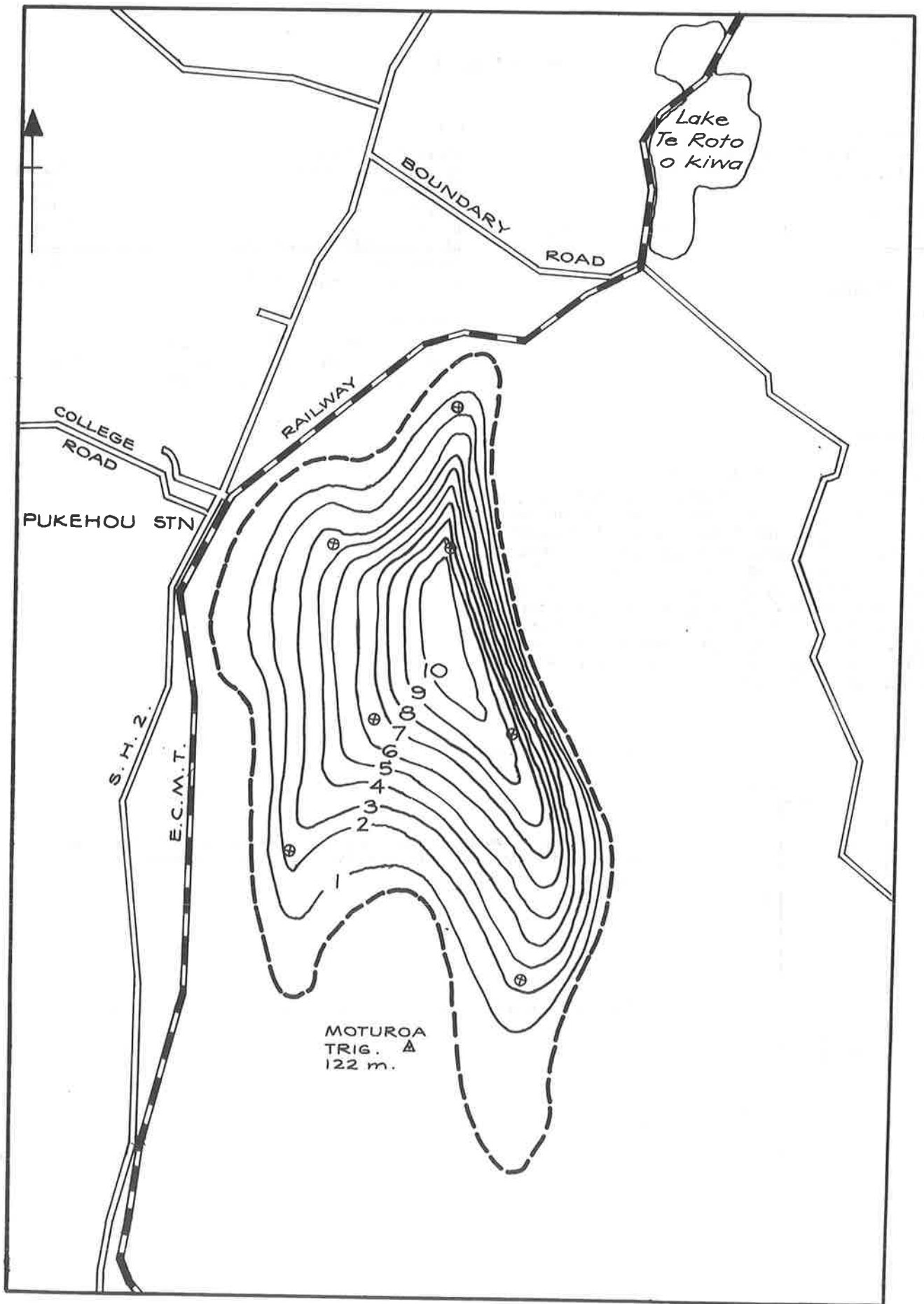


Mineralised peat.

Fibrous, *Baumea spp.*, *Calorophus minor*, some *Gleichenia dicarpa*.
Very woody. Woody/fibrous layers, difficult to penetrate,
common throughout profile.
Moderately decomposed, VP 5-6.

Some silty layers (tephra? or alluvial?).

Below 8.5m very dry, compact and could not be penetrated.



TE AUTE

SCALE , 1 : 25 000

Water & soil technical publication no. 14 (1978)

2

3 km

20. KONGAHU

Location

9km south of Karamea (S18: 550274).
Westland Catchment Board district.

Classification

Mesotrophic, with some eutrophic characteristics.

Present Status

Active.

Area

6.6 km².

Volume

11.5 million m³.

Surface Vegetation and Landuse

Most of the swamp is undeveloped, although a very small area in the north-east and on the south-west margin has been partially developed. In the north tall (up to 20m) stands of *Podocarpus dacrydioides* dominate the fringe areas. The swamp is covered by *Phormium tenax*, *Carex secta*, *Baumea* spp., some *Typha angustifolia*, with some *Gleichenia dicarpa* (often in rafts), *Sphagnum* spp. (often as mounds and rafts), and where firmer and drier, *Leptospermum scoparium*. It is very wet and with much open water.

Climate

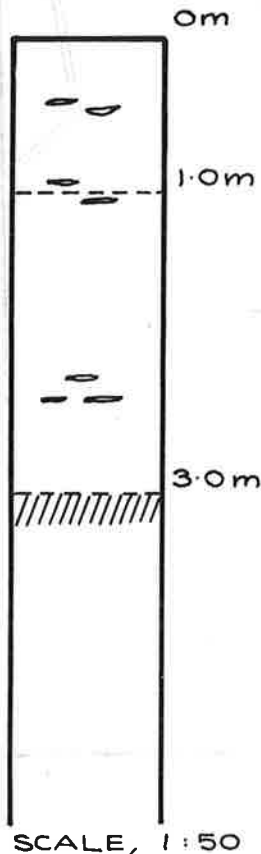
Westport Climate Station.

Mean annual rainfall	2152mm
Distribution	even
Frosts	44 days
Fogs	6 days
Mean annual temperature	12.1°C
Mean January temperature	15.8°C
Mean July temperature	7.9°C

General

The Westland Catchment Board is at present (1976-77) excavating a contour drain along the eastern flank of the Kongahu Swamp.

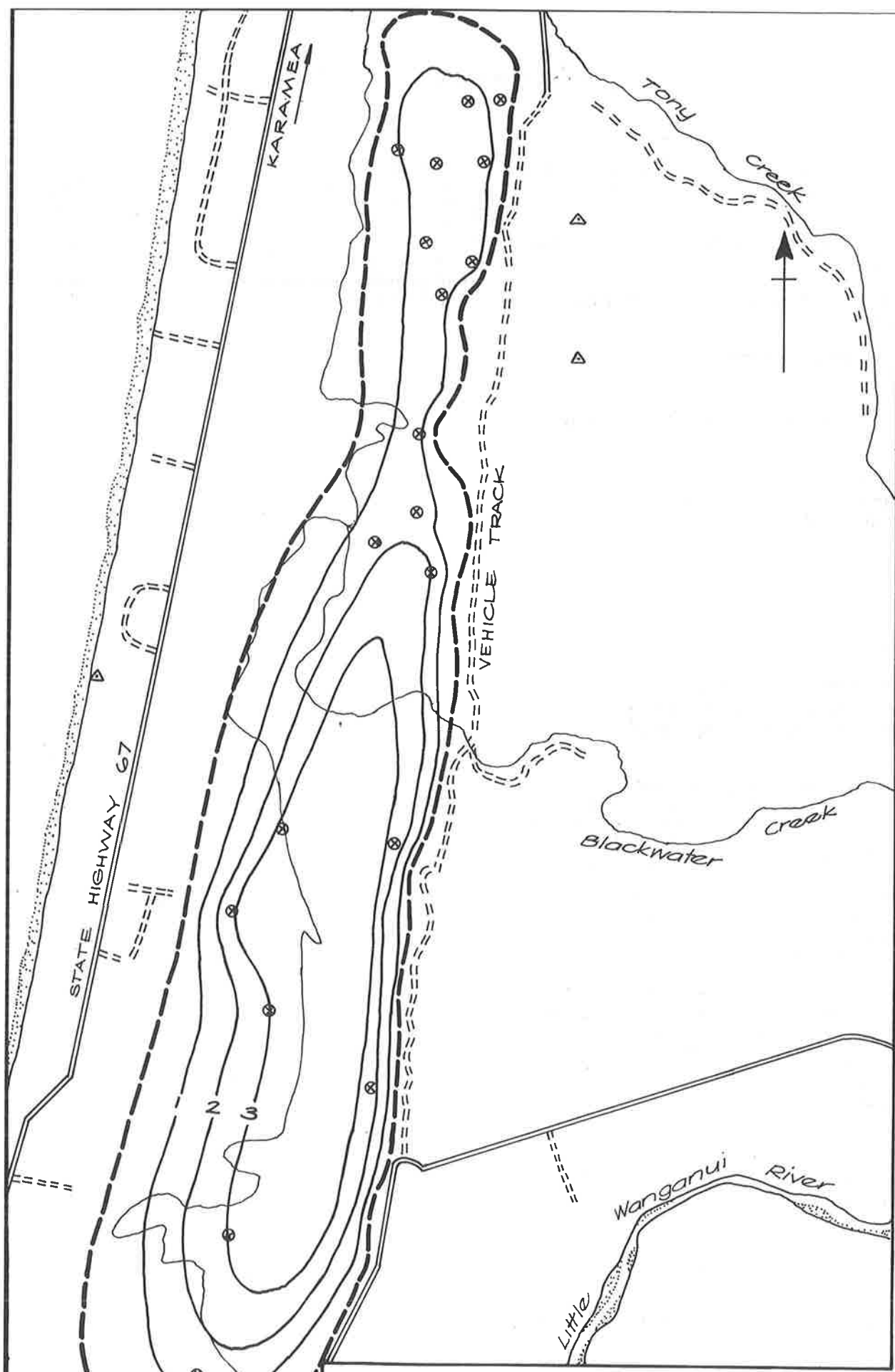
Peat Composition



Carex coriacea, *Baumea* spp., some *Gleichenia dicarpa*, and root nodules of *Podocarpus dacrydioides*. Poorly decomposed, VP 3-4. Some mineral additions.

Similar to above, but mineral content increases with depth.

Grey fine or medium sand.



KONGAHU

Water & soil technical publication no. 14 (1978)

SCALE, 1:25000

0.5 1.5km

21. KOKATAHI

Location

Kokatahi 1 is 7.5km south-east of Hokitika (S51:58505) although 90% of the peat area is on S58.

Kokatahi 2 is 8.5km south-east of Hokitika (S58:572473).

Kokatahi 3 is 11.5km south-east of Hokitika (S59:595451).

Westland Catchment Board district.

Classification

Mesotrophic, with some oligotrophic characteristics.

Present Status

Regenerating, although some areas have been extensively drained.

Area

6.6 km².

Volume

35 million m³.

Surface Vegetation and Landuse

The greater part of the 3 swamps is now dominated by regenerating peat forming species.

- (i) Kokatahi 1 is covered by regenerating *Baumea* spp., *Gleichenia dicarpa*, *Sphagnum* spp. in wetter areas, other moss species, and some introduced grasses. A small area in the north is partially developed but with extensive rushes and gorse. In the centre of the swamp there is a small, very wet, undeveloped area of *Baumea* spp., *Podocarpus dacrydioides*, *Phormium tenax*, some *Sphagnum* spp. and other mosses.
- (ii) Kokatahi 2 is covered by reverting, pasture; with regenerating *Baumea* spp., *Phormium tenax*, *Sphagnum* spp. in wetter areas, *Podocarpus dacrydioides* on the western margin, other mosses, gorse and some introduced grasses. Rushes are common where grasses and gorse are more dominant.
- (iii) Kokatahi 3 is pasture with gorse, rushes, regenerating *Baumea* spp., *Sphagnum* spp. in wetter spots, *Phormium tenax*, and other mosses.

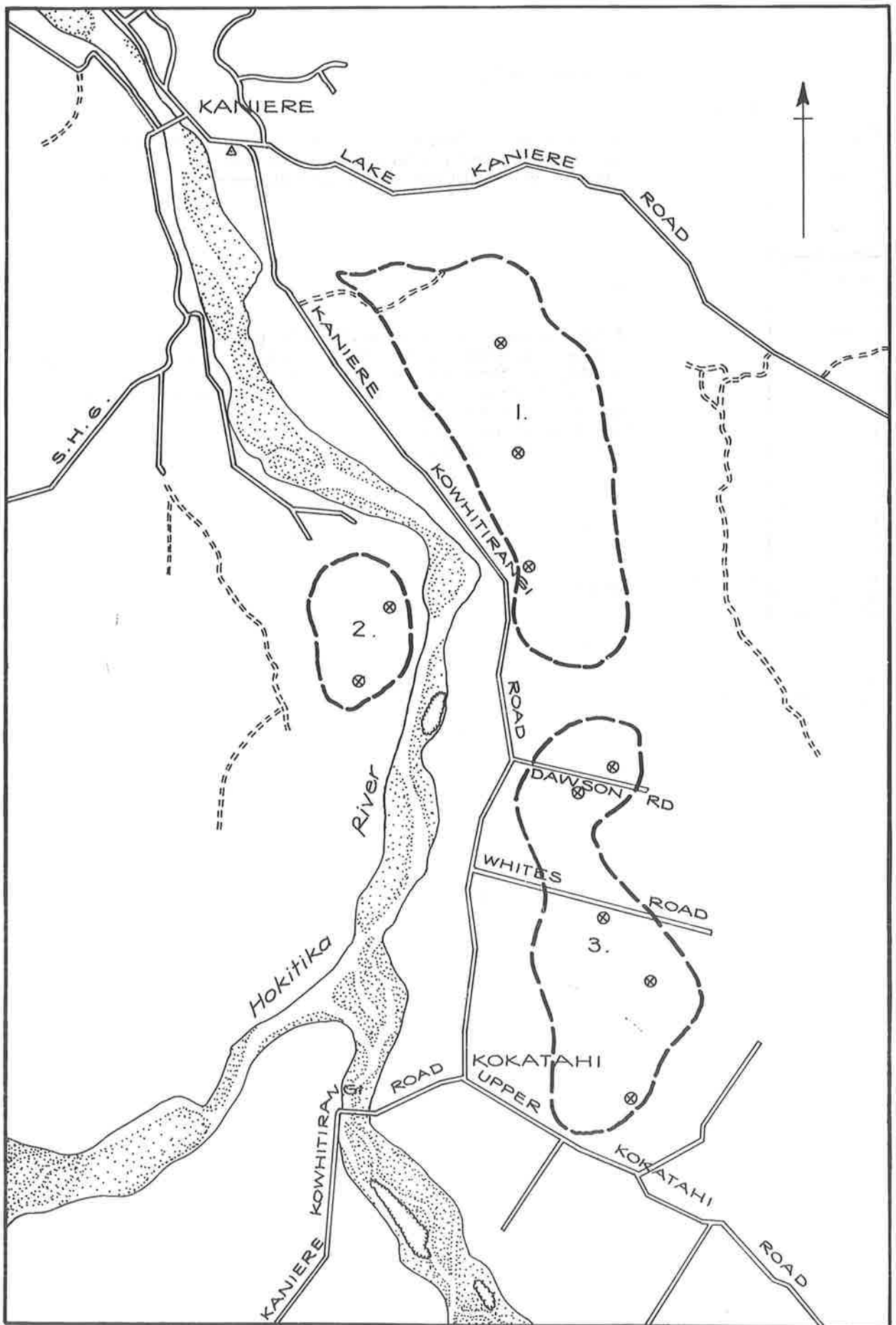
Peat Depth

Depths in excess of 6.0m were recorded in Kokatahi 1 and 3. Kokatahi 2 appears to be shallower with a maximum recorded depth of 3.0m.

Climate

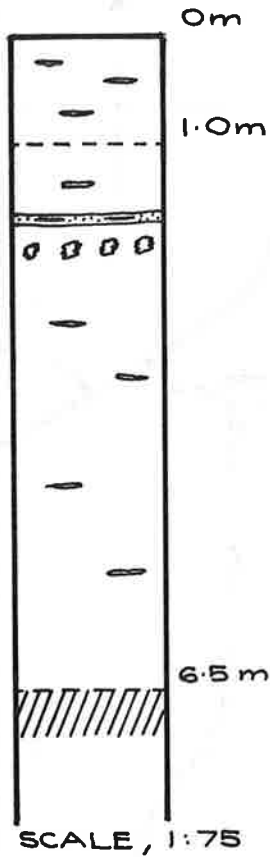
Hokitika South Climate Station.

Mean annual rainfall 2775mm
Distribution very even
Frosts 61 days
Fogs 14 days
Mean annual temperature 10.9°C
Mean January temperature 14.6°C
Mean July temperature 6.6°C



KOKATAHI

Peat Composition



Calorophus minor, *Baumea* spp., rare *Sphagnum* spp., some woody roots, rare *Gleichenia decarpa*, wood common.
Some mineral additions, poorly decomposed, VP3, very wet.

Mineral content increases with depth. Band of silt mixed with *Baumea* spp. roots. Below this is 0.1m layer of moderately decomposed *Sphagnum* spp., and *Calorophus minor*.
Plant remains predominantly *Calorophus minor*, some *Sphagnum* spp., *Dicranaloma billardieri*.
Podocarpus dactyloides common.
Very wet, moderately decomposed, VP 4-5.

Grey silt.

22. GROVES SWAMP

Location

13km south of Hokitika (S57:495422).
Westland Catchment Board district.

Classification

Mesotrophic.

Present Status

Active.

Area

6.5km².

Volume

16 million m³.

Surface Vegetation and Landuse

The swamp is undeveloped and is covered by *Baumea* spp., *Coprosma virgata*, *Juncus* spp., some *Phormium tenax*, *Sphagnum* spp., *Podocarpus dacrydioides* around the margins and shallower areas, and some *Calorophus minor* and *Gleichenia dicarpa* in drier parts.

Peat Depth

Maximum recorded thickness was 4.0m.

Climate

Hokitika South Climate Station.

Mean annual rainfall 2775mm

Distribution very even

Frosts 61 days

Fogs 14 days

Mean annual temperature 10.9°C

Mean January temperature 14.6°C

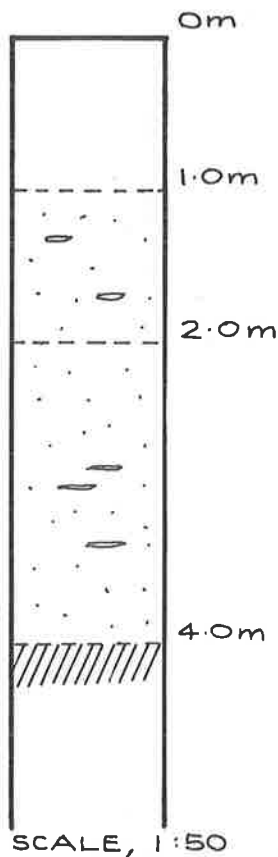
Mean July temperature 6.6°C

General

Groves Swamp is very wet, with the water table up to 0.3m above the plant surface making the swamp impassable in places. Silt and mud lines found at a height of 0.5m on plants were evidence of high flooding.

Peat Composition

Water table above or at surface.

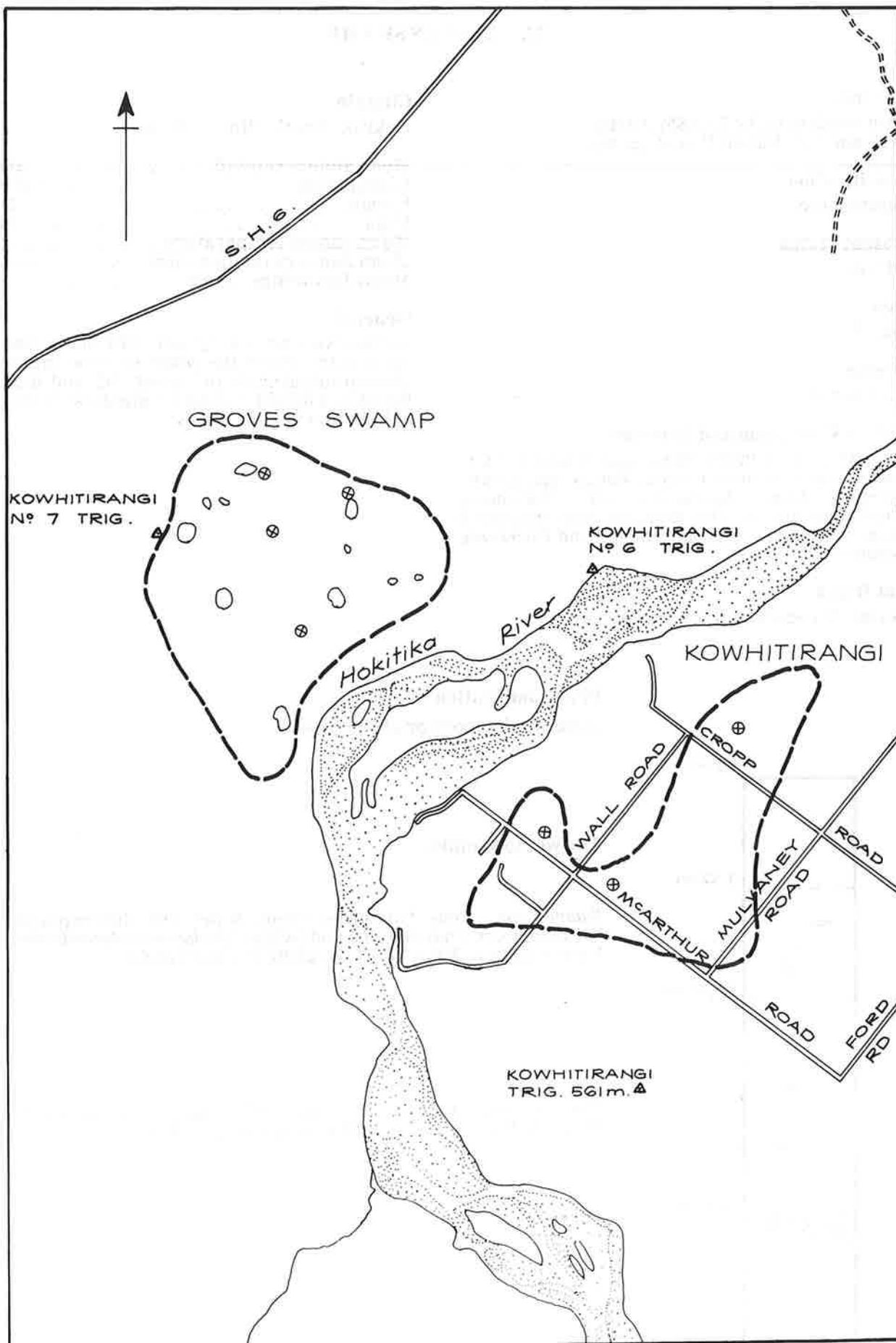


Too wet to sample.

Baumea spp., some *Calorophus minor*, some well decomposed-
Sphagnum spp., root nodules and twigs of *Podocarpus dacrydioides*.
Very wet, raw, VP 2. Grey silt addition (up to 20%).

Baumea spp., more woody roots, *Phormium tenax* fibres, in-
creasing mineral content. Poorly decomposed, VP 2.

Very wet grey silt.



GROVES SWAMP & KOWHITIRANGI

23. KOWHITIRANGI

Location

15km south of Hokitika (S58:552399) although most is on S57.
Westland Catchment Board district.

Classification

Mesotrophic.

Present Status

Degenerating, poor agricultural, but with some areas regenerating.

Area

4.5km².

Volume

4.5 million m³.

Surface Vegetation and Landuse

Most of the swamp has been cleared for development. Only small areas are now in pasture and these have extensive rushes, blackberry, some isolated kahikatea and gorse. Most of the once cleared land is now covered by regenerating *Baumea* spp., *Juncus* spp., bracken fern, *Leptospermum scoparium*, and some mounds of *Sphagnum* spp.

Peat Depth

The peat is shallow with a maximum recorded depth of 2.0m.

Peat Composition

Moderately to well decomposed (VP4-5) *Baumea* spp., *Sphagnum* spp. (well preserved to 0.3m), some *Calorophus minor*, *Gleichenia dicarpa*, with wood fragments and woody roots common, underlain by grey silt.

Climate

Hokitika South Climate Station.

Mean annual rainfall 2775mm
Distribution very even
Frosts 61 days
Fogs 14 days
Mean annual temperature 10.9°C
Mean January temperature 14.6°C
Mean July temperature 6.6°C

24. SHEARERS SWAMP

Location

29km south-west of Hokitika (S57:331314).
Westland Catchment Board district.

Classification

Mesotrophic.

Present Status

Active.

Area

2.2km².

Volume

6 million m³.

Surface Vegetation and Landuse

The swamp is undeveloped and is covered by *Baumea* spp., *Gleichenia dicarpa*, *Juncus* spp., *Calorophus minor*, *Sphagnum* spp. mounds and cushions, and low *Leptospermum scoparium*. *Podocarpus dacrydioides* is growing on the margins and shallower parts. There are considerable areas of open water.

Peat Depth

Maximum recorded depth was 3.5m.

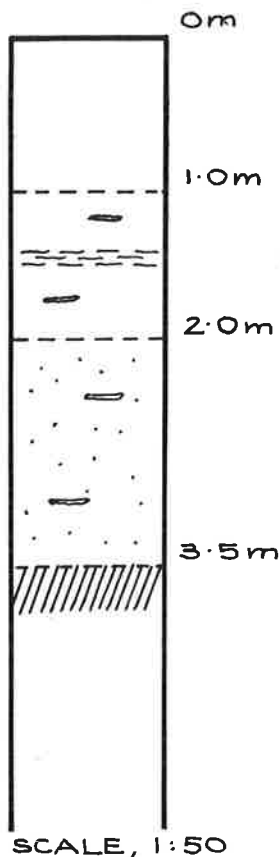
Climate

Hokitika South Climate Station.

Mean annual rainfall 2775mm
Distribution very even
Frosts 61 days
Fogs 14 days
Mean annual temperature 10.9°C
Mean January temperature 14.6°C
Mean July temperature 6.6°C

Peat Composition

Water table at or above surface.

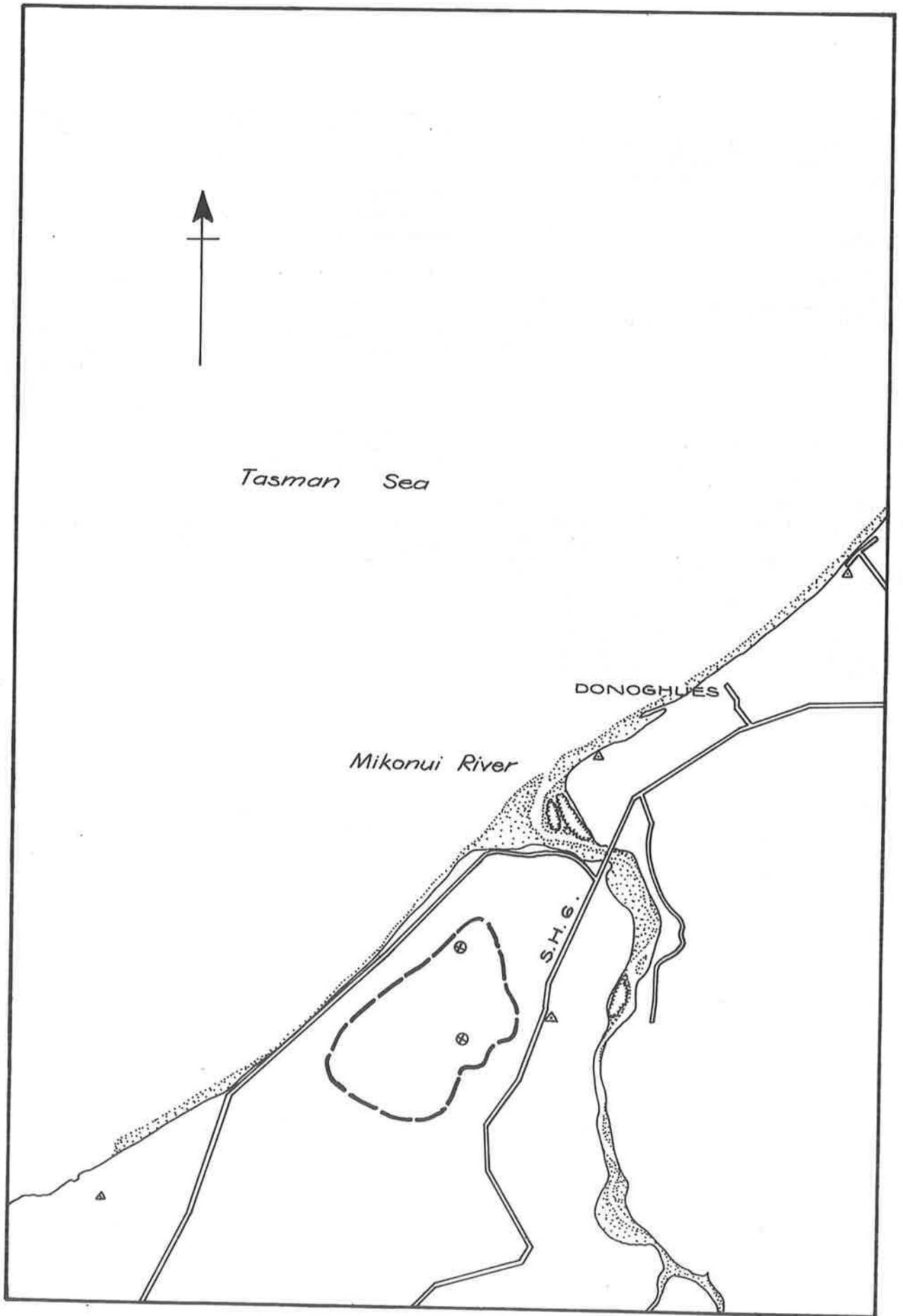


Too wet to sample.

Baumea spp., *schoenus brevifolius*, *Calorophus minor*, some *Sphagnum* spp., some *Gleichenia dicarpa*, large leaves of *Nothofagus truncata*, root nodules of *Podocarpus dacrydioides*.
Very wet and raw, VP2.
Layer of leaves (*Nothofagus truncata*) at 1.4m.

Similar to above, but with some *Phormium tenax* fibres.
Mineral content increases with increasing depth.
Poorly decomposed, VP 2-3. Very wet.

Coarse brown sand in west and blue-grey silt in eastern areas.



SHEARERS SWAMP

SCALE , 1 : 50 000

Water & soil technical publication no. 14 (1978)

0 1 2 3 4 5 6 km

Location

20km north-east of Bruce Bay (S78:516539 - grid reference of southern most point).
Westland Catchment Board district.

Classification

Mesotrophic.

Present Status

The southern part is degenerating but has some regenerating areas. The northern part is active.

Area

5km².

Volume

No estimate of peat volume was made.

Surface Vegetation and Landuse

The southern lobe of peat i.e. south of access track, has been partially drained and developed, but the pasture has mosses, rushes, some manuka and gorse. To the north of the access track the swamp is covered by regenerating *Carex secta*, *Chionochloa rubra*, some surface *Sphagnum spp.* and *Juncus spp.* To the north of the northernmost sampling position, the swamp is undeveloped and covered by *Phormium tenax*, *Chionochloa rubra*, *Carex secta*, *Gahnia rigida*,

mounds of *Sphagnum spp.*, *Leptospermum scoparium*, *Coprosma colensoi*, *Dracophyllum longifolium* and some fern species.

Peat Depth

The peat is shallow with a maximum recorded depth of 2.2m.

Climate

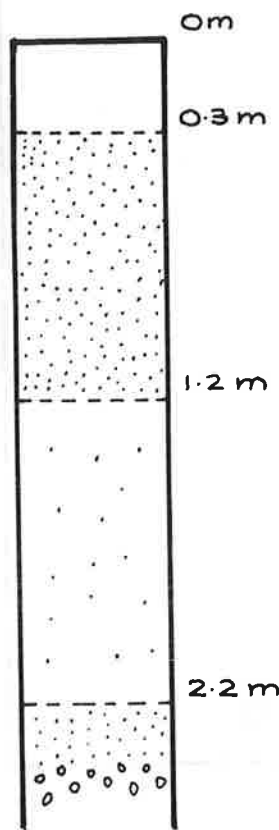
Haast Climate Station.

Mean annual rainfall	3470mm
Distribution	evenly over 175 raindays
Frosts	59 days
Fogs	5 days
Mean annual temperature	10.9°C
Mean January temperature	14.3°C
Mean July temperature	7.0°C

General

Access to the northern part of the swamp was not possible and no information about the peat is available.

Peat Composition

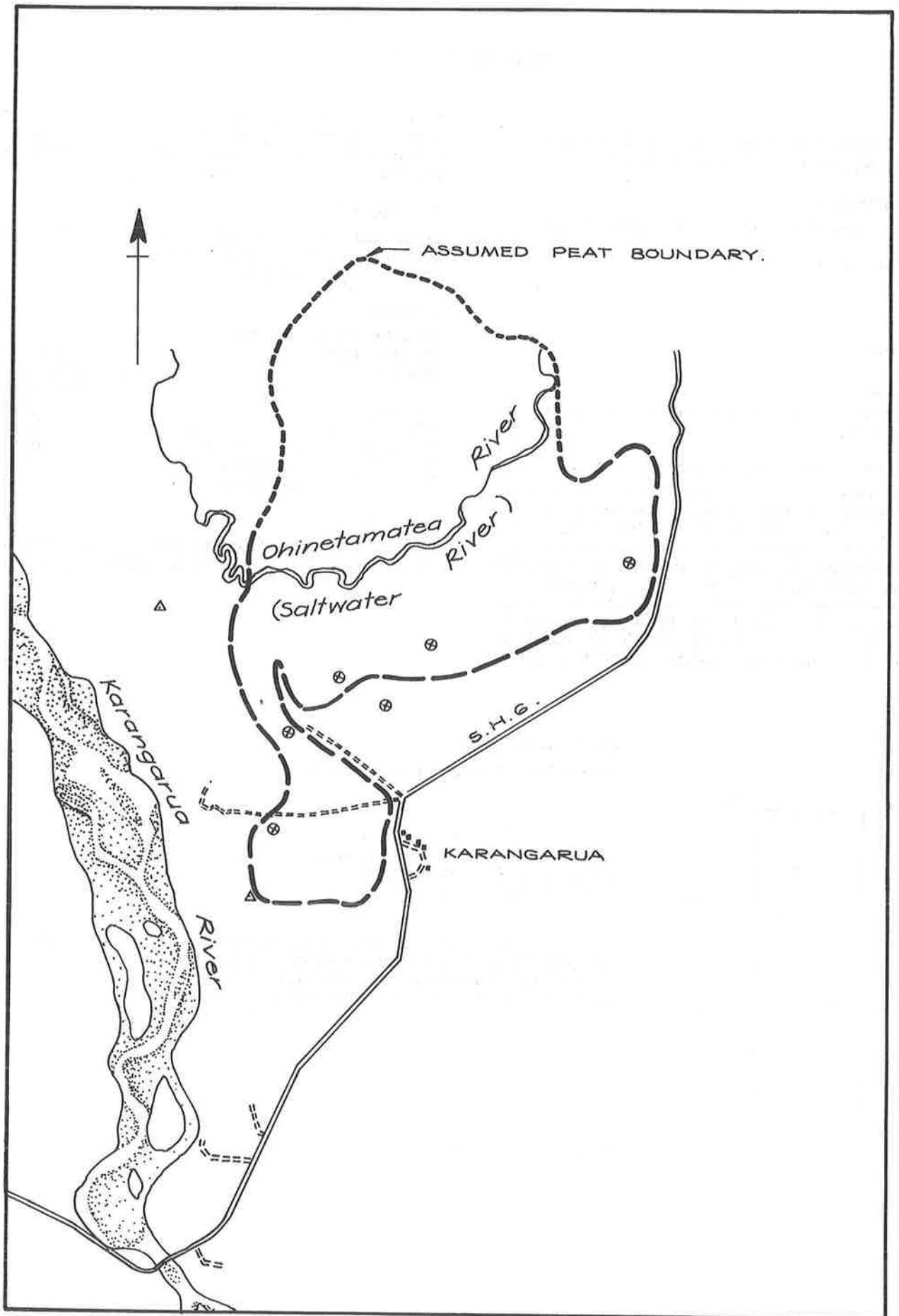


Carex spp., *Phormium tenax* fibres, some *Sphagnum spp.*, woody roots and root nodules of *Podocarpus dacrydioides*. Poorly decomposed, VP 2-3.

Grey sand or silty sand (micaceous).

Poorly decomposed *Carex spp.*, woody roots, *Phormium tenax* roots, wood fragments. Increasing mineral content. Peat often compressed and relatively dry.

Grey silt or silty sand overlying gravels.



OHINETAMATEA

SCALE, 1:50 000

Water & soil technical publication no. 14 (1978)

0 1 2 3 4 5 6 km

26. KINI SWAMP

Location

4.5km north-east of Bruce Bay (S78:353482).
Westland Catchment Board district.

Classification

Oligotrophic with some mesotrophic features.

Present Status

Active.

Area

12.5km².

Volume

No estimate of volume owing to insufficient sample sites.

Surface Vegetation and Landuse

The swamp is characterised by Lake Kini and by numerous other ponds and areas of open water. The vegetation is dominated by *Calorophus minor*, *Gleichenia dicarpa*, with some *Baumea teretifolium*, and mosses, especially *Campylopus kirkii*. There are patches of *Leptospermum scoparium* and *Phormium tenax*. *Podocarpus dacrydioides* is growing around the margins and as isolated stands on shallower peat. The vegetation tends to form extensive

rafts between very wet spongy ground, ponds and channels of open water. The water of the ponds and channels was very clear with the bottom covered by a pink-grey mud.

Peat Depth

Over the area sampled the peat was approximately 1.5 - 2.0m thick, with a maximum recorded depth of 4.6m.

Climate

Haast Climate Station.

Mean annual rainfall 3470mm
Distribution evenly over
175 raindays

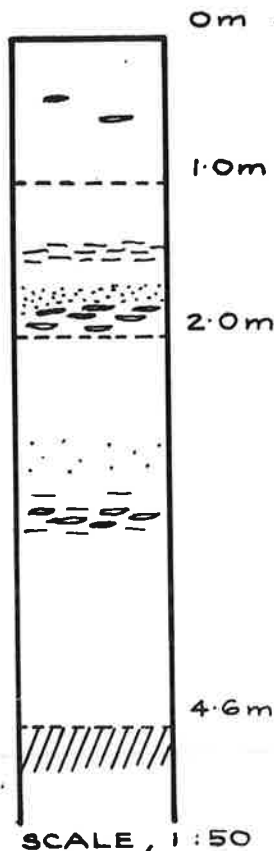
Frosts 59 days
Fogs 5 days
Mean annual temperature 10.9°C
Mean January temperature 14.3°C
Mean July temperature 7.0°C

General

Extensive areas of ponds and channels of open water prevented access to the southern part.

Peat Composition

Water table 0-0.1m, or above surface.



Very wet, difficult to sample.

Calorophus minor, *Gleichenia dicarpa*, *Baumea spp.*, woody roots, occasional *Phormium tenax* fibres.
Poorly decomposed, VP2.

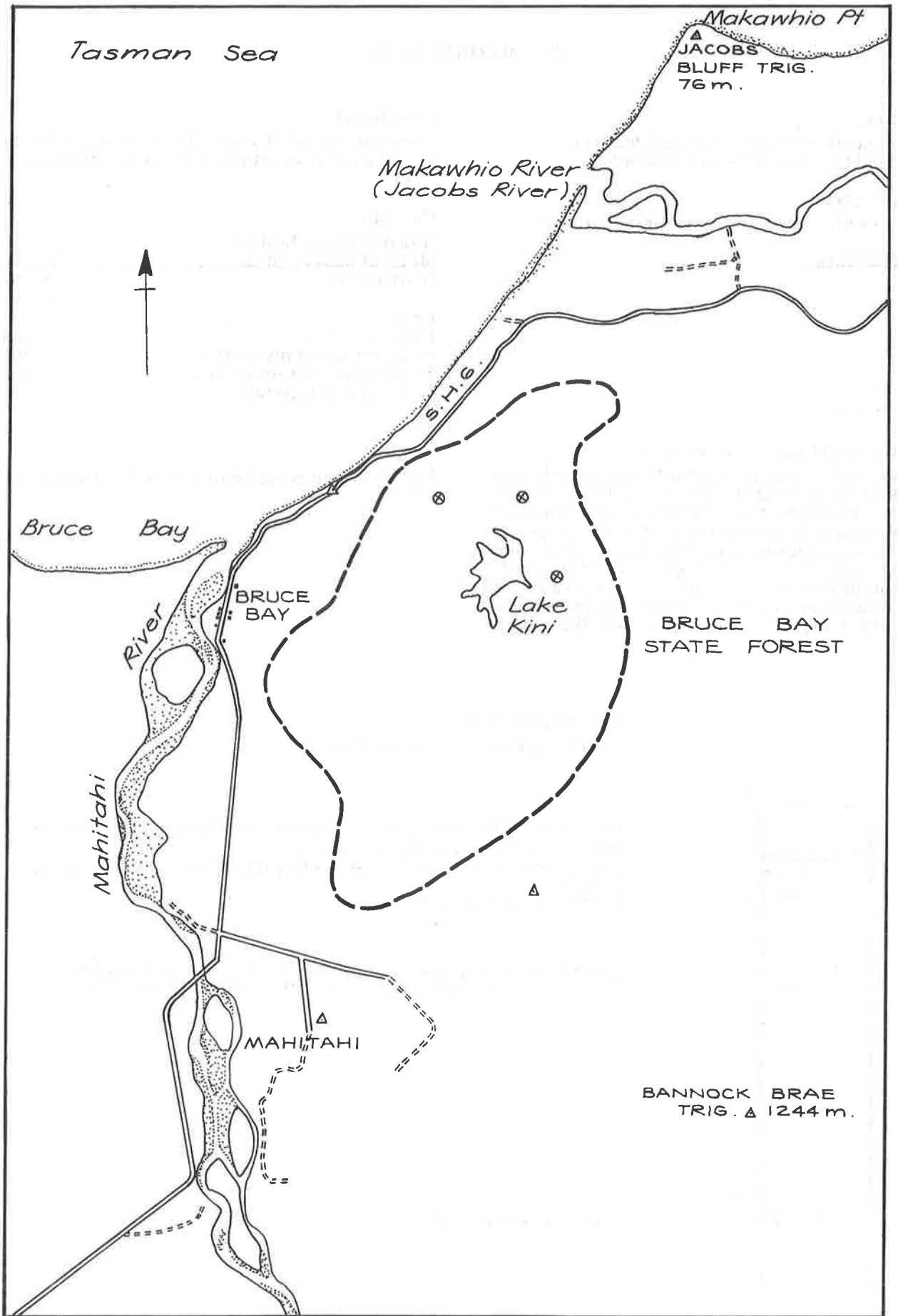
Calorophus minor, *Baumea spp.*, some *Sphagnum spp.*, many roots and root nodules of *Podocarpus dacrydioides*.

Baumea spp./Gleichenia dicarpa root mat at 1.5m.

Grey silt at 1.7m, poor to moderately decomposed, VP 3-4.

Woody/fibrous layer at 3.2m.

Grey-green or brown sand or sandy silt.



KINI SWAMP

SCALE, 1:50 000

0 1 2 3 4 5 6 km

Water & soil technical publication no. 14 (1978)

27. MAORI LAKES

Location

11.5km north-east of Haast (S87:903214).
Westland Catchment Board district.

Classification

Mesotrophic, with some eutrophic features.

Present Status

Active.

Area

29.5km².

Volume

73 million m³.

Surface Vegetation and Landuse

The swamp is undeveloped and has considerable areas of lakes (Maori Lakes), ponds and open water. The vegetation is *Baumea* spp., *Carex* spp., *Leptospermum scoparium* (up to 3m tall), *Coprosma* spp., *Phormium tenax*, some *Chionochloa rubra* and *Juncus* spp. Isolated *Cordyline australis* and *Podocarpus dacrydioides* grow on the margins and as isolated stands within the swamp. *Dicranoloma* spp., and *Campylopus* spp. dominate the ground layer.

Peat Depth

Over the sampled area, the peat was 1.5 - 2.5m deep, with a maximum recorded thickness of 3.7m.

Climate

Haast Climate Station.

Mean annual rainfall 3470mm

Distribution even over
175 raindays

Frosts 59 days

Fogs 5 days

Mean annual temperature 10.9°C

Mean January temperature 14.3°C

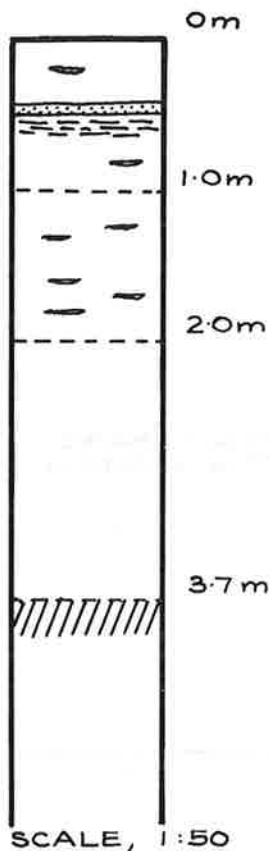
Mean July temperature 7.0°C

General

A boat was necessary to reach the investigation sites.

Peat Composition

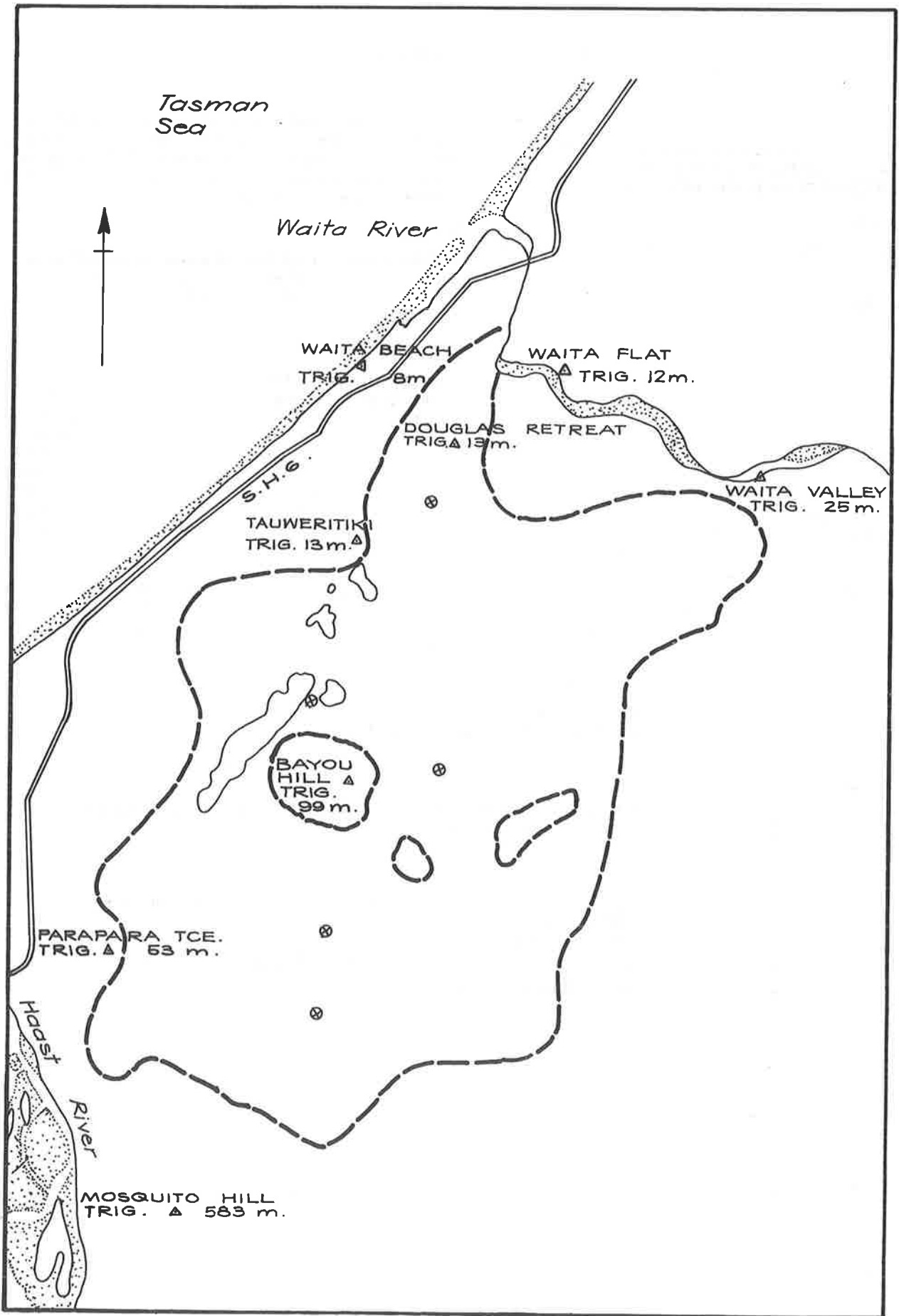
Water table at or above surface.



Very wet, difficult to sample. *Baumea* spp., *Carex* spp., some root nodules of *Podocarpus dacrydioides*.
2cm band grey silt at 0.5m, dense fibrous *Baumea/Carex* root mat at 0.6m.
Poorly decomposed, VP2.

Baumea spp., *Carex* spp., more wood and woody roots than above.
Mineral content increasing, moderately decomposed, VP3.

Grey or grey-blue silt.



MAORI LAKES

SCALE, 1:50 000

0 1 2 3 4 5 6 km
Water & soil technical publication no. 14 (1978)

28. CARTERS MILL

Location

13km south-west of Haast (S86:695044 although about one third of the swamp is on S97).
Westland Catchment Board district.

Classification

Oligotrophic, with some mesotrophic characteristics.

Present Status

Active.

Area

26km².

Volume

52 million m³.

Surface Vegetation and Landuse

The swamp is undeveloped, with a surface water table, ponds and considerable areas of open water. The vegetation comprises *Calorophus minor*, *Gleichenia dicarpa*, *Baumea* spp., *Lepidospermum scoparium*, *Dracophyllum longifolium*, some *Juncus* spp., isolated *Phormium tenax* and *Chionochloa rubra*, and a ground cover dominated by *Campylopus* spp.

The margins and isolated patches within the swamp support *Podocarpus dacrydioides*, *Dacrydium colensoi* and tussocks of *Gahnia rigida*. The vegetation on the open swamp tends to form dense and extensive rafts.

Peat Depth

Range from 1.5 - 4.5m; shallowest in the centre and western sections; and deepest in the east, where the maximum thickness of 4.5m was recorded.

Climate

Haast Climate Station.

Mean Annual rainfall..... 3470mm
Distribution..... evenly over
175 raindays

Frosts..... 59 days

Fogs..... 5 days

Mean annual temperature..... 10.9°C

Mean January temperature..... 14.3°C

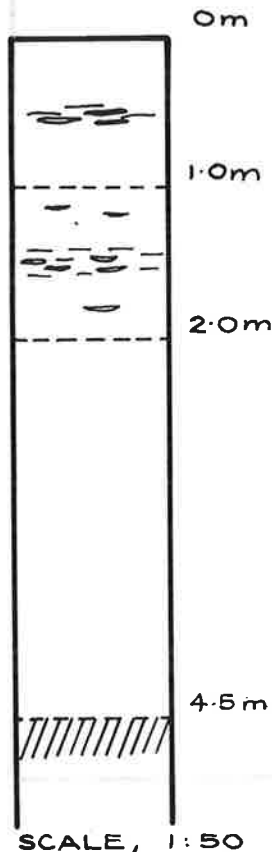
Mean July temperature..... 7.0°C

General

The peat deposit north of the Turnbull River has the same surface vegetation and peat composition as Carters Mill. Peat thickness recorded is 3.0m.

Peat Composition

Surface or above surface water table.

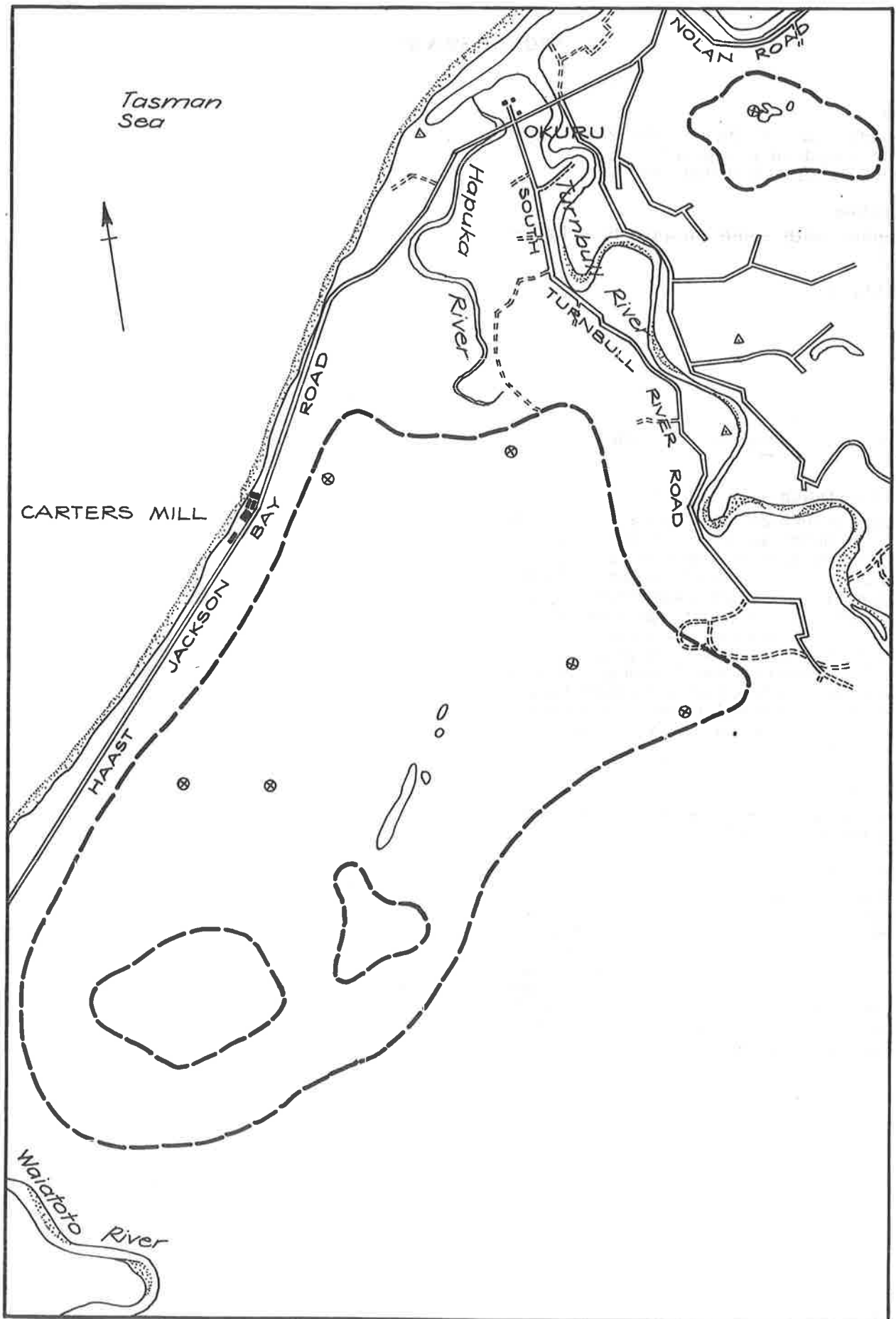


Too wet for satisfactory sampling. *Calorophus minor*, *Gleichenia dicarpa*, *Baumea* spp and woody roots.
Very raw, VP 1-2.

Calorophus minor, *Gleichenia dicarpa*, some *Baumea* spp., and roots and root nodules of *Podocarpus dacrydioides*.
Very wet, poorly decomposed, VP2.
Woody/fibrous (*Gleichenia dicarpa*/*Baumea* spp.) mat at 1.5m, difficult to penetrate.

No samples.

Grey, or grey-brown, silty or fine sand.



CARTERS MILL

SCALE, 1 : 50 000

Water & soil technical publication no. 14 (1978)



29. SPONGE SWAMP

Location

31km south-west of Haast (S97:602910 grid reference of western most point).
Westland Catchment Board district.

Classification

Oligotrophic, with some mesotrophic characteristics.

Present Status

Active.

Area

3.5km².

Volume

No estimate of peat volume was made.

Surface Vegetation and Landuse

The swamp is undeveloped, with a near surface water table, ponds and channels of open water. The vegetation forming rafts or mounds is *Calorophus minor*, *Gleichenia dicarpa*, *Baumea teretifolium*, *Dracophyllum longifolium*, some *Leptospermum scoparium*, and a ground cover of the mosses *Dicranatoma billardieri*, and *Campylopus introfleyus*, especially in water filled hollows. The banks of Dismal Creek are lined by *Leptospermum scoparium*, *Podocarpus dactyloides*, some *Dacrydium colensoi*, *Leptospermum scoparium*, and tussocks of *Gahnia rigida* dominate the swamp margins.

Peat Depth

The peat is 2.5 - 4.0m thick, with a maximum recorded thickness of 5.5m.

Climate

Haast Climate Station.

Mean annual rainfall 3470mm

Distribution..... evenly over
175 raindays

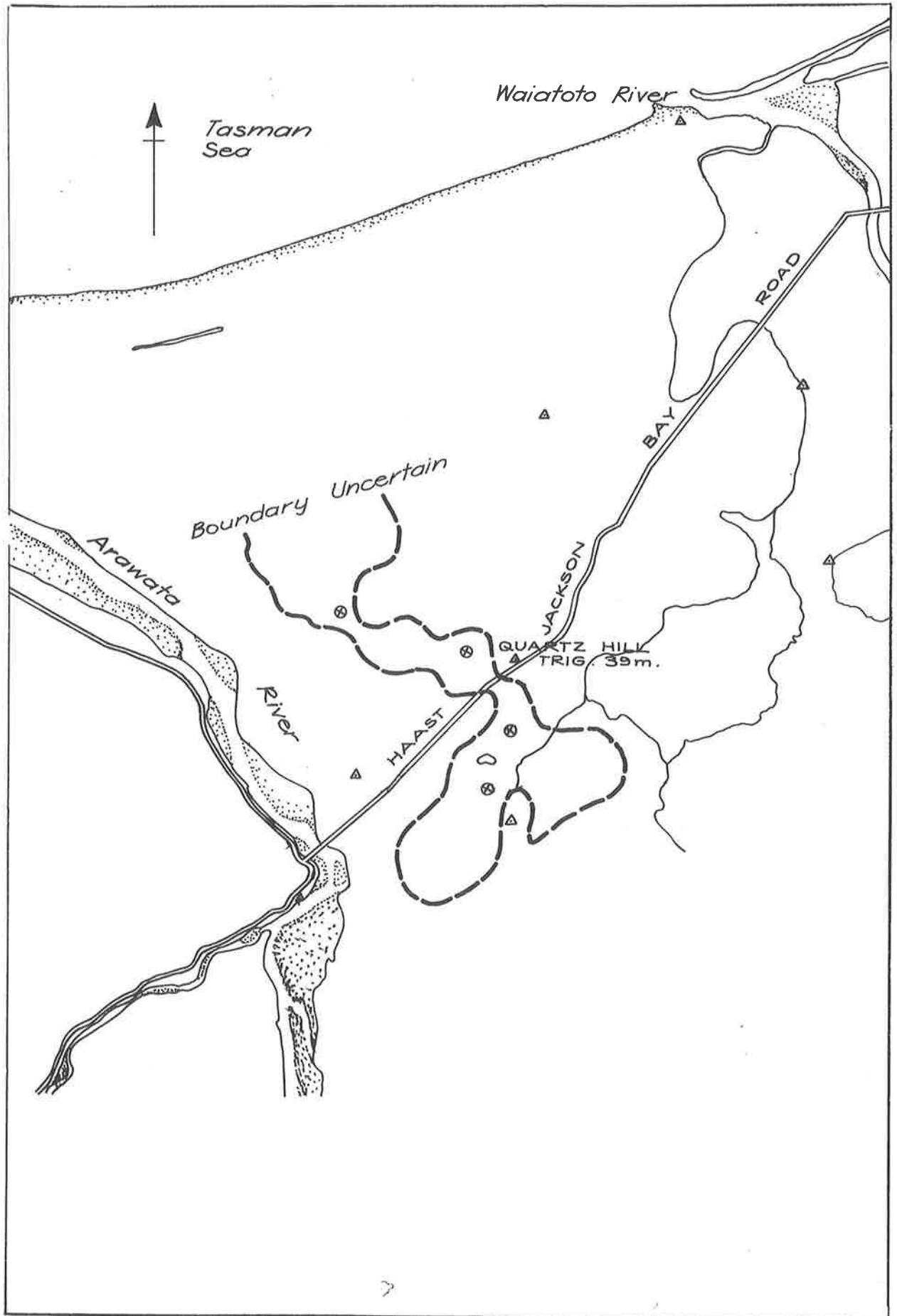
Frosts..... 59 days

Fogs..... 5 days

Mean annual temperature 10.9°C

Mean January temperature..... 14.3°C

Mean July temperature 7.0°C



SPONGE SWAMP

SCALE, 1:50 000

Water & soil technical publication no 214 (1978)

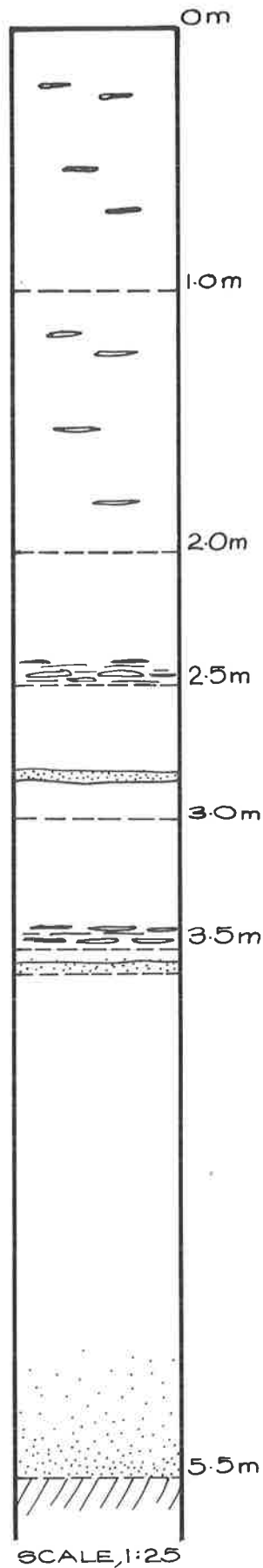


SPONGE SWAMP



Peat Composition

Surface or above surface water table.



Very wet, difficult to sample.
Calorophus minor and *Gleichenia dicarpa*.
Some wood and woody roots.
Poorly decomposed, VP 1-2.

Calorophus minor, *Gleichenia dicarpa*, *Baumea spp.*, roots and root nodules of *Podocarpus dacrydioides*.
Very wet, poorly decomposed, VP2.

Woody/fibrous (probably *Gleichenia/Baumea*) root mat at 2.5m.

Grey silt layer at 2.9m, 1cm thick.

Gleichenia/wood layer, moderately decomposed, VP 3-4, at 3.5m.
Grey silt/sedge layer at 3.6m.

Increasing silt content (with *Baumea spp.* and *Carex spp.*) with increasing depth.

Grey or blue-grey silt.

30. OLD MAN RANGE

Location

31 km south-west of Alexandra (S143:993218-map reference of Trig D, 1348m).

The peats occur in small gullies or as blankets covering long slopes. Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active.

Surface Vegetation and Landuse

The vegetation comprises *Sphagnum* spp., a dense mat of mosses, grass species, *Carpha alpina*, *Carex* spp., and *Baumea* spp. On the slopes, the vegetation includes *Gaimardia* spp., *Euphrasia zelandica* and *Herpolirion novae-zelandiae*, with *Chionochloa rubra* in drier areas.

Peat Depth

The depth varies from 1.0-1.5m at gully heads, decreasing to 0.2-0.5m down gully. The peat on the slopes varies from 0.2-0.3m on convex slopes, to 1.0m on concave slopes.

Peat Composition

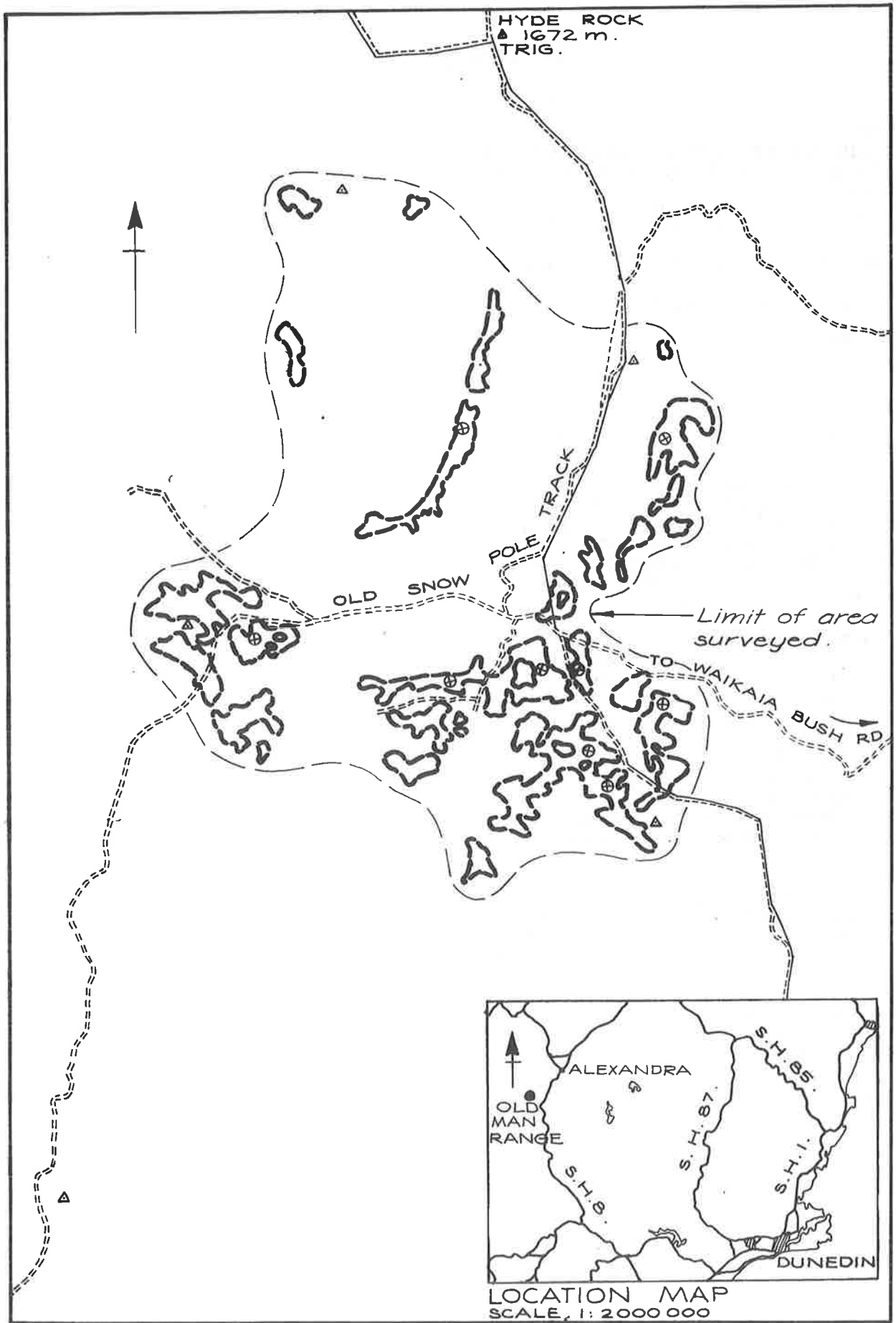
The gully peat is very fibrous, moderately decomposed (VP4) sedges with some *Sphagnum* spp. The peat on the slopes is poorly decomposed (VP2-3) *Sphagnum* spp., with some sedge remains. The peats are underlain by bedrock.

Climate

Data are from:

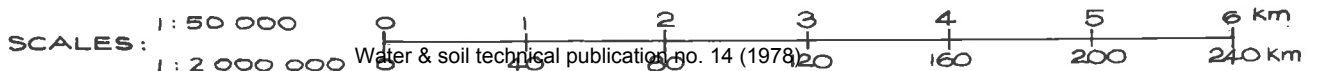
Mark, A. L. 1965. Vegetation and Mountain Climate. In "Central Otago" (Eds Lister, R. G. and Hargreaves, R. P. p69-91).

Mean annual rainfall	1335mm
Distribution	27 to 63%
	raindays/ month
Fogs	38-76% of the days/ month
Snowfalls	2-40% of the days/ month, with a May maxima
Mean annual temperature	3.4°C
Mean January temperature	7.7°C
Mean July temperature	-3.3°C



OLD MAN RANGE

SCALE 1:50 000



31. LONG VALLEY

Location

25km south-east of Alexandra on the south Rough Ridge Range (S144:489307-map reference for trig N, 1164m).

The peat occurs as numerous small deposits along a ridge and as a continuous deposit in the valley of Long Valley Stream. The ridge and valley deposits are at altitudes of 1050-1170 m and 825m respectively.

Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Ridge peats are active, valley peat is degenerating.

Surface Vegetation and Landuse

- (i) The ridge peats are dominated by *Sphagnum* spp., with other mosses, *Carpha alpina*, *Baumea* spp. and *Chionochloa rubra*.
- (ii) The valley peat is covered by grasses, mosses, tussock, isolated *Sphagnum* spp., and some surface water.

Peat Depth

- (i) The ridge peats are in small shallow basins with depths ranging from 0.4-1.0m.
- (ii) A drain runs the full length of the valley swamp and the peat is now only 0.3-0.5m deep.

Peat Composition

Both peats are dominated by poorly decomposed (VP2-3) *Sphagnum* spp. (up to 80%), and sedge remains. The ridge peat is underlain by bedrock, and the valley peat by alluvial material.

Climate

Manorburn Climate Station.

Mean annual rainfall 474mm

Distribution over 93 rain days

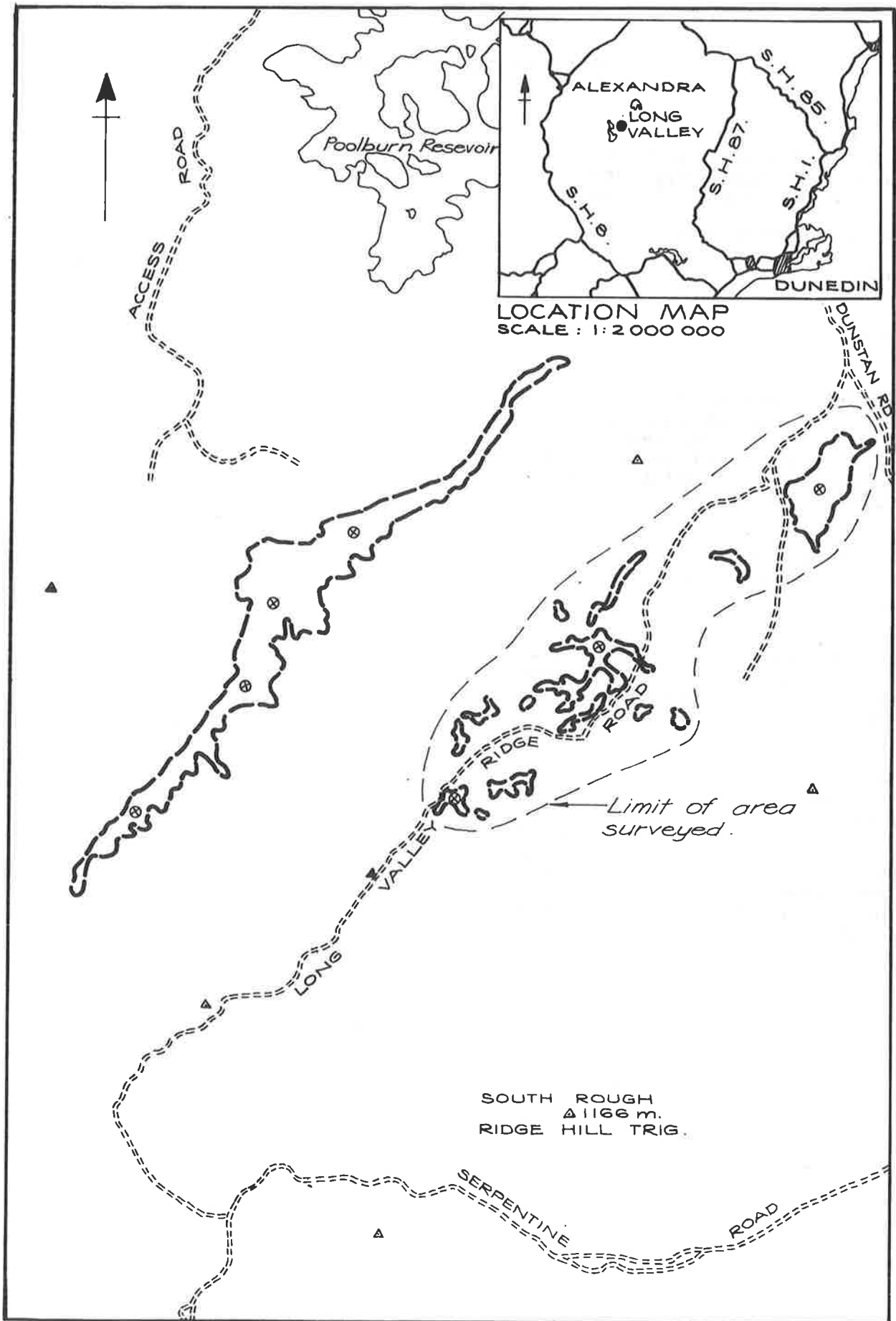
Frosts 155 days

Snowfalls 6 days

Mean annual temperature 6.5°C

Mean January temperature 12.0°C

Mean July temperature -1°C



LONG VALLEY

SCALE 1:50 000



32. ROCK AND PILLAR RANGE

Location

55km north-west of Dunedin and 8.5km west of Middlemarch. (S154:732153 - map reference of the Castle). The area lies in the altitudinal range 1050-1130m. Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active

Surface Vegetation and Landuse

The peat is covered by *Sphagnum* spp., *Donatia novae-zelandiae*, *Celmisia* spp., *Oreobolus* spp., *Gaimardia retacea*, with some *Carpha alpina*, *Carex ternaria*, *Drosera arcturi* and occasional lichens (*Cladonia* spp.).

Peat Depth

The peat is 2-2.5 m deep, although in places deepens to 3.5m and at basin margins shallows to 0.2-0.5m.

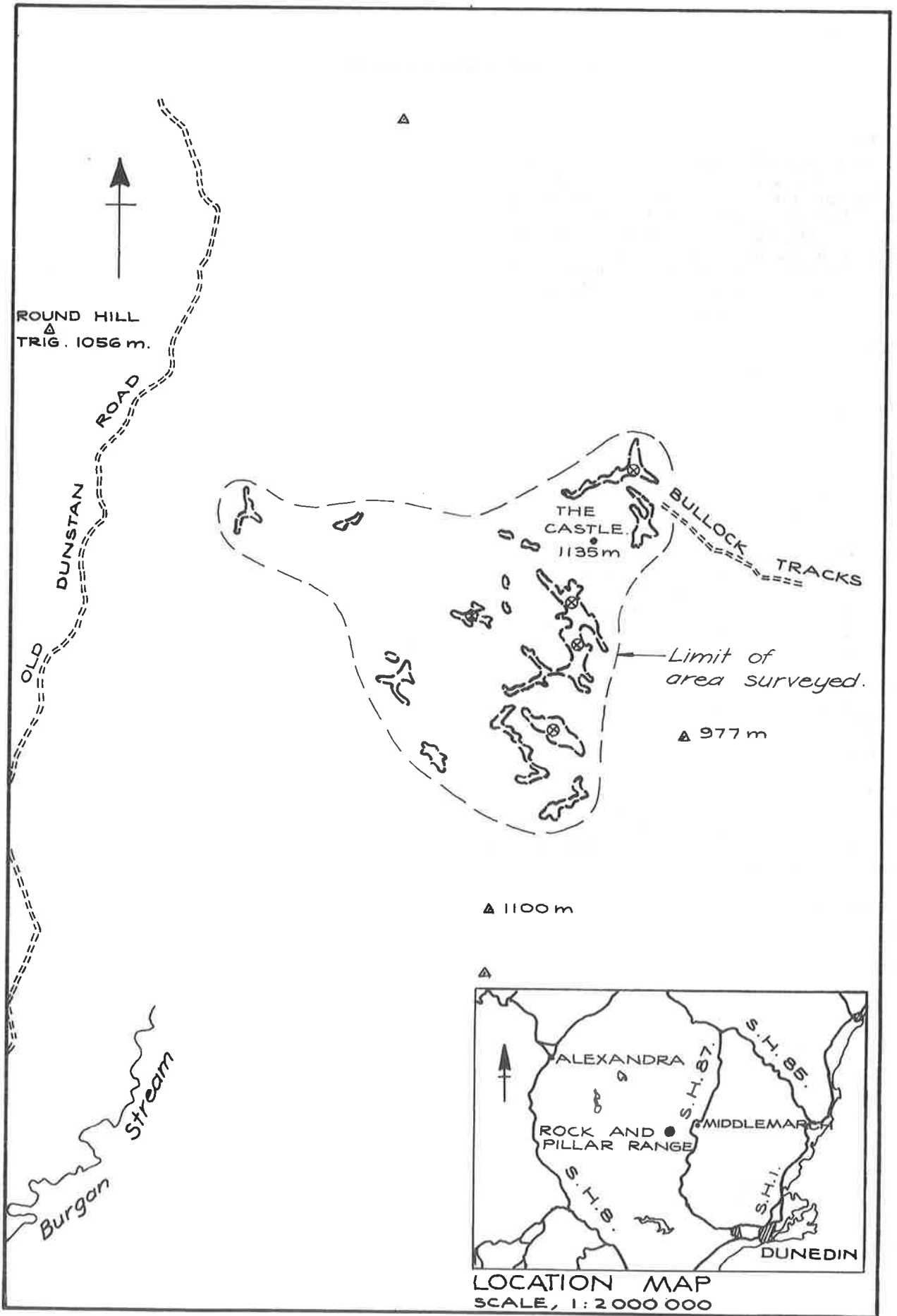
Peat Composition

Moderately decomposed (VP 4-5) sedge roots, remains of large sedge leaves, *Sphagnum* spp., other root remains and varying amounts of silt. The peat is underlain by bedrock.

Climate

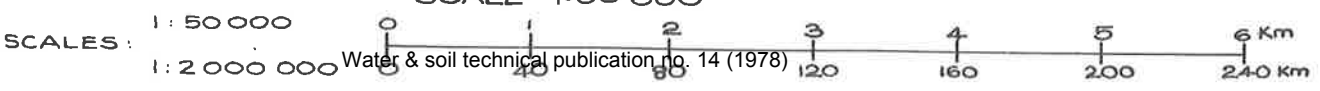
Manorburn Climate Station.

Mean annual rainfall	474mm
Distribution	over 93 raindays
Frosts	155 days
Snowfalls	6 days
Mean annual temperature	6.5°C
Mean January temperature	12.0°C
Mean July temperature	-1°C



ROCK & PILLAR RANGE

SCALE 1:50 000



33. GREAT MOSS SWAMP

Location

60km north-west of Dunedin (S153:605072—map reference for Trig P, 945m — and S154:667122 — map reference for Howells Hut). The swamp lies between the Lammermoor and Rock and Pillar ranges at an altitude of between 825m and 850m. No peat is found in the central basin. Peat is restricted to the tributary valley heads and to pockets in small gullies on adjacent ridges. Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active

Area

The Great Moss Swamp basin covers 20km², of which it is estimated 15-20% is peat.

Surface Vegetation and Landuse

The true peat areas are dominated by *Sphagnum* spp. (including *Sphagnum squarrosum*, which occurs only on the Lammermoor Range), with some *Carex* spp., *Carpha alpina* and bladderwort (*Utricularia* spp.).

Peat Depth

Peat depth is mainly from 1.0-2.0 m, but in places is up to 2.5m deep. Toward the central basin it shallows to 0.2-0.3m.

Peat Composition

Poorly decomposed (VP2) *Sphagnum* spp. (up to 80%) and some sedge remains. The peat is generally underlain by grey or green-brown silt, elsewhere by bedrock.

Highest Point

853m.

Outfall Level

Logan Burn (S154:654124) — 823m.

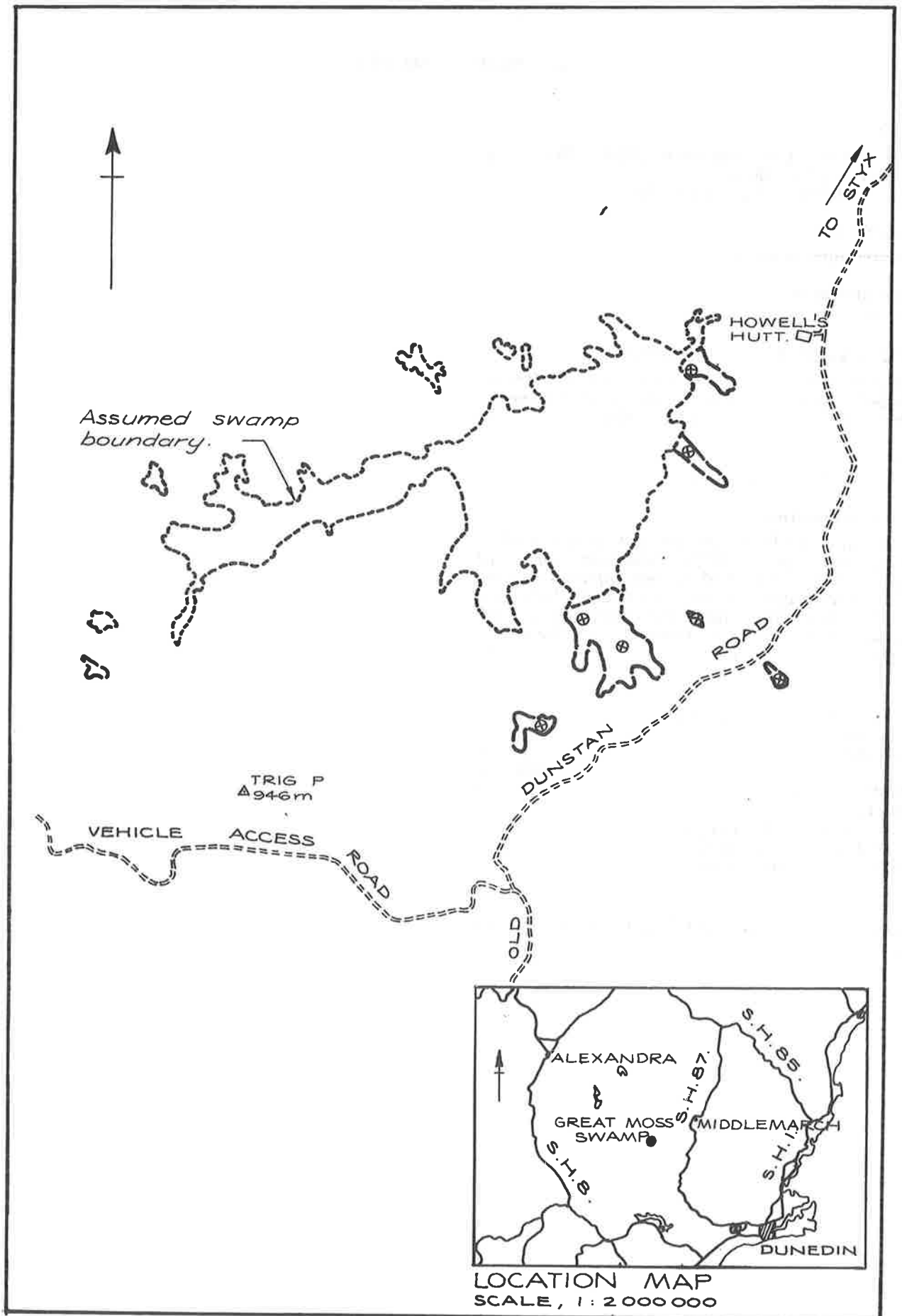
Climate

Manorburn Climate Station.

Mean annual rainfall.....	474mm
Distribution.....	over 93 rain days
Frosts.....	155 days
Snowfalls.....	7 days
Mean annual temperature.....	6.5°C
Mean January temperature.....	12.0°C
Mean July temperature.....	-1°C

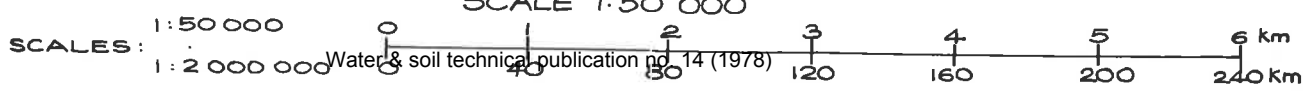
General

Some data have been obtained from:
"Proposed Maniatoto Irrigation Scheme."
Environmental Impact Assessment prepared by
Water and Soil Division, MWD, Dunedin (Oc-
tober, 1975).



GREAT MOSS SWAMP

SCALE 1:50 000



34. MIDDLE SWAMP

Location

75km south-west of Dunedin (S153:388075) at an altitude of about 685m. Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active.

Surface Vegetation and Landuse

In wetter places the vegetation is dominated by *Sphagnum spp.* and *Carpha alpina*; with *Chionochloa rubra* and other grasses in drier places.

Peat Depth

The peat is 1.0 - 1.5m deep.

Peat Composition

To a depth of 0.7m the peat is dominated by poorly decomposed (VP2) *Sphagnum spp.*, with some woody roots and *Carpha alpina* remains. Below 0.7m mineral content increases, *Sphagnum spp.* are uncommon and sedge species dominate (*Carpha alpina*, *Carex spp.*, *Baumea spp.*). The peat is underlain by bedrock.

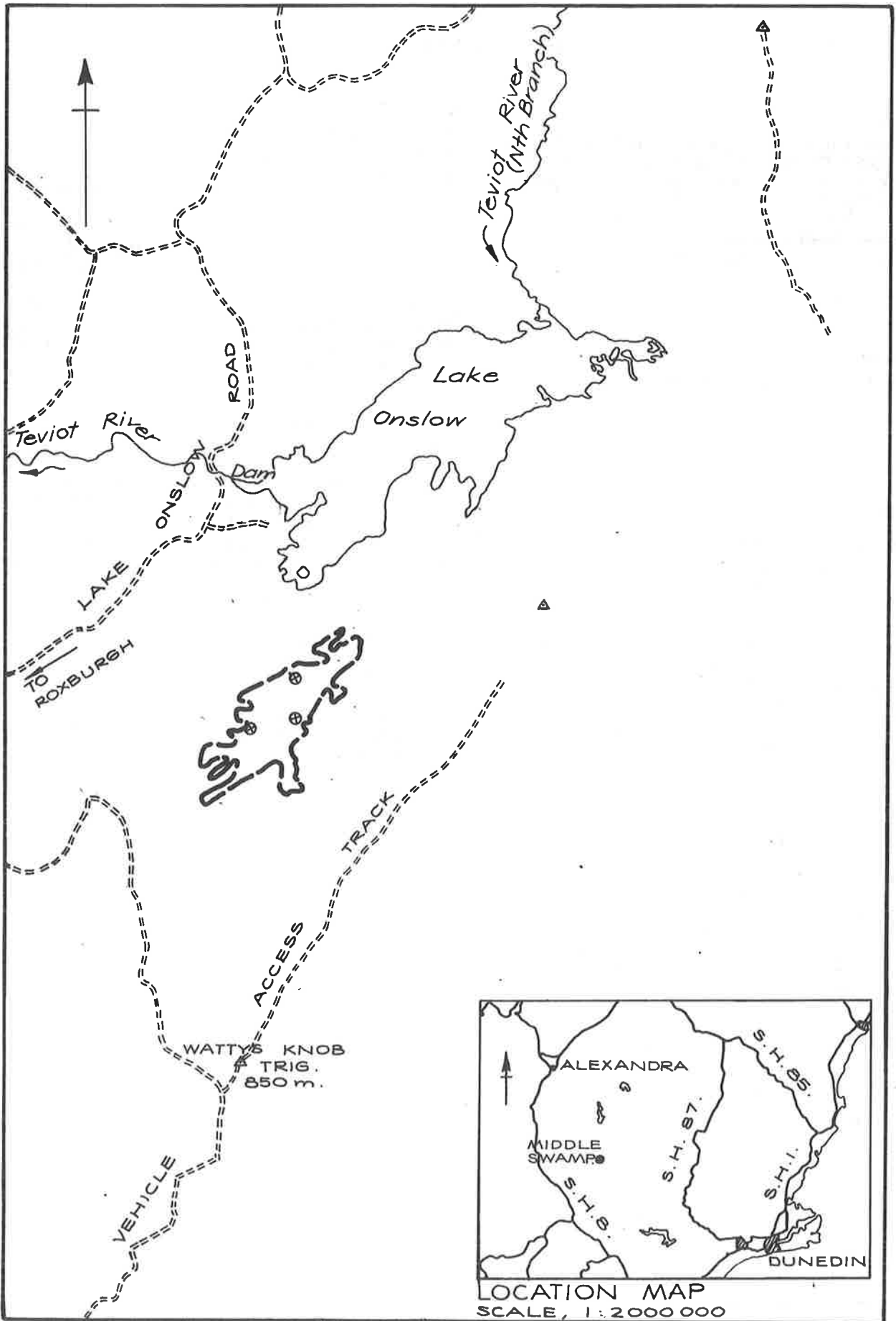
Climate

Manorburn Climate Station.

Mean annual rainfall.....	474mm
Distribution.....	over 93 raindays
Frosts.....	155 days
Snowfalls.....	6 days
Mean annual temperature.....	6.5°C
Mean January temperature.....	12.0°C
Mean July temperature.....	-1°C

General

Swampy areas shown on S153 were checked for peat.



MIDDLE SWAMP

SCALE 1:50 000



35. HOME CREEK

Location

There are a number of peat deposits within the Manapouri - Te Anau lowlands. Some are being modified by drainage, agricultural development and burning. The area surveyed was the Home Creek (or Kepler) Swamp, 11km north-east of Manapouri (S149:753111). Southland Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Active, but some degenerating margins.

Area

6.5 km².

Volume

20.5 million m³.

Surface Vegetation and Landuse

The surface has been burnt, possibly several times, and is divided into the dome and lagg vegetation types.

- (i) Dome: Covered by *Calorophus minor*, *Dracophyllum oliveri* and *Baumea rubiginosa*, with some *Leptospermum scoparium* and *Dacrydium spp.* The ground cover comprises the mosses *Sphagnum spp.*, *Campylopus kirkii* and *Eucamptodon inflatus*. In areas where burning has been less severe, *Dracophyllum oliveri* dominates, with *Calorophus minor* and species listed above as sub-dominants.

Numerous pools, arranged essentially parallel, have developed on the highest part of the dome. The origin is not certain, but appear to be "burn" ponds. They are steep sided and contain *Sphagnum falcatum* and algal mud. The hummocks between the pools are dominated by *Dacrydium spp.*, *Leptospermum scoparium* and some *Dracophyllum oliveri*.

- (ii) Lagg: The lagg area which comprises approximately 50% of the swamp, is dominated by *Carex spp.*, *Juncus articulatus*, occasional *Chionochloa rubra*, with in parts a ground cover of *Murchantia herteroana*. Closer to the dome *Baumea rubiginosa* and cushions of *Sphagnum spp.* are common.

Peat Depth

In the northern arm of the swamp (surveyed by the Southland Catchment Board) the peat is 0.4 - 10.0m. Peat on the dome is slightly thicker (up to 4.7m) and the remaining lagg is up to 2.7m.

Outfall

The Kepler Swamp drains by the Home Creek to the Waiau River.

Climate

Te Anau Climate Station.

Mean annual rainfall..... 1170m
Distribution evenly throughout the year, although severe summer droughts have been recorded
Frosts..... 105 days
Mean annual temperature 9.2°C
Mean January temperature..... 14.6°C
Mean July temperature 3.3°C

General

The combination of severe frost heave, strong winds and drainage render the peat very prone to wind erosion.

The peat swamps act as very efficient water control features, ensuring a high base flow and a relatively stable annual flow.

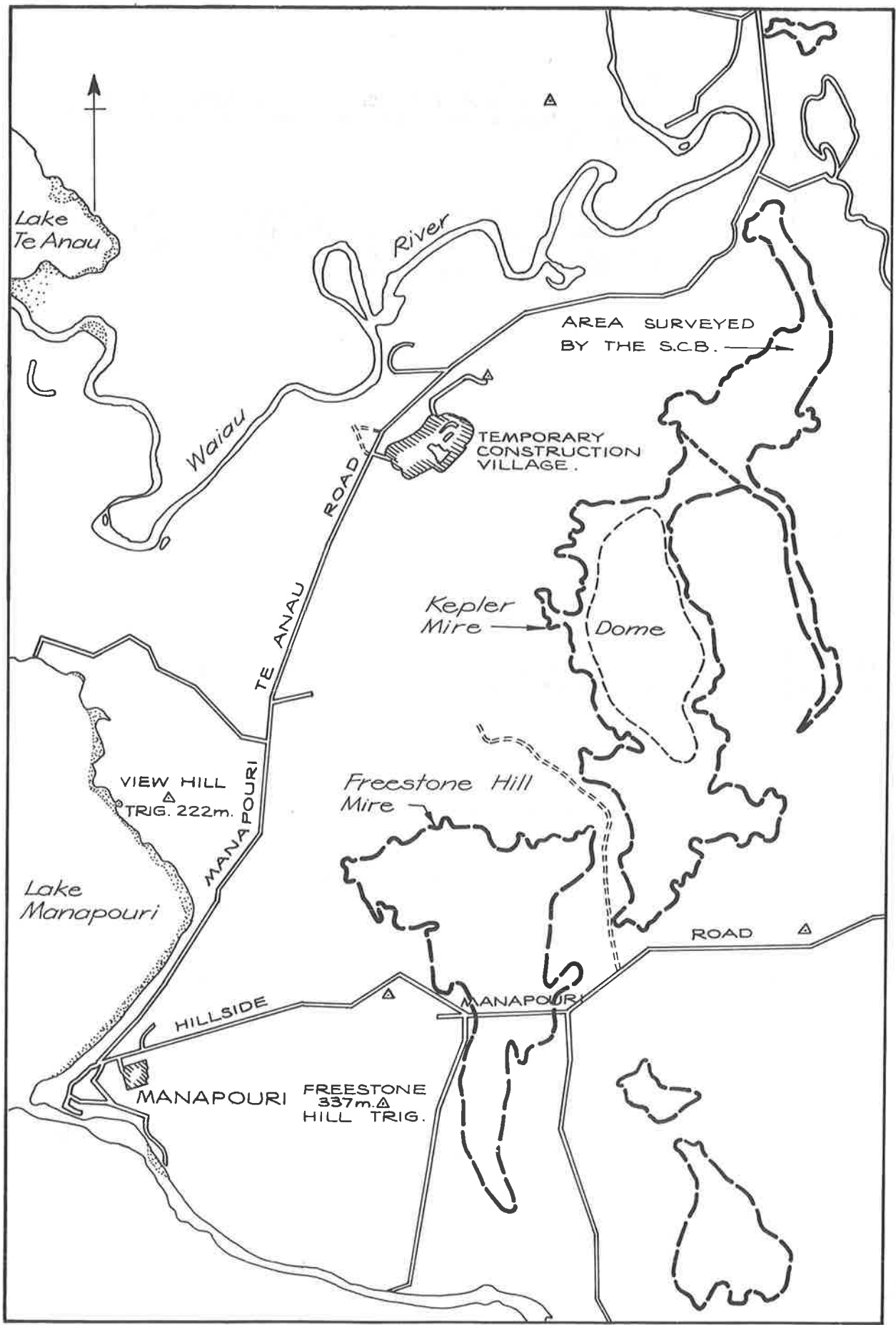
Information about surface vegetation of adjacent bogs is dealt with by Burrows and Dobson, 1972.

Information is included from:

Hunter, G. G. 1973: "Report on a Land Use Capability survey of Home Creek, Southland". Ministry of Works and Development, Christchurch. 17p.

Burrows, C. J.; Dobson, A. T. 1972: Mires of the Manapouri - Te Anau Lowlands. *N.Z. Ecological Society Proceedings*, 19: 75-94.

Southland Catchment Board 1972: "Home Creek - Manapouri Swamp Investigation Survey".



HOME CREEK

SCALE, 1:50 000

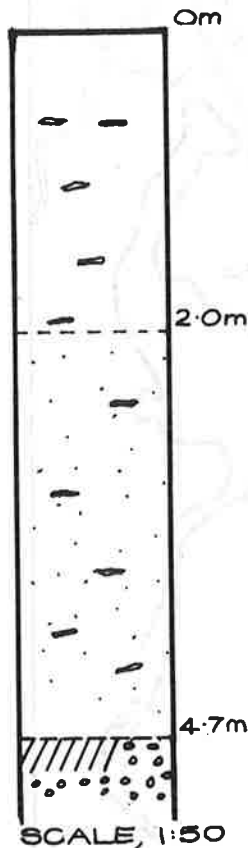
Water & soil technical publication no. 14 (1979)



Home Creek

Peat Composition

The profile is typical of the dome peat. The lagg peat is composed of *Baumea spp.*, *Carex spp.*, woody roots and wood fragments.



Calorophus minor, *Dracophyllum oliveri*, *Sphagnum spp.*, *Campylopus kirkii*, *Baumea spp.*, woody roots and fragments. *Sphagnum spp.*, are commonly concentrated in layers throughout the profile. Very wet, fibrous, and poorly decomposed, VP 2.

Similar to above but more decomposed, VP 4-5.

Grey-brown or green-brown coarse sand over glacial gravels, or glacial gravels.

36. RED SWAMP

Location

70km north-west of Dunedin (S153:462060), at an altitude of 970m on the Lammerlaw Range. Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active.

Area

0.8 km².

Volume

0.9 million m³.

Surface Vegetation and Landuse

The swamp is divided by a belt of *Chionochloa rubra*. To the south of this the vegetation is dominated by *Chionochloa spp.*, with ground cover of mosses and grasses. To the north the vegetation comprises *Sphagnum spp.* (up to 50-55%), *Donatia novae-zelandiae*, *Oreobolus spp.*, some *Carpha alpina* and other mosses.

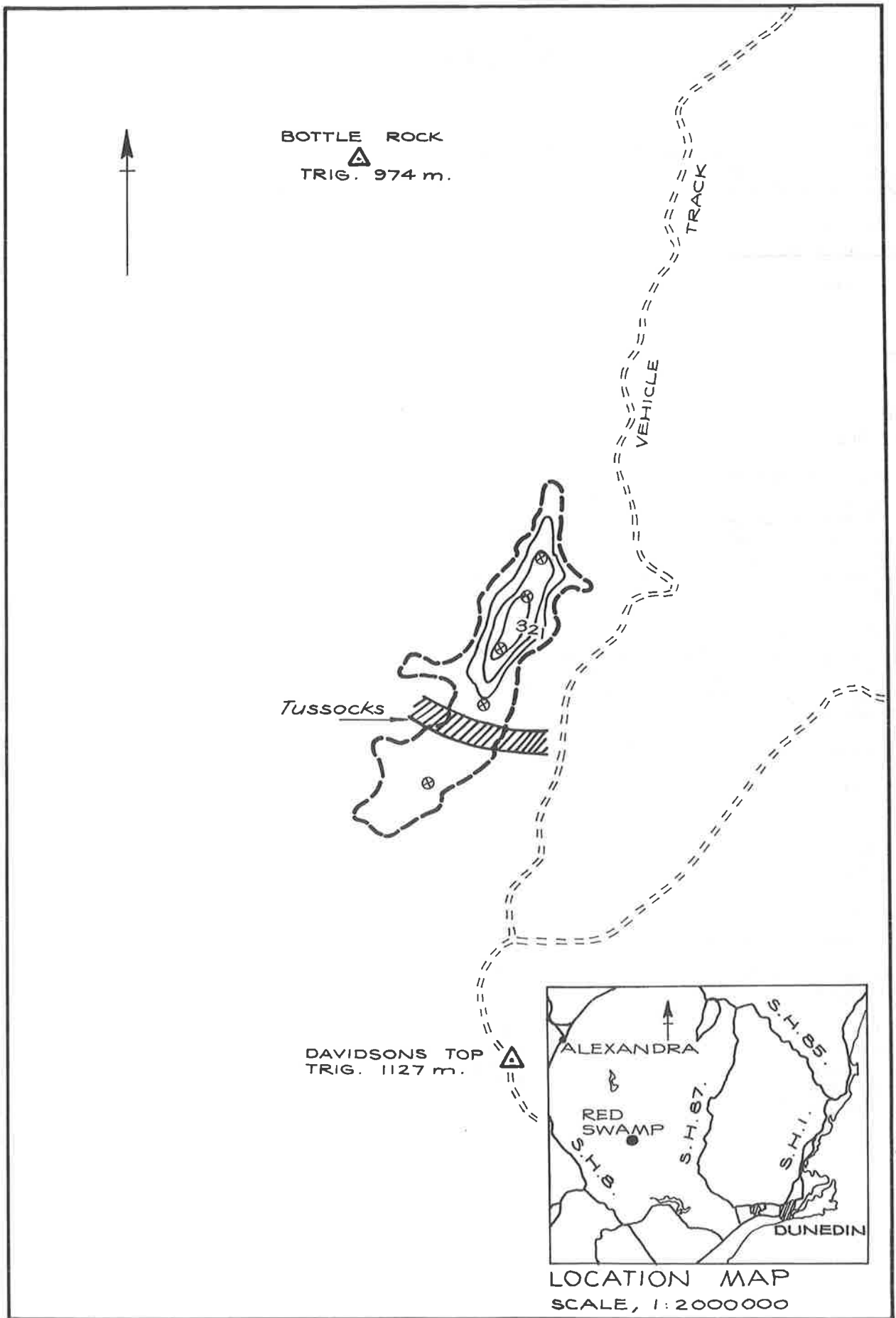
Peat Composition

The southern part of the swamp is dominated by well preserved *Chionochloa spp.*, with varying amounts of mineral material. The northern part is composed of poorly decomposed (VP 2-3) *Sphagnum spp.* (up to 60-65%), *Oreobolus spp.*, and other not identified root remains. The peat is underlain by bedrock.

Climate

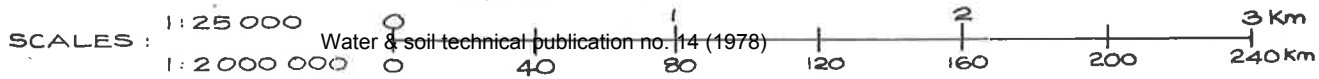
Manorburn Climate Station.

Mean annual rainfall.....	474mm
Distribution.....	over 93 raindays
Frosts.....	155 days
Snowfalls.....	6 days
Mean annual temperature.....	6.5°C
Mean January temperature.....	12.0°C
Mean July temperature.....	-1°C



RED SWAMP

SCALE 1:25 000



37. TEVIOT SWAMP

Location

60km north-west of Dunedin (S153:425994), at an altitude of 990m on the Lammerlaw Range. Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active.

Area

1.1km².

Volume

0.8 million m³.

Surface Vegetation and Landuse

Sphagnum spp. covers up to 75% of the swamp, with *Oreobolus pectinatus*, *Celmisia* spp., other mosses, sparse *Carpha alpina* and *Carex ternaria*. Close to the stream tussocks of *Carex ternaria*, and *Chionochoa* spp., are more common. There are ponds and channels of open water.

Peat Composition

The peat is composed of poorly decomposed (VP 2-3) *Sphagnum cristatum* (up to 90-95%), with *Oreobolus* spp., *Carex* spp. and other not identified root remains.

The peat is underlain by bedrock.

Highest Point

1006m.

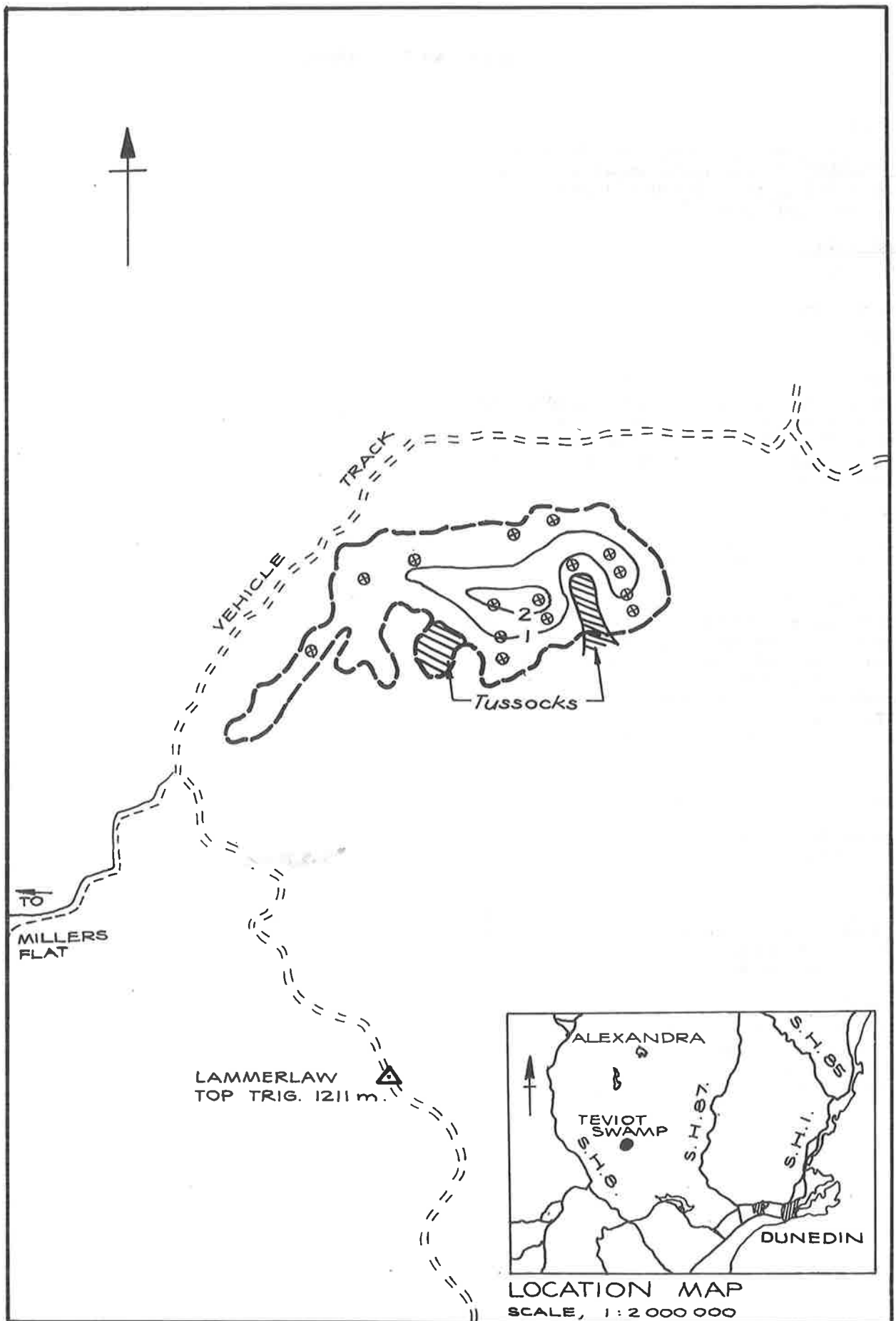
Outfall level

S153:410991-960m.

Climate

Manorburn Climate Station.

Mean annual rainfall.....	474mm
Distribution.....	over 93 raindays
Frosts.....	155 days
Snowfalls.....	6 days
Mean annual temperature.....	6.5°C
Mean January temperature.....	12.0°C
Mean July temperature.....	-1°C



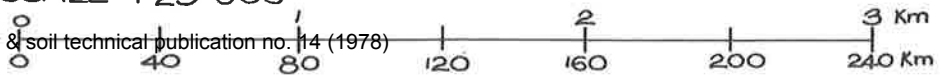
TEVIOT SWAMP

SCALE 1:25 000

SCALE: 1:25 000

Water & soil technical publication no. 14 (1978)

1:2 000 000



38. LAMMERMOOR RANGE

Location

North-east and south-west of Ailsa Craig (S153:541979) lie numerous small basins and gullies with peat, at an altitude of 1050-1130m. Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active.

Surface Vegetation and Landuse

Dominated by *Sphagnum spp.* (up to 75-80%), with *Donatia novae-zelandiae*, *Celmisia spp.*, other mosses, *Chionochoa rubra* and *Poa colensoi*. There are *Carpha alpina*, *Drosera spp.* and lichens of *Cladonia spp.* in places.

Peat Depth

Varies from 0.5m on the margins to 1.5-1.7m in the centre of the gullies or basins.

Peat Composition

Well preserved (VP2-3) root remains of *Donatia novae-zelandiae*, *Sphagnum cristatum* (up to 70-75% in places) and other root remains not identified. Drier or shallower patches are composed of *Campylopus spp.*, *Polytrichum spp.* and dwarf *Dacrydium spp.*
The peat is underlain by bedrock.

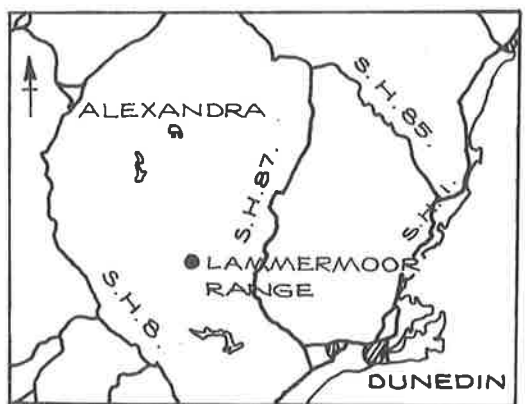
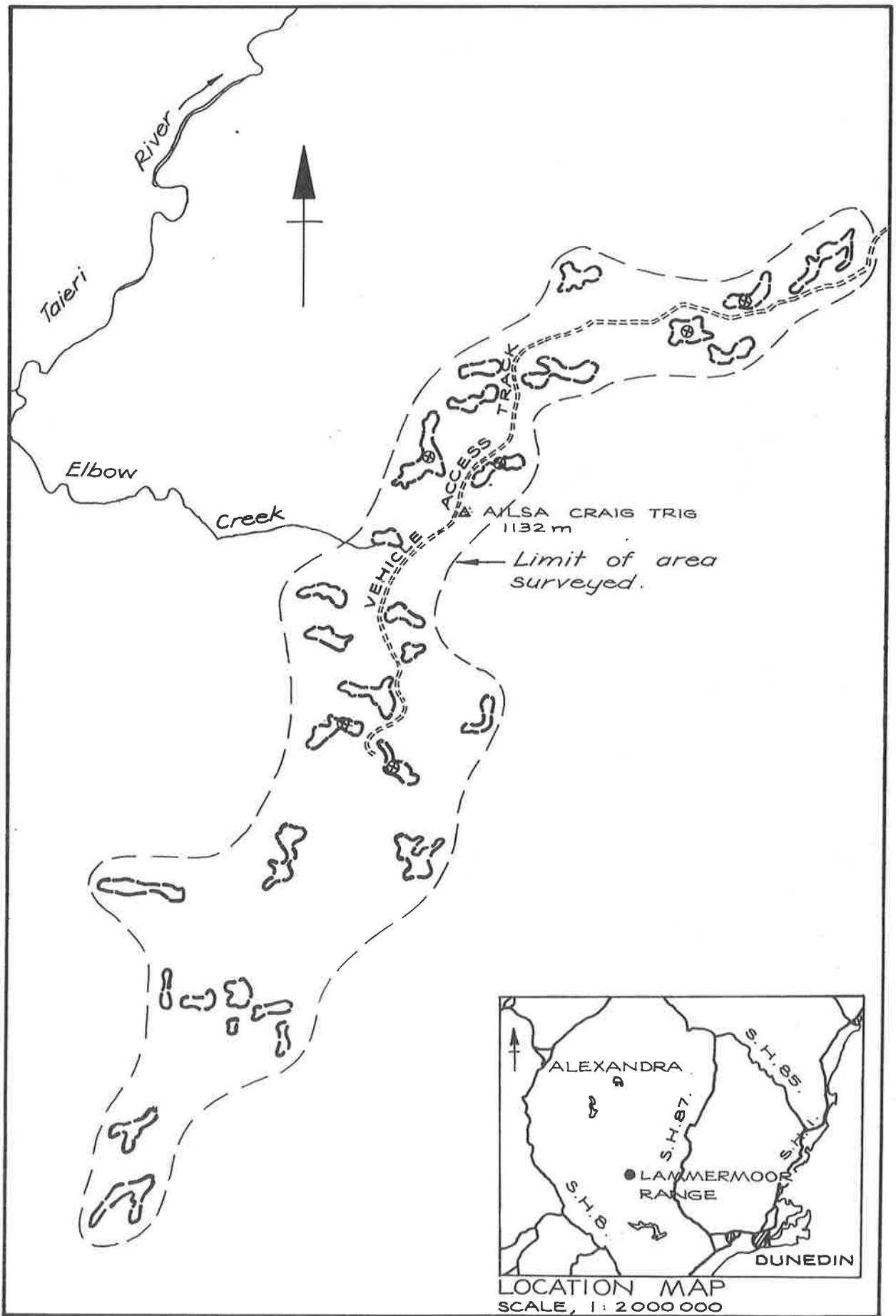
Climate

Manorburn Climate Station.

Mean annual rainfall.....	474mm
Distribution.....	over 93 raindays
Frosts.....	155 days
Snowfalls.....	6 days
Mean annual temperature.....	6.5°C
Mean January temperature.....	12.0°C
Mean July temperature.....	-1°C

General

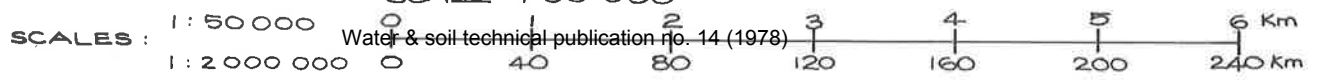
In the upper parts of the gullies ponds are very common, decreasing in number down valley. The peat tends to parallel the subsurface and shows a "terrace" effect in many places.



LOCATION MAP
SCALE, 1 : 2 000 000

LAMMERMOOR RANGE

SCALE 1:50 000



39. CLARKS JUNCTION

Location

A small alluvium floored valley with isolated pockets of peat 37km north-west of Dunedin (S163:788892), at an altitude of 500-518m. Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active.

Area

The swampy valley covers 1.3km²., but the area of peat is much less.

Surface Vegetation and Landuse

The peat, dominated by *Sphagnum spp.* (80-90%), is restricted to isolated pockets in the main valley and small pockets at the heads of side valleys.

Peat Depth

In the main valley the peat is about 0.3m deep and in the side valleys 0.3-0.5m deep.

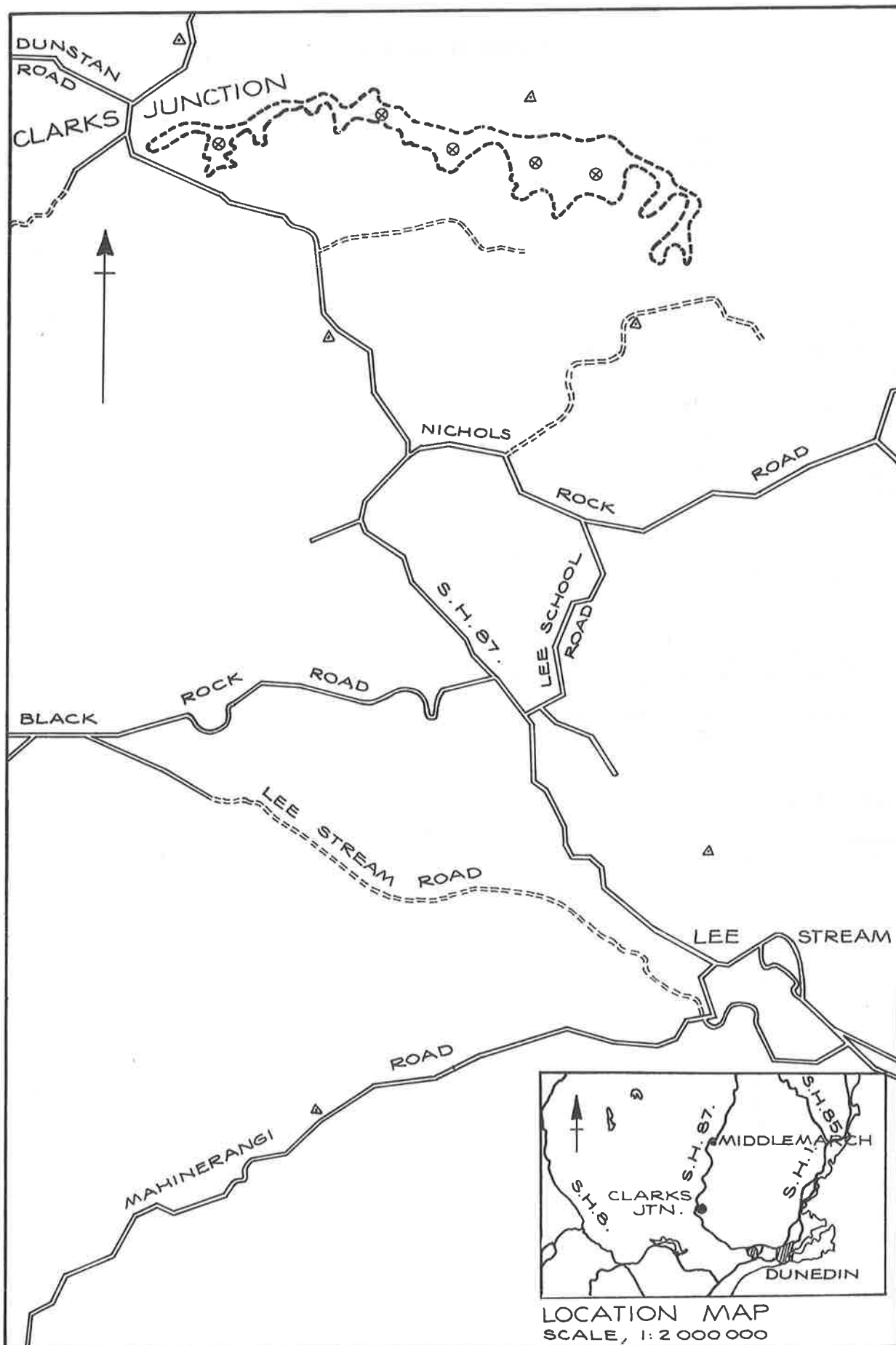
Peat Composition

Very wet, poorly decomposed (VP1-2) *Sphagnum spp.*, underlain by alluvial material.

Climate

Mahinerangi Dam Climate Station.

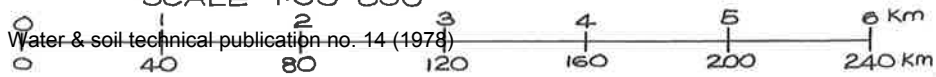
Mean annual rainfall	998mm
Distribution	over 174 raindays
Frosts	125 days
Snowfalls	6 days
Fogs	8 days
Mean annual temperature	7.7°C
Mean January temperature	13.9°C
Mean July temperature	1.9°C



CLARKS JUNCTION

SCALE 1:50 000

SCALES :
 1:50 000
 1:2 000 000



40. HAMILTON BURN

Location

17.5km north-west of Mossburn (S150:059898).
Southland Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active.

Area and Volume

Peat covers less than 35% of the total Hamilton Burn area of 18km².

Surface Vegetation and Landuse

The peat is covered by *Calorophus minor*, *Dracophyllum oliveri*, *Carex secta*, *Chionochloa rubra*, some *Epacris pauciflora*, *Sphagnum spp.* and *Campylopus kirkii*.

Peat Depth

Depth of pockets vary from 0.1-1.4m. Most of the peat is less than 0.5m thick.

Peat Composition

The peat is composed of *Calorophus minor*, *Sphagnum spp.*, *Carex secta*, woody roots and fragments, and varying amounts (0-40%) of mineral material. The peat is very wet, moderately decomposed (VP5) and is underlain by gravels or weathered bedrock.

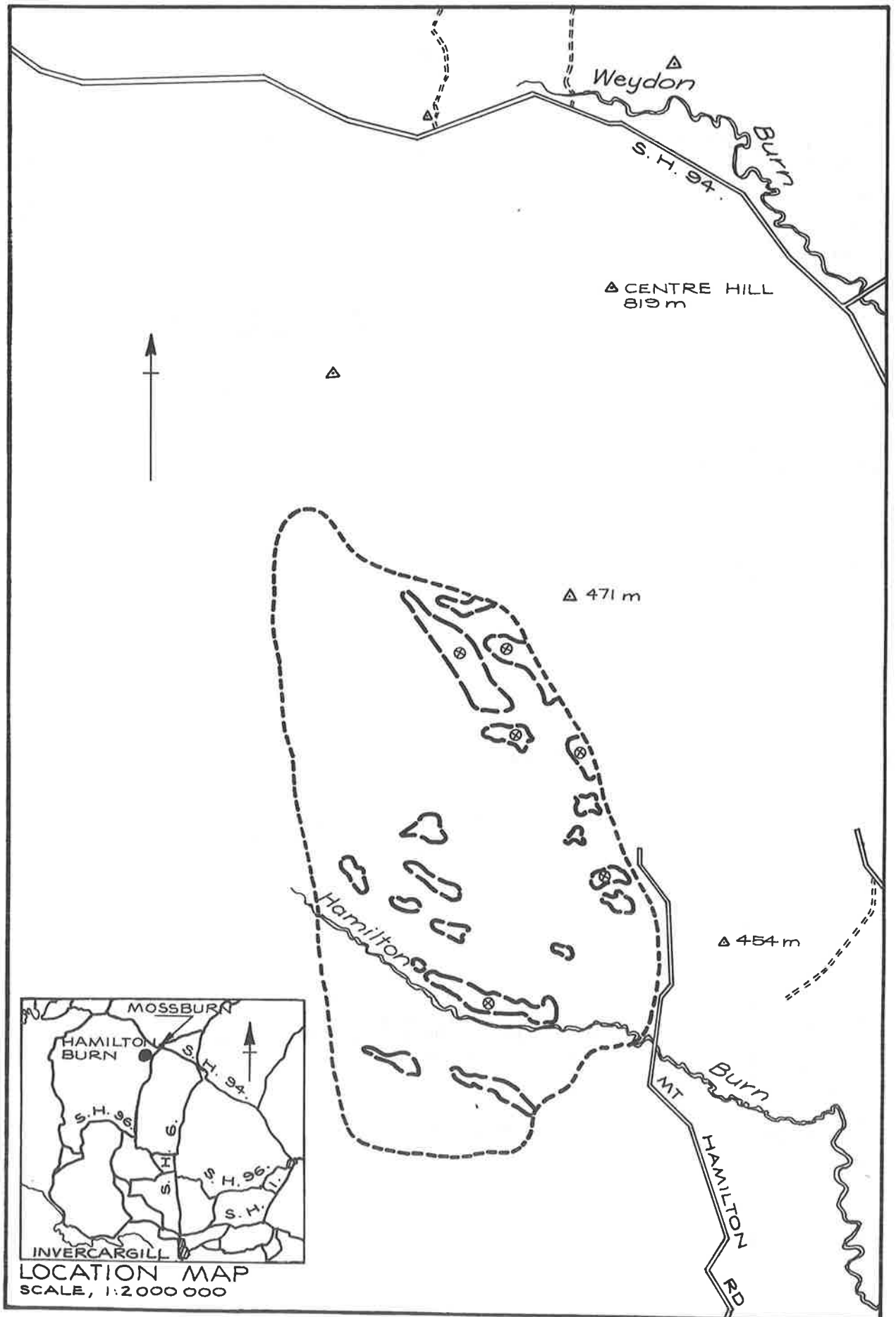
Climate

Mid Dome Climate Station.

Mean annual rainfall..... 971mm
Distribution..... 121 raindays
with low falls
June to October
Frosts..... 148 days
Fogs..... 54 days
Snowfalls..... 12 days
Mean annual temperature..... 9.4
Mean January temperature..... 14.3°C
Mean July temperature..... 3.2°C

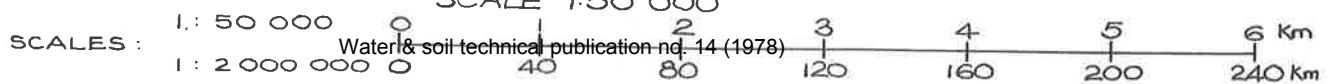
General

Peat depths and areas are taken from a map of Hamilton Burn Peat Resources prepared by the Southland Catchment Board.



HAMILTON BURN

SCALE 1:50 000



41. SOBIG

Location

9km north-west of Mossburn (S150:138956).
Southland Catchment Board District.

Classification

Oligotrophic, blanket.

Present Status

Active.

Area

2.5km².

Volume

3.2 million m³.

Surface Vegetation and Landuse

The entire swamp is undeveloped and is covered by *Calorophus minor*, *Dracophyllum oliveri*, *Carex secta*, *Epacris pauciflora*, *Sphagnum cristatum*, *Campylopus kirkii*, and some *Chionochoa rubra*. Closer to the swamp margins *Carex spp.*, *Chionochoa rubra* and introduced grasses are more common.

Climate

Mid Dome Climate Station.

Mean annual rainfall 971mm

Distribution 121 raindays
with low falls
June to October

Frosts 148 days

Fogs 54 days

Snowfalls 12 days

Mean annual temperature 9.4°C

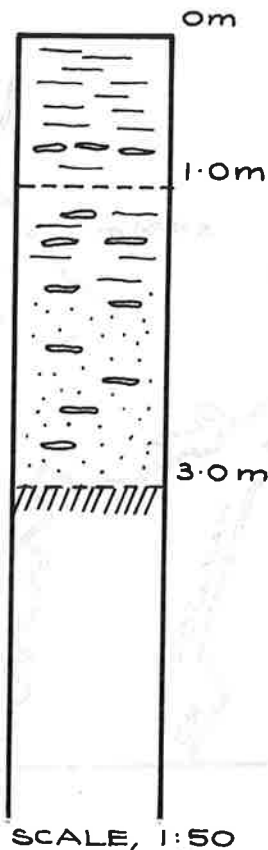
Mean January temperature 14.3°C

Mean July temperature 3.2°C

General

The Sobig Swamp is also known as Centre Burn.

Peat Composition



Calorophus minor, *Sphagnum spp.*, woody roots of *Dracophyllum oliveri* and *Epacris pauciflora*, with some *Carex spp.* (especially *C. sinclairii* and *C. gaudichaudiana*).

Woody layer at 0.8m.

Very wet, matted, moderately decomposed, VP 4-5.

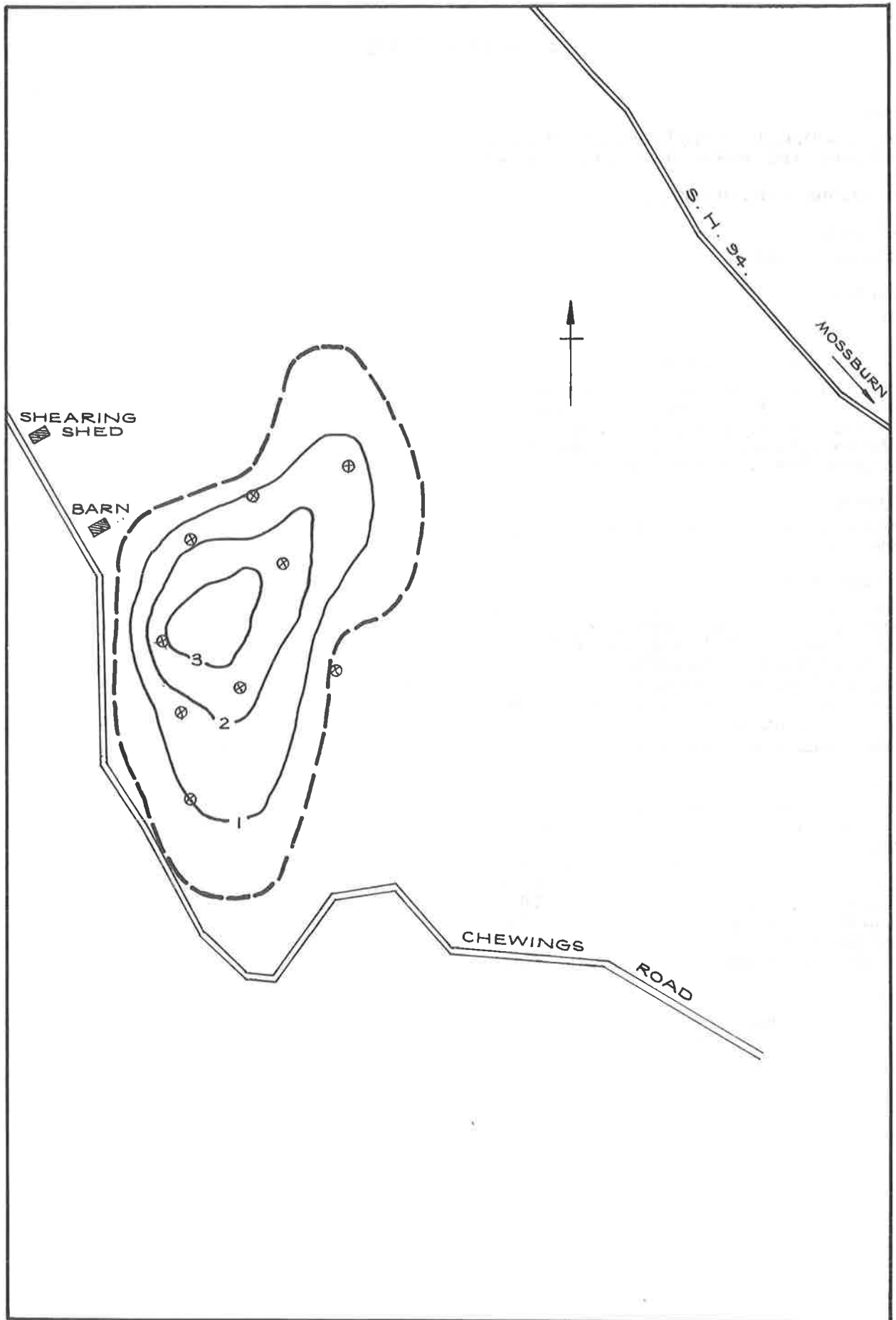
Calorophus minor, *Carex spp.* (as above) and some woody roots and fragments of *Dracophyllum oliveri*.

Mineral content (silt and quartz grains) increases.

Wood content increases.

Clay and occasionally gravels.

SCALE, 1:50



SOBIG

42. DEEP STREAM

Location

60km west of Dunedin on the Lammerlaw Range, centred about S162:560850, at an altitude of 700-1050m.

Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active.

Surface Vegetation and Landuse

Undeveloped peat covered by *Sphagnum spp.*, *Dicranoloma billardieri*, *Donatia novae-zelandiae*, *Oreobolus spp.*, *Celmisia spp.*, some *Dracophyllum spp.*, *Pentachondra pumila*, and *Drosera arcturi*. On the margins *Chinochloa spp.* dominates.

Peat Depth

The peat is generally 0.5 - 1.0m deep and deepest recorded was 2.7m.

Peat Composition

Samples collected showed variations in recognisable remains. In some places the peat is well decomposed (VP 7) with only *Calorophus minor* recognisable. Elsewhere the peat is composed of poorly decomposed (VP 2) *Oreobolus spp.*, *Dicranoloma billardieri*, *Dacrydium spp.* and some *Sphagnum spp.*

The peat is underlain by bedrock.

Climate

Manorburn Dam Climate Station.

Mean annual rainfall 474mm

Distribution over 93
raindays

Frosts 155 days

Snowfalls 6 days

Mean annual temperature 6.5°C

Mean January temperature 12.0°C

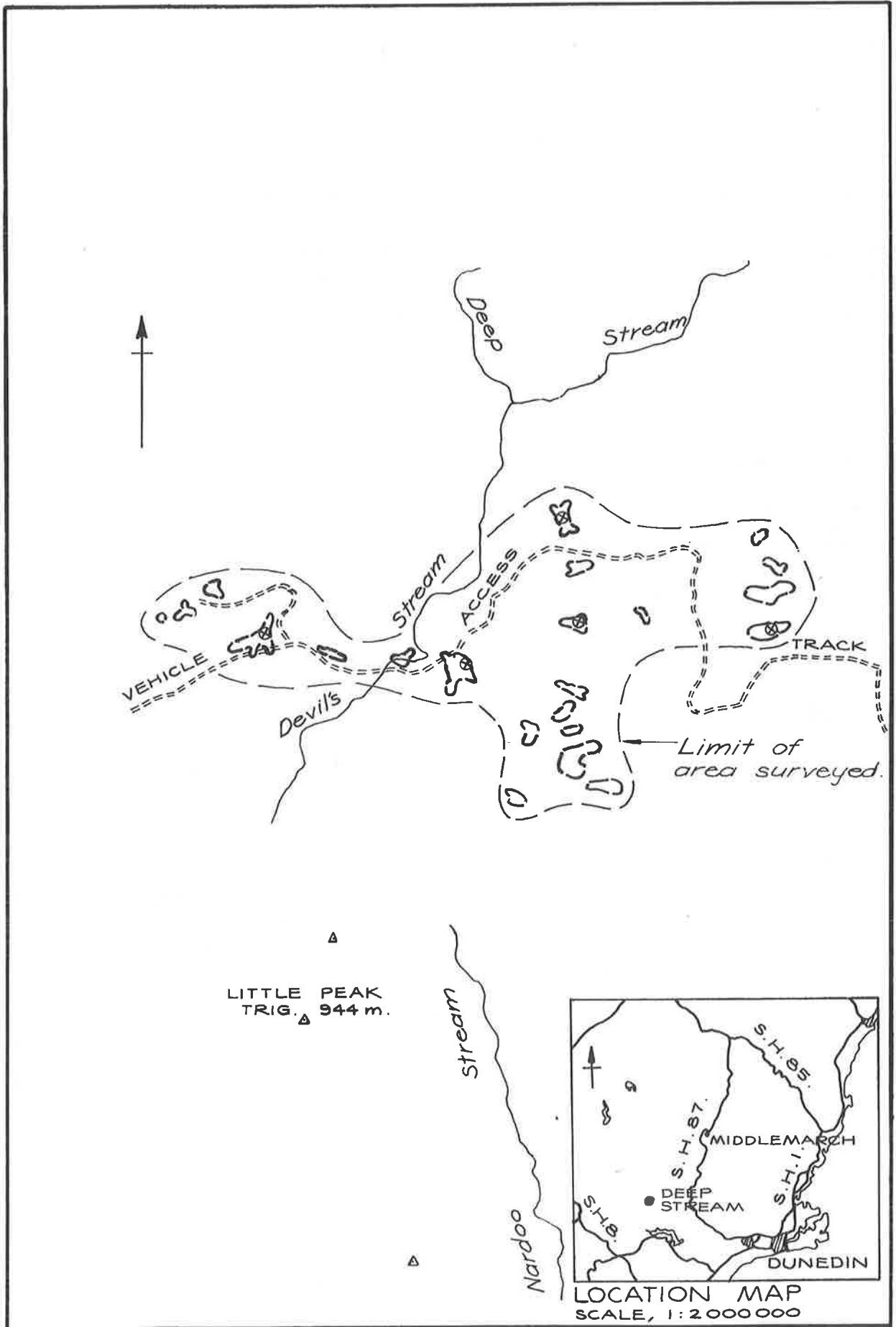
Mean July temperature -1.0°C

General

The peat lies in part of the catchment for the Dunedin City water supply.

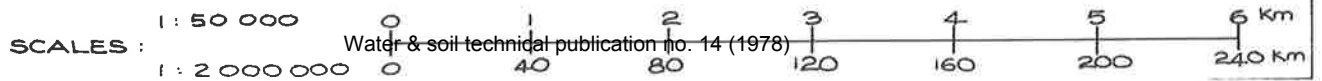


20810



DEEP STREAM

SCALE 1:50 000



43. SWAMPY HILL

Location

9.5km north of Dunedin (S164:134812). The swamp area comprises a number of shallow peat-filled basins separated by ridges of rock at an altitude of 715 - 725m. Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active.

Area

The area of the swamp is about 0.35km². About three quarters of this is covered by peat.

Surface Vegetation and Landuse

Present plant cover is *Donatia novae-zelandiae* cushions, *Sphagnum spp.*, *Carex spp.*, *Dracophyllum longifolium*, *Cassinia spp.*, *Coprosma spp.*, *Festuca novae-zelandiae*, with *Phormium colensoi* in drier, higher parts.

Peat Depth

The peat is generally 1.0 - 1.5m deep, but in places is up to 3.5m deep.

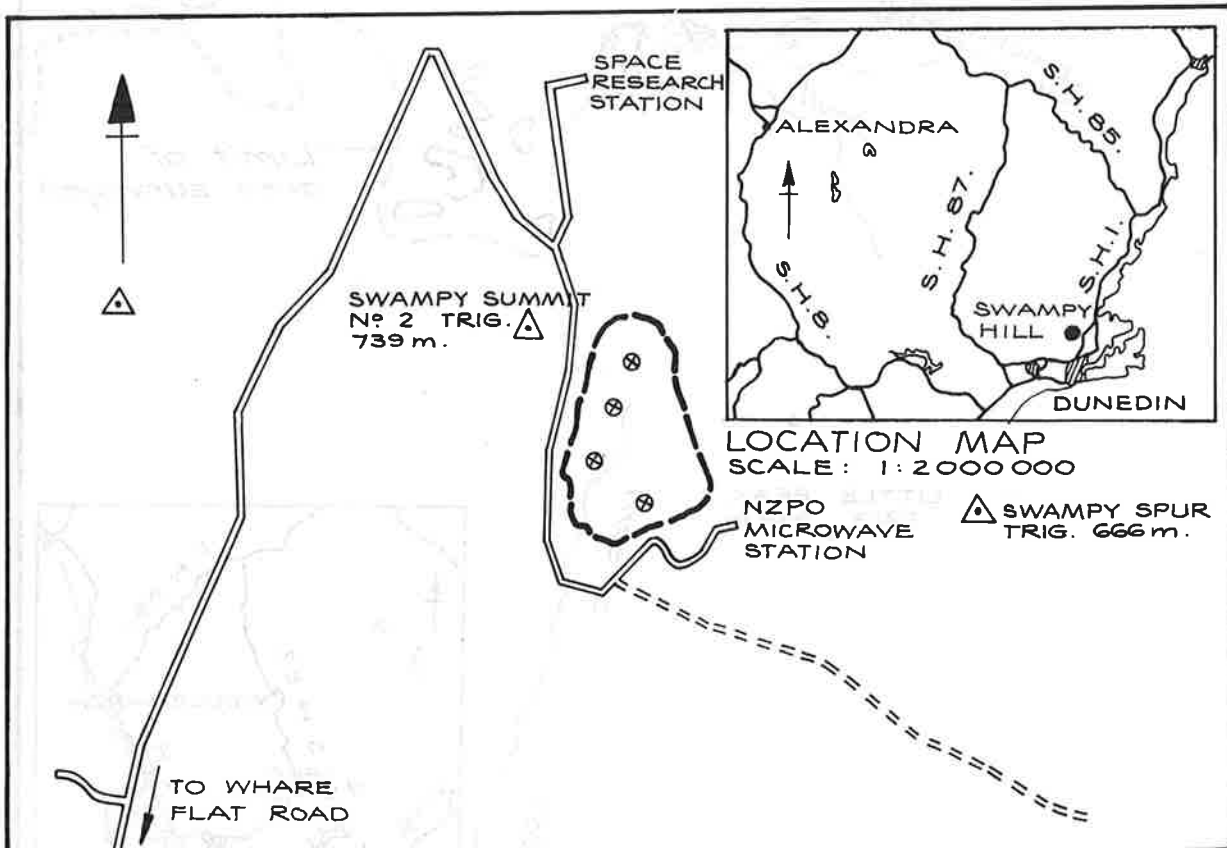
Peat Composition

The upper 0.3m is poorly decomposed (VP2) *Sphagnum spp.* (70-80%). Below is moderately decomposed (VP4) *Donatia novae-zelandiae*, *Dracophyllum longifolium*, *Coprosma spp.*, *Pentachondra pumila*, sedges and some layers of almost pure *Sphagnum spp.* The basement is bedrock or gritty brown mineral material.

Climate

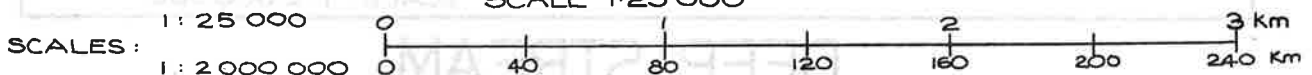
Taieri Invermay Climate Station.

Mean annual rainfall.....	687mm
Disribution.....	over 108 raindays
Frosts.....	115 days
Snowfalls.....	5 days
Mean annual temperature.....	10.1°C
Mean January temperature.....	14.6°C
Mean July temperature.....	4.8°C



SWAMPY HILL

SCALE 1:25 000



44. CASTLE DOWNS

Location

12km south of Mossburn, and 70km north of Invercargill (S159:213781) Southland Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Partly regenerating, partly active.

Area

12.9km².

Volume

57 million m³.

Surface Vegetation and Landuse

Most of the lagg area has been drained and developed for pastoral agriculture, although there are considerable rushes and tussock present. Part of the dome is undeveloped and the remainder has been burnt (now regenerating). The undeveloped area is covered by *Calorophus minor*, *Dracophyllum oliveri*, *Sphagnum spp.*, *Carex spp.*, *Dicranoloma billardieri*, *Epacris pauciflora*, some *Chionochloa rubra* and *Phormium tenax*, and other mosses. The regenerating area is covered

by stunted *Calorophus minor*, *Dicranoloma billardieri*, some *Epacris pauciflora*, and sparse *Dracophyllum oliveri*.

Climate

Mid Dome Climate Station.

Mean annual rainfall..... 971mm

Distribution..... 121 raindays
with low falls June to October

Frosts..... 148 days

Fogs..... 54 days

Snowfalls..... 12 days

Mean annual temperature..... 9.4°C

Mean January temperature..... 14.3°C

Mean July temperature..... 3.2°C

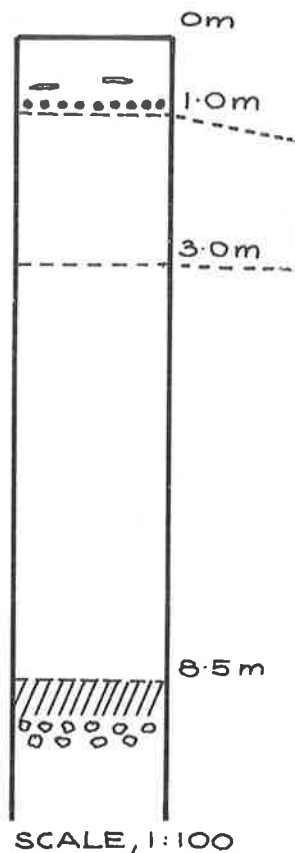
Peat Composition

Calorophus minor, *Sphagnum spp.* (moderately decomposed), *Carex spp.*, some *Dicranoloma billardieri*, woody roots of *Dracophyllum oliveri* and *Epacris pauciflora*, with a charcoal layer at 0.9m.

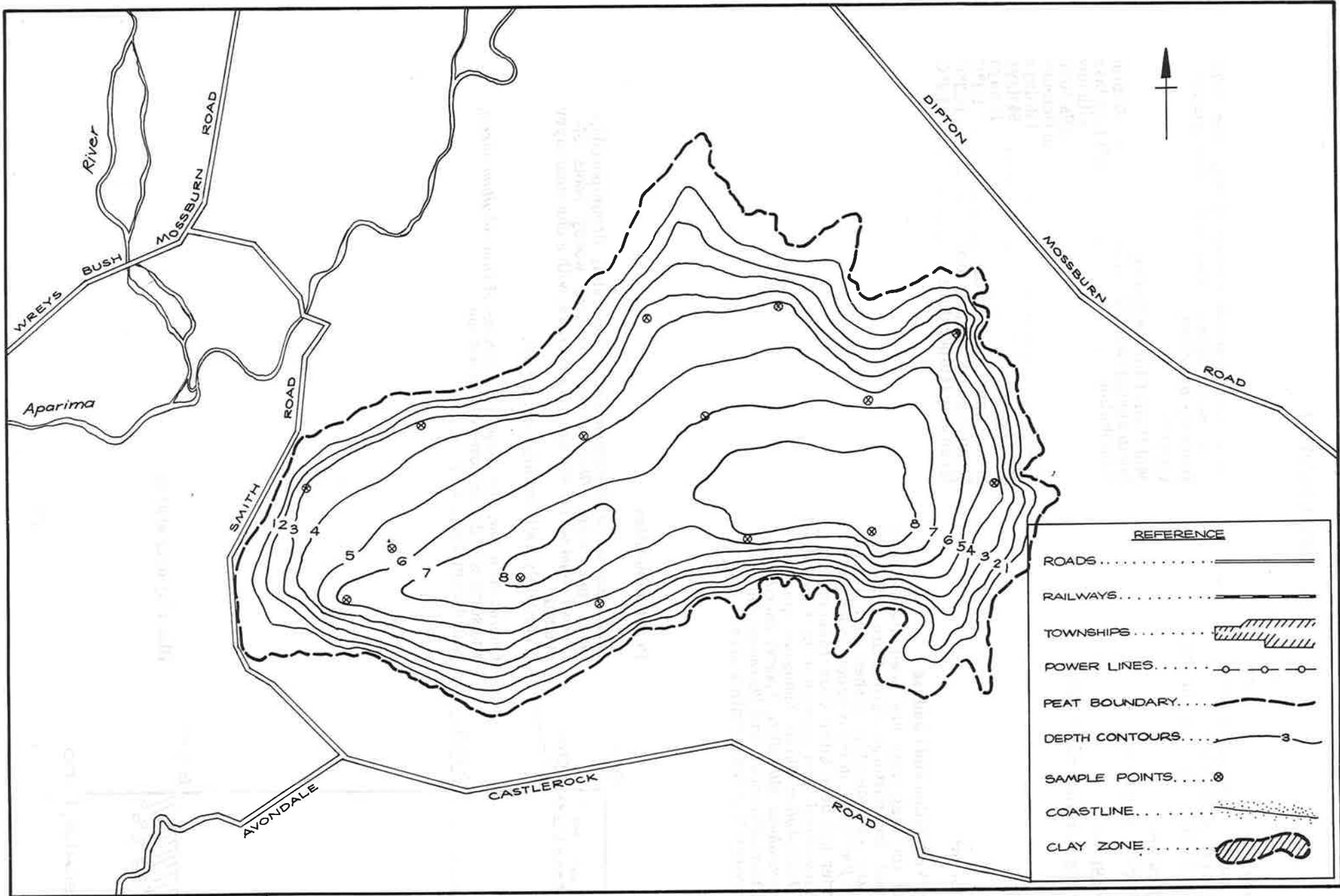
Moderately well decomposed, VP 5-6.

Calorophus minor, *Carex spp.*, woody roots of *Dracophyllum oliveri*, and some well decomposed *Sphagnum spp.*

Well decomposed, VP7.



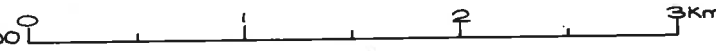
Blue clay over gravel.



CASTLE DOWNS

Water & soil technical publication no. 14 (1978)

SCALE, 1:50 000



45. MOSGIEL PONDING

Location

5.5km west of Mosgiel (S163:965728).
Otago Catchment Board district.

Classification

Mesotrophic.

Present Status

Degenerating, agricultural.

Area

5.0km².

Volume

No estimate of volume.

Surface Vegetation and Landuse

Recently broken in for pastoral agriculture, with rushes present. Considerable wood and stumps, mainly manuka, litter the pasture.

Peat Depth

Ranges from 0.3-1.7m thick, but generally less than 0.5m.

Peat Composition

The peat has a high mineral content, often greater than 50%. Plant remains are dominated by *Baumea* spp., *Carex secta*, woody roots (*Leptospermum scoparium*) and fragments of wood, and are poorly decomposed (VP 3-4). The peat has thin silt layers and is underlain by grey silt.

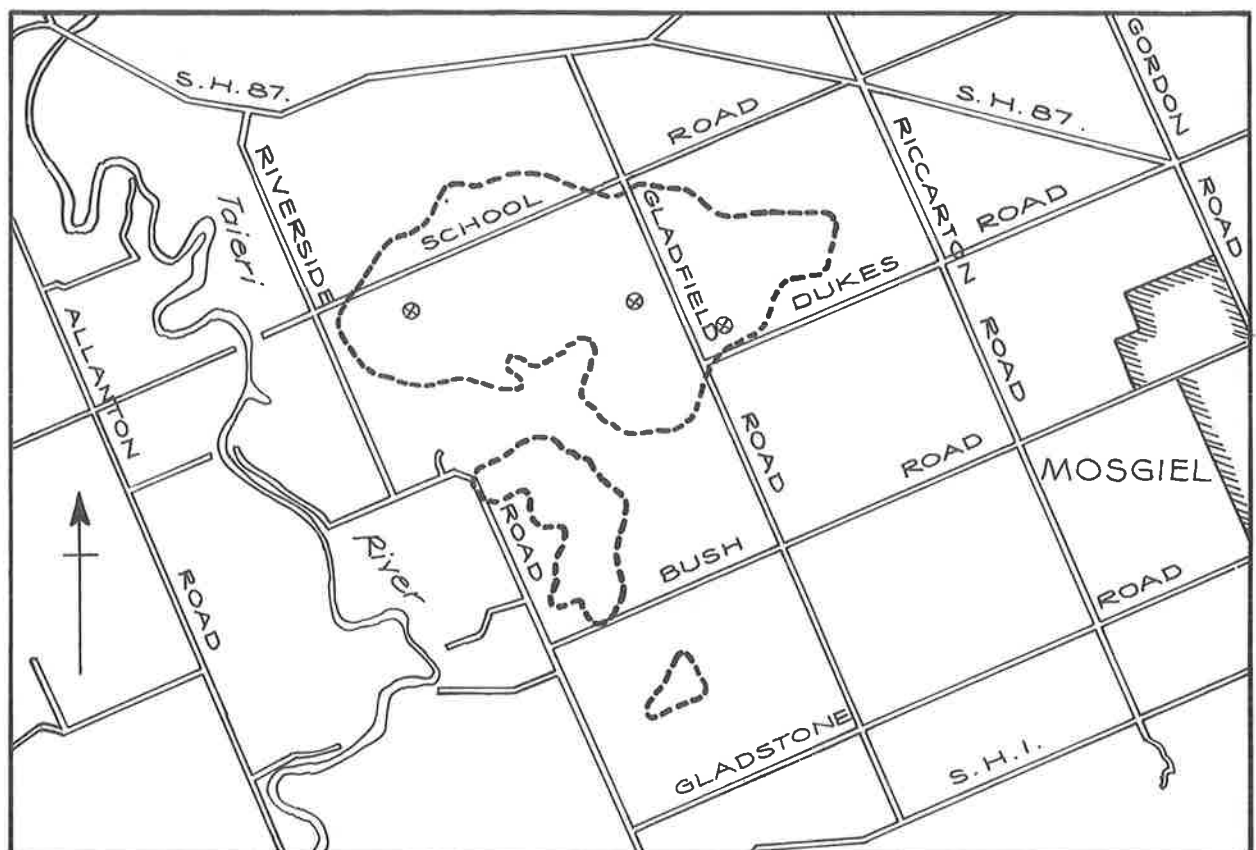
Climate

Dunedin Airport Climate Station.

Mean annual rainfall	688mm
Distribution	unevenly over 159 raindays
Frosts	105 days
Fogs	68 days
Snowfalls	4 days
Mean annual temperature	10.4°C
Mean January temperature	14.8°C
Mean July temperature	4.7°C

General

The area is used to pond flood waters from the streams that drain into the Taieri River from the north-east e.g. Mill Creek, Silverstream.



MOSGIEL PONDING

SCALE, 1:50 000 0 1 2 3 4 5 6 km

46. MAUNGATUA

Location

28km west of Dunedin (S163:821703) — map reference of Maungatua summit) and comprises three main and a number of small pockets between 800 and 895m (the summit). Otago Catchment Board district.

Classification

Oligotrophic, blanket.

Present Status

Active, with surrounding snow tussock apparently being invaded and replaced by the peat.

Surface Vegetation and Landuse

Most of the peat is covered by *Donatia novae-zelandiae*, *Celmisia argentea*, *Oreobolus pectinatus*, *O. pumilo*, *Gaimardia setacea*, *G. pallida*, *Dracophyllum prostratum*, *Pentachondra pumila*, *Drosera arcturi* and lichens of the *Cladonia* and *Thamnolia* genera. *Sphagnum spp.* are found growing only in the margins of open water and small gullies, and is accompanied by *Phormium colensoi*, *Chionochoa spp.*, *Dracophyllum longifolium*, *Dacrydium bidivilli*, *Carpha alpina* and *Carex ternaria*.

Peat Depth

Peat is in small basins (up to 1-2 hectares in area) and is up to 1.0 m in thickness.

Peat Composition

Very wet, poorly decomposed (VP2-3) *Donatia novae-zelandiae*, *Dracophyllum longifolium*, *Pentachondra pumila*, with some *Sphagnum spp.* in layers. Poorly decomposed (VP2) *Sphagnum spp.* dominate under actively growing *Sphagnum spp.* The peat is underlain by bedrock and in some places by buried soils.

Climate

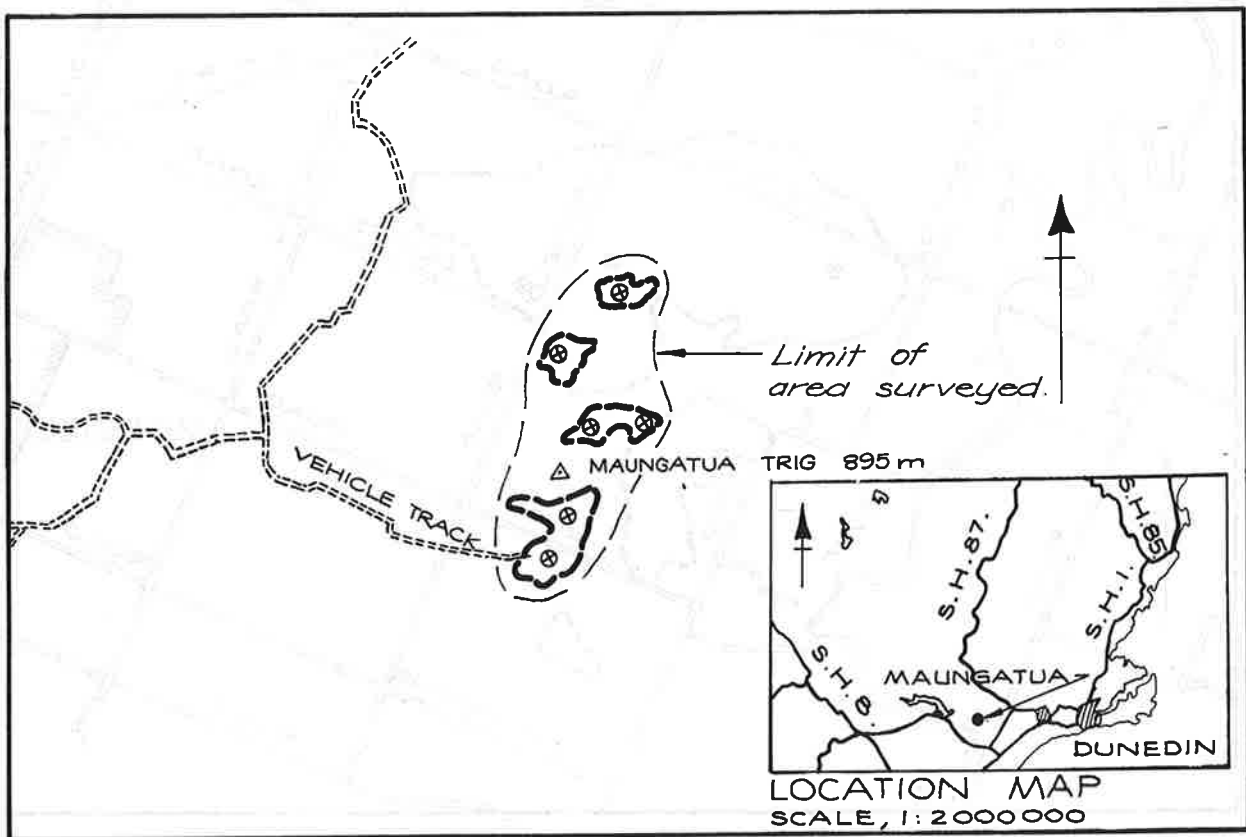
Climate Stations on Maungatua.

Mean annual rainfall	1000mm
Mean annual temperature	5.6°C
Mean January temperature	8.8°C
Mean July temperature	-0.1°C

Frosts of up to -17°C are common.

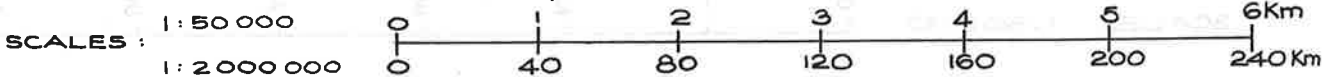
General

Some data have been obtained from:
Mark, A. F. 1955: Grassland and Shrubland on Maungatua, Otago. *N.Z. Journal of Science and Technology*. A37: 349-66.



MAUNGATUA

SCALE, 1:50 000



47. BLUE MOUNTAINS

Location

Extensive peat deposits lie across the summit plateau of the Blue Mountains, 6.5-13.5km east and north-east of Tapanui (S161:164611-map reference of trig K), in the altudinal range 914-1005m.

Otago Catchment Board district.

Classification

Oligotrophic, blanket

Present Status

Partly active (especially in south - west) and, degenerating through erosion (especially in north-east).

Surface Vegetation and Landuse

- (i) The south-western parts are covered by hummocks of *Oreobolus spp.*, *Donatia novae-zelandiae*, *Gaimardia spp.*, *Sphagnum cristatum*, *Carpha alpina*, *Carex spp.*, *Baumea spp.*, and some mosses. Degenerating *Donatia/Oreobolus* surface is colonised by lichens such as *Alectoria spp.*, and the moss *Racomitrium lanuginosum*.
- (ii) The active north-eastern parts are covered by *Dracophyllum longifolium*, *Cassinia spp.*, *Sphagnum cristatum*, *Chionochloa rubra*, *Poa colensoi*, and some *Carpha alpina*. The degenerant areas are bare rock covered by *Cassinia vavilliersii* roots.

Peat Depth

The plateau is covered by an almost continuous layer of peat 0.4-1.0m thick, with bare rock protruding through the surface in places. On leeward slopes the peat may be up to 2.5 m thick.

Peat Composition

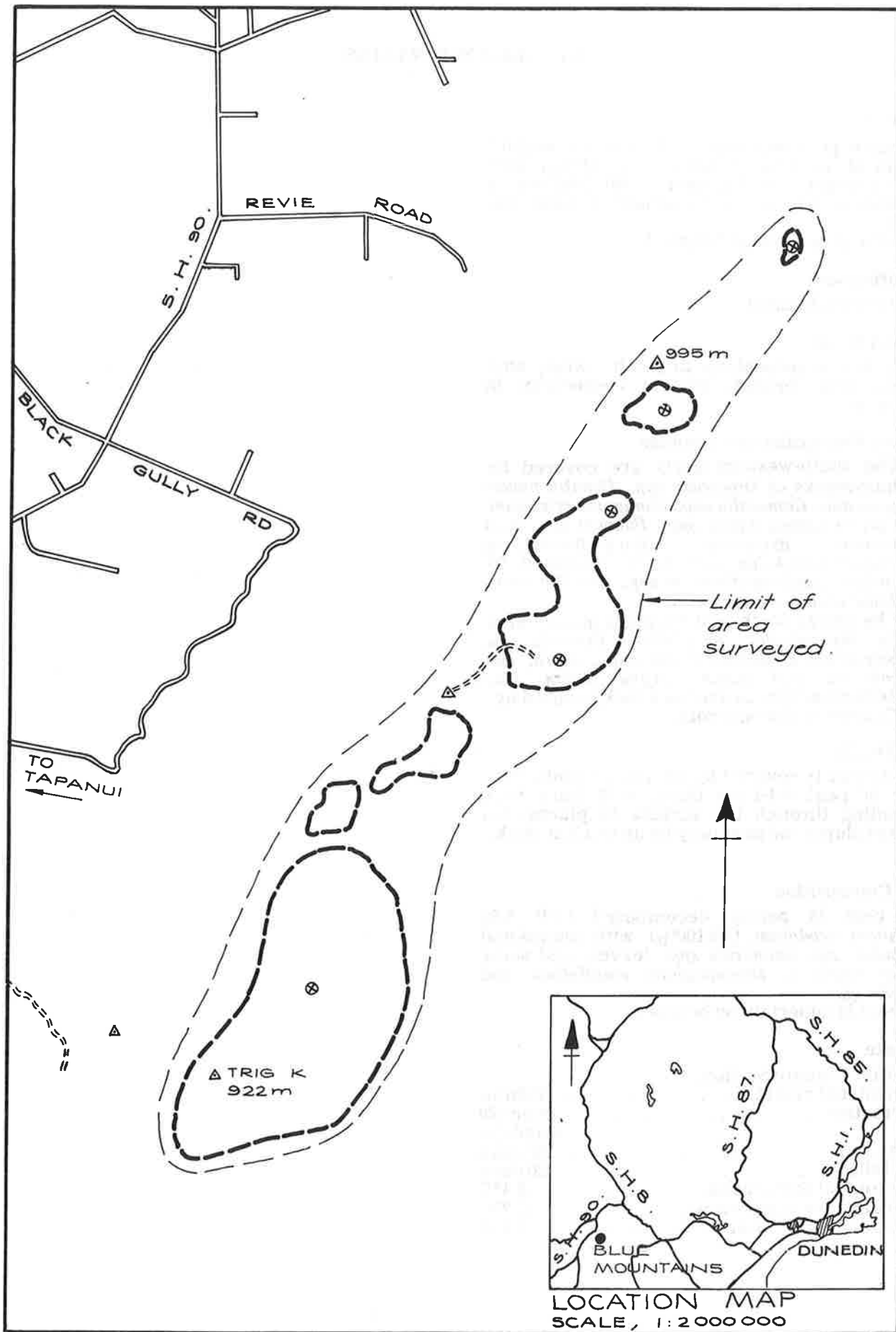
The peat is poorly decomposed (VP 1-2) *Sphagnum cristatum* (95-100%) with occasional *Oreobolus spp.*, *Gaimardia spp.* leaves, and some woody roots of *Dracophyllum longifolium* and *Cassinia spp.*

The peat is underlain by bedrock.

Climate

Moa Flat Climate Station.

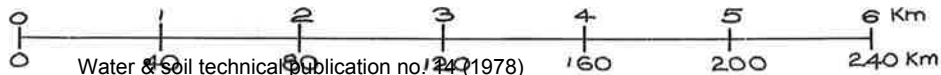
Mean annual rainfall 739mm
Distribution over 120
raindays
Frosts 132 days
Snowfalls 20 days
Mean annual temperature 8.4°C
Mean January temperature 12.7°C
Mean July temperature 2.9°C



BLUE MOUNTAINS

SCALE 1:50 000

SCALES:
 1: 50 000
 1: 2 000 000



48. BLACK SWAMP

Location

48km south-west of Dunedin (S171:643554) at an altitude of about 395m. Otago Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Active.

Area

0.5km².

Volume

1.5 million m³.

Peat Depth

The thickness on the dome ranges from 4.0-4.7m and on the margins from 1.0-1.5m.

Climate

Mahinerangi Climate Station.

Mean annual rainfall 998mm
Distribution unevenly over
173 days

Frosts 125 days

Fogs 7 days

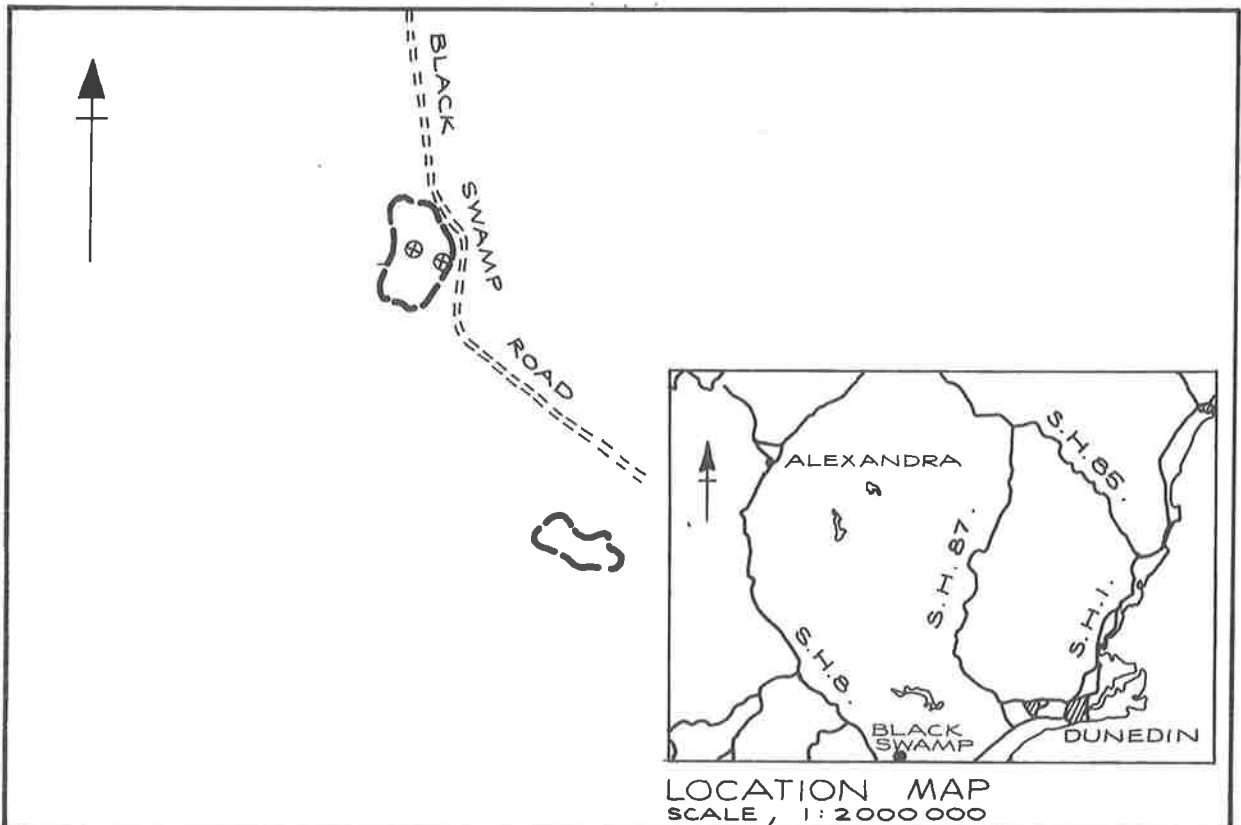
Mean annual temperature 7.7°C

Mean January temperature 13.9°C

Mean July temperature 2.0°C

Surface vegetation and Landuse

Most of the swamp is undeveloped, with very small areas of the margins partially drained. The dome is covered by *Calorophus minor*, *Sphagnum spp.*, *Dracophyllum longifolium* and some low *Leptospermum scoparium*. On the fringes of the dome there are some patches of *Phormium cookianum* and taller *Leptospermum scoparium*.



BLACK SWAMP

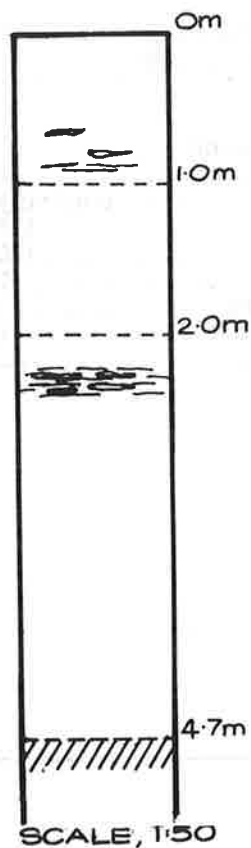
SCALE 1:25 000

SCALES : 1:25 000

1:2 000 000



Peat Composition



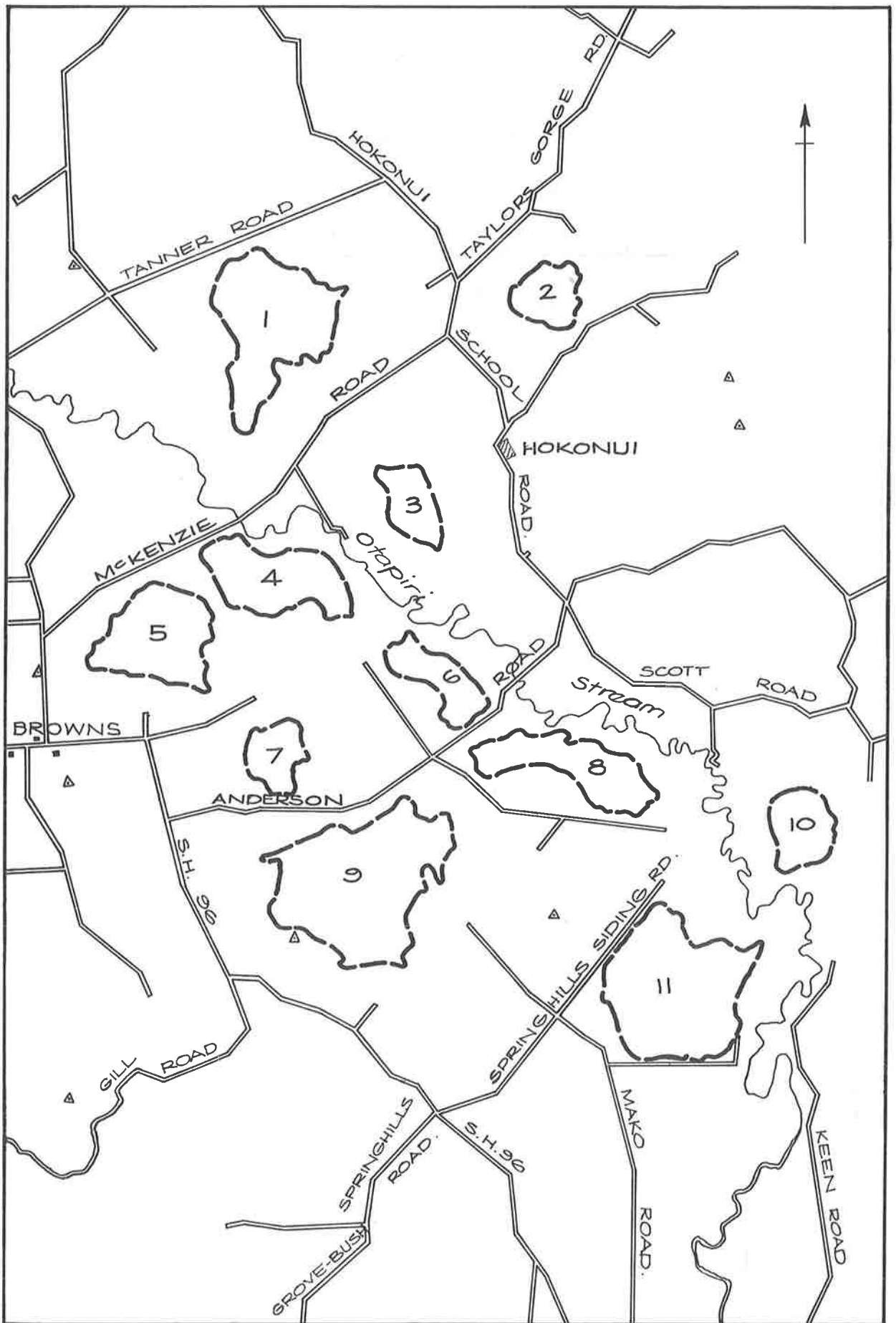
Calorophus minor, *Sphagnum spp.* and some woody roots. Poorly decomposed, VP 1-2.

Calorophus minor, *Sphagnum spp.* Poor — moderately decomposed, VP 2-3.

Fibrous-woody root mat at 2.3m.

Grey silt.

SCALE, 1:50



SPRINGHILLS

SCALE 1 : 50 000

0 1 2 3 4 5 6 km

Water & soil technical publication no. 14 (1978)

49. SPRINGHILLS

General

A series of eleven peat bogs in the Browns district east of Winton and 30-35km north-north-east of Invercargill.

Six of these bogs i.e. 1,3,4,5,9 and 11 (see location map) were surveyed in detail and are discussed individually. The southern most peat bog (11) is being mined at present. The majority of the bogs have deep drains surrounding them. Occasional drains traverse the bogs. Some have been burnt and grazed by stock.
Southland Catchment Board district.

Springhills 1

Location

11.5km north-east of Winton (S169:389425)

Classification

Oligotrophic, high moor.

Present Status

Active, although small areas of the lagg are degenerating, agricultural.

Area

1.2km².

Volume

3 million m³.

Surface Vegetation and Landuse

The small areas of the lagg that are developed are in pasture, but stumps are now protruding

through the surface. The greatest proportion of the swamp is undeveloped and is covered by *Calorophus minor*, *Gleichenia dicarpa*, *Leptospermum scoparium*, *Epacris pauciflora*, *Oreobolus spp.*, *Drosera spp.*, *Sphagnum spp.* and *Dicranoloma billardieri*. Isolated areas are regenerating after burning and are dominated by gorse and bracken fern.

Climate

Winton Climate Station.

Mean annual rainfall	847mm
Distribution	over 128 raindays
Frosts	120 days
Fogs	5 days
Snowfalls	4-5 days
Mean annual temperature	9.3°C
Mean January temperature	14.6°C
Mean July temperature	3.0°C

Peat Composition

The peat profile described is typical of the dome peat. The lagg peat has a greater proportion of woody and sedge roots.

Sphagnum spp. (up to 60%), *Calorophus minor*, some *Dicranoloma billardieri*, *Gleichenia dicarpa*.
Poorly decomposed, VP 2-3.

Less *Sphagnum spp.*, *Calorophus minor*, *Gleichenia dicarpa*, root nodules and twigs of *Podocarpus dacrydioides*.
Moderately decomposed, VP 4-5.

Sphagnum spp. not present below about 2.5 metres.



Grey or grey-brown clay.

Springhills 3

Location

12km east of Winton (S169:366442).

Classification

Oligotrophic, high moor.

Present Status

Regenerating.

Area

0.4km².

Volume

0.6 million m³.

Climate

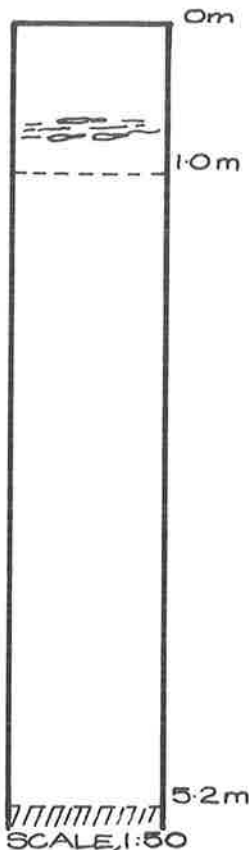
Winton Climate Station.

Mean annual rainfall	847mm
Distribution	over 128
	raindays
Frosts	120 days
Fogs	5 days
Snowfalls	4-5 days
Mean annual temperature	9.3°C
Mean January temperature	14.6°C
Mean July temperature	3.0°C

Surface Vegetation and Landuse

The swamp has been extensively drained and burnt. The native peat forming vegetation, now regenerating, comprises *Sphagnum spp.*, *Calorophus minor*, *Gleichenia dicarpa*, *Leptospermum scoparium*, *Epacris pauciflora*, *Oreobolus spp.*, *Carex spp.* (in drier areas), *Phormium tenax*, and a ground cover of mosses and lichens (*Cladonia retipora*, *C. aggregata*). Gorse and blackberry are also present.

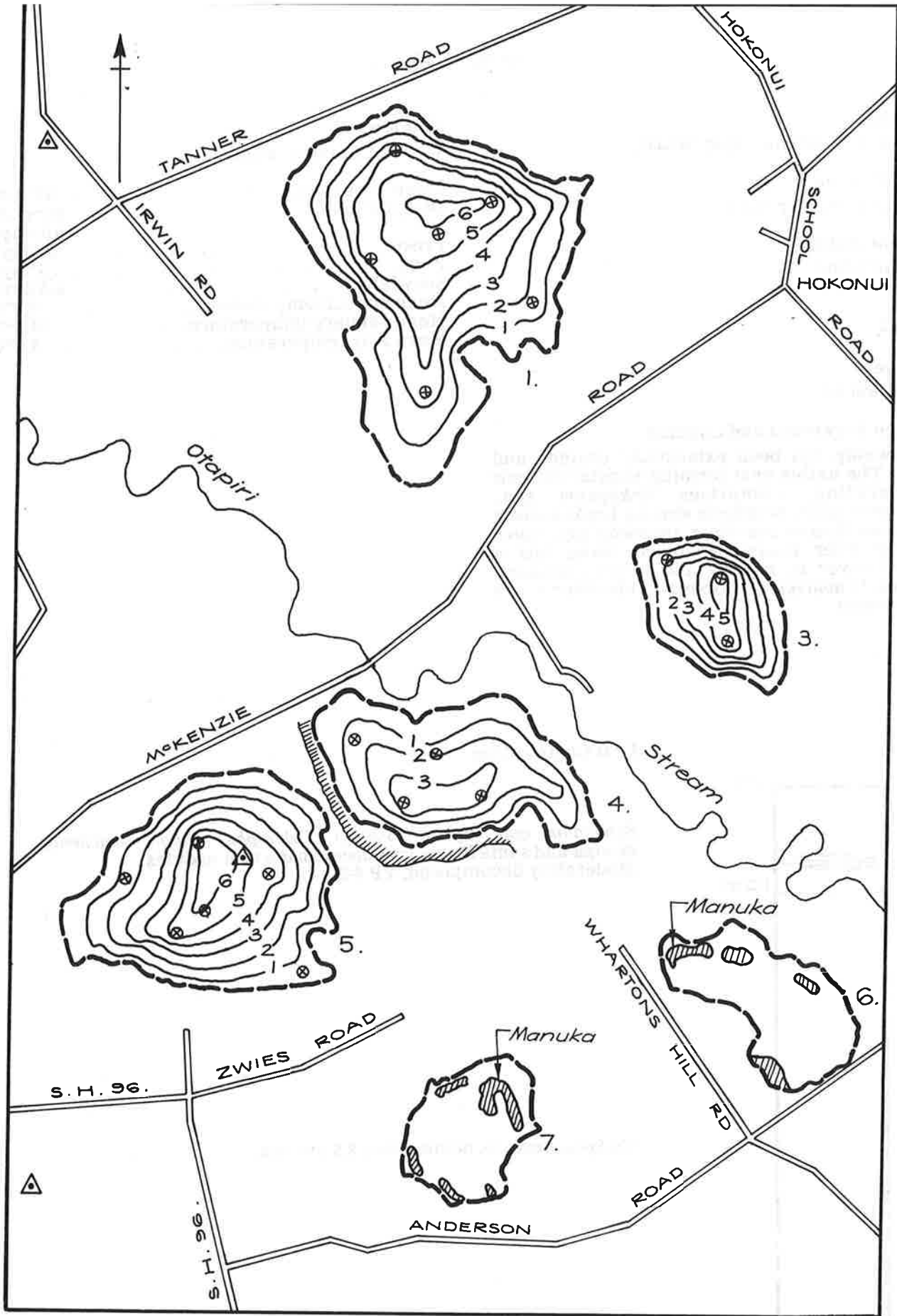
Peat Composition



Sphagnum spp. (up to 45-50%), *Calorophus minor*, *Gleichenia dicarpa* and some *Podocarpus dactyloides* root nodules. Moderately decomposed, VP 4-5.

No *Sphagnum spp.* below about 2.4 metres.

Grey or blue-grey clay.



SPRINGHILLS

SCALE, 1:25 000



Springhills 9

Location

12km east of Winton (S169:442328).

Classification

Oligotrophic, high moor.

Present Status

Active and partly regenerating after burning.

Area

1.8km².

Volume

5.7 million m³.

Climate

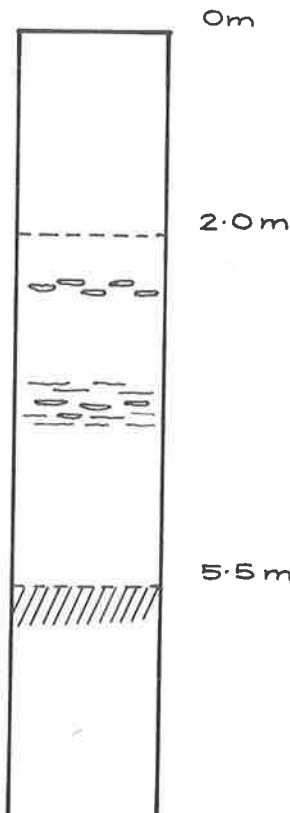
Winton Climate Station.

Mean annual rainfall	847mm
Distribution	over 128
	raindays
Frosts	120 days
Fogs	5 days
Snowfalls	4-5 days
Mean annual temperature	9.3°C
Mean January temperature	14.6°C
Mean July temperature	3.0°C

Surface Vegetation and Landuse

Much of the lagg and rand areas have been drained and developed for pastoral agriculture. The dome area is partly undeveloped and partly drained, and has been burnt recently. The undeveloped area is covered by *Calorophus minor*, *Gleichenia dicarpa*, *Leptospermum scoparium*, *Epacris pauciflora*, *Oreobolus spp.*, with *Carex spp.*, *Dicranoloma billardieri* and, on fringe areas, some *Juncus spp.* The areas regenerating after burning are covered by *Calorophus minor*, *Dicranoloma billardieri*, *Oreobolus spp.*, some *Gleichenia dicarpa* and small *Leptospermum scoparium*. The drains on and around this swamp are very deep and wide.

Peat Composition

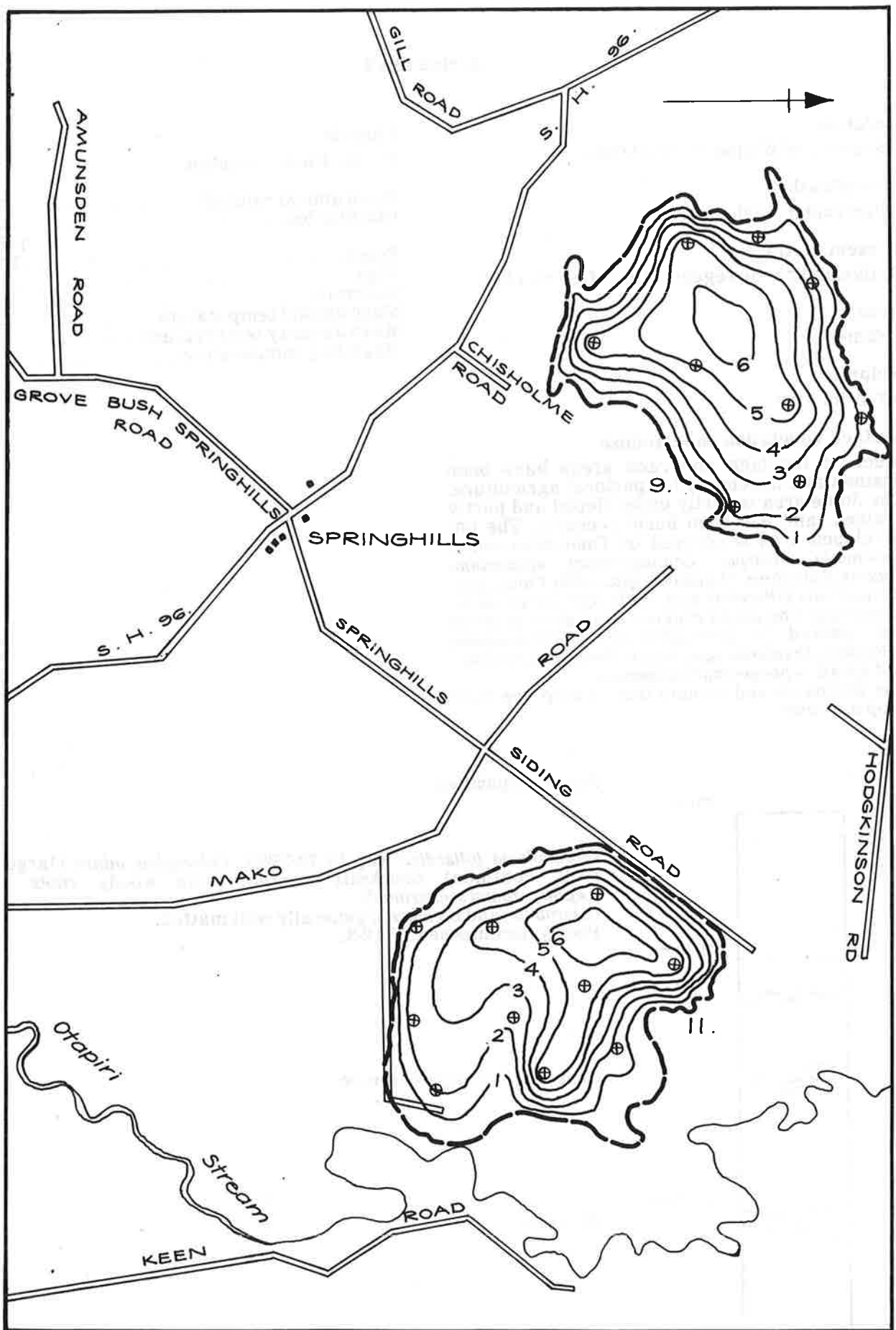


Dicranoloma billardieri (up to 70-75%), *Calorophus minor* (large roots common) *Gleichenia dicarpa*, some woody roots (*Leptospermum scoparium*?). *Calorophus* and *Gleichenia* generally well matted. Poorly decomposed, VP 2-3.

Root/woody layers common.

Grey clay.

SCALE, 1:75



SPRINGHILLS

SCALE 1 : 25 000 0 1 2 3 km
 Water & soil technical publication no. 14 (1978)

Springhills 11

Location

14.5km east of Winton (S169:470317).

Classification

Oligotrophic, high moor.

Present Status

Primarily active, a small area degenerating, mining.

Area

1.8km².

Volume

5.1 million m³.

Climate

Winton Climate Station.

Mean annual rainfall.....	847mm
Distribution.....	over 128
	raindays
Frosts.....	120 days
Fogs.....	5 days
Snowfalls.....	4-5 days
Mean annual temperature.....	9.3°C
Mean January temperature.....	14.6°C
Mean July temperature.....	3.0°C

Surface Vegetation and Landuse

Except for small areas in the swamp margins and in the northern end of the swamp, which have been developed for pastoral agriculture, and a small area which has been cleared for mining, the swamp is in an undeveloped state. The vegetation is *Calorophus minor*, *Sphagnum spp.*, *Gleichenia dicarpa*, *Dracophyllum oliveri*, small and low *Leptospermum scoparium*, with some *Dicranoloma billardieri* and *Chionochloa rubra*.

Peat Composition

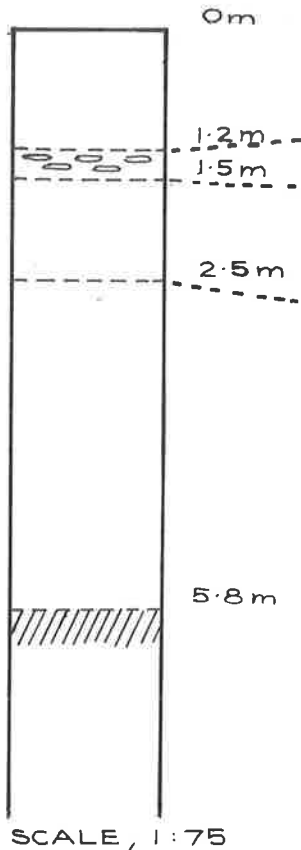
Sphagnum spp. (up to 85%), *Calorophus minor*, some *Gleichenia dicarpa*, *Podocarpus dacrydioides* root nodules and *Dracophyllum oliveri* roots.

Poorly decomposed, VP 2-3.

Twig/root layer, difficult to penetrate, prominent in all drains.

Sphagnum spp. (more decomposed and less dominant), *Calorophus minor*, some *Gleichenia dicarpa* and *Podocarpus dacrydioides* root nodules.

Moderately decomposed, VP 4-5.



Blue or blue-grey clay.

50. OTAUTAU

Location

40km north-west of Invercargill and 5.5km north-east of Otautau (S168:091358).

The swamp is divided by a broad, deep drain running south into the Waimatuku Stream. Southland Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Active.

Area

12.2km².

Volume

50.9 million m³.

Surface Vegetation and Landuse

The entire swamp is undeveloped, although there are substantial drains in some places. The vegetation is *Calorophus minor* (comprising up to 90% of the canopy layer), *Baumea* spp., *Leptospermum scoparium*, some *Gleichenia dicarpa*, *Dracophyllum oliveri*, and a ground cover of *Sphagnum* spp. (65-70%) and *Dicranoloma billardieri*.

Climate

Otautau Climate Station.

Mean annual rainfall 1068mm

Distribution over 138
raindays

Frosts 107 days

Fogs 7 days

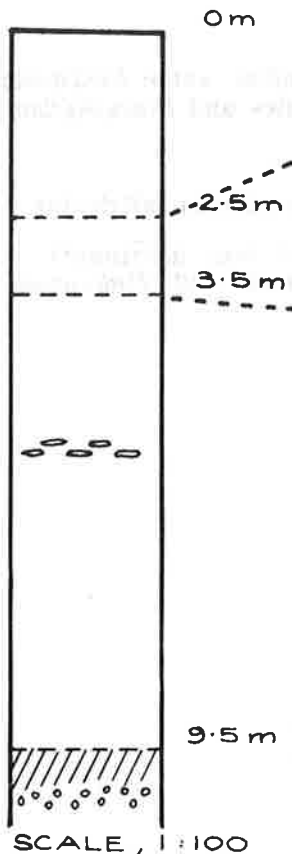
Snowfalls 3 days

Mean annual temperature 9.7°C

Mean January temperature 13.9°C

Mean July temperature 4.3°C

Peat Composition



Calorophus minor, moderately decomposed *Sphagnum* spp., *Baumea* spp., some *Gleichenia dicarpa* and *Podocarpus dacrydioides* root nodules.

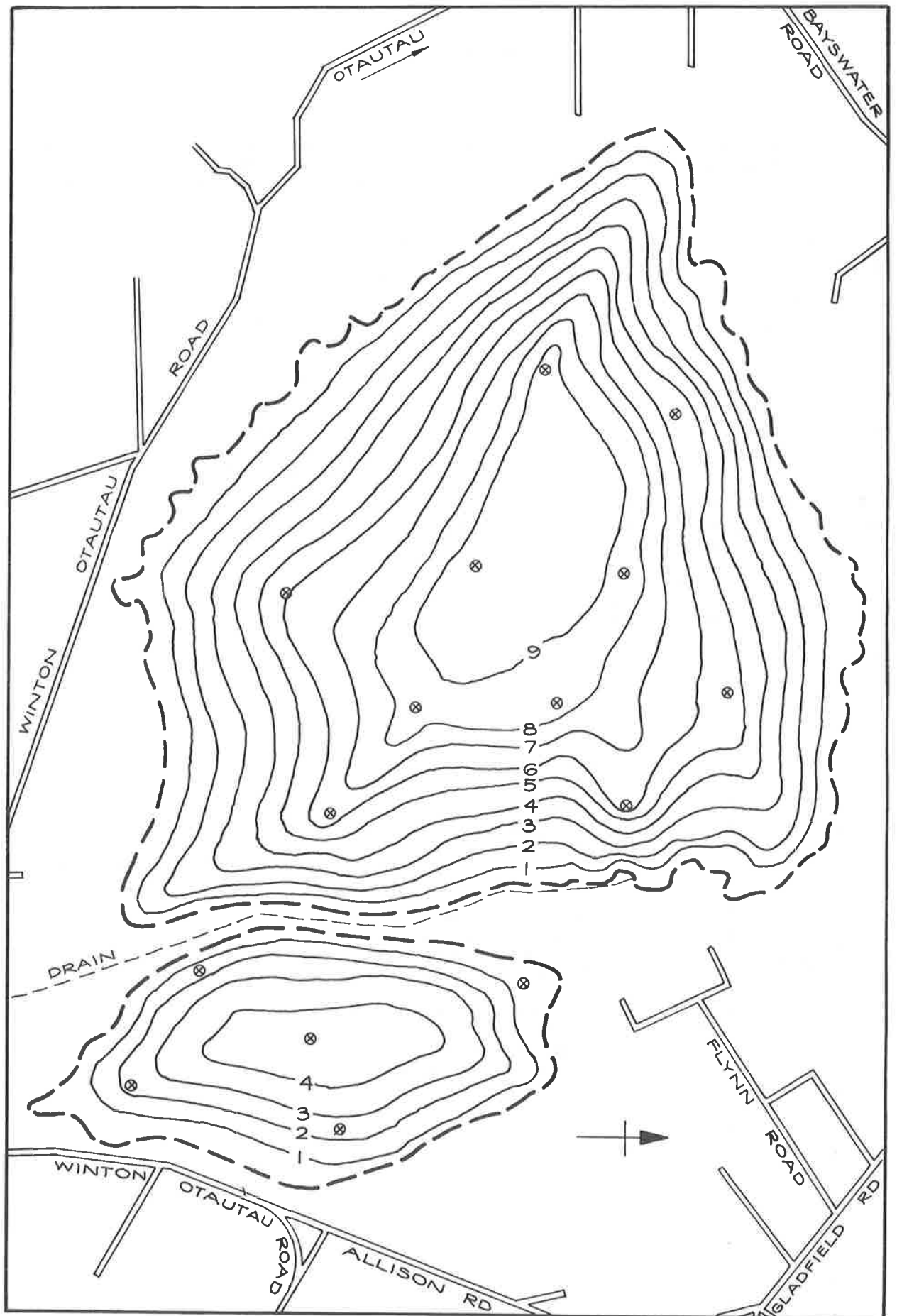
Very wet, moderately decomposed, VP 4-5.

Calorophus minor, *Dicranoloma billardieri* (in layers), *Baumea* spp., some *Gleichenia dicarpa*, some *Podocarpus dacrydioides* root nodules.

Wet, moderately decomposed, VP 4.

Layer of timber at 5.5m.

Grey or blue-grey clay over gravel.



OTAUTAU

SCALE, 1:25 000 0 1 2 3km

51. DRUMMOND

Location

16.5km east of Otautau and 4.5km south-east of Drummond (S168:210310, although the largest part lies on S176).

Southland Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Active, but in parts regenerating.

Area

4.9km².

Volume

14.2 million m³.

Surface Vegetation and Landuse

Parts of the swamp have been burnt, but are now regenerating. The lagg is covered by manuka, gorse and a ground cover of introduced grasses and *Marchantia* spp. The unburnt areas of the dome are covered by *Calorophus minor*, *Gleichenia dicarpa*, *Leptospermum scoparium* (up to 0.4m high), *Coprosma* spp., *Carex coriacea*, *Epacris pauciflora* and *Sphagnum* spp. (mainly cushions).

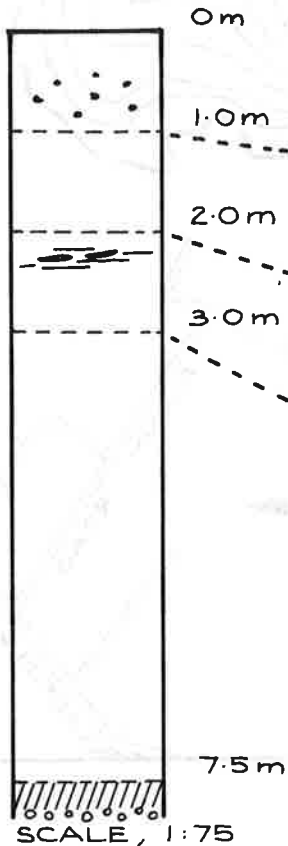
The regenerating areas are dominated by *Baumea* spp. and *Calorophus minor*; with *Leptospermum scoparium*, *Gleichenia dicarpa*, *Celmisia* spp., *Oreobolus* spp., *Nertera* spp., *Drosera* spp., mosses and large domes of dead *Sphagnum* spp.

Climate

Otatau Climate Station.

Mean annual rainfall	1068mm
Distribution	over 138 raindays
Frosts	107 days
Fogs	7 days
Snowfalls	3 days
Mean annual temperature	9.7°C
Mean January temperature	13.9°C
Mean July temperature	4.3°C

Peat Composition

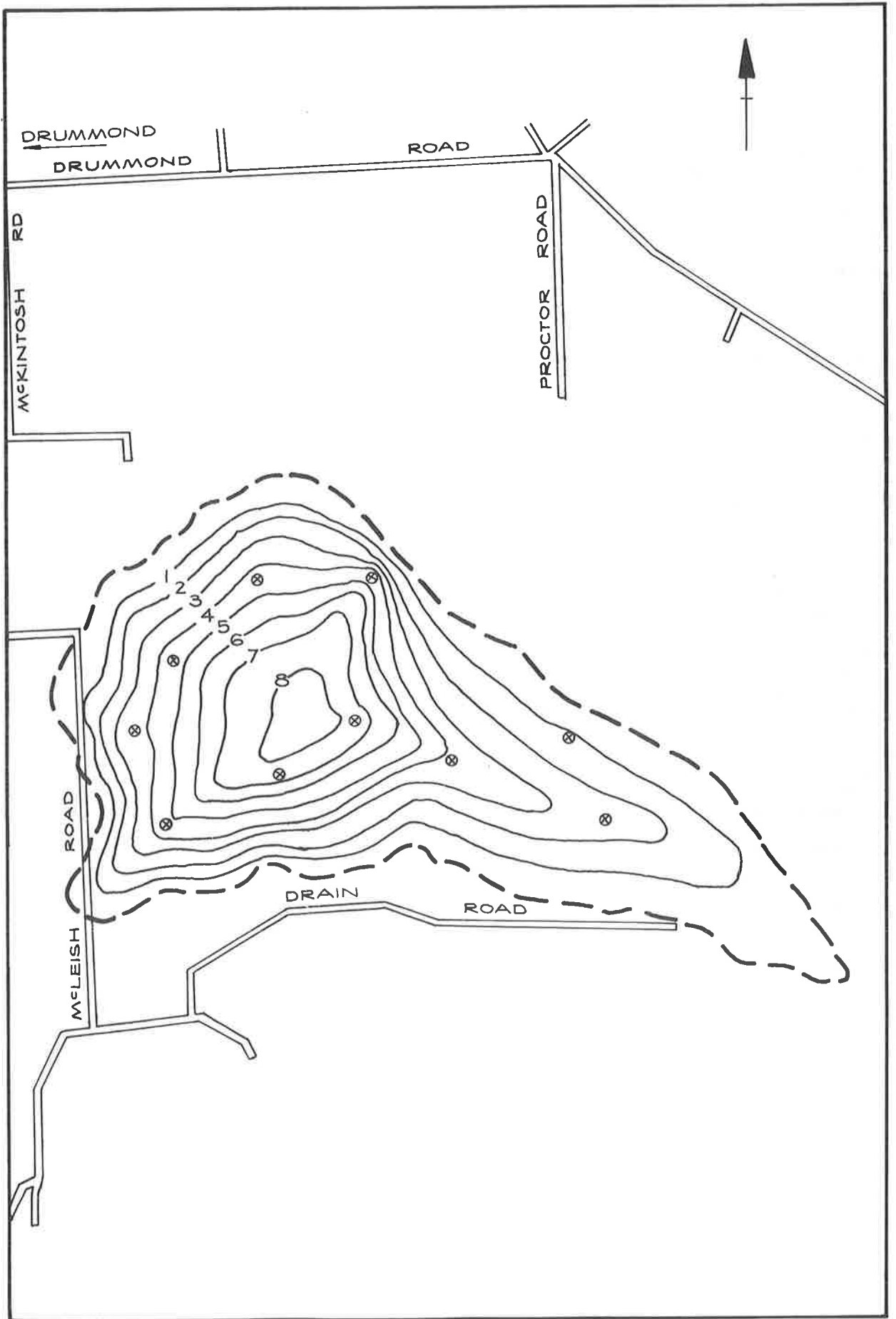


Moderately decomposed *Sphagnum* spp., *Calorophus minor*, *Gleichenia dicarpa*, *Baumea* spp., *Carex* spp. (especially *C. coriacea*), *Podocarpus dacrydioides* root nodules. Some charcoal fragments, poorly to moderately decomposed, VP 3.

Calorophus minor, *Gleichenia dicarpa*, some well decomposed-*Sphagnum* spp., *Baumea* spp., *Carex* spp., and *Podocarpus dacrydioides* root nodules. Moderately decomposed VP 4-5.

Calorophus minor, *Gleichenia dicarpa*, some *Cassinia* spp. and woody roots. Moderately decomposed, VP 4-5. Layers of poorly decomposed (VP 2-3) *Sphagnum* spp.

Blue clay over gravels.



DRUMMOND

SCALE, 1:25 000 0 1 2 3km
Water & soil technical publication no. 14 (1978)

52. STIRLING

Location

4.5km east of Balclutha (S179:562262).
Otago Catchment Board district.

Classification

Mesotrophic.

Present Status

Degenerating, agricultural.

Area

1.3km² although about 15% is covered by 0.3-0.6m of grey alluvial silt.

Volume

5.5 million m³.

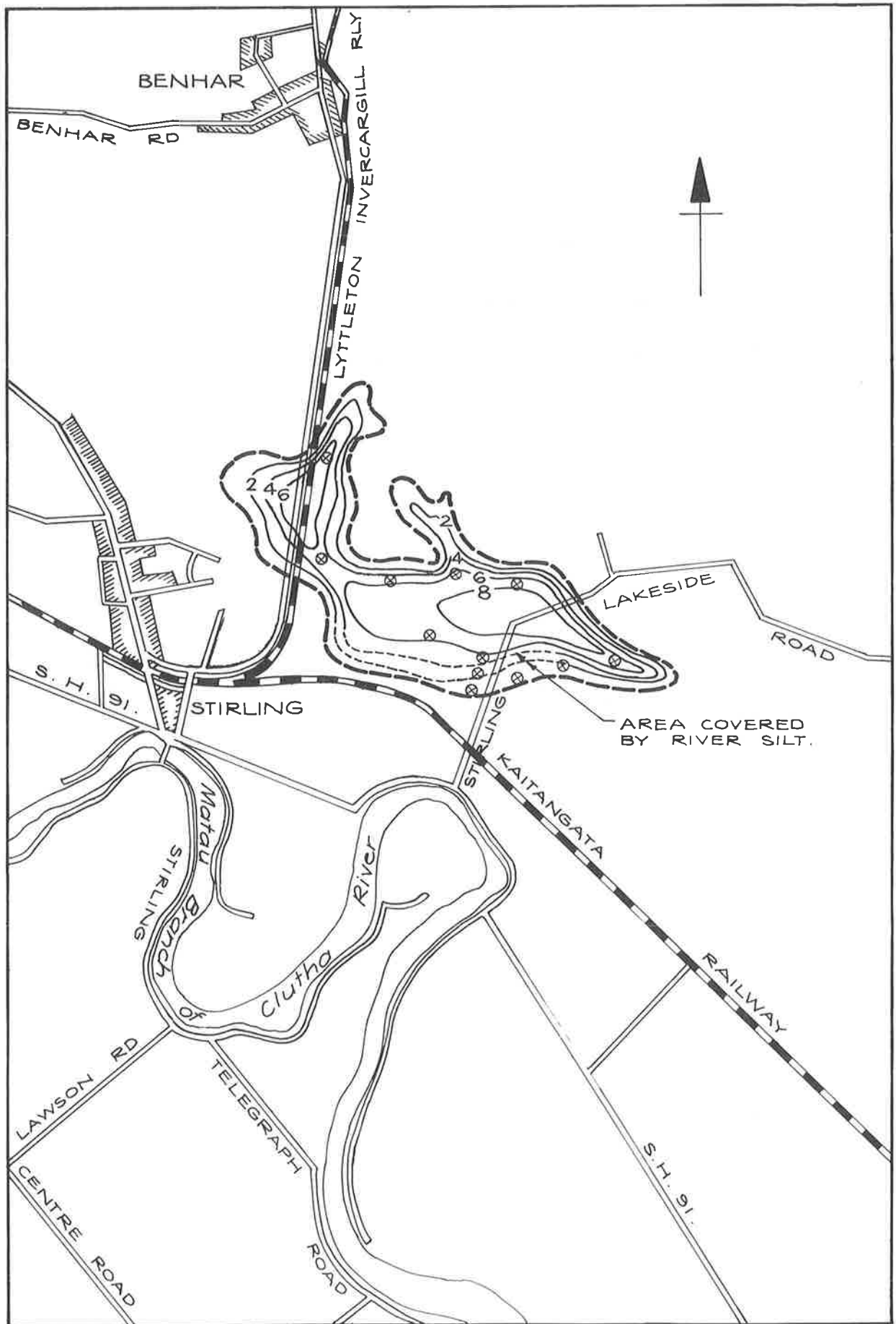
Surface Vegetation and Landuse

Almost the entire swamp has been developed agriculturally, the largest part is in pasture. Some small areas of pasture have sedges, rushes, gorse, stumps and logs. Small areas are cultivated for fodder crops. The eastern north-south lobe is still covered by *Baumea* spp., *Phormium tenax*, gorse and *Leptospermum scoparium*.

Climate

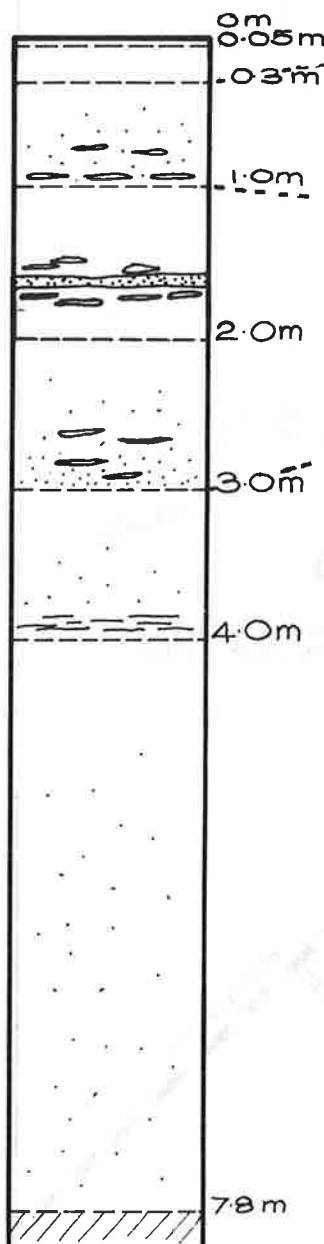
Fineand Climate Station

Mean annual rainfall	786mm
Distribution	unevenly over 121 raindays
Frosts	58 days
Fogs	31 days
Snowfalls	3 days
Mean annual temperature	7.7°C
Mean January temperature	18.0°C
Mean July temperature	4.2°C



STIRLING

Peat Composition



Mineralised peat.

Baumea spp., some *Gleichenia dicarpa*, *Calorophus minor*, *Podocarpus dacrydioides* root nodules, and *Carex* spp.
High mineral content, moderately decomposed, VP 5-6.
Layer of wood at 1.0m.

Increasing mineral content, moderately decomposed, VP 6.
Layer grey silt at 1.6m, layer of wood at 1.7m. *Baumea* spp., *Carex* spp. (especially *C. sinclairii* and *C. goudichaudiana*), some *Podocarpus dacrydioides* root nodules and rare *Myrsine divaricata* leaves.
High mineral content, well decomposed, VP 6-7.

Baumea spp., some *Calorophus minor*, and *Carex* spp., layers of *Myrsine divaricata* leaves, and some *Podocarpus dacrydioides* root nodules.

Mineral content increasing, well decomposed, VP 7.
Fibrous root layer (*Baumea/Carex*) at 3.8-3.9m.

Grey silt.

SCALE, 1:50

53. TUSSOCK CREEK

Location

20km north of Invercargill (S177:366221).
Southland Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Active.

Area

2.1km².

Volume

5.6 million m³.

Climate

Invercargill Airport Climate Station.

Mean annual rainfall 1042mm

Distribution..... evenly over
157 raindays

Frosts..... 116 days

Snowfalls..... 4 days

Mean annual temperature 9.5°C

Mean January temperature..... 13.4°C

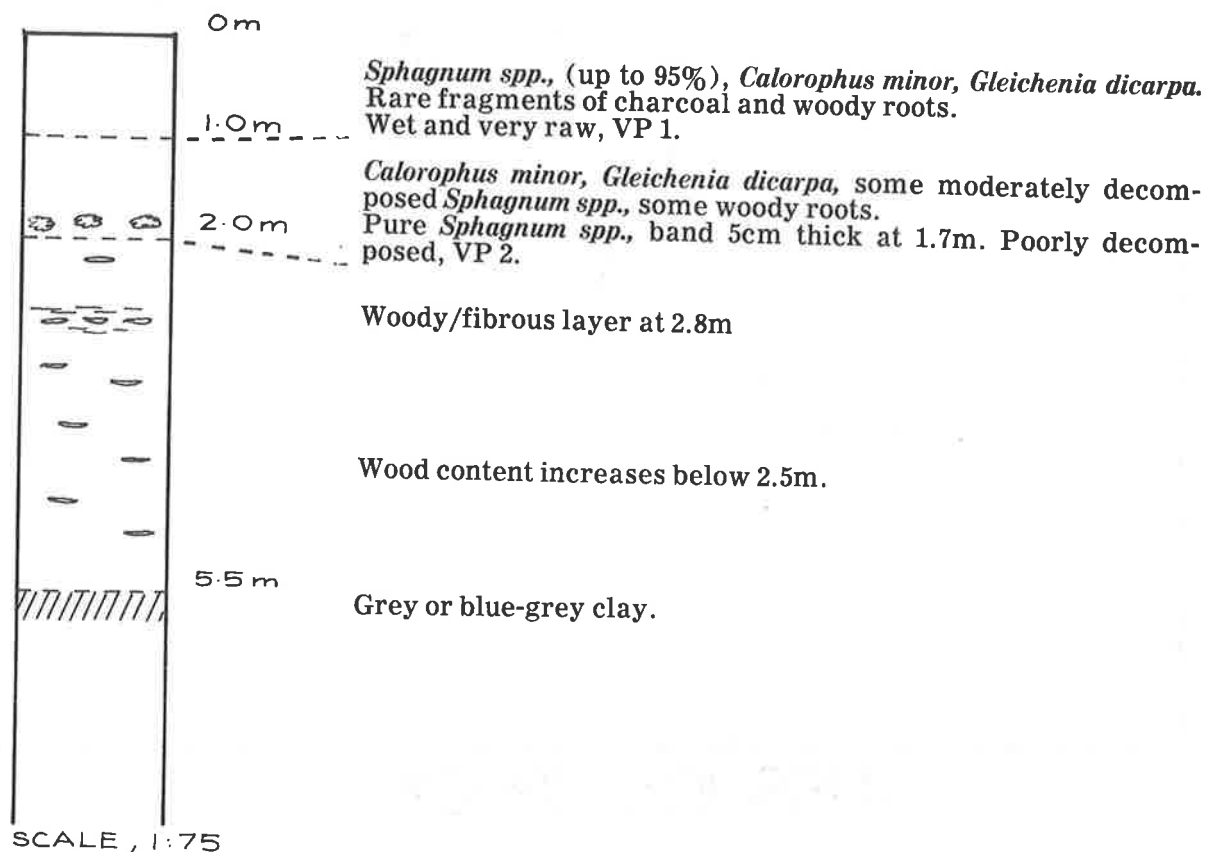
Mean July temperature 4.7°C

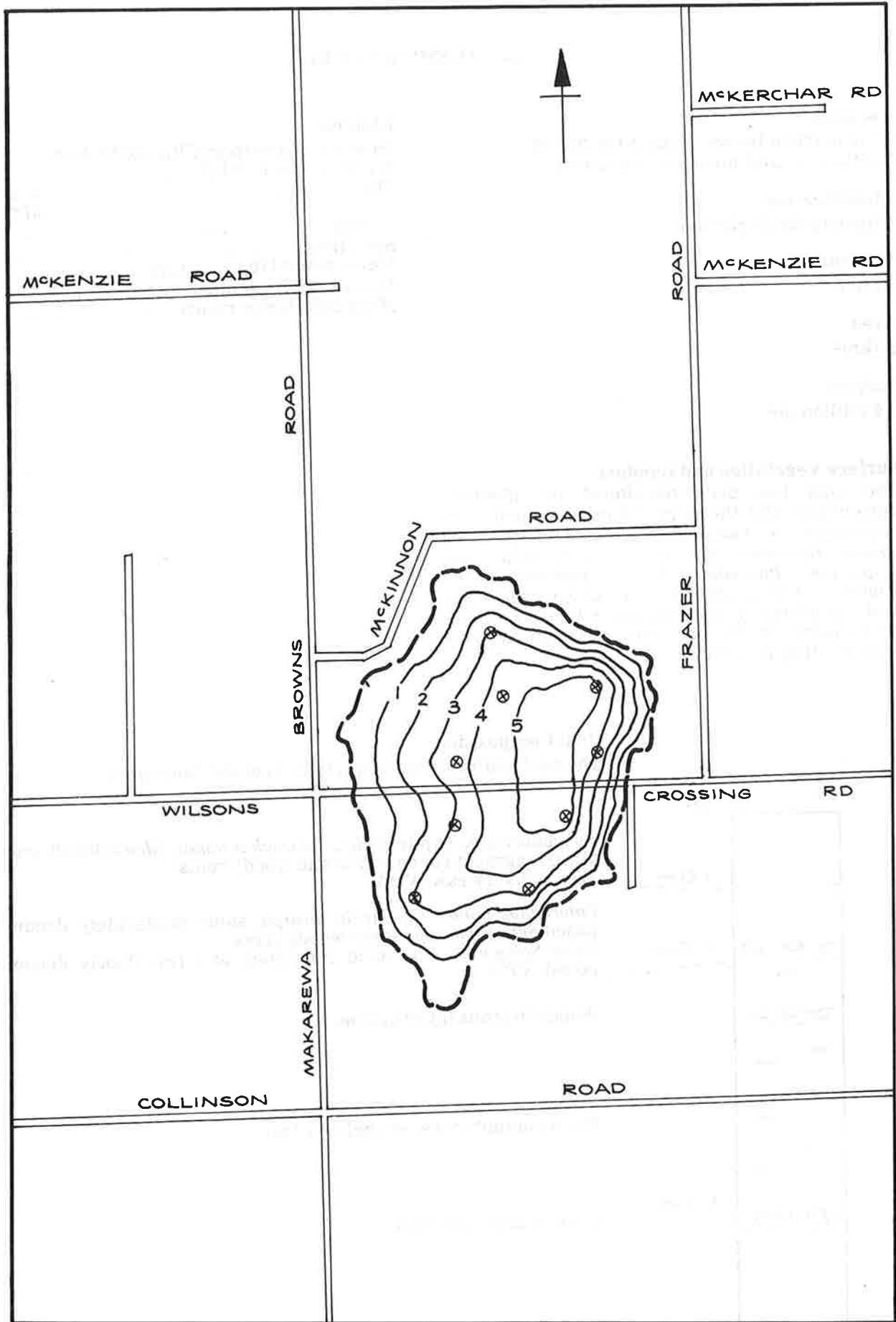
Surface Vegetation and Landuse

The tagg has been developed for pastoral agriculture and the dome is undeveloped. The vegetation is *Calorophus minor*, *Dracophyllum olivieri*, *Gleichenia dicarpa*, some *Leptospermum scoparium*, *Phormium tenax*, *Donatia novae-zelandiae*, with a ground cover of *Sphagnum spp.* and occasionally *Dicranoloma billardieri*. Small areas burnt in the past now have an actively regenerating vegetation.

Peat Composition

The peat profile described is typical of the dome peat.





TUSSOCK CREEK



54. OTANOMOMO

Location

Three small peat domes south of the Clutha delta in an area of impeded drainage and gleyed swampy soils.

Dome 1: 8.5km south of Balclutha (S179:512174);

Dome 2: 9km south of Balclutha (S179:527168);

Dome 3: 11km south-south-east of Balclutha (S179:558157).

Otago Catchment Board district.

Classification

Domes 1 and 2 are oligotrophic, high moor. No detailed sampling of Dome 3 was carried out, but is assumed to be oligotrophic, high moor.

Present Status

Dome 1 degenerating;
Dome 2 degenerating, agricultural;
Dome 3 degenerating, agricultural.

Area

Dome 1: 0.5 km².
Dome 2: 0.4 km².
Dome 3: 2.8 km².

Volume

Dome 1: 1.3 million m³.
Dome 2: 0.6 million m³.
Dome 3: 2.2 million m³, the greater part of which is mineralised peat.

Surface Vegetation and Landuse

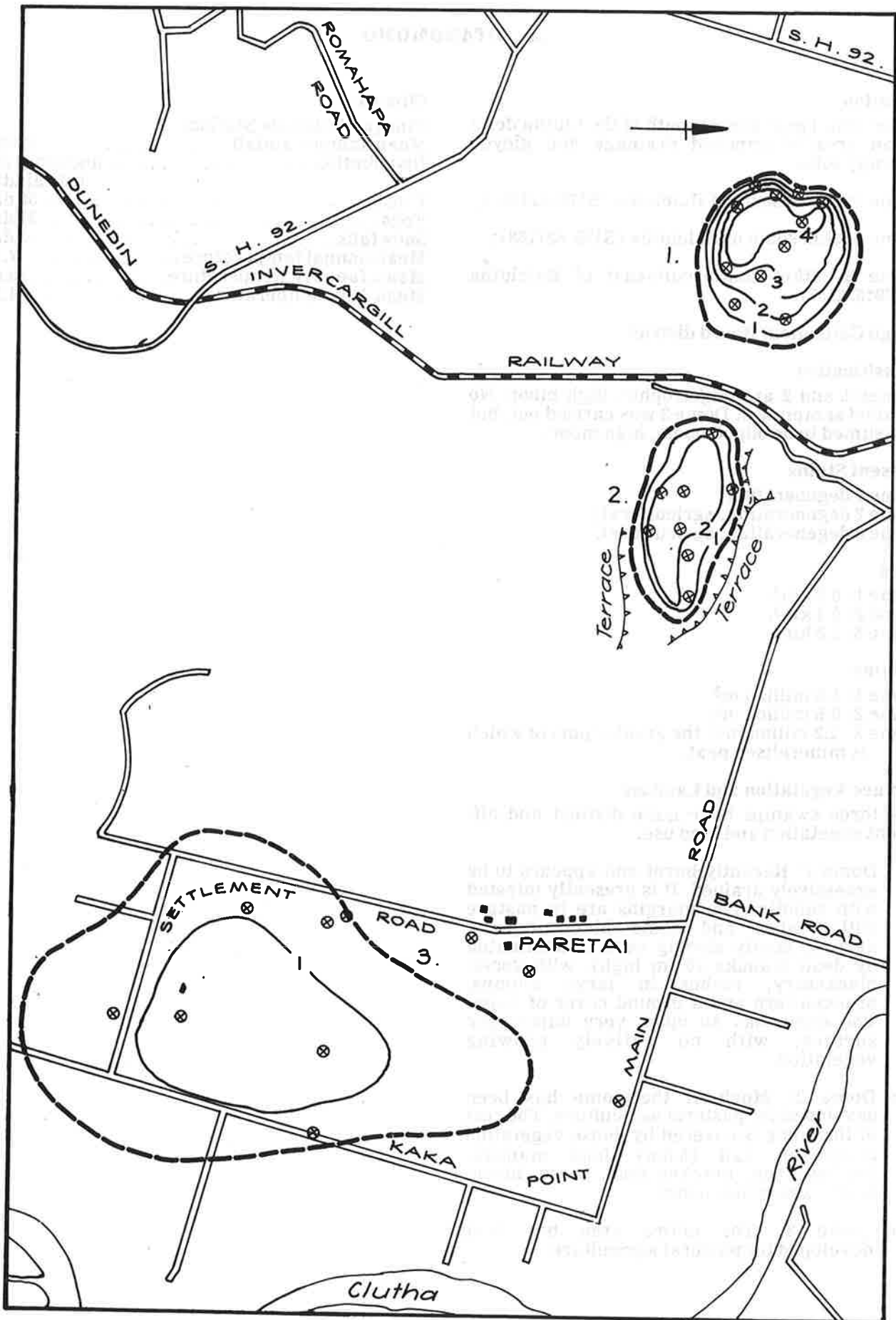
The three swamps have quite distinct and different vegetation and land use.

- (i) Dome 1: Recently burnt and appears to be excessively drained. It is presently infested with rabbits. The margins are in pasture with rushes and some blackberry. A narrow, gently sloping rand is dominated by dead manuka (6-7m high), with gorse, blackberry, rushes in large clumps, bracken fern and a ground cover of moss. The dome has an open, very hummocky surface, with no actively growing vegetation.
- (ii) Dome 2: Much of the dome has been developed for pastoral agriculture. The rest of the dome is covered by dense vegetation comprising tall (5-6m) dead manuka, *Coprosma spp.*, bracken fern, gorse, blackberry, and some rushes.
- (iii) Dome 3: The entire area has been developed for pastoral agriculture.

Climate

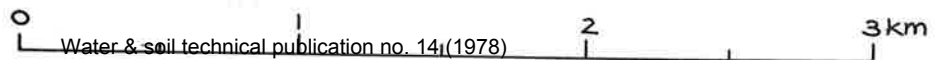
Finegand Climate Station.

Mean annual rainfall	786mm
Distribution	unevenly over 121 raindays
Frosts	58 days
Fogs	31 days
Snowfalls	3 days
Mean annual temperature	7.7°C
Mean January temperature	18.0°C
Mean July temperature	4.2°C



OTANOMOMO

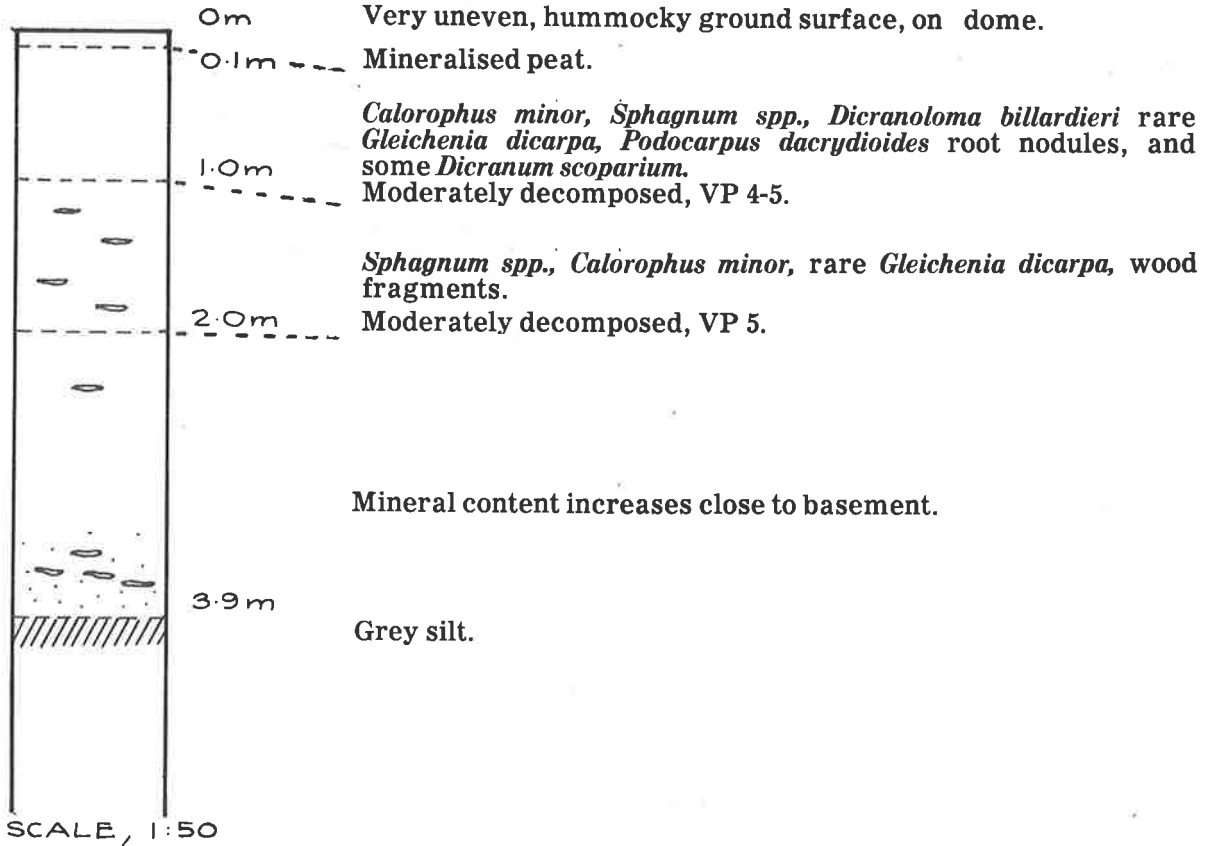
SCALE, 1:25000



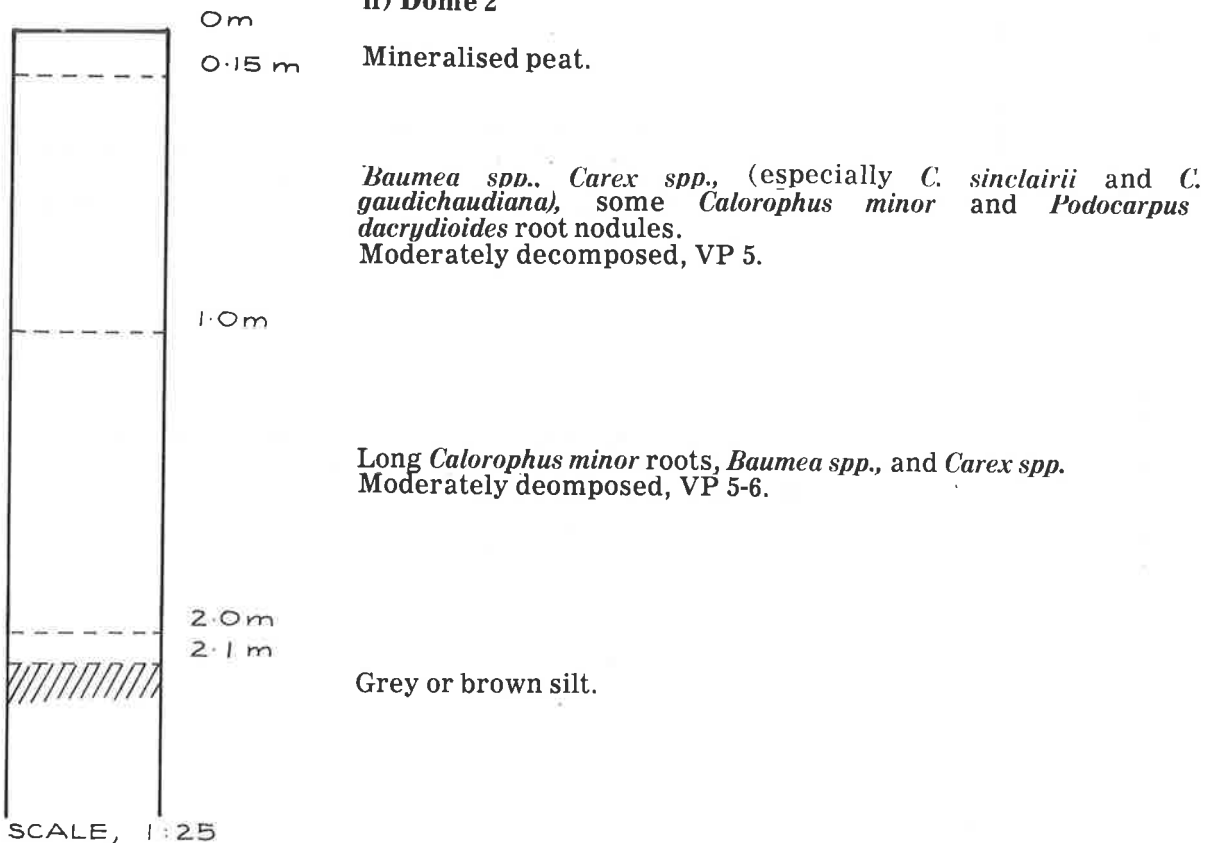
Peat Composition

No detailed sampling of Dome 3 was carried out, thus there is no detailed peat composition profile.

i) Dome 1



ii) Dome 2



55. SCHOOL ROAD

Location

17.5km north of Invercargill (S177:379191)
Southland Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Active.

Area

2.2 km².

Volume

3.1 million m³.

Surface Vegetation and Landuse

Very small parts of the lagg have been developed for pastoral agriculture but the largest part of the swamp is undeveloped and can be divided into two distinct zones:

- (i) Rand: Very broad and is covered by manuka, flax, blackberry, gorse, bracken fern, and some *Sphagnum spp.*

- (ii) Dome: The vegetation regenerating after recent burning is *Calorophus minor*, *Leptospermum scoparium*, *Dracophyllum oliveri*, *Gleichenia dicarpa*, some *Baumea spp.*, *Sphagnum spp.*, *Dicranoloma billardieri*, and swards of *Herpolirian spp.* Burn ponds are also common.

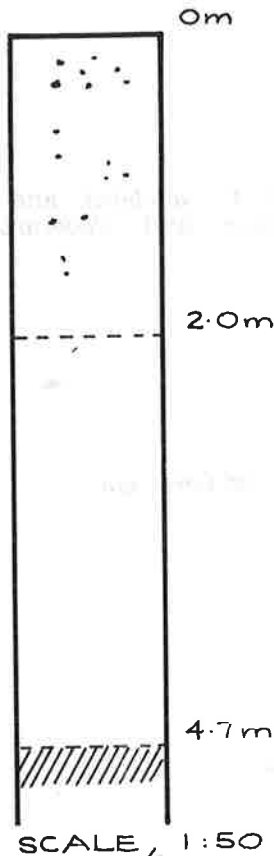
Climate

Invercargill Airport Climate Station.

Mean annual rainfall	1042mm
Distribution.....	evenly over 157 raindays
Frosts.....	116 days
Fogs.....	41 days
Snowfalls.....	4 days
Mean annual temperature	9.5°C
Mean January temperature.....	13.4°C
Mean July temperature	4.7°C

Peat Composition

The peat profile described is typical of the dome. Much of the lagg peat has been developed and is now mineralised.

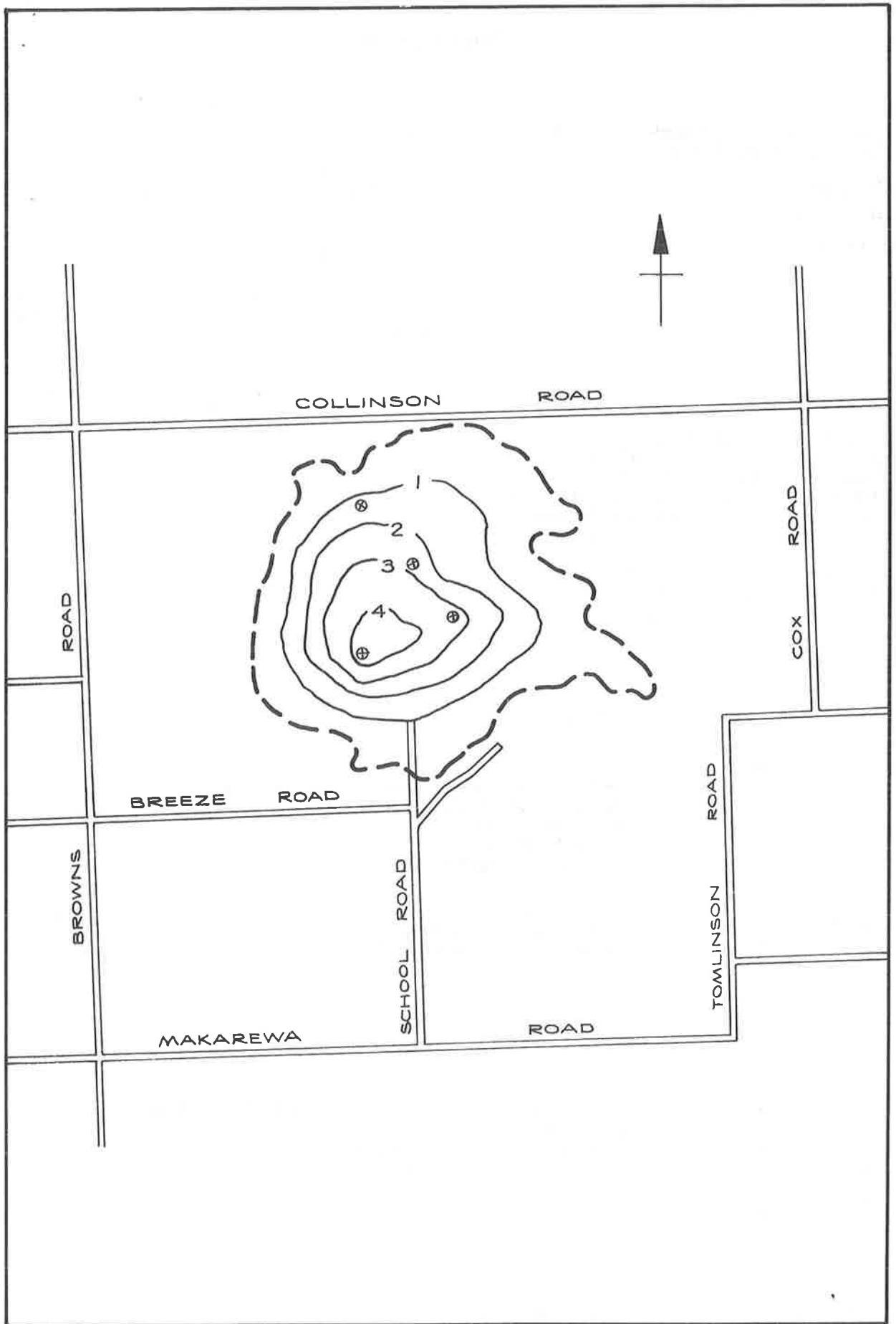


Calorophus minor, *Sphagnum spp.* (often up to 90%), *Gleichenia dicarpa*, *Podocarpus dactyloides* root nodules, and woody roots of *Dracophyllum oliveri* and *Leptospermum scoparium*. Charcoal fragments common, very wet, poorly decomposed, VP 2.

Calorophus minor, *Gleichenia dicarpa*, *Podocarpus dactyloides* root nodules, *Baumea spp.*, and *Dracophyllum Oliveri* roots. Poorly decomposed, VP 2-3.

No *Sphagnum spp.* preserved below 1.8-2.0m.

Blue-grey or green-grey clay.



SCHOOL ROAD

56. ROSLYN BUSH

Location

15km north-east of Invercargill (S177:422152)
Southland Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Active.

Area

1.6 km².

Volume

2.4 million m³.

Surface Vegetation and Landuse

Except for the small part north-west of Hormon Road, which has recently been cleared and fired, the swamp is undeveloped. It is covered by *Calorophus minor*, *Gleichenia dicarpa*, *Leptospermum scoparium*, *Dracophyllum oliveri*, *Baumea* spp., *Carex* spp. (in drains), *Epacris pauciflora*, sparse *Phormium tenax*, *Juncus palliosus* and a ground cover of *Sphagnum* spp. and *Dicranoloma billardieri*.

Highest Point

28m.

Outfall Level

Catchment Board drain — 26m.

Climate

Invercargill Airport Climate Station.

Mean annual rainfall..... 1042 mm

Distribution..... evenly over
157 raindays

Frosts..... 116 days

Fogs..... 41 days

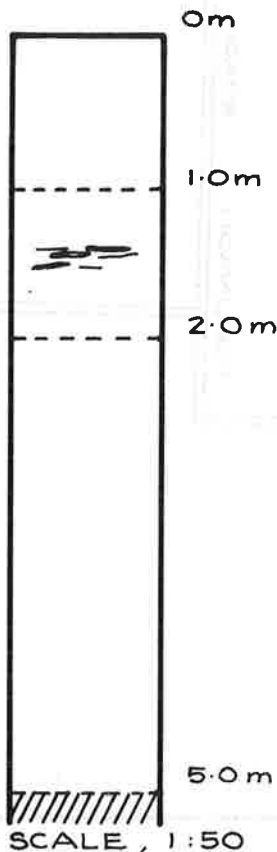
Snowfalls..... 4 days

Mean annual temperature..... 9.5°C

Mean January temperature..... 13.4°C

Mean July temperature..... 4.7°C

Peat Composition



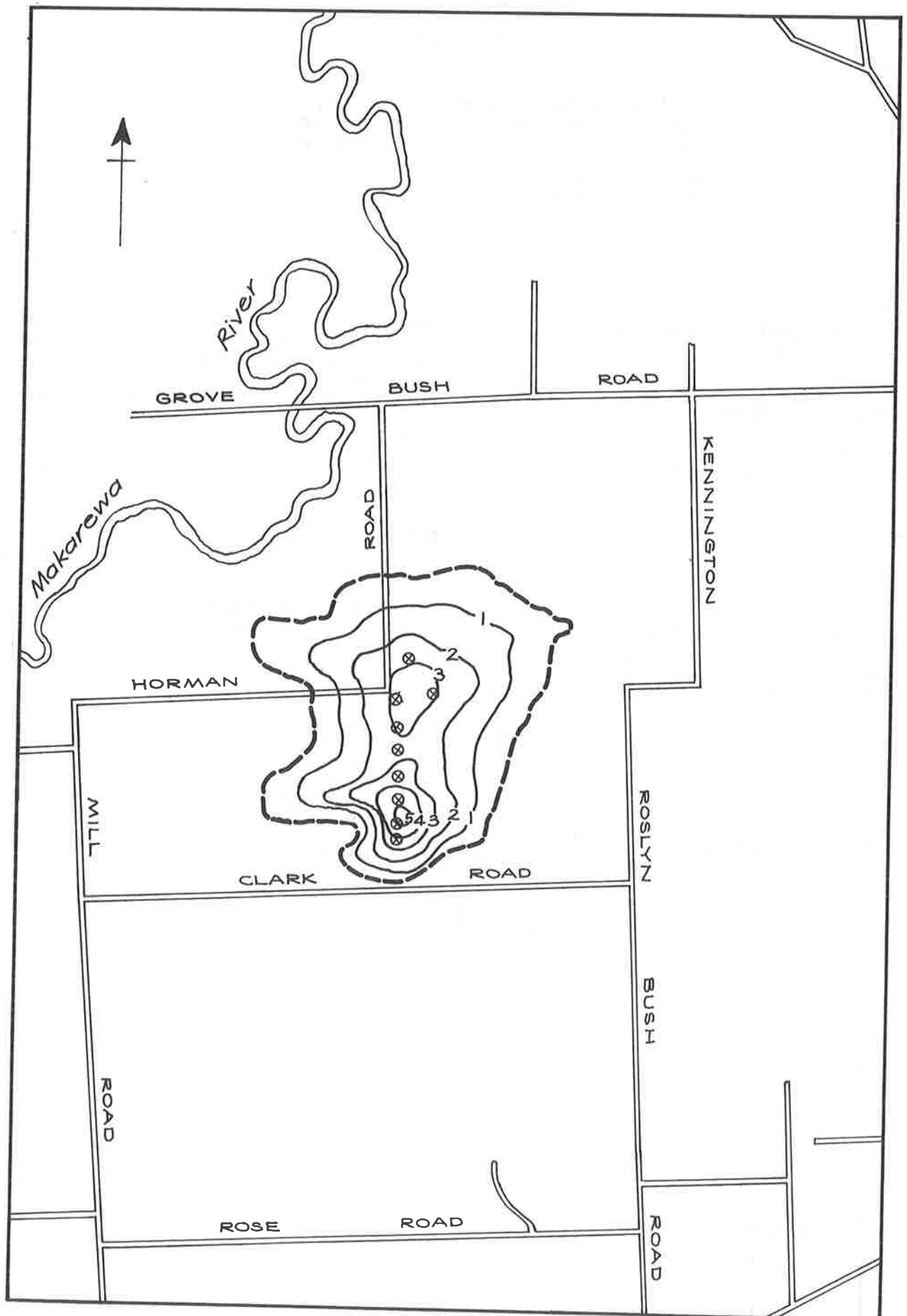
Sphagnum spp., *Calorophus minor*, *Gleichenia dicarpa*, woody roots, *Baumea tenax*, occasional *Dicranoloma billardieri*, and *Podocarpus dacrydioides* roots.

Some charcoal.
Poorly decomposed, VP 3.

Calorophus minor, *Gleichenia dicarpa*, some well decomposed *Sphagnum* spp., woody roots.
Moderately decomposed, VP 5.

★ In some areas (especially in south-east) *Dicranoloma billardieri* comprises up to 90% of peat to depth of 2.0m, with *Calorophus minor*, *Gleichenia dicarpa* and woody roots associated.
Poorly decomposed, VP 3.

Grey or blue-grey silt.



ROSLYN BUSH

SCALE, 1:25 000

Water & soil technical publication no. 14 (1978)

2

3 km

57. RIVERTON

General

South of State Highway 99, between the Aparama and Oreti Rivers and behind the coastal dunes, there are a number of small peat swamps and swampy areas. Two of the peat swamps were investigated and are described.
Southland Catchment Board district.

Riverton 1

Location

17.5km north-west of Invercargill at Wrights Bush (S176:210144).

Classification

Oligotrophic, high moor.

Present Status

Active, but with small regenerating areas.

Area

1.5km².

Volume

4 million m³.

Surface Vegetation and Landuse

Parts of the lagg have been drained and developed for pastoral agriculture. Most of the swamp is undeveloped and is covered by

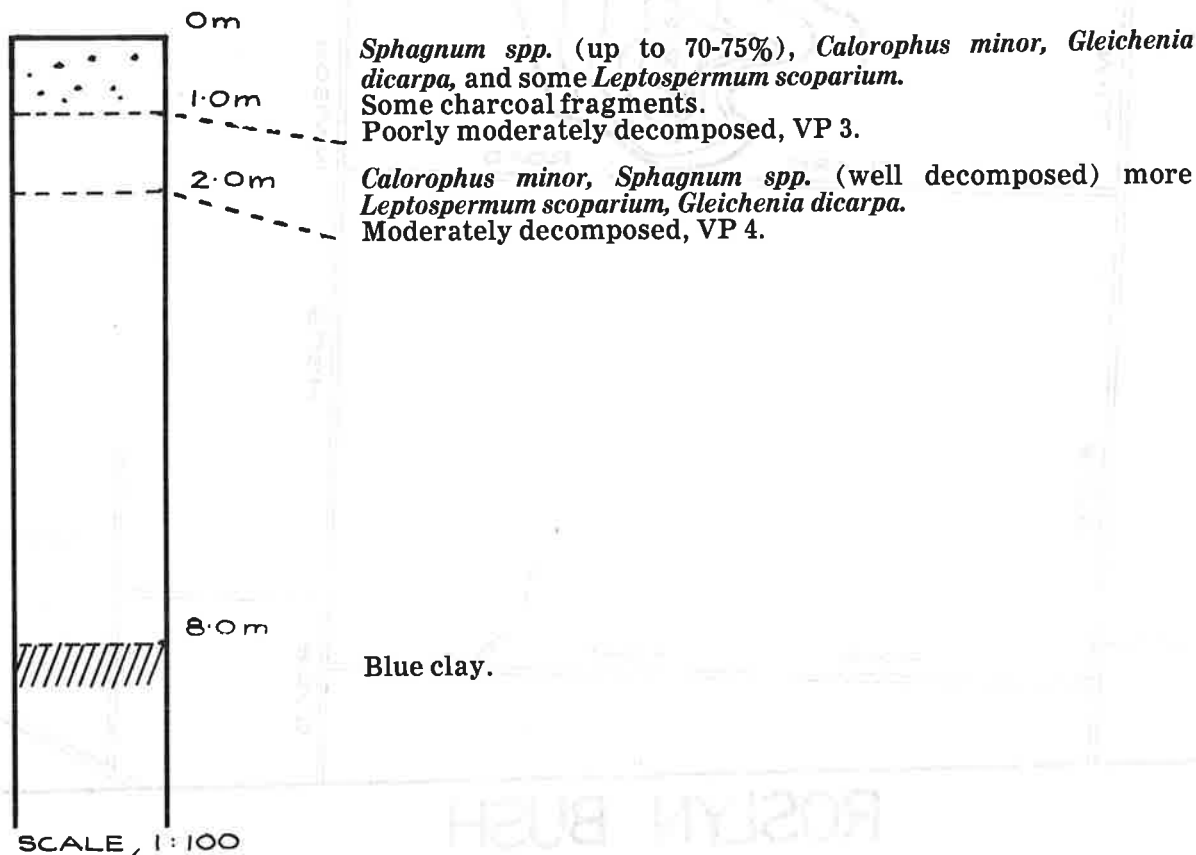
Calorophus minor, *Gleichenia dicarpa*, *Sphagnum spp.*, *Leptospermum scoparium* and some *Baumea spp.* Some small parts of the land have been burnt and are covered by regenerating *Gleichenia dicarpa*, bracken fern and sparse *Baumea spp.*

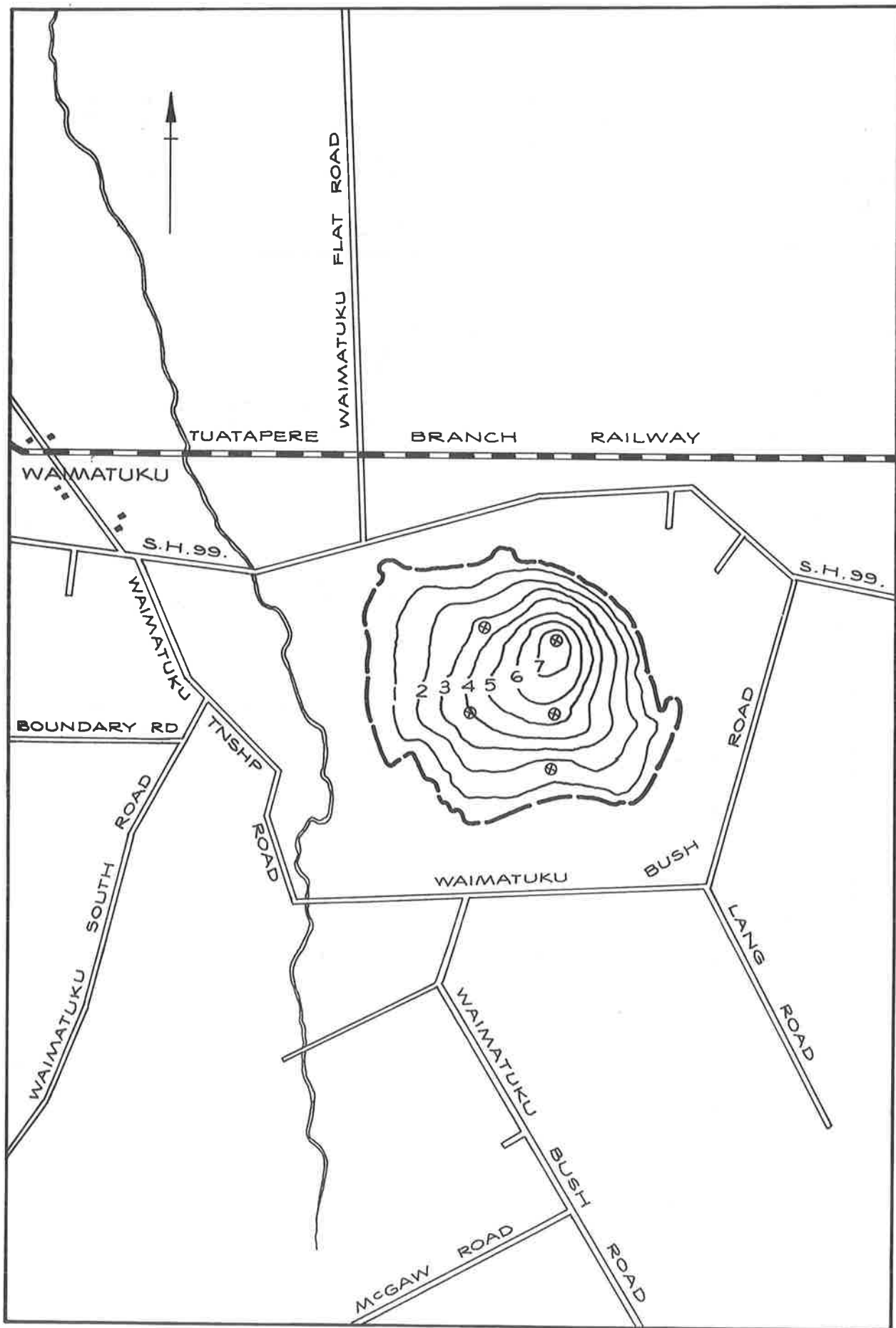
Climate

Invercargill Airport Climate Station.

Mean annual rainfall. 1042 mm
Distribution. evenly over
157 raindays
Frosts. 116 days
Fogs. 41 days
Snowfalls. 4 days
Mean annual temperature. 9.5°C
Mean January temperature. 13.4°C
Mean July temperature. 4.7°C

Peat Composition





RIVERTON 1

Riverton 2

Location

21 km north-west of Invercargill, immediately south of Thornbury (S176:153144).

Classification

Oligotrophic, high moor.

Present Status

Active, but small areas are degenerating.

Area

1.1km².

Volume

3.9 million m³.

Surface Vegetation and Landuse

Most of the lagg is being drained and developed

for pastoral agriculture. The dome slopes down from south-east to north-west and the lower part is very wet with rafts of *Sphagnum spp.*, *Calorophus minor*, some *Leptospermum scoparium*, *Baumea spp.*, *Gleichenia dicarpa*, *Sphagnum spp.* and other mosses cover the rest.

Climate

Invercargill Airport Climate Station.

Mean annual rainfall 1042mm
Distribution evenly over

157 raindays

Frosts 116 days

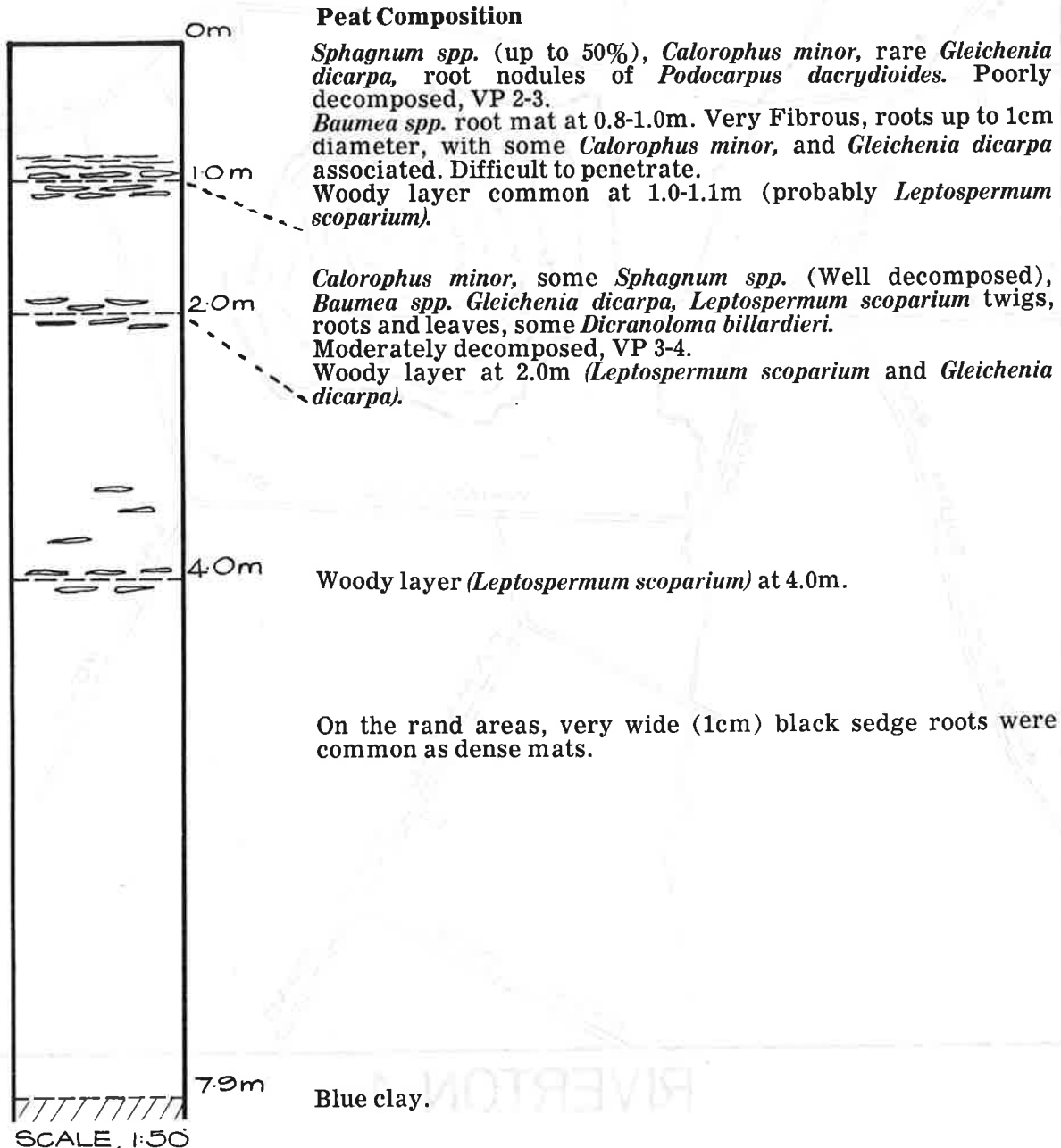
Fogs 41 days

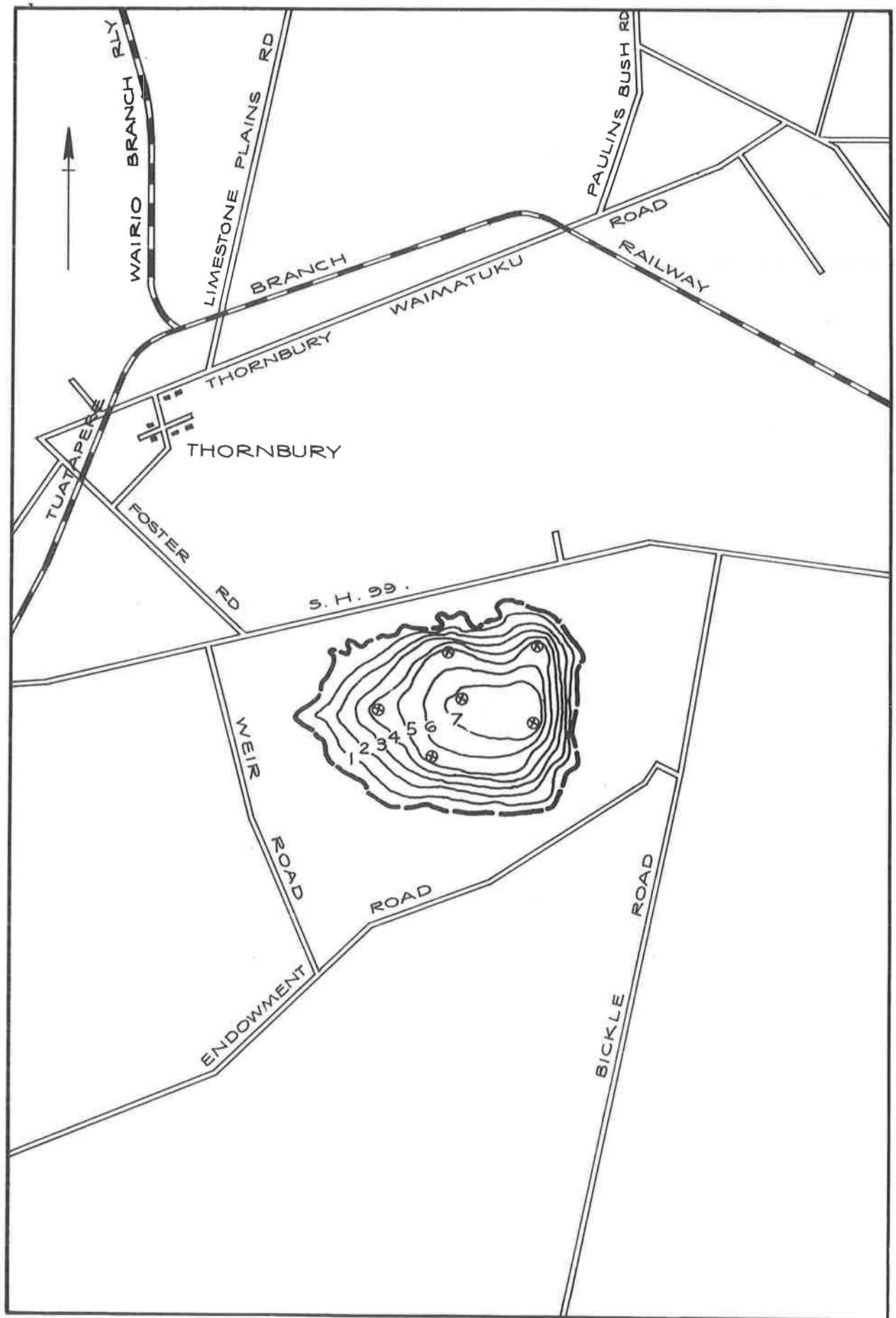
Snowfalls 4 days

Mean annual temperature 9.5°C

Mean January temperature 13.4°C

Mean July temperature 4.7°C





RIVERTON 2

SCALE, 1 : 25 000 0 1 2 3 km
 Water & soil technical publication no. 14 (1978)

58. TAHAKOPA

Location

60km south-east of Gore and 45 south-west of Balclutha (S184:255904).
Otago Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Active, although the western part has been partially developed.

Area

1.3 km².

Volume

2.7 million m³.

Surface Vegetation and Landuse

The surface vegetation and land use pattern is shown in Fig 5.

Type 1: The partially developed and drained western part is covered by rushes, isolated *Calorophus minor* and *Chionochloa rubra*, and introduced pasture grasses.

Type 2: Small areas covered by *Phormium tenax*, dead *Leptospermum scoparium* (up to 2 m tall), young *L. scoparium*, *Carex secta* and some *Coprosma spp.*

Type 3: The rand is covered by dense, tall (1m) *Dracophyllum oliveri*, *Calorophus minor*, *Sphagnum spp.* and *Gleichenia dicarpa*.

Type 4: The dome is covered by *Calorophus minor*, *Dracophyllum oliveri*, *Sphagnum spp.* and some *Gleichenia dicarpa*. The *Dracophyllum oliveri* is smaller and less dense than in type 3.

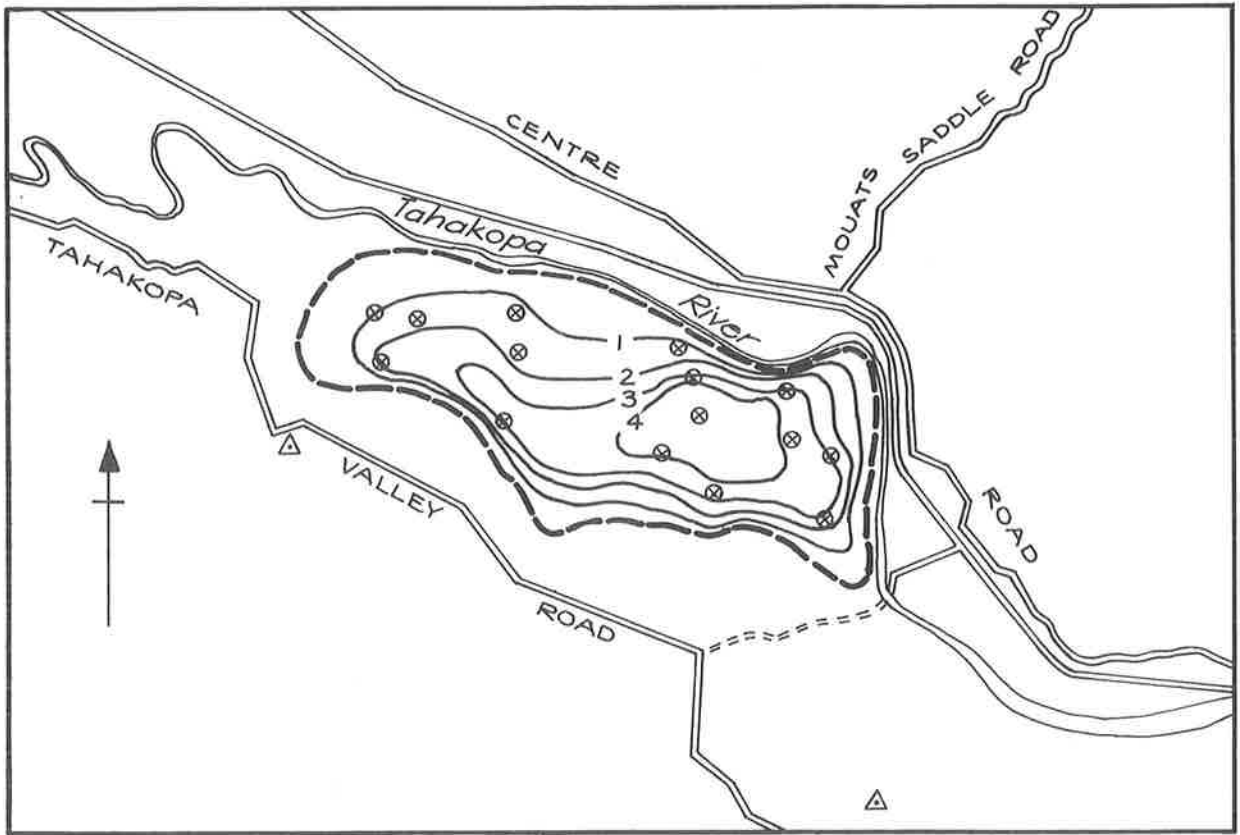
Epacris pauciflora, small low *Leptospermum scoparium*, sparse *Baumea spp.*, the moss *Dicranoloma billardieri* and some *Drosera arcturi* are present in Types 3 and 4.

Climate

Nugget Point Climate station.

Mean annual rainfall..... 908mm
Distribution..... unevenly
over 148
raindays

Frosts 3 days
Fogs 17 days
Mean annual temperature 9.3°C
Mean January temperature..... 13.4°C
Mean July temperature 5.1°C



TAHAKOPA

SCALE, 1:25 000

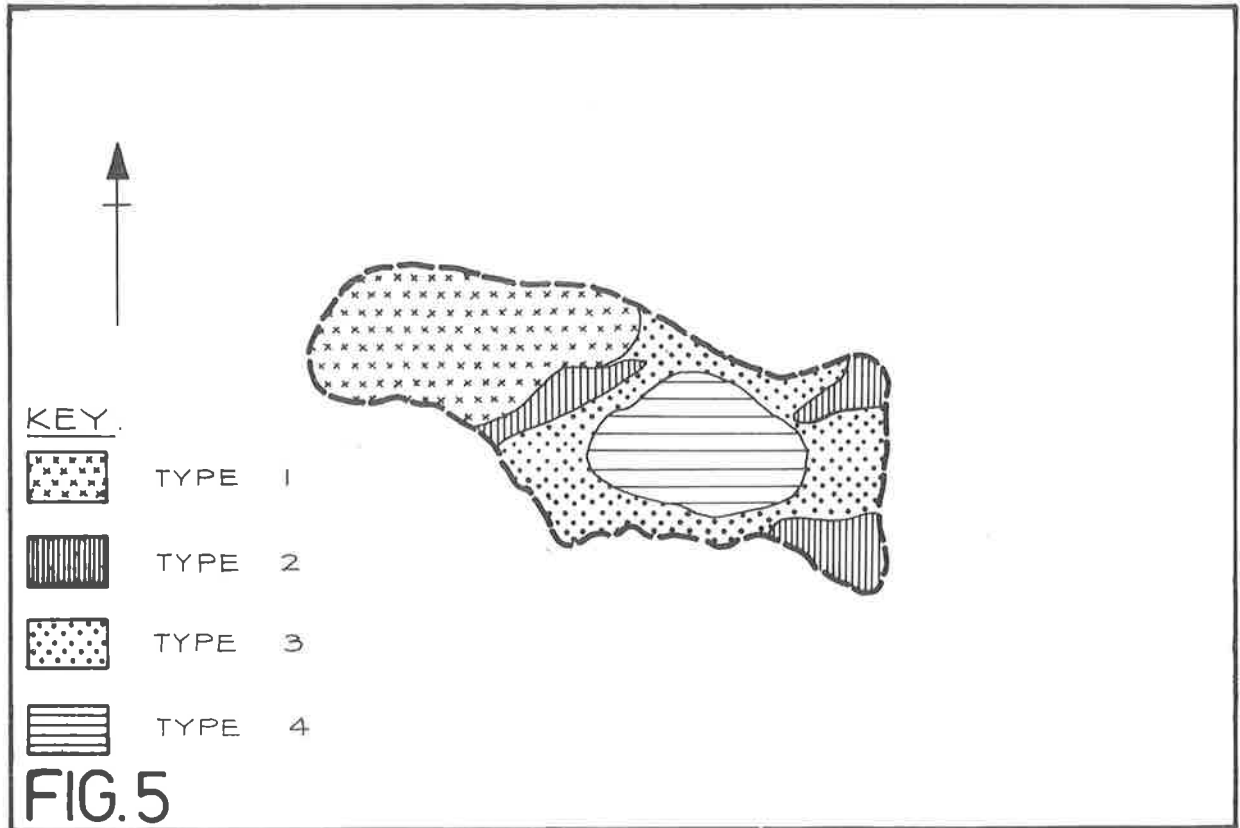


FIG. 5

TAHAKOPA SURFACE VEGETATION & LAND USE

SCALE 1:25 000

Water & soil technical publication no. 14 (1978)

Peat Composition

The peat composition is separated into two:

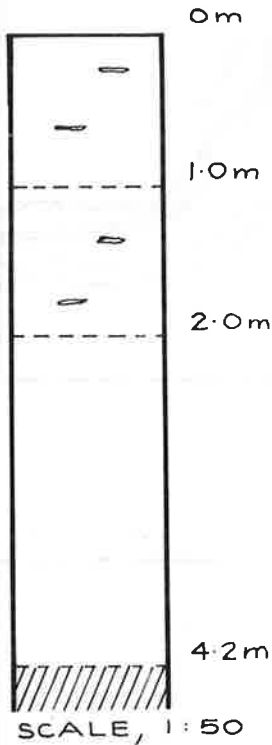
i) The peat on the dome.

ii) The peat on the area surrounding the dome i.e. the rand and lagg areas.

A third type, underlying the areas covered by flax was not sampled in detail but had a very high mineral content.

i) Dome Peat

Water table 0.1-0.25m.

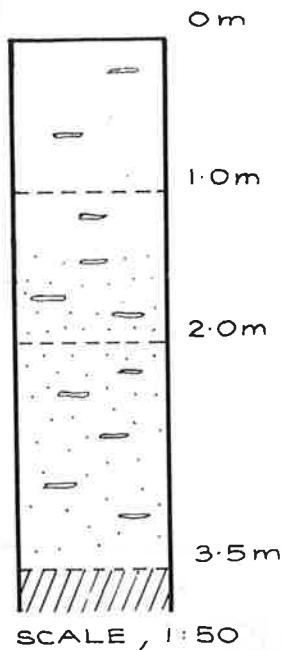


Sphagnum spp. (60-80%), *Calorophus minor*, some *Gleichenia dicarpa*, woody roots, *Dicranoloma billardieri* and *Baumea spp.*, root nodules of *Podocarpus dacrydioides*.
Wet and very raw, VP 2.

Sphagnum spp. (up to 80%), *Calorophus minor*, *Gleichenia dicarpa*, with some woody roots and *Baumea spp.*
Wet, poorly decomposed, VP 3-4.

Grey silt.

ii) Rand and Lagg Peat



Calorophus minor, woody roots (*Dracophyllum* or *Leptospermum*), *Baumea spp.*, some well decomposed *Sphagnum spp.*, *Dicranoloma billardieri* and *Gleichenia dicarpa*.
Poorly decomposed, VP 3.

Calorophus minor, increasing woody roots and *Baumea spp.*, some *Gleichenia dicarpa*, wood fragments.
Increasing mineral content.
Moderately decomposed, VP 4.

Grey silt.

59. AWARUA PLAIN-SEAWARD MOSS

Location

A complex swamp to the south of State Highway 92, west of the Maitava River and behind the sand dunes bordering Toetoes Bay and Bluff Harbour. Gravel ridges divide the 34km long swamp into a number of separate peat areas.

The areas to the west of Waituna Lagoon Road are locally referred to as Awarua Plain whereas the area to the east is called Seaward Moss.

The swamp occupies the greater part of S181 and S182.

Southland Catchment Board district.

Classification

Oligotrophic, high moor.

Present Status

Predominantly active, small parts degenerating agricultural, and some parts regenerating.

Area

179 km².

Volume

300.5 million m³.

Surface Vegetation and Landuse

Type 1: Pastoral agriculture with some rushes.

Type 2: Partially developed for pastoral agriculture with significant rushes, flax, and low manuka.

Type 3: Undeveloped areas covered by *Calorophus minor*, *Geichenia dicarpa*, *Sphagnum spp.*, *Dracophyllum oliveri*, *Baumea spp.*, *Carex spp.*, *Donatia novae-zelandiae*, *Epacris pauciflora*, some *Cyathodes petrifolia*, *Pentachondra pumila*, and *Dicranoloma billardieri*.

Type 4: Predominantly undeveloped areas, but with some old drainage, covered by *Calorophus minor*, *Gleichenia dicarpa*, *Chionochloa rubra* and *Phormium tenax*, with some *Dracophyllum oliveri*, *Baumea spp.*, *Sphagnum spp.*, *Donatia novae-zelandiae*, and *Leptospermum scoparium*. (Generally shallower peat than Type 3).

Parts of Type 3 and Type 4 areas have been recently burnt. Older burnt areas are now regenerating. Burn ponds are common on all burnt areas.

Climate

Invercargill Airport Climate Station.

Mean annual rainfall 1042mm

Distribution evenly over
157 raindays

Frosts 116 days

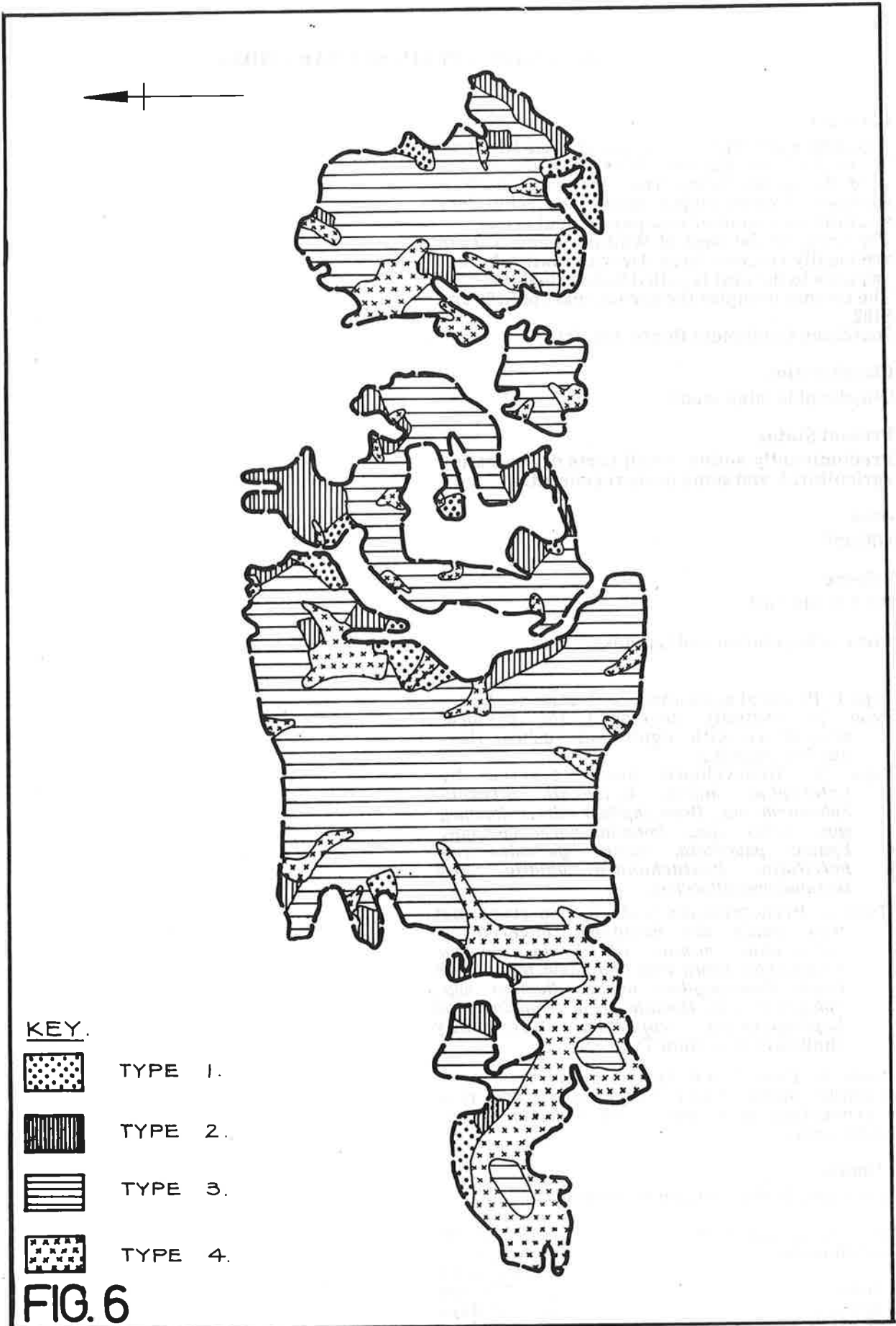
Fogs 41 days

Snowfalls 4 days

Mean annual temperature 9.5°C

Mean January temperature 13.4°C

Mean July temperature 4.7°C



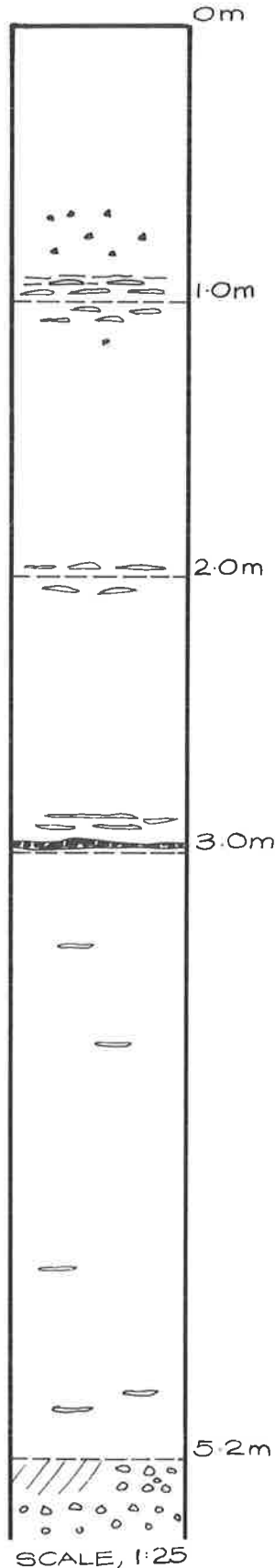
**AWARUA PLAIN - SEAWARD MOSS
SURFACE VEGETATION & LAND USE**

SCALE, 1 : 108 500

Water & soil technical publication no. 14 (1978)

Peat Composition

The profile described is typical of the peat found under vegetation type 3 and type 4. The areas of developed land (types 1 and 2) are shallow and are mineralised to 0.2 - 0.5m. The shallower areas of type 4 have mineral additions, and are more decomposed.



Sphagnum spp. (30-80%), *Calorophus minor*, *Gleichenia dicarpa*, some *Baumea spp.*, *Leptospermum scoparium* fragments and roots, occasional *Phormium tenax* rhizomes, root nodules of *Podocarpus dacrydioides*.

Charcoal common, poorly decomposed, VP 2-3.
Wood often concentrated about 1.0m.

Calorophus minor, *Sphagnum spp.* (moderately decomposed), *Gleichenia dicarpa*, *Dicranoloma billardieri* (up to 40%) in places), some *Leptospermum scoparium*, and root nodules of *Podocarpus dacrydioides*.

Poor to moderately decomposed, VP 3-4.
Woody layer at 2.0m common.

Calorophus minor, *Sphagnum spp.* (well decomposed, not always present), some *Gleichenia dicarpa*, *Leptospermum scoparium*, and twigs and root nodules of *Podocarpus dacrydioides*.

Charcoal band at 3.0m common.

Some mineral additions, moderately decomposed, VP 5-6.

Below 3.0m, mineral and wood content increases.

Grey or brown clay over quartz gravels, or quartz gravels.



Figure 1. Soil profile showing various layers and their characteristics.

Figure 2. Soil profile showing various layers and their characteristics.

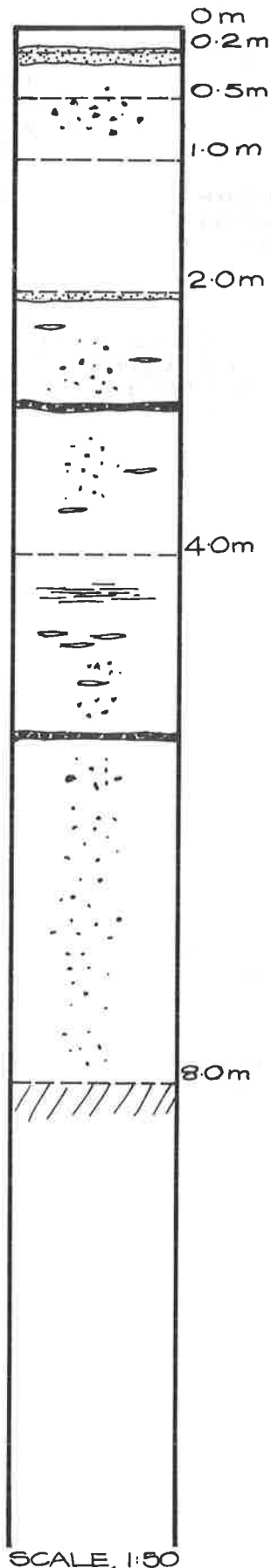
Figure 3. Soil profile showing various layers and their characteristics.

Figure 4. Soil profile showing various layers and their characteristics.

Figure 5. Soil profile showing various layers and their characteristics.

Figure 6. Soil profile showing various layers and their characteristics.

Peat Composition



0.2m Mineralised peat. White silt 0.2m thick common at 0.2m (volcanic ash?).

0.5m Fragmented *Calorophus minor*, some *Gleichenia dicarpa*, charcoal, wood fragments.
1.0m Black and well decomposed, VP 7-8.

Calorophus minor, some *Gleichenia dicarpa*, charcoal (generally in bands), *Leptospermum scoparium*.
Black well decomposed, VP 7.

2.0m Light grey silt layer at 2.0m (not common).

Calorophus minor, some *Gleichenia dicarpa*, wood (up to 0.1m diameter), charcoal layers and fragments.
Black, well decomposed, VP 7.

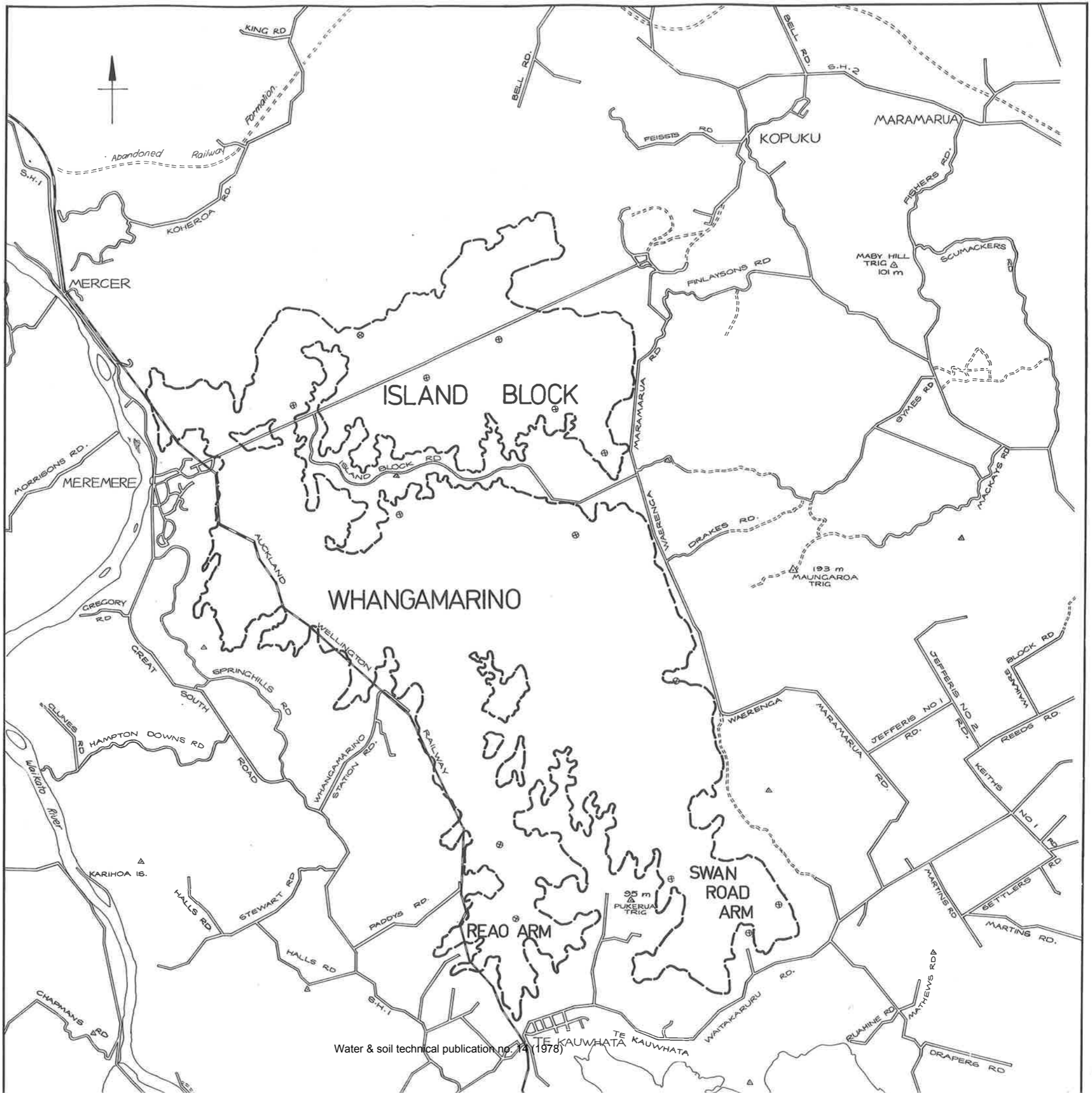
4.0m Fibrous root mats (probably *Gleichenia dicarpa*) common throughout the profile. Difficult to penetrate.

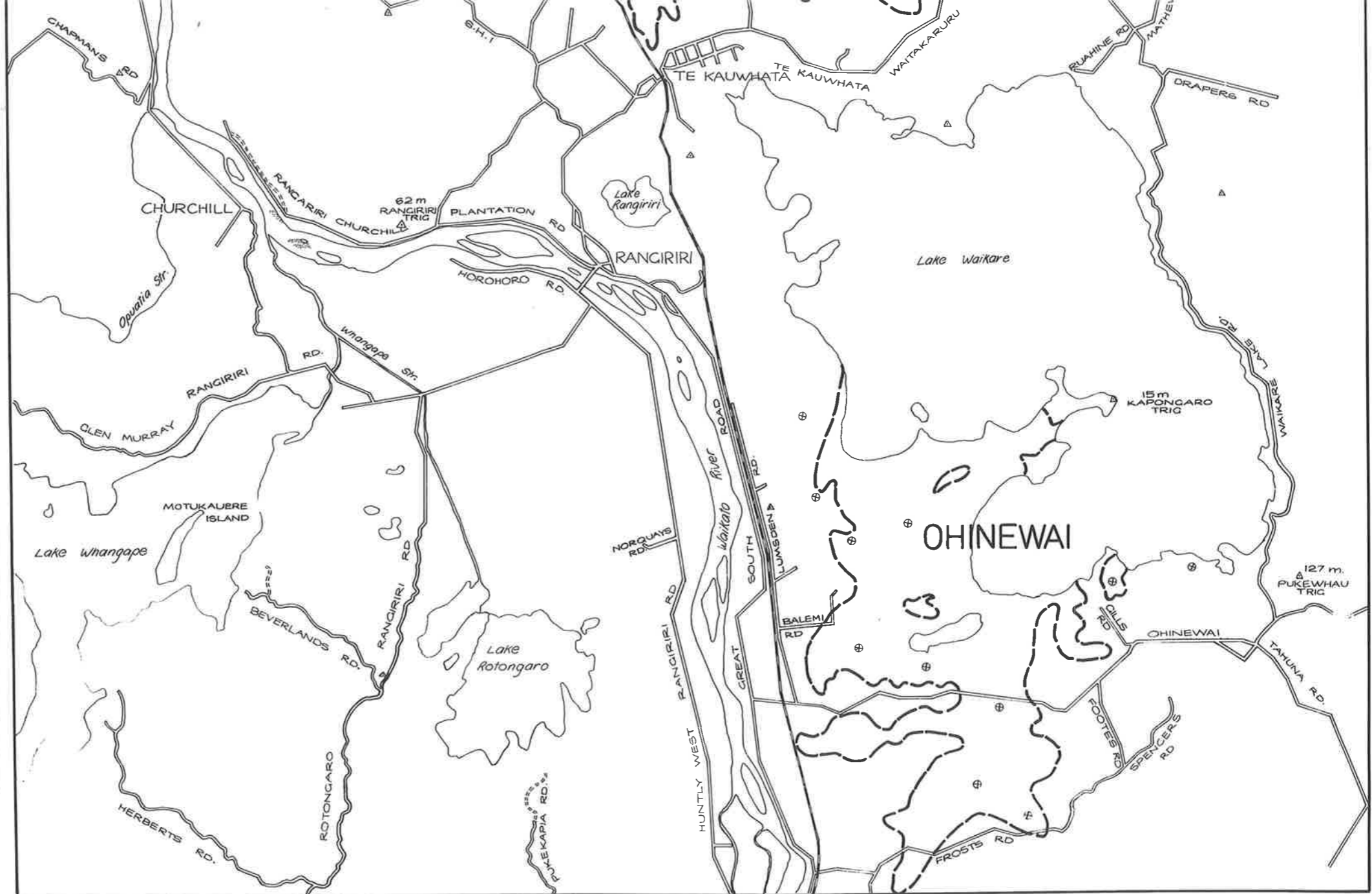
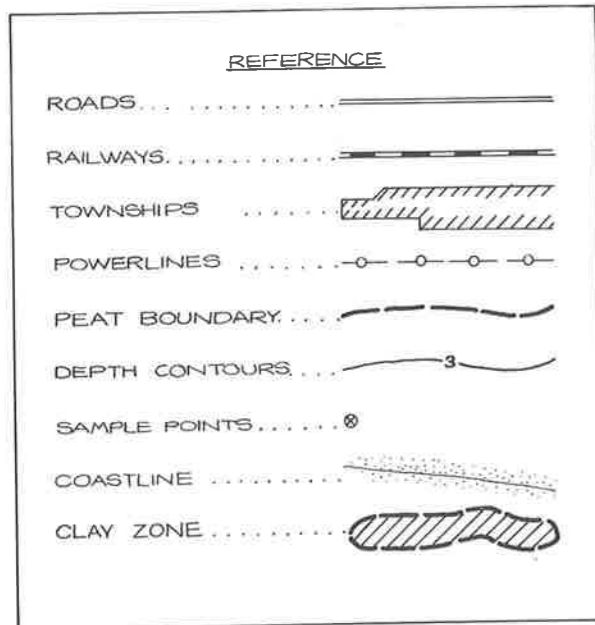
Wood not common, but scattered throughout profile. Generally *Leptospermum scoparium*.

Charcoal, both as fragments and layers, is common throughout profile.

8.0m Generally grey, grey-green silt or silty sand; occasionally coarse brown sand or brown clay.

SCALE, 1:50

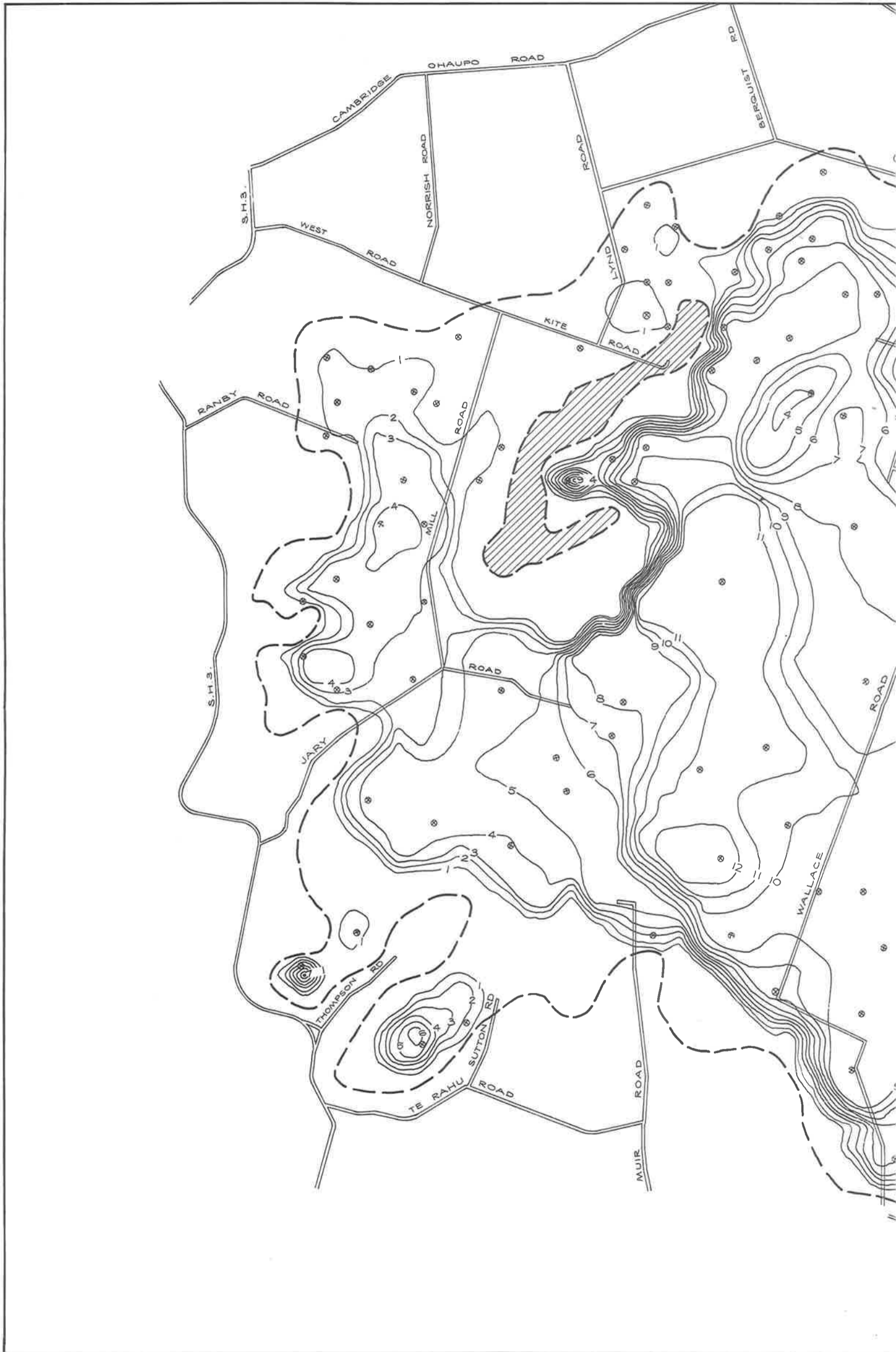




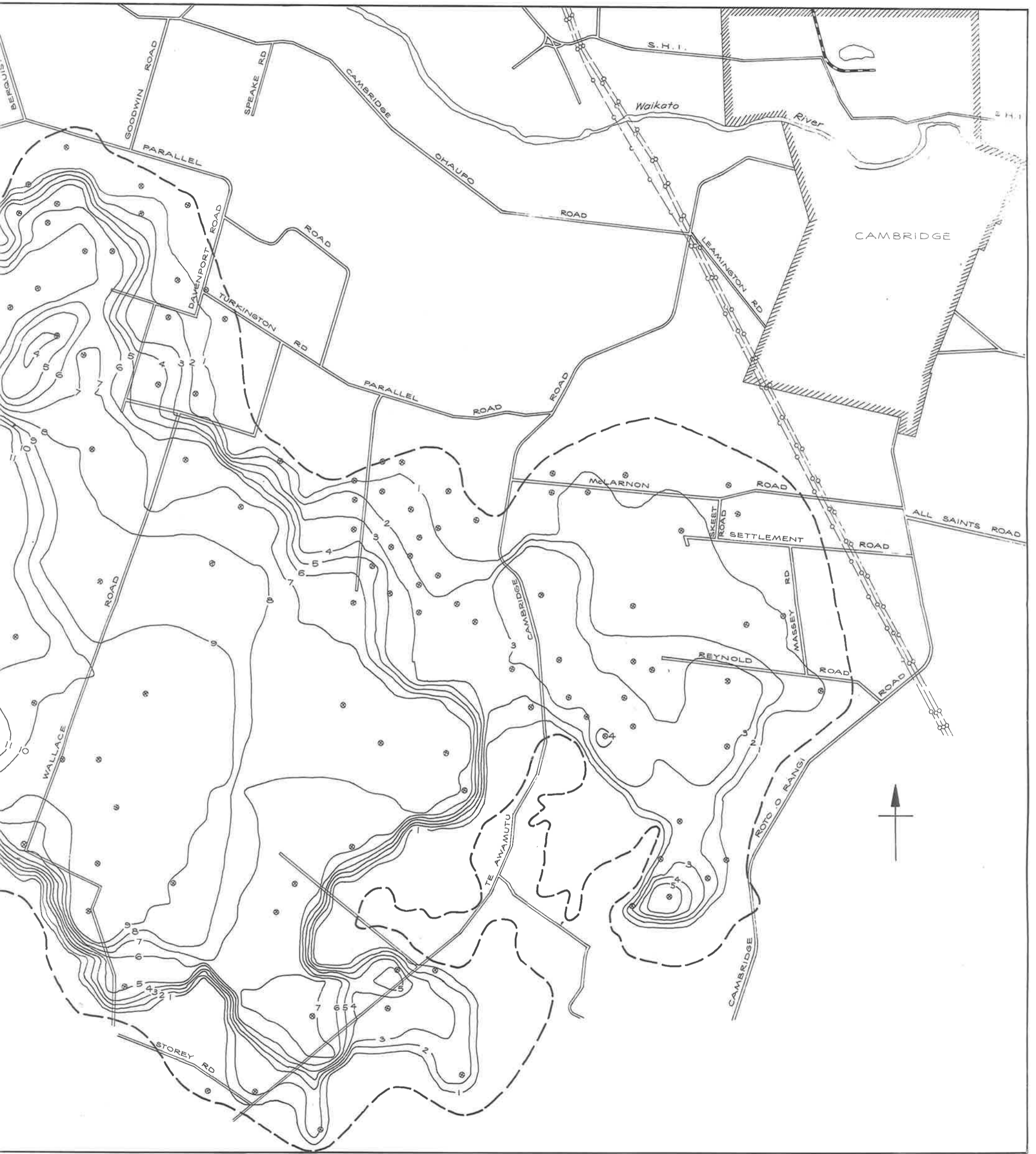
WHANGAMARINO / ISLAND BLOCK
&
OHINEWAI
PEAT RESOURCES SURVEY



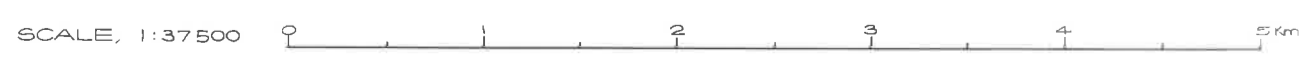
REFERENCE	
ROADS	
RAILWAYS	
TOWNSHIPS	
POWERLINES	
PEAT BOUNDARY	
DEPTH CONTOURS	
SAMPLE POINTS	
COASTLINE	
CLAY ZONE	

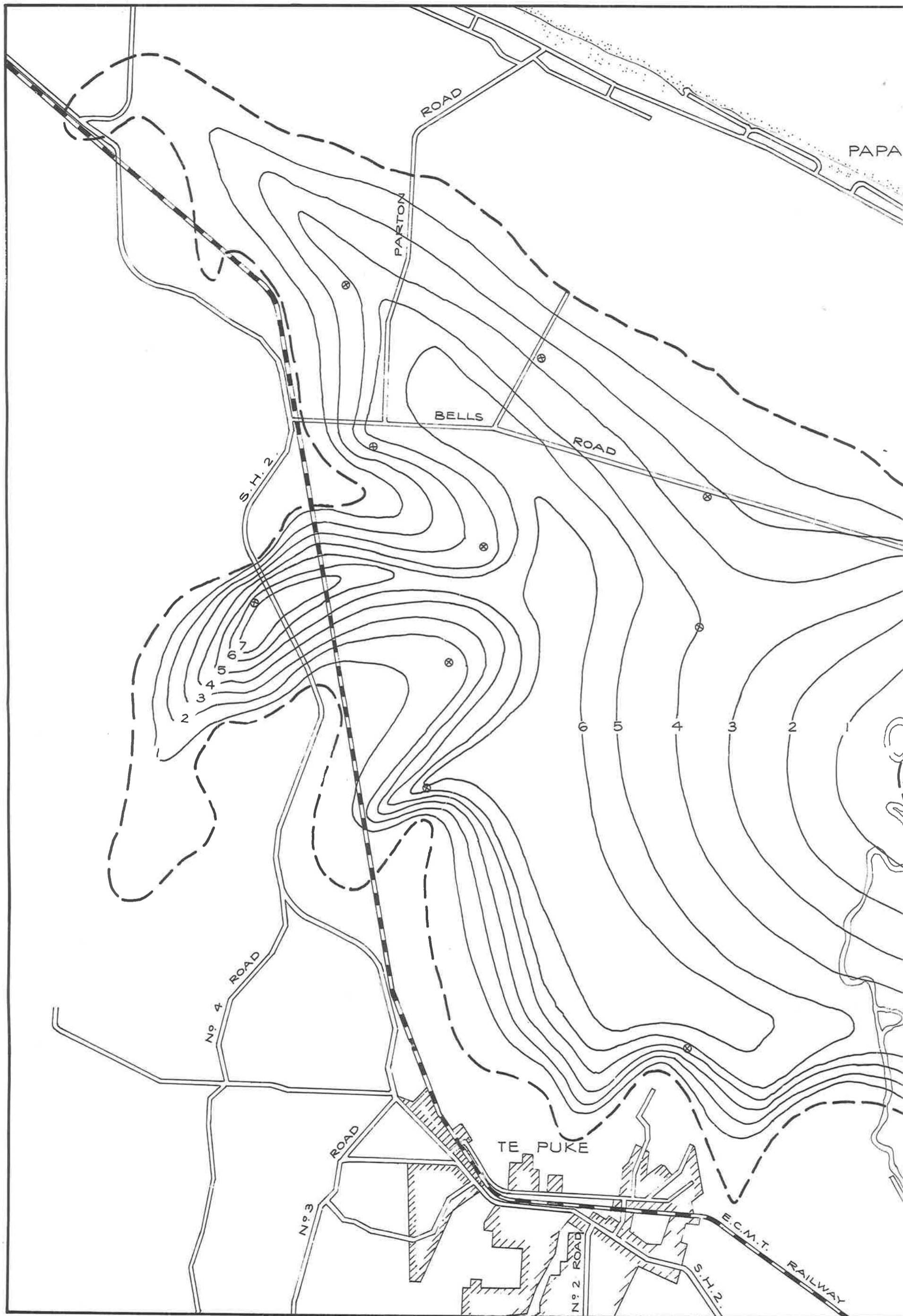


MOANA
PEAT RESOU



MOANATUATUA
 PEAT RESOURCES SURVEY







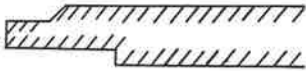






KAITUNA

PEAT RESOURCES SURVEY

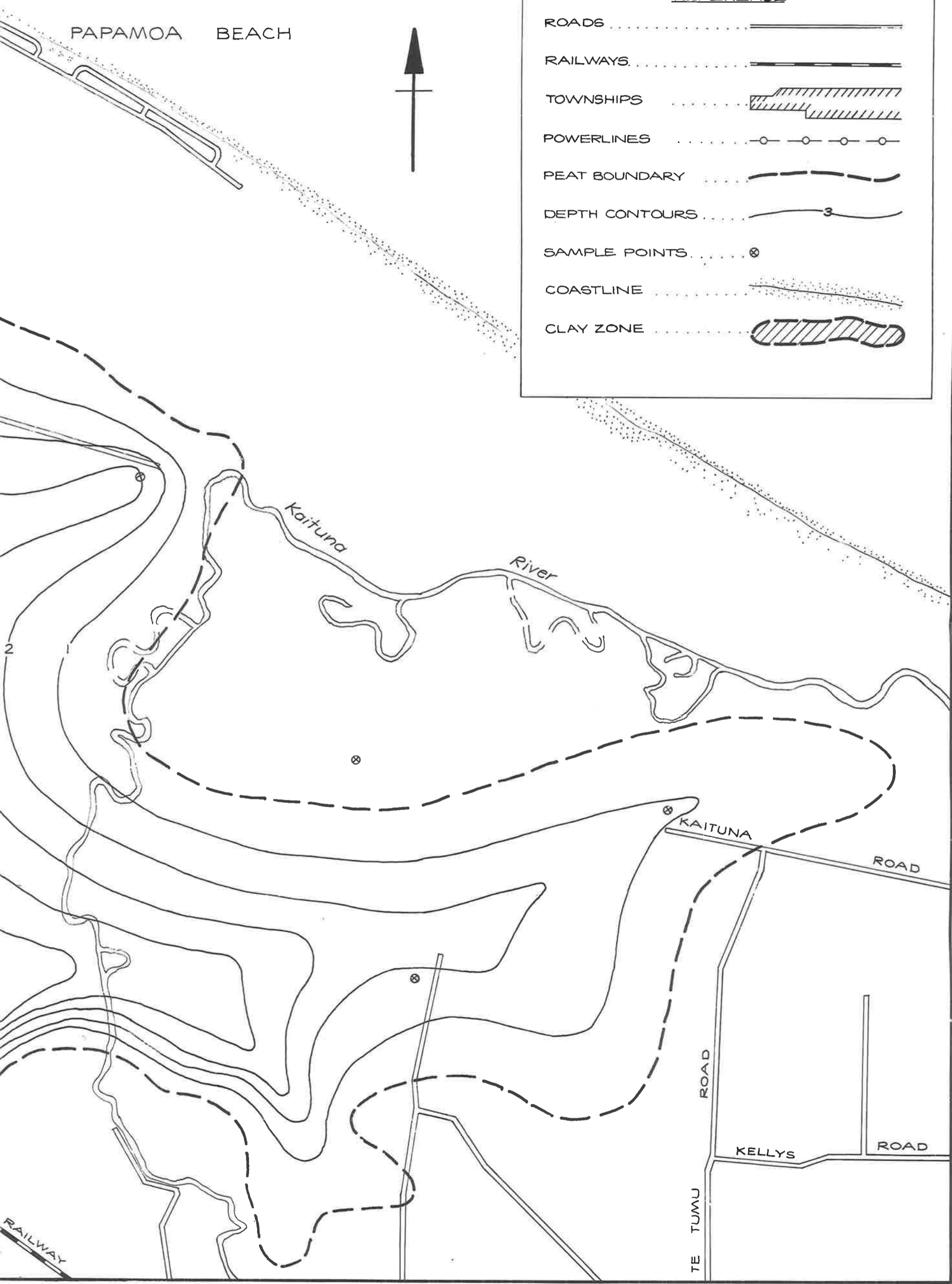
SCALE 1:250

Bay of Plenty

REFERENCE

- ROADS 
- RAILWAYS 
- TOWNSHIPS 
- POWERLINES 
- PEAT BOUNDARY 
- DEPTH CONTOURS 
- SAMPLE POINTS 
- COASTLINE 
- CLAY ZONE 

PAPAMOA BEACH

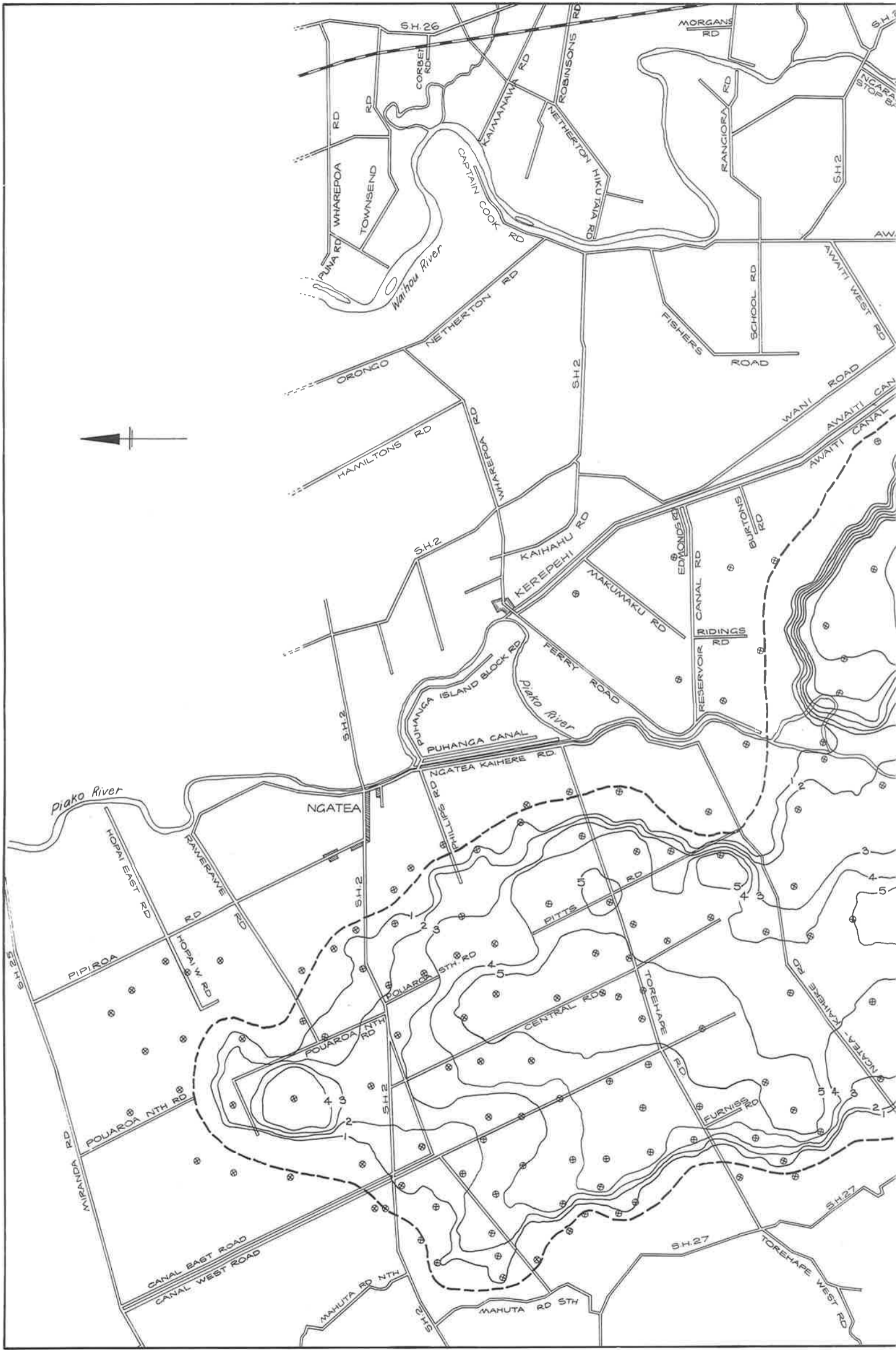
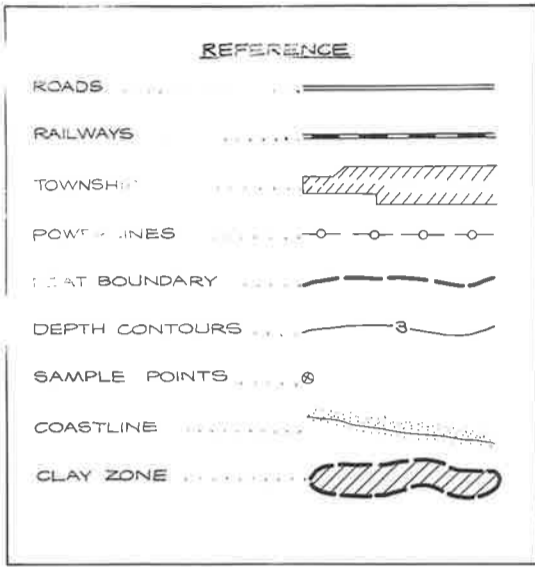


UNA

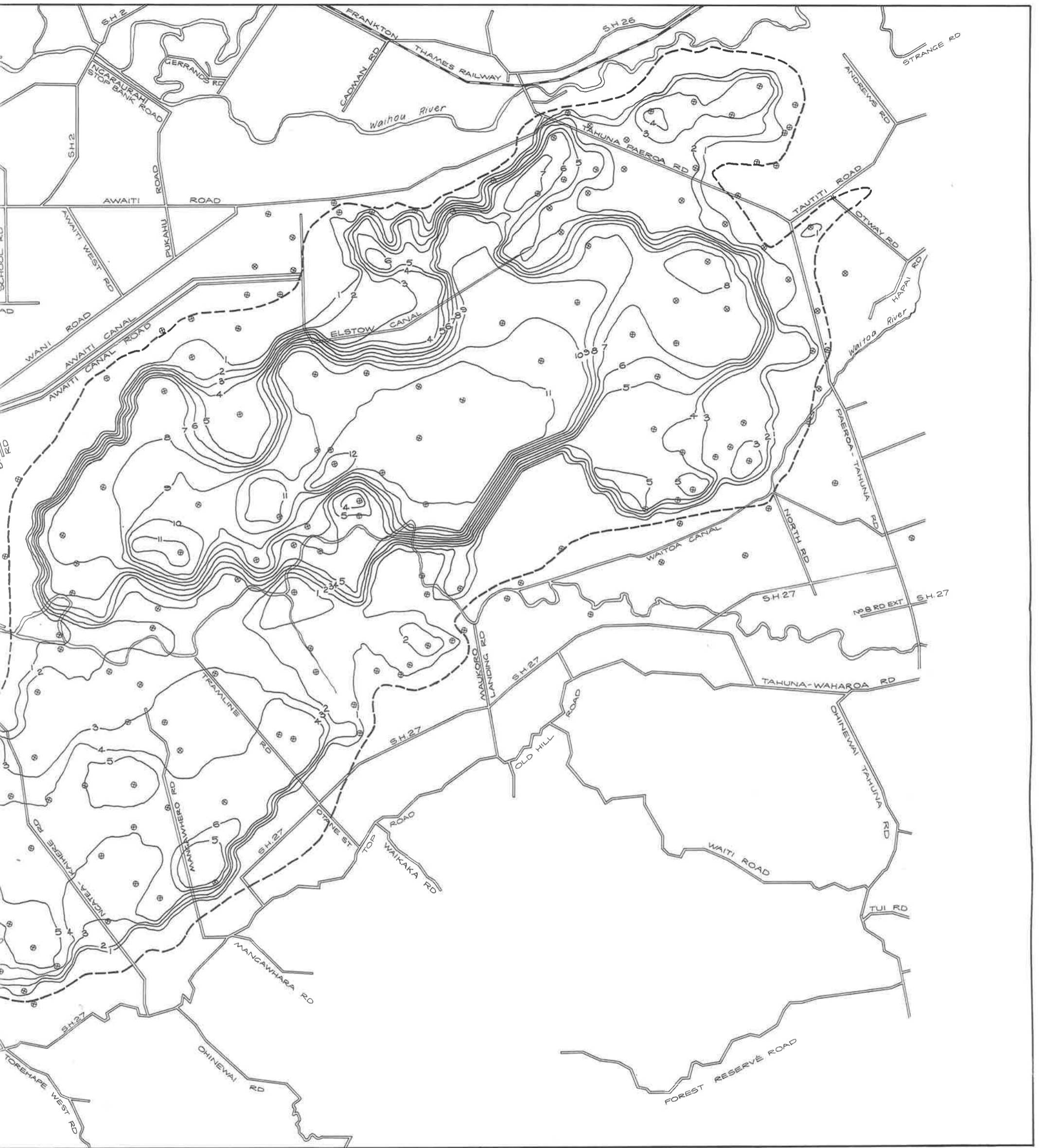
RESOURCES SURVEY
SCALE, 1:25000



Water & soil technical publication no. 14 (1978)



PEAT



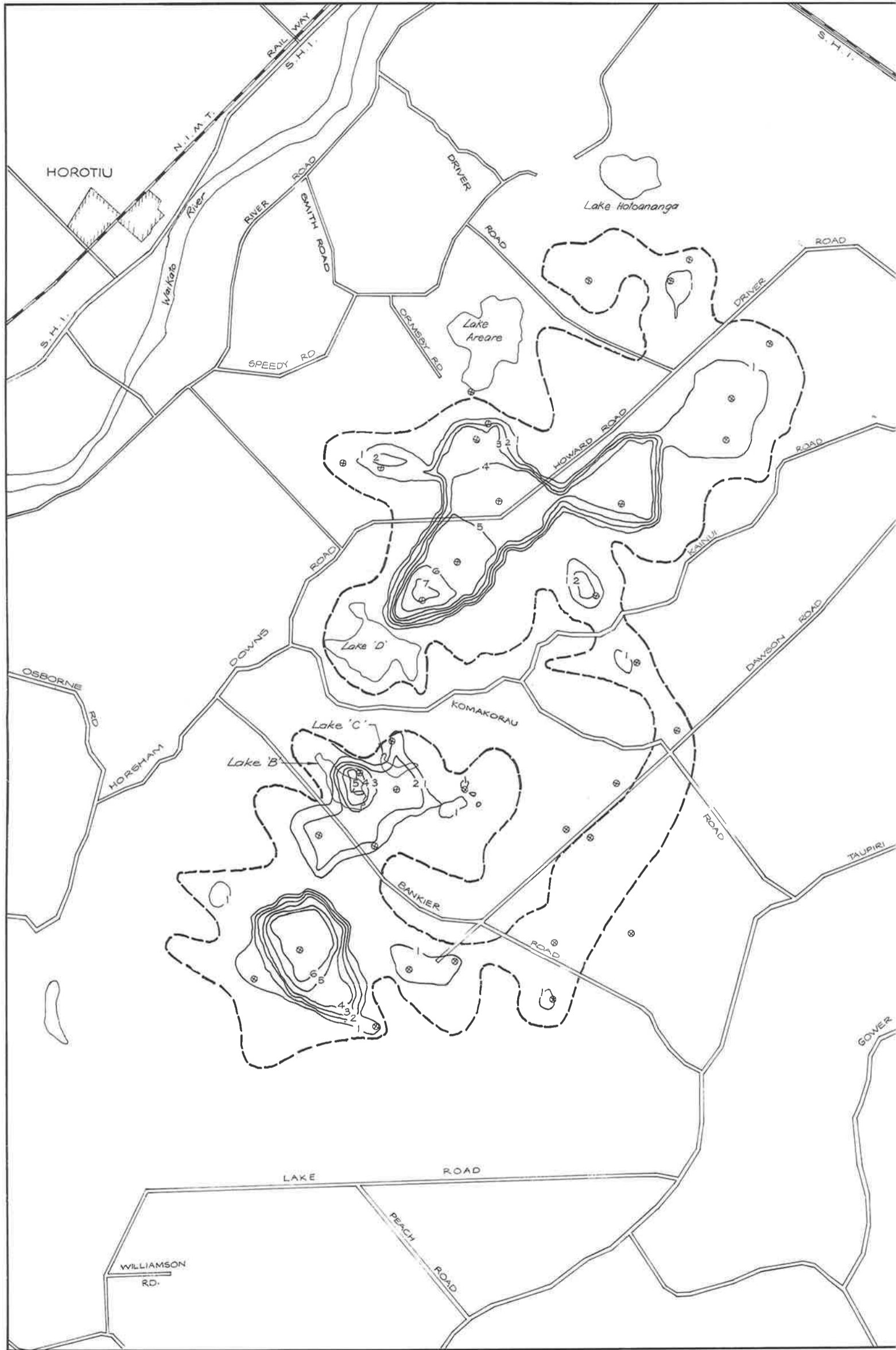
HAURAKI

PEAT RESOURCES SURVEY

SCALE, 1:75 000 0 1 2 3 4 5 6 7 8 9 10km

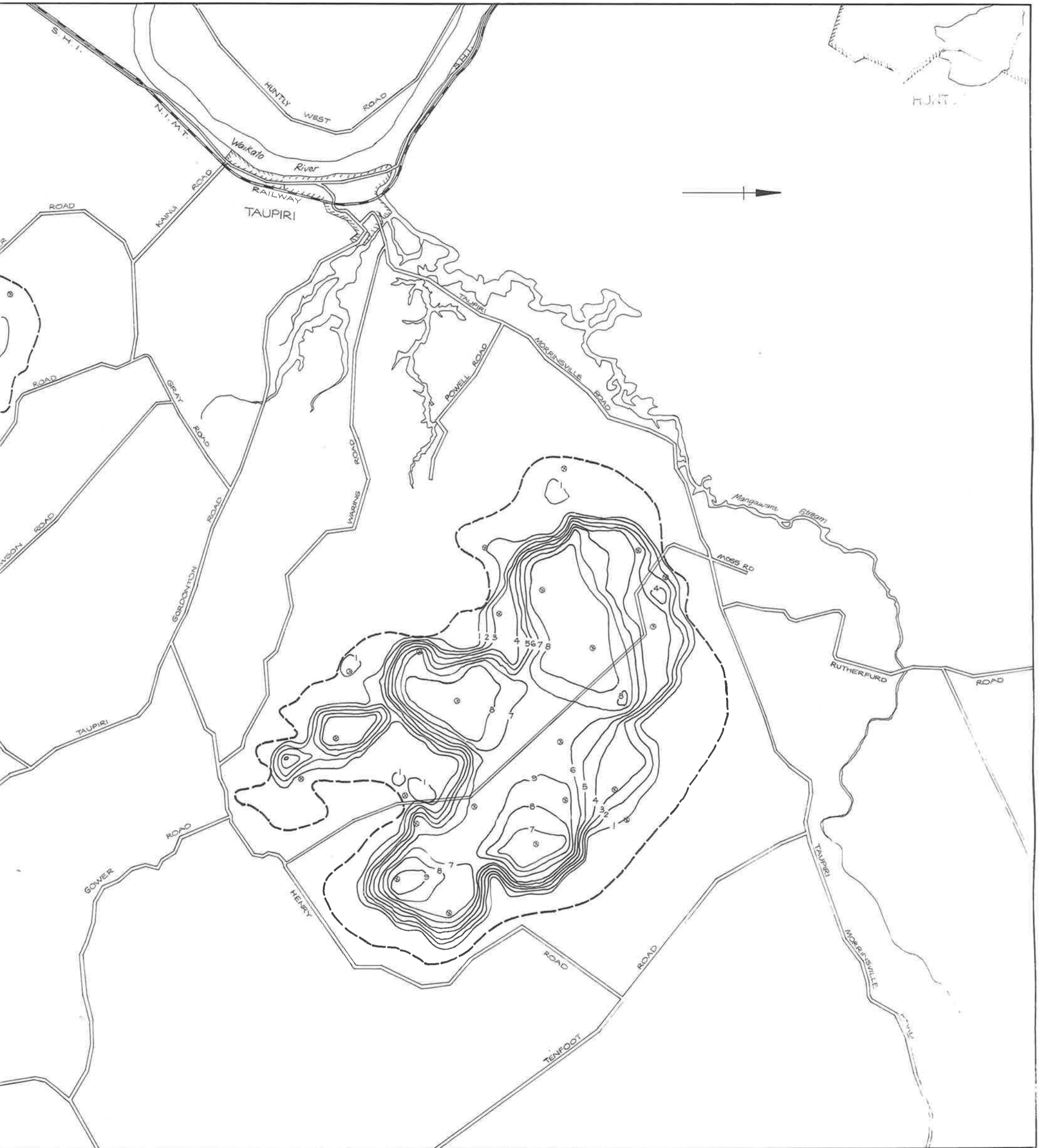
Water & soil technical publication no. 14 (1978)

REFERENCE	
ROADS	— — — — —
RAILWAYS	— — — — —
TOWNSHIPS	▨ ▨ ▨ ▨ ▨
POWERLINES	— ○ — ○ — ○ — ○ —
PEAT BOUNDARY	- - - - -
DEPTH CONTOURS	— 3 —
SAMPLE POINTS	⊙
COASTLINE	— — — — —
CLAY ZONE	▨ ▨ ▨ ▨ ▨




KAINUI

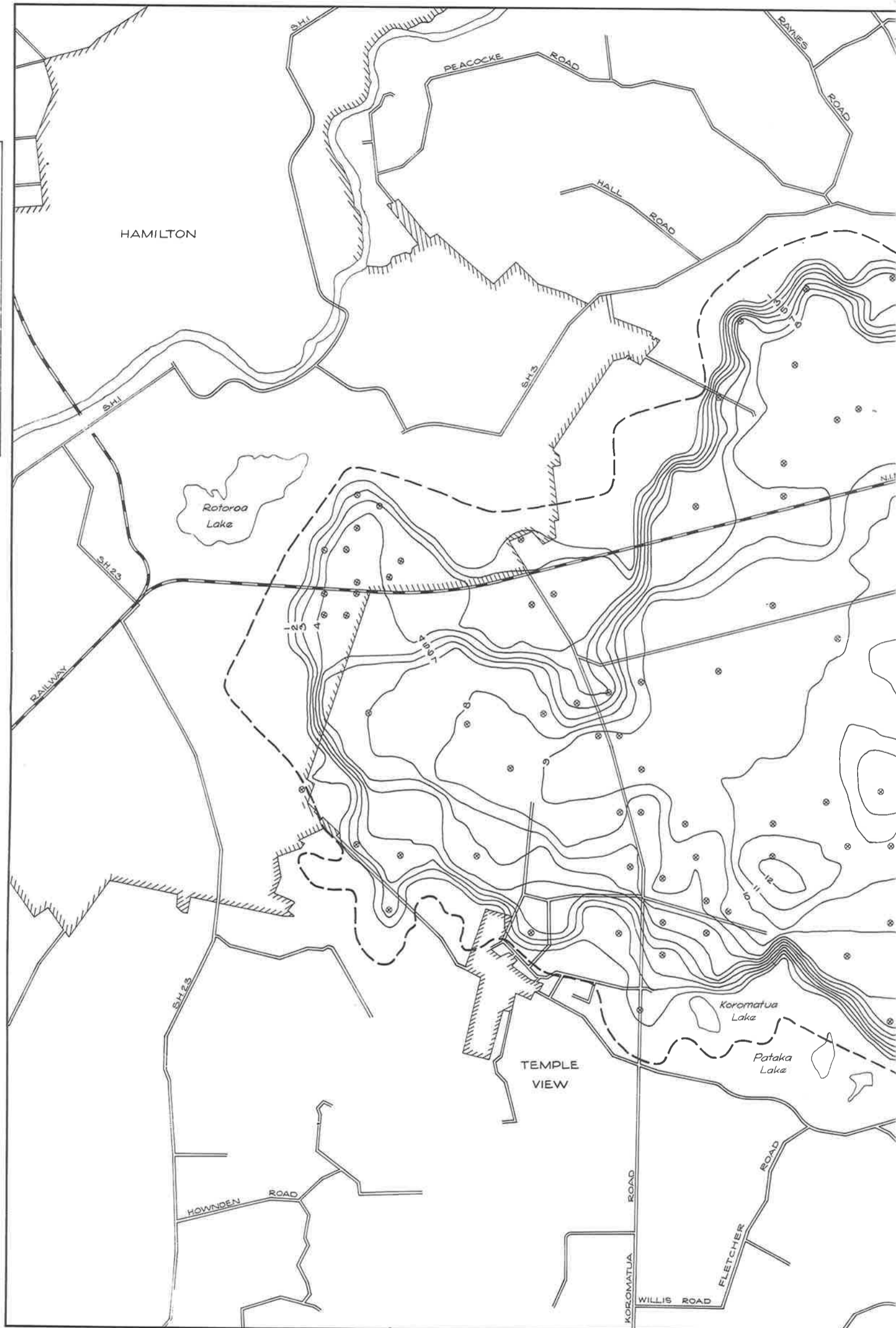
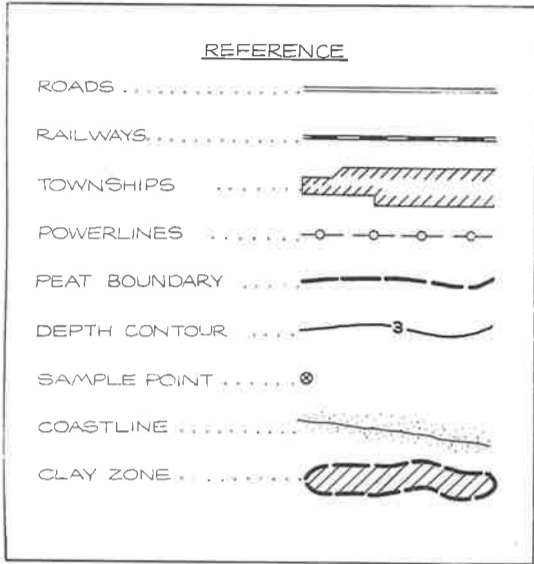
PEAT RESOURCES



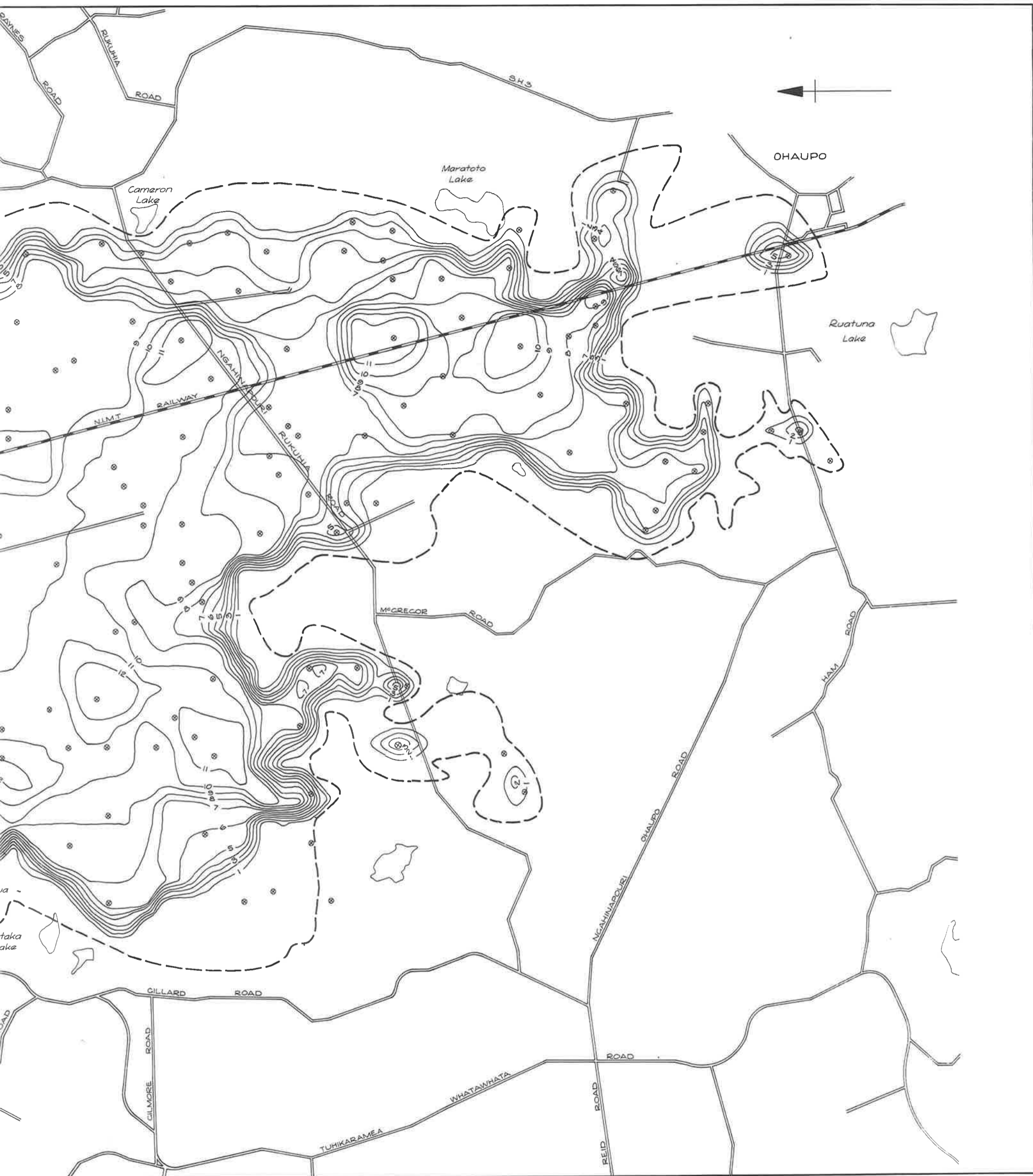
ORINI

EAT RESOURCES SURVEY

SCALE, 1:37 500  5 km

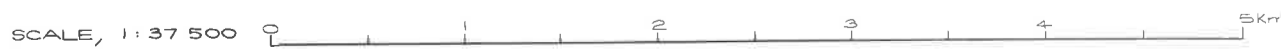


RU
PEAT RESO

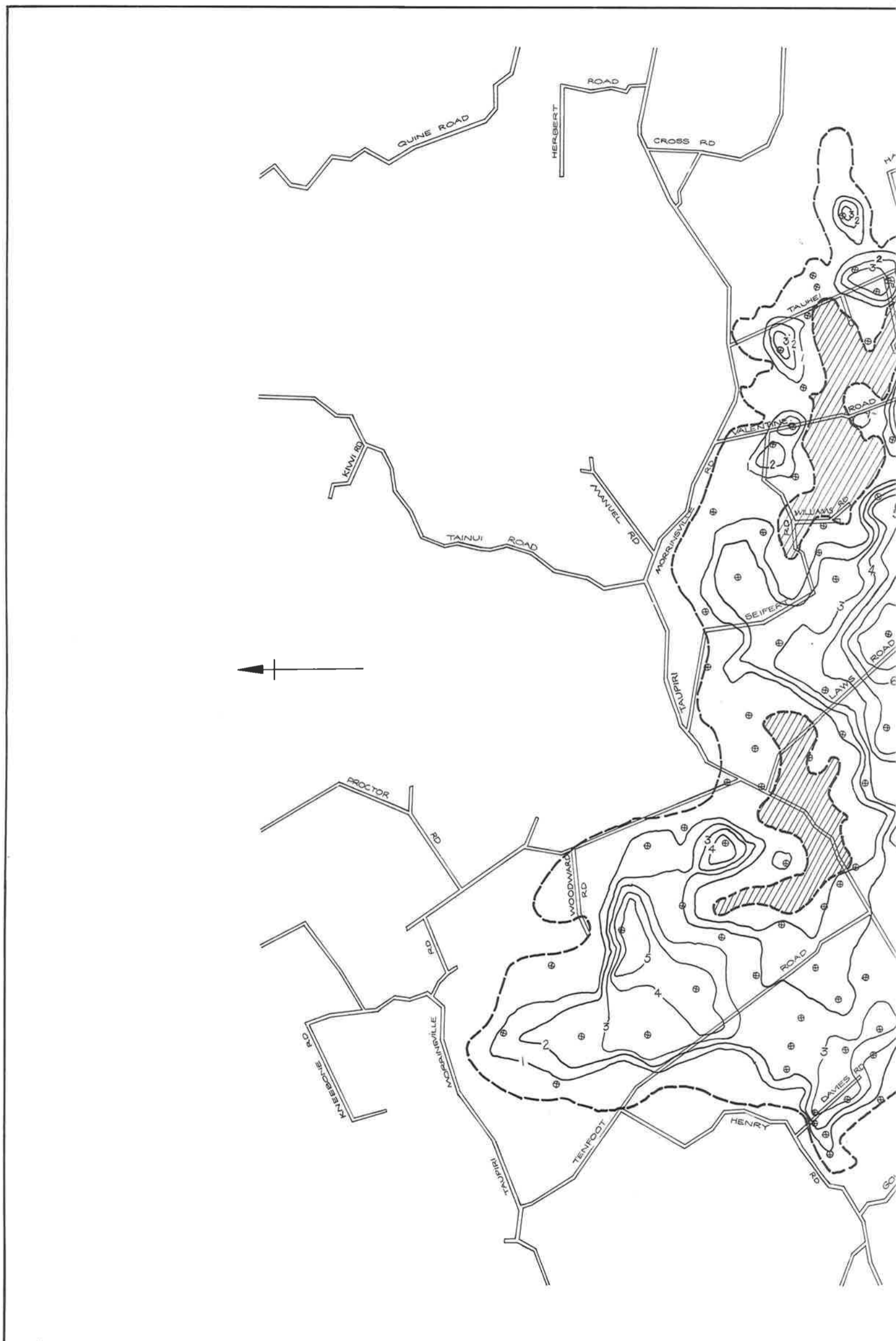


RUKUHIA

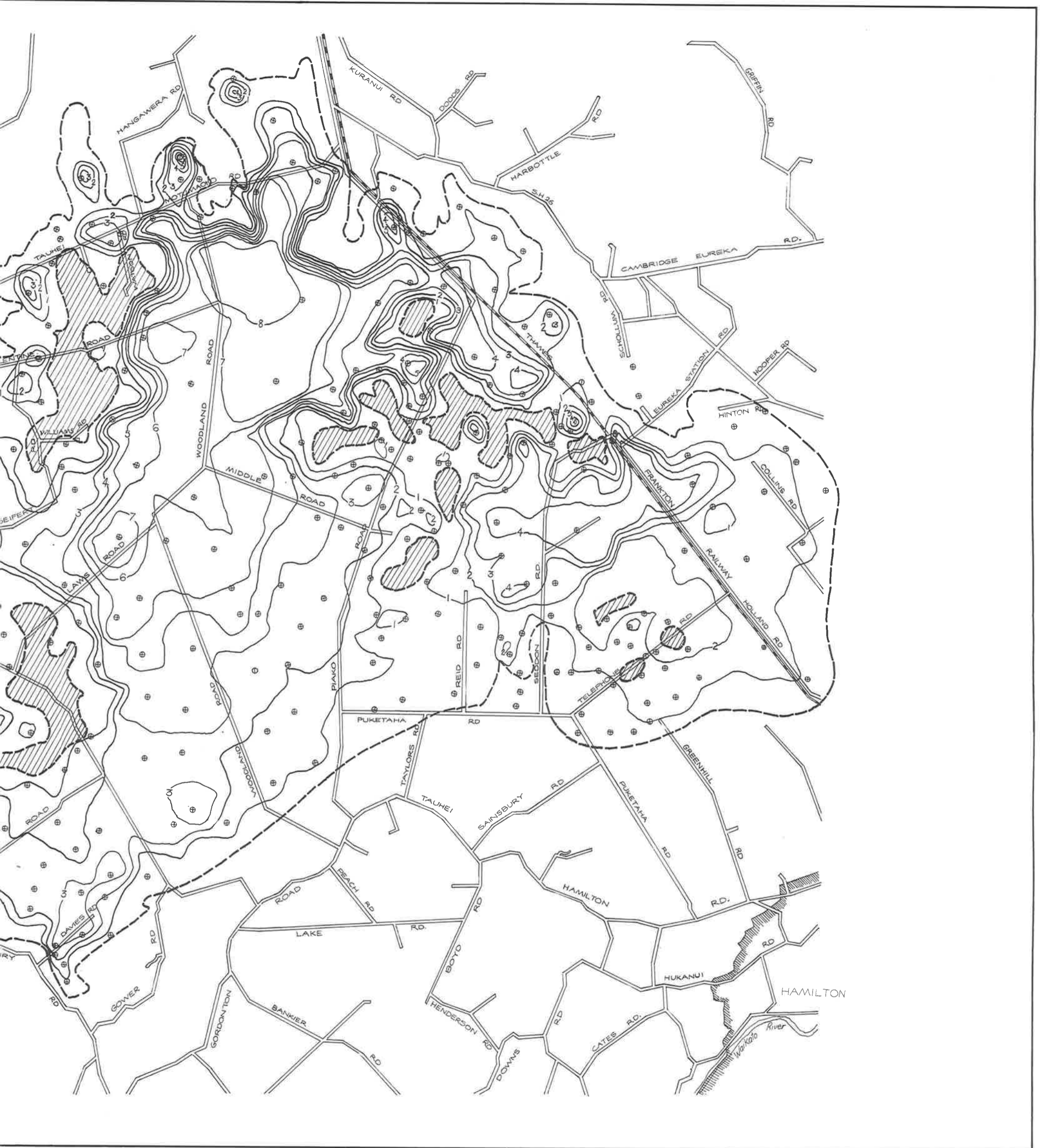
PEAT RESOURCES SURVEY



REFERENCE	
ROADS	
RAILWAYS	
TOWNSHIPS	
POWERLINES	
PEAT BOUNDARY	
DEPTH CONTOURS	
SAMPLE POINTS	
COASTLINE	
CLAY ZONE	



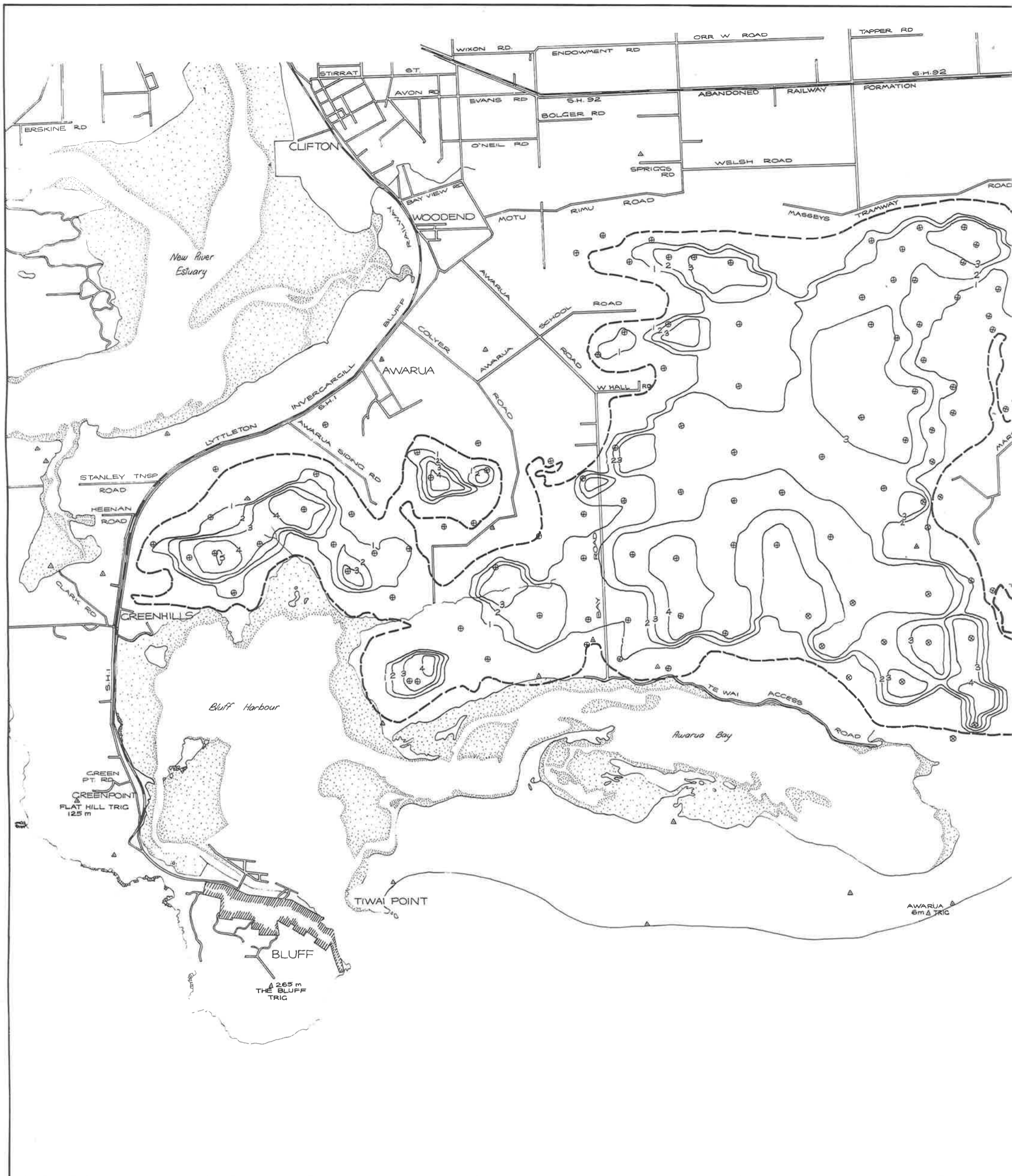
K
PEAT



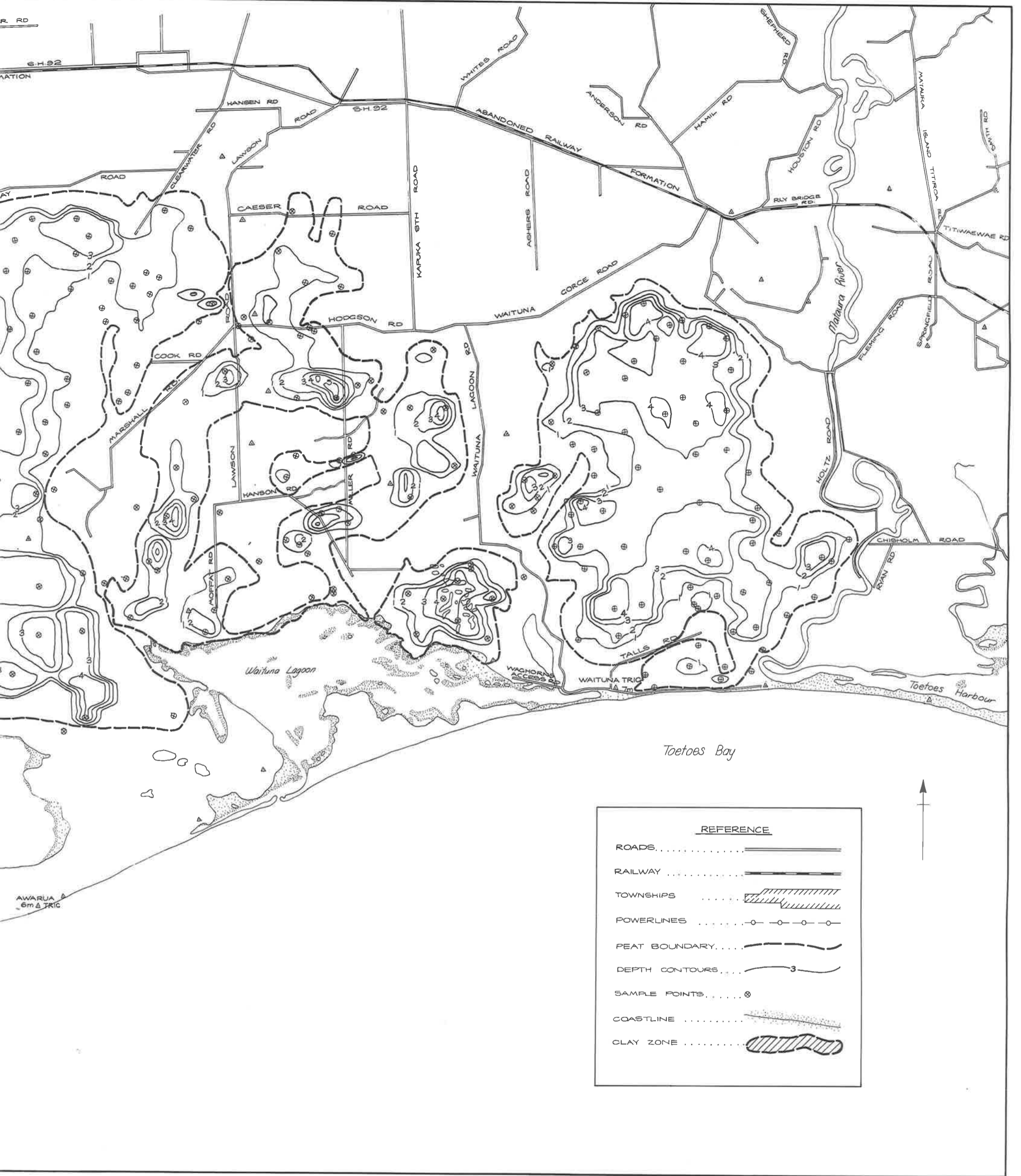
KOMAKORAU

PEAT RESOURCES SURVEY

SCALE, 1 : 75 000 0 1 2 3 4 5 6 7 8 9 10 km

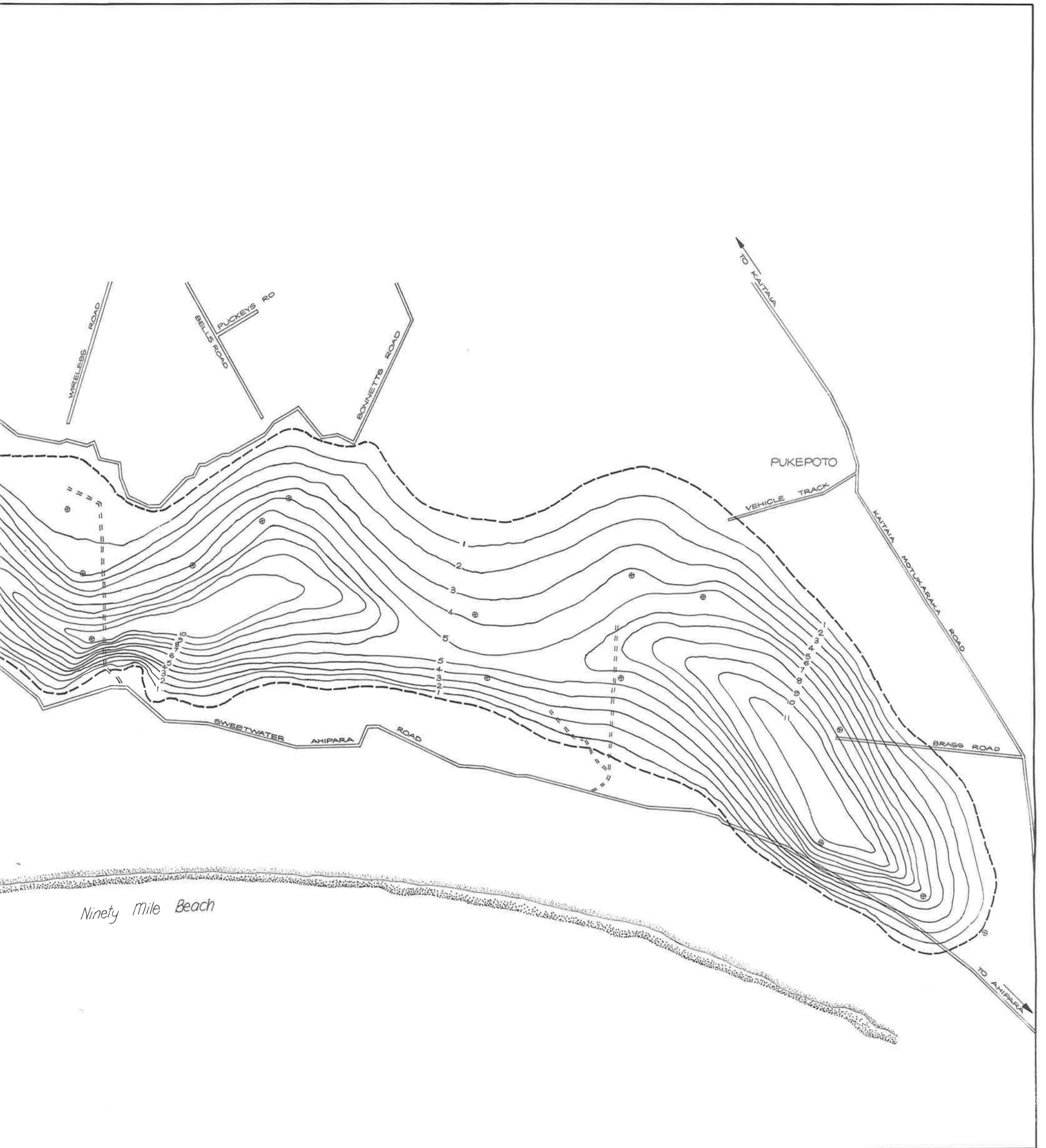


AWARUA PLAIN
PEAT RESC



MA PLAIN - SEAWARD MOSS
 PEAT RESOURCES SURVEY

SCALE, 1:75 000



SWEETWATER

PEAT RESOURCES SURVEY

