A RECONNAISSANCE SURVEY

OF

LAKE ELLESMERE AND ITS BORDER LANDS.

THESIS

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LIST OF ILLUSTRATIONS.

INTRODUCTION.

The purpose of this paper is to give a descriptive account of Lake Ellesmere and the land immediately adjacent to it. Ever since the settlement of Canterbury the utilization of this land marginal to Lake Ellesmere has presented a special problem which has been largely one of recurring inundations due to rise of the lake level. The frequent flooding of much of it temporarily puts large areas out of economic use. Therefore the primary purpose of this paper is to define on a map the limits of the area adversely affected by the rise of the lake level. Having done this, an attempt is made to describe in general terms the nature, management and use of this land and to examine the various schemes by which man has attempted to control the rise and fall of the lake. Incidental, but at the same time essential to this discussion of the lowland bordering the lake is a study of the nature and origin of the lake itself and the shingle barrier enclosing it.

With one departure the boundary of the region under discussion is that drawn up by the Ellesmere Lands Drainage Board. This Drainage Board boundary includes all that land directly flooded by the lake as it rises, and all the land liable to be indirectly flooded because of the reduced fall in the rivers and creeks. The area included

in the region under review but not in the Ellesmere Lands Drainage Board's area is the shingle bank separating the lake from the sea. This has been included because it is responsible for the formation of Lake Ellesmere. Though the Drainage Board boundary is a purely arbitary one, a glance at the soil survey map will show that it coincides very closely with the boundary between the saline or partly saline soils and the non saline soils.

For the discussion of the nature and origin of the spit, extensive use has been made of Professor R. Speight's paper on the "Lake Ellesmere Spit" which appears in the "Transactions of the New Zealand Institute", Vol. 61, 1930, pp. 147-69. For information about the Maoris and the early European settlement in the region a series of articles written by Mr . W. Taylor and appearing in the "Ellesmere Guardian" of 1943-44 proved most helpful. For the account of the utilization of the land of the region it was necessary to make field observations and interview the farmers themselves.

In an endeavour to control the rise and fall of the lake level the Ellesmere Lands Drainage Board, which has been in existence for thirty-eight years, has collected a great deal of useful information. This information has been of great help and thanks are due to the Board for permission to use it. The writer

is also indebted to Professor E. Percival and Mr.L.W. McCaskill for information on the fauna and flora of the region; to the Public Works Department for a copy of their contour map; to Mr.C.S. Harris of the soil survey division of the Department of Scientific and Industrial Research for access to a soil survey map of the region; to Mr. V.C. Browne for aerial photographs; to Mr. F. Millar, Mr. F. Coop, Mr. Stalker and Mr. W.O. Rennie for much valuable information about the present and past land utilisation in the region.

Lake Ellesmere and its Border Lands

Location Map

Scale 1" = 4 miles

Scale 1" = 1.3 miles

Waimakariri River
Belfast
Sockburn
Christchurch
Prebbleton
Halswell
Lincoln
Tai Tapu
Greenpark
Leeston
Selwyn River
Southbridge
Lakeside
Lake Ellesmere
Jaumutu
Little Lake
Rakaia River
Irwell Creek
No. 2 River
Selwyn River
Sumner
Lyttelton
Banks Peninsula
Malukarara
Kaituna
Little River
Lake Forsyth
Birdling's Flat
Akaroa
Akaroa Lagoon
Akaroa Valley
Village Settlement
Gebbie's Valley
McQueen's Valley
McQueen's Lagoon
Waikaha
Kaituna Creek
Kaituna Valley
Kaituna Lagoon
Birdlings Valley
Stoney Point
Price's Creek
Price's Valley
Devil's Knob
Hart's Creek
Lakeside
Jaumutu

a — b — c — d — e — f

— Former proposed schemes for the permanent drainage of Lake Ellesmere as set out on Page 5?

— Boundary of Border Lands.

— Christchurch-Little River Railway.

— Christchurch-Akaroa Main Highway.

— Main Secondary Roads.

CHAPTER I.

THE PHYSICAL GEOGRAPHY OF LAKE ELLESMERE AND ITS BORDER LANDS.

The Nature and Origin of the Ellesmere Spit.

Since the formation of Lake Ellesmere is a result of the building up of the enclosing shingle barrier, any study of the lake must, of necessity, begin with a brief survey of the nature and origin of this spit. It stretches in a west to south-west direction for seventeen miles from Birdlings Flat to Taumutu. Two miles wide at its eastern end, it narrows to a few chains at the western end. This gives the spit an area of approximately 12,000 acres, most of which is about eighteen to twenty feet above mean sea level. Near Taumutu the spit is much lower and during high seas the waves may break right over it.

The gravel of the spit is predominately greywacke, so it could not have been derived from the erosion of the adjacent Banks Peninsula which is volcanic in origin. Therefore the gravel must have come from the south. It is either gravel from the rivers south of Banks Peninsula, in particular the Rangitata, Ashburton and Rakaia, or it is derived from wave erosion of the coast. In either case the ultimate source would be the central hard rock highland zone of the South Island.

Odd pieces of limestone, rhyolites and hypersthene andesites are found amongst the greywacke. The limestone must have come from such foothills of the Canterbury mountains as the Malvern Hills. The volcanic rocks are quite different from those of Banks Peninsula, so that they, too, must have come from the south. The pebbles are of the beach shingle type, flat and well smoothed. They range in size from those nine inches in diameter to coarse sand grains.

The maximum height of the spit above sea level is fifty feet. In general the spit has a flat surface. The most conspicuous irregularities are the coastal dunes, the beach barrier, and the numerous undulations at the eastern end. The belt of sand dunes extends from about two miles south-west of Lake Forsyth to Taumutu. This belt has a maximum width of several chains but forms only a narrow strip at the western end. The summits of the dunes are more or less accordant, being about twenty to twenty-five feet above the general level of the spit. In places there are two rows of dunes with level ground between them. The more stabilized dunes lying inland merge with the general level of the spit. On the seaward side, however, there is quite a steep front. In the centre of the spit the dunes are being attacked by the sea but further

towards Lake Forsyth the shore appears to be prograding.

Starting at the eastern end and extending twelve miles down the spit is a well defined ridge which has all the characteristics of a beach barrier. About a chain wide, it rises in places to a maximum of thirteen feet above the general level of the spit. There is a steep drop to the swampy ground on the lake side but the outer slope is very gentle. In front of the ridge are numerous hollows, sometimes a chain in diameter, the formation of which is difficult to explain, though they may possibly be the sites of old springs which have been dry for some time. Behind the ridge is a fairly large depression which in former times afforded an excellent camping ground for the Maoris. About ten miles from the eastern end there are a number of smaller ridges. At the Birdlings Flat end the spit consists of sub-parallel ridges. The crests of the higher ridges are nearly thirty feet above sea level and the intervening hollows about seven feet lower. Just to the west of the point where the spit joins the land is an old beach which lies across the mouth of Birdlings Valley. It was probably formed when seas from the west broke directly into the valley which was then a bay facing to the west.

Another important feature is the presence of gravel rather than blown sand at the top of the eastern end of the spit which is here about thirty feet above sea level. The implication is that the land must have been lower at one time.

Except at the shore and in some gravel pits near the railway there is a total absence of sections, making it impossible to do anything but guess at the precise structure of the spit. In the gravel pit near the railway, about one mile from Birdlings Flat on the Christchurch side, there are several beds exposed. These beds of fine grained material, well stratified, are either flat or dip to the south-east at angles up to twenty five degrees. Above these beds are well stratified younger gravels which dip to the north-west at a uniform angle of ten degrees. The pebbles are as large as one inch in diameter but there is much coarse sand with interstratified layers of pebbles up to two inches in diameter. The definite stratification indicates a fairly quiet water at the time of deposition. According to Marshall[1] the heavier the seas the flatter the stratified beds, so that the high angle of ten degrees points to sheltered waters when the beach was built up.

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1. P.Marshall "Beach Gravels and Sands," Trans. N.Z.Inst., vol. 60, pt. 2. pp. 324-365

The definite break in sequence of the beds, and the ridges at the western end of the spit indicate that there was an abrupt change in conditions at one stage in the building of the spit. In the gravel pit near Devil's Knob there are well developed stratified layers dipping seawards at low angles. Similar stratification occurs in the barrier beach found between Taumutu and Hart's Creek.

Beds of clay are exposed on the eastern end of the spit and at the opening of Lake Forsyth, and scattered blocks of clay are found on the beach to the south-east of the present temporary outlet of Lake Ellesmere. However, it is impossible to determine whether these clay beds are continuous with each other and with the clay beds beneath the lake itself.

Where the spit ties on to Banks Peninsula there is a definite wave cut cliff. All the Peninsula spurs from here to within a mile of Tai Tapu have cliffed ends. These spurs must have been wave-cut at a time when there was no spit or when the land was submerged enough to allow the waves to break over the spit and against the ends of the spurs. The height of the spur-end shore platforms shows that the land must have been ten to fifteen feet lower than it is now. It is impossible to say whether the waves which cut the cliffs were lake or sea waves, but if they were lake waves the lake must have been twelve to fifteen feet higher

than it is now. However, the present height of the spit near Taumutu makes this appear improbable.

The extremely flat and well smoothed pebbles found everywhere on the spit indicate that the spit was formed by wave action. The composition of the pebbles indicates that they have come from the south. The wave action has been aided by the current flowing up the east coast of the South Island. This current, about the nature of which it has been difficult to obtain evidence, appears to extend less than three miles out from the coastline. Thus the waves, helped by wind-induced currents, are the chief cause of the alongshore drift of shingle from the south. This northerly movement is probably influenced by the very gradual deepening of the sea offshore. Since the drift has been up the coast from the south it is difficult to understand why ther is no tidal opening beside the cliff at the eastern end of the spit. It is known that until 1840 Lake Forsyth had a permanent opening to the sea.

The possibility of the present spit being the remnant of a much larger one which is now submerged beneath the sea, seems quite likely when we realize how much shingle must otherwise have been transported along the present narrow zone. Therefore the history of the spit may be very complex.

Though there are plenty of signs that the coast is being prograded near the Lake Forsyth end the sand hills some few miles from Taumutu are being strongly attacked by the sea. It is quite possible that a natural break through by the sea might take place here.

Another feature difficult to explain is the presence of totara stumps in the sand hills on the seaward side of the spit. Often standing upright on their roots they may be as high as six feet. The top few feet are riddled with teredo borings. As these stumps are found just above high tide mark the finer roots have all been destroyed by sand and gravel. The difficulty lies in deciding whether the wood is drift. If it is drift, as some of it certainly seems to be, the problem of accounting for its place of origin arises. There are only two possible sources. One is Banks Peninsula where totara was plentiful in pre-European days, but it would have had to be carried into its present position by a current flowing southward from the Peninsula. Records kept by the late Captain Bollons of the G.S.S. "Tutarekai", refer to a southerly current at certain times. Another possible source is the upper Rakaia valley where totara trees are growing in a beech forest. However, there is no beech-wood drift to be found on the spit which would seem to indicate that the totara stumps must be drift from Banks Peninsula. The only other source possible is

the spit itself. Since totara is a characteristic plant of dunes there may have been a forest here if the land had been higher to allow the trees to establish themselves. On the other hand the teredo borings make it necessary to suppose that the land has been at least twelve feet lower than it is now. That the land was so much lower is a conclusion also to be reached on the evidence of the wave-cut cliffs. There is certainly no documentary or human evidence of a forest on the spit, but it is known that there was a wide belt of forest on the opposite side of the lake. This forest, which was largely Kahikatea,[1] was destroyed long before the European settlers arrived. The pine forest may have extended to join a totara forest along the coast. Evidence of such an extension may be found in the submerged upright stumps in the lake near Hart's Creek. If, however, there was a forest growing on the spit, it might be expected to contain trees other than totara. There is no evidence of these. This of course may be because totara is so durable. It seems likely that the bored stumps drifted into their present position during an early stage in the

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1. The popular name for Kahikatea is white pine.

formation of the spit, and that the lower parts of them were quickly buried under a protective cover of sand and gravel.

It may be assumed that the land was once lower and that the lake was once open to the sea at the Taumutu end. If this assumption is correct there should be traces of a similar spit on the west side of the lake. There is, indeed, a barrier ridge, composed of well stratified beach shingle, extending from Taumutu in a northerly direction for about two miles. At its highest it is eighteen feet above lake level and has a very flat summit. In front of this ridge there are two others which also exhibit barrier forms. Towards Hart's Creek the main ridge becomes ill-defined. However, stretching out at right angles are three definite ridges, the most conspicuous of which is just south of Hart's Creek. If the main barrier ridge had been formed by lake waves it should have been continuous round the lake. Also there should have been an admixture of Banks Peninsula volcanics in the material since the dominant wind on the lake is the north-east. The material, however, is exactly similar to that of the main spit.

In summary it may be said that there is evidence of five major stages in the development of the topography of the area adjacent to Lake Ellesmere.

The land must have been considerably higher to allow for the eroding of the valleys on Banks Peninsula. Then followed a depression and an invasion of the valley floors by the sea. Next the spit was contructed when there was no major vertical movement of the land. Then the land subsided again till the spit was awash, when the barrier beach on the lake margin was formed, the totara stumps were bored, and the shore platforms cut on the ends of the spurs along the Tai Tapu - Little River road. Lastly there was an elevation of from twelve to fifteen feet bringing the land to its present level in relation to the sea.

The Nature and Origin of the Inner Lands Adjacent to Lake Ellesmere.

Lake Ellesmere submerges a part of the Canterbury Plain which extends from Amberley to Timaru. The lowlands around the inner edge of the lake consist of fine sands, silts and swamp accumulations. The surface is extremely flat having a grade of only one foot per mile on the northern side, ten feet per mile on the eastern side and twenty four feet per mile on the western side.

The entire plain has been built up of the soil from the erosion of the western mountains. The spoil which was brought down by the rivers forms overlapping shingle fans.

The outer edge of the plain has marine as well as alluvial deposits. In the course of time the rivers have wandered over considerable areas of the lower parts of their fans. This is particularly true of the Rakaia and Waimakariri rivers, as is shown by the old river banks and bare stony lands of characteristically recent river bed type. At one time the Waimakariri river flowed into Lake Ellesmere by a course just a little to the west of Christchurch. The Rakaia river flowed into the north-west end of a formerly much more extensive lake. Therefore the Selwyn basin lies within the junction of the Rakaia and Waimakariri alluvial fans. The silts, sands, and muds of the lands around the inner lake margin were deposited largely by these three rivers when they flowed into the lake. The Selwyn river has continued to build out its fan into the lake since the Rakaia and Waimakariri have changed their courses to flow directly to the sea. The numerous lines of sand dunes found between the lake edge and the Waimakariri river indicate the former erratic course of this river.

As has been shown the barrier ridges between Hart's Creek and Taumutu were probably formed at a time when the spit was awash by the sea near Taumutu. Much of the alluvial soil of the eastern side of the lake had its origin in the loess of Banks Peninsula.

The chief inflowing streams are the Selwyn, No.2, Halswell and Kaituna rivers and Hart's, Irwell and Price's creeks. Of these the Selwyn is by far the largest. The Selwyn and No.2 Rivers enter the lake at its northern corner. The lands marginal to the north-east of the lake are drained by the Halswell river. The Kaituna river and Price's Creek drain the eastern side and Irwell and Hart's Creeks drain the land adjacent to the west side of the lake. The whole drainage area for the lake is 835 square miles, of which 233 square miles is hill country.

Before European settlement almost the entire area adjacent to the lake was swamp, only the patches of higher ground being free from water all the year. The extreme flatness of the ground resulted in the rivers taking tortuous courses to the lake. In order to settle here the early colonists were forced to dig many ditches for the artificial draining of the area. Today drains are far more numerous than roads, the rivers have been straightened and their beds kept free of weeds. For example, the Halswell river draining the Ahuriri lagoon has been diverted down a straight canal to the lake.

The Lake.

The lake with its very flat floor is a large shallow area of water.

Nowhere more than eight feet deep, it has an area of approximately 38,000 acres when it's height is mean sea level. Normally the lake has no outlet to the sea and as water is brought in by the rivers and creeks its level gradually rises. Unless an outlet is cut through the shingle bank near Taumutu, the lands marginal to the lake are flooded. The length of time during which a channel, cut through the shingle bank, will remain open is dependent on the state of the ocean.

When it is open regular tidal outflow and inflow occurs making the lake water saline, However, when the outlet is blocked the inflow of salt water ceases. Though the salinity of the lake water is always relatively low it varies considerably, being approximately one fifth the salinity of sea water. The amount of salt water entering the lake through the channel is augmented by sea water washing over the narrow gravel bank at Taumutu during heavy storms. Though artesian wells are general round the lake shores, there is no evidence that springs exist on the lake floor though there is a general belief that they do.

The lake water is normally discoloured by the suspension of fine sediment brought down by the rivers. The floor of the lake is predominately composed of

sandy and silt loams, this very fine material being widely distributed within the lake water before it settles to the bottom. The sandy loam is most extensive in the south-west part of the lake floor where the south-west wind, in time of storm, blows the sand from the bare seashore near the lake outlet.

The Local Climate.

The most important element of the local climate is precipitation. The nearest recording station is at Lincoln where records have been kept continuously since the Agricultural College was established there in 1880. The average annual rainfall is 24.98 inches. This is distributed evenly over the whole year with only a slight winter maximum. The driest season is Autumn but the range between Autumn and Winter is only two inches. However, averages are not as important here as are the departures from normal. The annual rainfall is relatively low but the nature of the plain makes easy and rapid run-off impossible, so that occassional high intensity rains cause recurring floods. This flooding is intensified if the lake is already at a relatively high level. These heavy falls may occur at any time during the year

though they are less frequent in summer than at other seasons. From the point of view of the farmer, however, the most harmful times for them to occur are in late summer and spring. It is then that cereal crops and newly sown grasses suffer the most. Conversely very dry summers which are of quite frequent occurrence may cause as much damage as do the floods.

Since the level of the lake is an important factor in determining the intensity of flooding, the rainfall of the whole drainage basin is important, Therefore, the two areas to be specially considered are the upper Selwyn basin and that portion of Banks Peninsula which drains into Lake Ellesmere. The upper Selwyn basin lies in the foothills of the Western mountains. The average annual precipitation in both these areas is much higher than in the area immediately adjacent to the lake itself. The rainfall in these two places, of from 35 inches to 45 inches is, however, also distributed evenly throughout the year with a tendency for a summer maximum in the upper Selwyn basin and an autumn maximum on Banks Peninsula. Though the Selwyn river discharges by far the greater amount of water into the lake, any considerable increase in its flow does not immediately affect the lands marginal to the lake except in the immediate vicinity of its banks. Flooding occurs rather when

there is a heavy fall of rain on Banks Peninsula and the marginal lands themselves at a time when the lake level is high. Any considerable increase in the amount of water discharged into the lake by the Selwyn affects the marginal land only indirectly through the raising of the lake level. The land immediately adjacent to the north edge of the lake is most completely inundated when the lake level is high and there is a strong south-west wind blowing.

The rain is associated mainly with the south-west wind though the north-east wind is more frequent and often brings fine misty rain especially to Banks Peninsula. Generally it is a windy area with very few calm days. The south-west wind is of very high velocity on the Ellesmere spit as is shown by the prostrate nature of most of the vegetation there. Winds of gale force are frequent on the spit. This high wind velocity combined with the high intensity of sunshine, and the porous character of the gravel are responsible for the marked xerophytic character of the vegetation.

The average annual temperature is 50 degrees Fahrenheit with an annual range of 18 degrees. Frosts are common in the winter months, there being an average of one hundred frost days annually. This, of course, is at Lincoln which is farther away from sea influences.

These figures are applicable to all the lake margin lands except the outer spit. Here the annual range of temperature should be lower while the average annual temperature should also be slightly less. The Ellesmere area has 2087 hours of sunshine annually which is high in comparison with other parts of Canterbury.

Vegetation.

The natural vegetation of the area was marked by the strong contrast between the steppe of the Ellesmere spit and the swamp vegetation around the inner margin of the lake. This contrast is related rather to the character of the soils and the amount of water in the ground than to atmospheric conditions above it. As the spit is a high barrier of porous material with a gentle slope seawards and a steeper slope towards the lake, easy and rapid runoff is possible. Only occasional hollows remain wet for any considerable time. The gravelly nature of the material of which the spit is formed allows for rapid seepage of the rain water. The xerophytic character of the plant covering is induced by the poverty and thinness of the soil, the exposure to strong wind and sun, the proximity to the sea, and the small utility of the rainfall. Along the sandy sea coast there is a typical dune vegetation while over the larger part of the spit there is a plant

covering similar to that found in the shingle beds of the Canterbury rivers. The beach at both the western and eastern end is composed of pure shingle and is entirely devoid of any vegetation. The most important role in the development of vegetation here is that of the mat plants. They trap the blown sands and seeds and act as seed beds. Thus they help to establish plants and grasses and are, today, largely instrumental in spreading introduced grasses and weeds.

Th two most important plants in the dune area are the sand sedge, Carex pumila, which is a far creeping, sand binding, grasslike plant, and a sand convolvulus, Calystegia soldonella, which is a prostrate sand binding herb. Immediately behind the dunes are some very dry and barren patches where grows chiefly a scab weed, Raouli lutescens, which is a low cushion plant. Over the rest of the spit the predominant plant is the low tussack, Poa caespitosa. Associated with this are numerous grasses and herbs among which are the yellow pincushion, Sceleranthus biflorus, a small cushion plant; the yellow oxalis, Oxalis corniculata, which is a spreading prostrate herb; the scab weed, Raouli lutescens, which is a low cushion plant; and the sand fescue, Festuca littoralis, which is a medium sized tussock grass. Among the larger plants and shrubs are the southern cranesbill, Geranium Sessiflorum, which is a rosette

forming semi-woody plant; the creeping pohuehue, Muchlenbeckia axillaris, which is a mat forming creeping shrub; the Muchlenbeckia ephedroides, which is a leafless prostrate shrub; the New Zealand broom, Carmichaelia subulata, which typically is a medium sized, but leafless shrub but which here may be perfectly prostrate, partly so, or erect; and the wild irishman, Discaria toumatou. The only exotics to be found here today are thistles, trefoil and nettle which may be found all over the spit and some clover and ryegrass on the low-lying land at the lakes edge but this land really does not belong to the spit proper.

On the land round the inner margin of the lake between the present high water mark and the low water line there was a thick growth of reeds, rushes, rank grass and other water loving plants. Remnants of this vegetation are found today in the McQueen's, Kaituna, and Ahuriri lagoons. Here are found swamps of raupo, Typho augustifolia and Ruppia maritima forms submerged masses of filiform stems and leaves on the floors of the lagoons. Salt marsh has replaced this vegetation over most of the area. On land subject to frequent flooding there was a typical swamp vegetation. There are, however, remnants of an extensive Kahikatea forest which was

exterminated before the European settlers arrived. The swamp areas which were mainly along the river and small creeks were covered with New Zealand flax, Phormium tenax, in association with raupo. The artificial lowering of the normal lake level and the draining of the region by ditches has resulted in the destruction of this swamp vegetation. It has been replaced by salt marsh in some places and in others by exotic ryegrass and clovers.

Above the high water line on the slightly drier parts was found the salt marsh. Here the dominant plant was Salicornia australis which when fully developed forms a thick carpet but which cannot grow in stagnant water. As the land became drier salt marsh gave way to salt meadow. Salt meadow occurs usually on ground subject to occasional flooding. There is a close turf made up of low growing herbs with rushes and divaricating shrubs. Salicornia australis is still present but is no longer dominant. These two latter areas have been almost entirely altered by man. Because of the artificial drainage the salt marsh has been made considerably drier but Salicornia is still predominant in the pasture. Similarly the salt meadow has been made drier and with the sowing of such exotics as clovers and ryegrass there are now high fertility pastures on this area.

Lake Ellesmere Border Lands.

Map **Soil Types**

Scale 1" = 1·3 miles

N.

- Sandy Loam.
- Damp Wet Sandy Loam.
- Silt Loam.
- Sand Hills.
- Slightly Saline Swamp.
- Wet Gravel & Sand Ridge
- Only Hollows Saline.
- Saline.
- Very Saline.
- Extremely Saline.
- Saline with Gravel.
- ----- High Water Mark.

Round the margin of the lake water itself there are patches of a brownish water weed, Patamageton cheesemanai. On patches of still water are close red sheets of the floating water fern.

Lake Fauna.

Because of its richness in native fish Lake Ellesmere was well known to the Maoris. The chief fish was and still is the flounder, which lives on small transparent shrimps found in large quantities on the lake. The shrimp in turn lives on lake detritus. The other fish so important to the Maori was the eel. This was found in large numbers at the mouths of creeks and rivers.

Of the birds, the chief native species are the grey duck, swamp hen, pied stilt, godwit, tern, black-billed gull and the shag.

Soils.

As with the vegetation there is a marked contrast between the soils of the spit and those of the other lands adjacent to the lake. The soil on the spit is extremely shallow, very poor, and almost entirely lacking in humus. It is either pure sand or gravel. On the other hand the lake flats have a fairly deep fertile soil of silt and sand loams marred only by salinity.

The only areas not saline are small patches of sand dunes, the gravel ridge on the west side of the lake and small areas of sandy loam immediately adjacent to the Selwyn river. The saline soils are divided into four types.[1.]

Stretching in a broad belt round the edge of the lake from the Selwyn river to the Kaituna river is an area of very saline soil. This belt probably should extend right round the lake from Kaituna to the western end of the spit and so include the lake flat land or the northern side of the spit, but as yet no soil surveying has been done in this area. Excluding the western edge of the lake the outer limit of this area is approximately the high-flood water mark. Next to the very saline soil belt is an area of fairly saline soil which supports a poor Salicornia pasture. Beyond this belt there is the slightly saline soil in which will grow reasonably high fertility pastures. The whole western shore of the lake between the high and low water marks is included in this division, but here the soils have an admixture of gravel. Lastly there is the land which is only saline in hollows. This land supports high fertility pastures. On the west side of the lake adjoining the saline gravel belt is a gravel and sand ridge.

1. See soil map.

In making a report on the possibility of draining the lake and reclaiming the floor, the Public Works Department made a survey of the soils of the lake floor. This showed that there is no sample finer than a silt loam, implying that no great difficulty would be experienced in cultivating the soils. The soil is abnormally rich in available phosphates, potash, magnesia and lime while the total plant food is high compared with the average New Zealand soil. The amount of nitrogen is low but this would increase rapidly when the soil was cultivated.

Summary.

The physical geography of the land adjacent to Lake Ellesmere clearly indicates that the region can be divided into two distinct areas, the land adjacent to the inner margin of the lake and the spit. Of these two areas the most important economically is the land adjacent to the inner lake margin. The poverty of the soil and the porous nature of the gravel make the land on the spit suitable only for low fertility native grasses. On the other hand, the land adjacent to the inner lake margin has a fertile soil which, when properly drained, will grow high fertility grasses. Therefore the draining of this land presents the greatest

problem to the settlers here.

Though much has been done to keep the land adjacent to the inner lake margin effectively drained, there still remains the major problem as to how the lake can be kept open permanently. If this problem were solved the danger of flooding would be largely overcome. At the same time, with the erection of stop banks large areas of the present lake floor, which has a potentially fertile soil, could be brought into production.

CHAPTER II.

SETTLEMENT HISTORY OF THE LAKE ELLESMERE AREA.

Maori Settlement.

To the Maori Lake Ellesmere, or Waihora, as he called it, together with the land marginal to the lake, had no rival in the South Island as a place of food supply. The lake teemed with patiki[1]. and tuna[2]. and pukeko[3]. were plentiful on the adjacent land. Flax and numerous edible plants grew on the lands adjacent to the lake.

From the scanty information available it would seem that the first Maori settlement in this area was at Taumutu. The first pa which was built there about three hundred years ago was destroyed and carried away by heavy seas a few years later. Soon afterwards the ancestors of the present day Maoris of Taumutu built a second pa just a little to the west of the first one. By 1840 Taumutu with a population of about thirty was the only Maori settlement in the area. The nearest Maori settlement to Taumutu was on the north side of Lake Forsyth.

1. Flounder
2. Eel
3. Swamp Hen.

The remnants of old pas, and the various relics which have been found at several places right wound the edge of the lake are an indication of the formerly much greater Maori settlement. Evidence of Maori settlement has also been found in all the valleys and on all the hill points from the head of the Ninety Mile Beach to Gebbies Pass. One of the most recently evacuated pas was the Ngati Koreha which lay back near the hills between Ahuriri and Motukarara. The people of this pa belonged to the Ngai Tahu tribe as did nearly all the Maoris in this area. This tribe was almost completely wiped out by the "Eat Relation Feud" in the early eighteen hundreds and the people of the Ngati Koreha pa moved to Kaiapoi about 1830. Afterwards, on odd occasions, some of these people visited this area and camped by the Ahuriri lagoon. Waikaka was a settlement lying back from the outlet of the Halswell river. There are also remnants of Maori settlement on the spit where the barrier beach afforded shelter, and where there was a spring and a small swamp.

It was on fishing that the Maoris depended largely for their livelihood. They bartered flounders and eels for shark with the Maoris of Rapaki and Port Levy. The flounders came in when

the lake was opened, spread themselves over it and ascended the numerous streams. When the boulder bank was opened the Maoris, men, women and children, worked from daylight till dark using hoop nets to trap the flounders. When the outlet was blocked and the fish again moved to the open sea the Maoris dug a series of trenches into the shingle bank. When a trench was full one Maori would throw the fish onto the bank and the women would gather them up. They were then dried in the sun. In the creeks the flounders were speared.

The catching of eels was surrounded with much ceremony. Each hapu of the tribe had its own eeling grounds and any trespassing resulted in bloodshed. The common method of catching the eels was spearing. On a much larger scale was the building of weirs with manuka sticks in the larger streams. It was in order to secure good hauls of eels that the Maoris only let the lake out once in every three years. However, the present practice of letting the lake out twice a year does not seem to have had amy detrimental effect on the supply of eels.

Fishing, which was formerly the chief occupation of the Maori, is now a rapidly dying industry. The eel has suffered little from European settlement since the European does not like it. The flounder, however,

is just as much a favourite with the European as with the Maori. In 1893 the Maoris of Taumutu were sending forty cases of flounders to Christchurch daily. There were about 250 men and twenty boats employed in fishing. Today there are only about twenty fishermen most of whom are not Maoris and some are only part time fishermen. The trout introduced by the Acclimatisation Society and the destruction of spawn caused by the early and frequent letting out of the lake have been responsible for a decline in the number of flounders in the lake but the real cause of the decay of the fishing industry lies not in a lack of fish but a lack of fishermen. Other and more lucrative work can be found in the cities.

The Maori of Taumutu today is not a fisherman, as of old, but a farmer. Here again the Maori has fared badly at the hands of the European. All the best lands have been alienated and only a small area of the poorest land remains in their possession. The total amount of land reserved for the Taumutu Maoris today is 1023 acres of which nearly 700 acres is under water for part of the year. The Maoris, today, are drifting to the towns and the only way to prevent this would seem to be the setting up of a small secondary industry, such as eel oil extraction or fish preservation works.

The edible plants to be found in the area were the raupo which grew in the swamps and the cabbage

tree which flourished at Greenpark just north-east of the Ahuriri lagoon.

The native flax was used by the Maoris for making mats, cloaks, bags and even rafts. Extensive flax swamps existed on either side of the Halswell river from Tai Tapu to Halswell as well as the smaller strips of flax along the Halswell river below Tai Tapu and along the small streams.

Unlike so many Europeans, they thought of the future and preserved their food supplies.

The European Settlement.

From the beginning of their contact with the Europeans, the Taumutu Maoris were always friendly. During the early days they were often responsible for rescueing people who had been shipwrecked just offshore. The earliest settlers came not to the western or northern swampy areas but to the eastern valleys and the extreme eastern portion of the spit. One of the earliest settlers was Joseph Price who took up land in Prices Valley. He kept dairy cows and made cheese which he took by whaling boat across the lake to Gebbies Valley. Cheese was also made by William Birdling and taken by boat to Gebbies Valley from Birdling's Valley where he had settled in 1850. McQueens Valley was settled in the forties by Archibald McQueen

who used his holding to graze sheep.

The greater part of the lake margin land was not settled till after 1889. The relatively late settlement here was due to the bad drainage and frequent flooding of the land. However, in 1874 William White of Little River was operating a paddle steamer on the lake between Stony Point and Hart's Creek for the purpose of carrying timber from his saw mill at Little River to the settled areas of Leeston and Southbridge.

Almost the whole of the land adjacent to the lake forms part of reserve 959. The first general survey of the area was made in 1851 but the area was not declared a reserve till 1868. The first sale or lease of land did not take place till 1889. The first part of the reserve to be put up to auction was on the north side of the lake immediately south of the Ahuriri lagoon. The last area to be settled was part of the eastern end of the spit which was not taken up till 1895. These first occupiers began by grazing dairy cattle and sheep on the driest parts. As they began to drain the land they ploughed it and sowed grass and seed crops.

The natural steppe vegetation of the spit has been scarcely altered by human occupation. Exotic grasses and weeds have become established to a small

extent but they have been in the main self-sown. The few macrocarpa trees, Cupressus macrocarpa, growing on the spit are very poor specimens. With one exception the grazing of sheep and a few beef cattle has been and remains the only form of farming on that part of the spit extending from the railway line to Taumutu . Just to the west of the railway line there is one dairy farm on land which is a great deal better than the rest of the spit. The soil is an isolated patch of alluvium. The land between the railway and the hill inPrices Valley is used for the grazing of sheep and beef cattle where formerly it was used for dairy farming.

The greatest change which has occurred has been in the draining of much of the area. The land above high water mark has been changed from an area of poor native pastures and swamp to one of good pasture and arable land. The only areas of swamp vegetation now are around the Ahuriri, McQueens and Kaituna lagoons. The land below high water mark, though still subject to recurrent inundations, remains above the lake level for a much longer period and can be used for the summer grazing of sheep. This has all been achieved by the letting out of the lake more frequently and at a much lower level than was the case before European settlement, and by the digging of drainage ditches and the straightening, widening and cleaning

of the rivers and creeks.

The fauna of the area has also been changed by European settlement. The body chiefly responsible for this change is the Acclimatisation Society which was founded in 1864. Its chief work has been in preserving the existing fauna and the introduction of new species. The flounder and the eel are still to be found in large quantities in the lake and at the mouths of the streams. The introduced trout is now to be found here too. One of the most outstanding instances of successful acclimatisation is that of the black swan which is now a familiar sight on the lake. The swan feeds on the lake weed. Its nesting grounds extend from the Kaituna to the Ahuriri lagoons. Too great a natural increase in their number has been prevented by the scarcity of nesting grounds and the lack of food as well as by shooting during the open season and the collection of eggs by the Society. The Canadian goose has also become well established and is already proving a pest on the land immediately adjacent to the lake as it destroys the grass. Both the introduced and native birds are protected and are allowed to be killed only at a certain season of the year.

The building of roads and railways increased as settlement increased. The only railway line passing through the area is the Christchurch-Little River line which serves the eastern and north-eastern areas.

The Christchurch - Akaroa main highway also passes through the eastern part of the area. These two lines of communication were built primarily to serve Banks Peninsula and they owe their existence to the early economic importance of that area. The area as a whole is served well by second class roads.

The small villages of Kaituna and Motukarara have declined in importance as communicatinns have improved. The most striking example of this is the closing of both schools and taking of the children by bus to the Tai Tapu school.

CHAPTER III.

LAND USE ON THE LAKE MARGINS.

Most of the land in the whole region is either in sown or in native pastures. Only a very small total acreage is utilized for the growing of other than grass crops. Fodder crops, such as lucerne and mangolds occupy by far the largest part of the land not in grass. Barley, which is the only cereal crop grown, is found only on the drier portions, particularly near the outer limits of the region. On those farms where short rotation or temporary pastures predominate ryegrass and clover seeds are harvested.

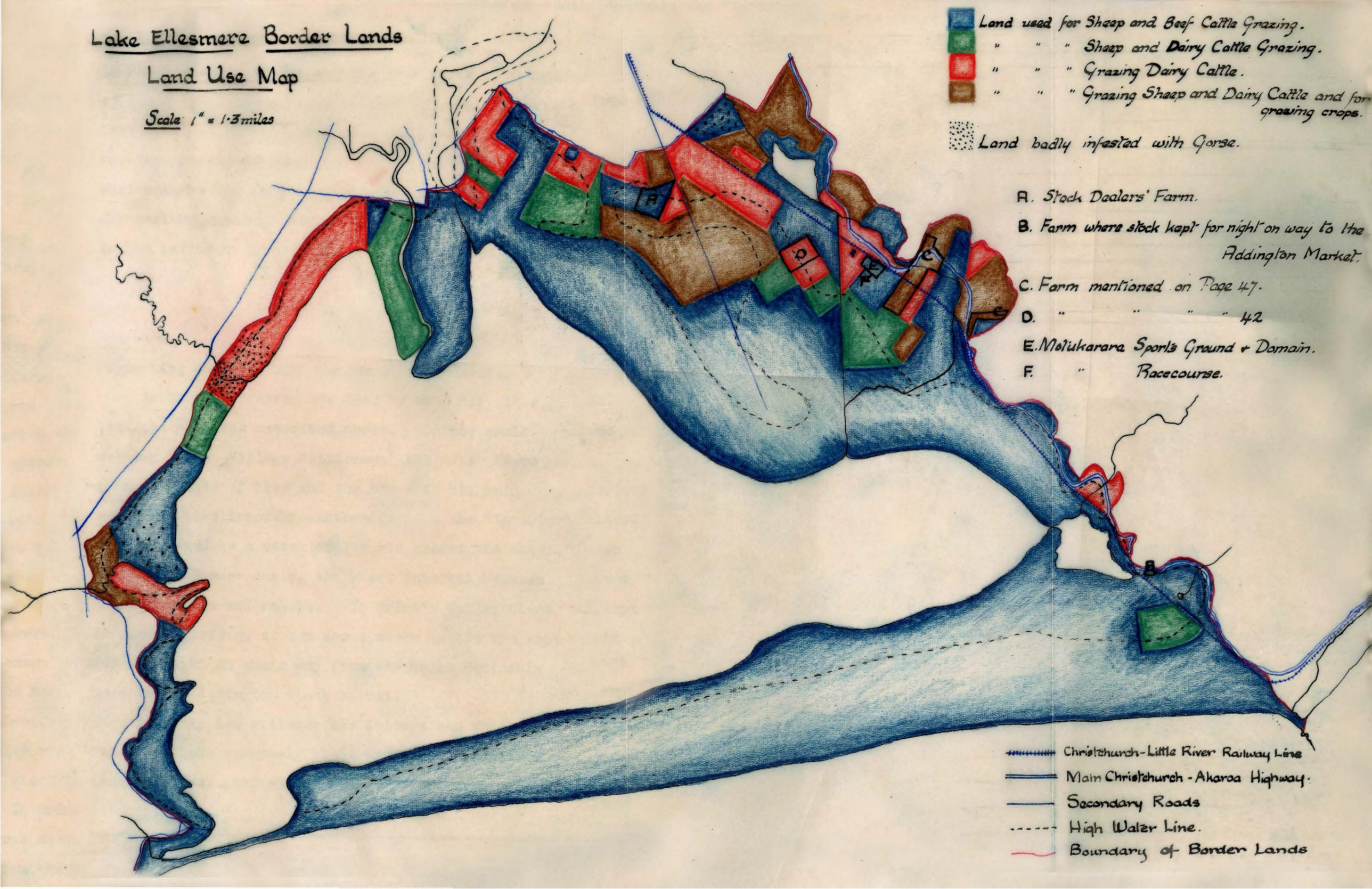
In the region as a whole three distinctive farm economies are recognizable. The first type is the small dairy farm which has long rotation or permanent pastures and a small acreage of mangolds and sometimes lucerne. The second type is the much larger sheep farm where permanent pastures predominate. Intermediate between these two types is the medium sized mixed farm. Here pastures are short rotation ones with occassional temporary pastures. Usually there are some cereal and fodder crops grown. Either sheep or dairy cattle or both may be grazed.

The distinction between the sheep farms on the one hand and the dairy farms or mixed farms on the other is largely a result of the degree to which the land is liable

Lake Ellesmere Border Lands

Land Use Map

Scale 1" = 1·3 miles



to be flooded. Almost all the land which is inundated by the lake during a heavy south-west gale, with the lake level at 3' 6'' above mean sea level,[1] is utilized for the grazing of sheep and a few beef cattle. When not flooded this land provides comparatively dry healthy grazing country for sheep, but the soil is too saline to grow high fertility pastures. capable of supporting herds of dairy cows. The extensive sheep farming on the spit is a result not of flooding but of a thin gravelly and porous soil incapable of supporting anything but low fertility grasses.

In three instances the land is used for other than the purposes described above. On one small holding in the Village Settlement[2] the owner keeps a large number of bees and the honey is his main source of livelihood. Another farm in the "Interior" Area is owned by a stock dealer who grazes the sheep, cattle and horses during the short interval between their purchase and resale. In Price's Valley there is a small holding of ten acres where cattle are kept for the night on their way from the Banks Peninsula bays to the Addington stock market.

The only two villages are Kaituna and Motukarara. These are both extremely small and contain little more than a railway station, a hall, a post office and in

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1. See Land Use Map.
2. See location map.

the case of Motukarara a shop. The local schools have both closed down and the children from these districts are taken by bus to the Tai Tapu school. Lakeside is a small village near Hart's Creek on the west side of the lake and Birdling's Flat which has little more than a railway station is situated in the extreme south-east corner. Both these places are just beyond the edge of the region under discussion though they may serve part of its needs.

There is a marked change in the landscape as one travels from the outer limit of the region towards the lake shore. This difference is essentially one of land utilisation. Near the outer limits of the region the countryside is characterized by small green fields, numerous houses surrounded by macrocarpa[1] trees, and here and there patches of arable land. As the lake shore is approached fields become larger, houses fewer and trees rare until within a mile of the lake itself the only sign of habitation is a few sheep.

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1. The saline and swampy nature of the soil prohibits the growing of many types of trees but it has been found that the macrocarpa, Cupresses macrocarpa, will thrive in most parts of this region. Its shallow spreading root-system enables itto establish itself in ground where the water table is very near the surface.

The land in the outer zone is usually occupied under a different system of tenure from that of the inner zone. All the land below high water mark between the Selwyn and Halswell rivers is crown land which is leased by the farmers on a yearly basis. The shingle barrier and all the land on the east side as far as the old Halswell river bed is crown land leased in perpetuity.[1] The remainder of the land is freehold and is generally farmed by the owners.

In this discussion on the land utilisation the region has been divided into two parts.[2] All that land which lies below the high water line and the spit has been called the lake shore area. It is used predominately for the grazing of sheep. The rest of the region has been called the interior area. One feature common to both areas is the considerable amount of land which is farmed in conjunction with either drier flat land outside the region or with hill country.

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1. Lease in Perpetuity or L.I.P. as it is termed dates from the time when the Government stopped selling land outright to the settlers but rented it to them for 999 years.

2. See Land Use Map.

The Interior Area.

Though not directly flooded by the lake when it is at its highest level the area is indirectly affected because the reduced fall of the rivers and creeks causes them to overflow and flood the surrounding land. However, it is generally much drier than the lake shore area and because it is not directly inundated by the lake itself the soil is less saline.

Though only containing approximately 8,500 acres or about one quarter of the whole region, this area supports about 85% of the population. There are fifty complete farm units of which thirty range from fifty to one hundred and fifty acres. There are also seventeen pieces of land which are farmed in conjunction with land not in the region.

Approximately three quarters of the land has been ploughed at some time but native grasses are still prominent in much of the pasture.

The milking of between fifteen and thirty dairy cows is the basis of the typical farm economy. The general practise is to grow just enough lucerne, hay and mangolds to feed the cows during the three winter months when there is no grass growth. On the better land the pastures are short rotation ones which means that they are ploughed every four or five years. However, the greater part of the land

is under long rotation or permanent pasture. The best pasture swards are made up of perennial ryegrass, white and strawberry clover. Heavy grazing and general bad pasture management causes these high fertility grasses to be replaced by lower fertility native grasses especially if the pastures are left down for any considerable length of time.

Where lucerne hay is grown the number of acres in lucerne varies with the size of the dairy herd and the amount fed out to each cow. Where the dairy herd numbers fifteen about five acres of lucerne are grown. Three cuts yearly are taken off the paddock, each cut averaging one ton per acre. The same paddock of lucerne lasts about ten years in this region.. Where only one ton of hay is fed out to each cow during the winter, some mangolds are grown but the amount of ground in this crop is never much greater than half an acre per farm. Lucerne, as a fodder crop is particularly valuable because of its high yield per acre, its persistence for several years and its good feeding qualities. Lucerne hay is predominant around Motukarara but elsewhere grass hay is more important. The grass hay is usually cut from the best perennial or Italian ryegrass and clover pastures though one or two farmers make hay from native grass pastures. Native grass being

of lower fertility does not make nearly such nutritive hay.

As in many parts of New Zealand the old practise of stacking hay is being replaced by the more modern method of baling the hay. As yet no silage is made. The hay-making season lasts from about the end of October to the end of December, The stock are never housed in winter but are fed on hay and mangolds in the paddocks.

The number of milking cows kept on each farm varies, of course, with the size of the farm, the number of dry stock kept, the proportion of the winter feed which is grown on the farm, the quality of the pasture and also how well the stock are fed. Where all the winter feed is grown, where the stock are reasonably well fed, and where pastures are good the average number of acres per cow is four.[1] The number of dry cattle kept varies from farm to farm but usually enough heifer calves are kept to maintain the herd. Besides the calves there is a bull and often a few dry cows which are being fattened before being sold. The total number of non milking cattle on a farm where fifteen cows are milked is about six. Only

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1. According to E.J.Fawcett in "Agricultural Organisation in New Zealand", p. 462, the highest fertility grasses growing under the best conditions in New Zealand will support almost one cow per acre.

on one or two farms is hay bought and the practice of wintering milking cows on the hills has almost entirely ceased.

Since no official herd testing is done in the area it is difficult to obtain any reliable figures on the amount of butterfat produced annually by each herd. However, it is probable that the average production per cow does not exceed 300 lbs. of butterfat annually. The cows are mainly Friesian, shorthorn, or Jersey crosses.

Only from two farms is the milk sent to Christchurch for direct human consumption. All the other farmers separate the milk from the cream, using electrically driven separators, and send the cream to the Tai Tapu Central Co-operative Dairy Company Ltd.[1] in Christchurch. The cream is collected by motor lorries four times weekly in summer and once a week in winter. Before the recent introduction of butter rationing the cream lorry delivered the farmer's weekly requirements of butter, since no butter is made on the farms.

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1. Until 1944 there were two factories collecting cream from this area. One was the Tai Tapu Co-op Dairy Company Ltd. and the other the Central Co-op Dairy Company Ltd. but in 1944 these two companies combined to form the Tai Tapu Central Co-operative Dairy Company Ltd.

The skim milk is used for the feeding of pigs which are found on every farm where dairying is important. There are, however, no farms where pigs form the basis of the farm economy but they are regarded everywhere rather as a profitable side line. On those mixed farms where barley is grown the seconds of barley also form an important part of the pig's feed.

Most of the purely dairy farms are worked by one man with additional labour during haymaking. There are, however, several small holdings of ten to twenty acres where the occupier milks about six cows but his chief occupation is working for the Railway Department or the Ellesmere Lands Drainage Board. These small holdings are on land which was originally divided up into small sections in the belief that a village would eventually become established there. Often during the summer months the cows are grazed on the roadside.

The use of milking machines and separators is universal except where the number of cows milked is too small to warrant their installation. Hence where a herd has more than twelve cows in it milking machines are used.

Typical of this kind of farming is a dairy farm[1] of 104 acres situated just to the west of the point where the railway line crosses the Halswell diversion channel. Part of this farm lies below the high water

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1. See Land Use Map for exact position

mark and is therefore in the lake shore area. The whole farm is in fairly high fertility permanent ryegrass - white clover pastures. About seven acres of lucerne are grown and about half an acre of mangolds. Besides this some grass hay is also kept for winter feed for the dairy cows. Between twenty and twenty five cows are milked annually with machines and the cream sent to the dairy factory. There is little, if any, artificial fertilising of the soil here.

In several instances dairy farming has been replaced by the grazing of sheep. There does not seem to be any reason for this other than the ability of ageing farmers to obtain a sufficient income by the much easier method of grazing sheep.

Most of the sheep grazing land is farmed in conjunction with land outside the area. Where the land is farmed in conjunction with hill country the general practice is to shift the sheep down to the flat during the summer months and to fatten the lambs there. The pasture generally is permanent reygrass --white clover with an admixture of native grasses. The carrying capacity of this land varies from three sheep to the acre on the best land to two sheep near the boundary between the interior and the lake shore areas, since the soil here is more saline and consequently the pasture poorer. Where the sheep

are kept on the land throughout the year some turnips and rape are grown on the drier ground for supplementary feed during the winter. The danger in keeping sheep on much of this land during the winter months is that they are liable to develop foot rot. This is particularly the case where the sinking of artesian wells, which allow the water to run over the land all the year, has made the ground much wetter than it otherwise would be. Though this causes foot rot in sheep and thus is partly detrimental to the land it is of great value in summer when the light sandy soils dry out quickly if wells are absent. Thus in several instances the sinking of artesian wells has forced the farmers to change from sheep to dairy farming.

The sheep are bred both for wool and mutton as is the case throughout the whole region. They are mainly Romney - Southdown crosses. As in the lake shore area the smaller flocks of sheep are taken to the larger farms to be dipped and shorn. The wool is sent to Christchurch either by rail or motor lorry to be sold. The lambs, which are nearly all sold fat, are sold directly to the freezing works located near Christchurch. Representatives of the freezing companies travel round the country and select those lambs ready to be killed. These lambs are then sent to the various freezing works either by rail or in motor lorries. The days when flocks of fat lambs

travelled on foot to the stock market in Christchurch are gone. A small percentage of the fat lambs are still sold at the stock market but they too travel by rail or motor lorry.

Mixed farming becomes more prominent near the outer margin of the area especially in the north-east portion. Some of the mixed farms graze sheep, aome dairy cows and some both. Barley is frequently grown and short rotation pastures are common. The light sandy soil over much of the area is not particularly good for growing cereal crops but is more suited to barley than to wheat or oats. Short retation grasses and fodder crops are the main arable crops. A great deal of the soil is too saline to give good yields of barley but on the less saline patches the yields are as high as sixty bushels per acre. The average yield over a fairly long period of years is about thirty bushels per acre. No single farm grows more than fifty acres of barley annually and most grow less than thirty acres. Dry summers frequently cuase extremely low yields in barley crops. This is caused by the extremely rapid drying out of the soils during a hot dry summer even though the spring may have been very wet. On the other hand heavy rain during the spring, after crops have been sown, results in many paddocks being flooded and the

young plants drowned,

Short rotation grasses are easily the most important single crop. The pasture is sown down every three or four years in perennial ryegrass, white and red clover. In the first year a crop of grasseed is usually harvested unless particularly dry weather makes this not worthwhile. Near the outer limits of the area crops of grasseed frequently average fifty bushels per acre but on the more saline and poorer soils crop yields are much lower and more variable from year to year. The paddocks are then grazed or perhaps kept shut up and a crop of red clover harvested. Clover is considered only a catch crop which may be gathered in an extremely favourable year. In some cases, but particularly where dairy cows are important in the farm economy, hay is cut in November and the paddock afterwards either grazed or shut up and a crop of red clover harvested.

Sometimes Italian ryegrass and clovers are sown in the spring. This pasture is grazed during the summer and a crop of grasseed harvested in the following summer. The pasture is only temporary and is ploughed up again in the autumn or the following spring.

The harvesting of the seed crops is done largely by header harvesters. Until recent years the barley and grasseed was cut with a reaper and binder, stooked,

and then either stacked or threshed directly from the paddock. The clover was cut with a grass mower which placed the clover in fairly well separated rows and later it was piled into small heaps by hand forking. The great advantage of the header harvester over the old methods is the amount of labour it saves. Two men can now do the work it formerly took eight to ten men to do. Its great disadvantage lies in the fact that the seed must be allowed to get much riper before being cut. This is liable to cause heavy losses through the seed being blown out by strong winds. As strong winds are frequent in the district this factor is of great importance. However, it has been partly overcome by the cutting of the crops with a reaper before they are ripe enough for direct heading and, as with the old method, allowed to remain in the paddock for about a fortnight before being threshed by the header. Just as the "tin mill" and the tractor replaced the old "wooden mill" and the traction engine, so the header harvester and the tractor are now replacing the "tin mill". Tractors are in general use for cultivation and only on the smaller farms are horses still used.

An example of a well farmed mixed arable - dairy farm in this area is that of three small farms owned by three brothers who farm their holdings as a single unit. The total area is 318 acres located near Motukarara.[1.]

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1. See land use map for exact location.

The land is all flat and contains some of the best soil in the area. About twenty five to thirty acres of barley are grown annually and the average yield is fifty bushels. About the same number of acres of grasseed are harvested yearly. In very favourable years clover is also kept for seed. The pastures are all short rotation ones and are ploughed up every five years at least and often every four years. The pasture sward consists mainly of perennial ryegrass, white and red clover. Only a little grass hay is made as the chief winter fodder for the cows is lucerne hay. About eight acres of lucerne is grown and about half an acre of mangolds. Approximately thirty Friesian grade cows are milked annually with milking machines. The milk is separated and the cream sent to the dairy factory in Christchurch. Pigs are kept but the numbers are extremely variable. Also there are about ten to twenty head of dry stock grazed. Some liming and spreading of super phosphate is done on the pastures.

The landscape of the area is characterized by small green fields on which graze dairy cows, with here and there a flock of sheep, tiny patches of cultivated land, numerous haystacks and scattered farm houses surrounded by cow bails, pig sties, fowl houses and a few macrocarpa trees.

Lake Shore Area andthe Spit.

This area is devoted almost entirely to the grazing of sheep and a few beef cattle on permanent pastures. The farms generally are much larger than those in the previous area. Nearly 60% of the farms are over 200 acres in contrast with the interior area where only 6% are over 200 acres. Here the largest farm is 5,000 acres in extent whereas the largest farm in the "Interior Area" has only 810 acres. The size of the farms is generally smaller near the outer limits of the area.

There are of course many farms which have land in both areas and it is on these farms that dairying is carried on. Several of the smaller farms of from 150 to 300 acres graze from 130 to 200 sheep and from 15 to 20 dairy cows besides growing some lucerne or grass hay. Where dairying forms part or all of the farm enonomy it is found that the land is slightly higher and less liable to recurrent flooding than is the greater part of the lake shore area or else the farm has some land not within the lake shore area.

Though utilized in the same way as the rest of this area the shingle barrier or spit proper[1] differs in nearly all other respects. The thin porous nature

1. Between the shingle barrier and the southern edge of the lake is a strip of land which is farily extensive at the eastern end. This is lowlying and possesses the same characteristics as the land immediately adjacent to the north, east and west sides.

of the soil makes it useless for anything but extensive sheep grazing. Some parts have a better native plant covering than others but over the whole spit the land considered suitable for farming carries less than one sheep to every four acres. The only farm on the spit is of 5000 acres, 2000 of which are lake shore land between the spit and the lake. The breeding ewes are wintered on the spit and the lambs are fattened on the adjacent lake shore land. The farm carries about 2000 sheep throughout the year. Except for a shepherd's hut and the fishing huts near the outlet to Lake Forsyth there is no settlement on the spit.

The greater part of the lake shore area has never been ploughed and is still in native grasses particularly water twitch and Salicornia. This provides good healthy grazing for sheep and beef cattle during the summer months. The beef cattle are found particularly on the west and south side of the lake but over the whole area sheep far outnumber cattle. During the summer this land carries about one sheep per acre. The carrying capacity of the land increases, however, between the land at the edge of the lake and that at the edge of the interior area. This is the natural result of less frequent flooding. Some of the land at the lake edge will be covered with water for several months of each year while farther inland it may be flooded by lake water only once in four or five years.

Where the land is farmed in conjunction with the hill country the lambs are fattened on the lake flat during the early summer. The beef cattle are likewise grazed on the hills during the winter. The cattle are Herefords and are sold at the Addington Stock Market in Christchurch, to which they travel on foot.

Though the greater part of the land in the farms to the west of the Selwyn river is below high water mark nearly all of these farms contain some land which belongs to the interior area. Immediately adjacent to the west bank of the Selwyn river is a very narrow strip of dry fertile sandy loam in which grows wheat, lucerne and cocksfoot. Generally the soil to the west of the Selwyn river is less sandy than that to the east of the Selwyn and consequently it dries out less quickly. This makes the ground very boggy throughout the year and so unsuitable for sheep grazing even in the summer months. However, self sown ryegrass is widespread and the pastures are suitable for grazing dairy cows. The farm economy of these dairy farms is similar to that of the interior area except that much hay is bought. This is because it is too wet to grow lucerne and the native grass does not make high fertility hay. There are at least four farms where gorse has made good land unproductive. Also in many instances the artificial drains on the farms have been neglected and the productivity of the land reduced.

Over the lake shore area as a whole houses are few and are confined to the outer limits of the area.

Summary.

Though this survey of the utilisation of the land adjacent to Lake Ellesmere has, of necessity, been more in the nature of a reconnaissance survey than of a detailed land use and farm management survey several important features stand out clearly. The major problem, of course, is that of lake drainage but this is dealt with in a separate chapter.

In gathering the necessary field information it was interesting to see the many different farming techniques employed on land which itself did not vary greatly in fertility. On some farms the general management and practise was good on others it was extremely bad. The greatest improvement possible in farming techniques is in the interior area, since, until the lake is permanently drained little more can be done with the lake shore area except to use it for the grazing of sheep during the summer months. The spit, because of the poor, thin and porous nature of the soil, must remain an area for extensive grazing of sheep.

The three major improvements possible are in the quality of the pastures, the quality of the dairy cows, and the stock and pasture management. In the past there has been too much use of inferior quality grasseed

and clover in both the rotation and permanent pastures. Though some artificial fertilising is done, many pastures could be improved greatly if this practice were more widespread. Probably the greatest need for improvement is in the quality of the dairy cows. It is impossible to judge accurately which are the highest producing cows unless systematic herd testing is undertaken. Besides the necessity of testing each individual cow for butterfat production in order to find out which calves to rear it is necessary to have a bull with a high production record. Where dairy herds are small this would mean a heavy initial outlay but joint ownership by two neighbours would lighten the cost to each and be of much greater value than two inferior bulls.

However, important though breeding may be, cows must be well fed if production is to be high. In a district where the weather from year to year is fairly variable the practise of stocking a farm to capacity during a good year usually means that it is heavily overstocked in many years.

The amount of hay fed out to nearly all the dairy herds during the winter is not sufficient. That does not mean the stock are starved but a little more food during this period would undoubtedly increase production during the next season.

Though not a region of very good farming techniques it is by no means a region where poor farming is the rule. Rather, it is a region where, with a greater knowledge, much could be done to increase what is a reasonably productive area. Unlike so many parts of New Zealand there is very little land covered by gorse or other noxious weeds. There are only about five or six farms in the whole region which are extensively covered in gorse, neither has the ground suffered from excessive cropping with consequent loss of soil fertility.

CHAPTER IV.

THE LAKE DRAINAGE PROBLEM and the PROSPECTS for the FUTURE DEVELOPMENT of the ADJACENT LANDS.

It is quite apparent from the previous discussion that the whole question of the land utilisation of the land adjacent to the lake is bound up with the lake drainage problem. The local body, whose task it has been to try and solve this problem over the last thirty-eight years, is the Ellesmere Lands Drainage Board. Therefore, it is necessary, that any study of the area should contain a brief survey of the work of the Board in connection with the lake and the adjacent lands as well as an account of what had been done before the board's foundation.

Left to itself the lake would probably eventually make a natural break through in the narrow shingle bank near Taumutu, but this would happen only after it had flooded extensive areas of what is now good farming country. The Maoris, who were interested in the area as a fishing ground and not for the cultivation of crops, let the lake out only once in every three years[1]. When the Europeans settled on the eastern margin of the lake they induced the Maoris

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1. The Maoris thought that by letting the lake out only once in every three years they would get a better catch of eels.

to let the lake out once a year. The Maoris let it out by cutting a pilot channel through the shingle bank near Taumutu.

In 1858 the Provincial Government's engineer, Edward Bobson, in his report to the Provincial Government suggested that they should undertake the annual letting out of the lake hitherto done by the Maoris, but his advice was not acted upon. In 1863 the Provincial Government passed a resolution to drain the lake permanently but it did not apply for permission to do so until 1873. In 1864 it reserved as Crown land all that land below the high water marks of Lakes Ellesmere and Forsyth[1].

The report on the first inspection of the two lakes by the Provincial Government engineer advised the permanent drainage of both lakes by means of an open canal through the shingle bank and then to drain both lakes to the sea through a tunnel cut in the cliffs at the end of the Ninety Mile Beach. In 1875 the Provincial Government's engineer, W.B.Bray, made a thorough report on the various schemes for a permanent outlet to Lake Ellesmere which had been submitted to the Provincial Government. The following are the six schemes which he examined[2].

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1. See Land Utilisation Map for position of high water mark.

2. See Location Map.

(a) To drain Lake Ellesmere by cutting a channel to the sea via Halswell and Sumner.

(b) To drain Lake Ellesmere by cutting a channel to the Little Rakaia River.

(c) To drain Lake Ellesmere into the Little lake and thence by a channel to the sea.

(d) To drain Lake Ellesmere by means of syphons between the lake and the sea.

(e) To drain Lake Ellesmere into Lake Forsyth and to drain both lakes to the sea through a tunnel in the cliffs.

(f) To drain Lake Ellesmere by establishing a permanent channel through the shingle bank at Taumutu. The permanent channel was to be kept free of shingle by the construction of moles out to sea.

The first three schemes he rejected because of the great distance between the lake and the point of discharge into the sea. The fourth scheme he did not consider feasable because of the large amount of water which had to be shifted. The fifth scheme he rejected because of its excessive cost and the fear that the accretion of shingle along the foreshore would block the outlet in a comparitively short time[1].

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1. Justification for the fear lies in the fact that when Bray made his report in 1875 the shingle extended 22½ chains along the cliff face and today it extends 27½ chains. Also a more recent

examination of this scheme by the Public Works Department reveals that the two foot fall necessary to give the required velocity to the water between the lake and the sea would mean that the lake would always be two foot above mean sea level which is considerably higher than is the case for part of the year when the lake is let out only periodically.

The sixth scheme was the only one he considered practicable but the Provincial Government did not undertake it and the Maoris continued to let the lake out annually until 1889. In that year the settlers undertook to let the lake out by cutting a pilot channel as the Maoris did, but they used horse drawn scoops in place of hand methods.

The need for a more organised method of dealing with the lake drainage problem led to the formation of the Ellesmere Lands Drainage Board in 1906. The area under the board's control includes not only the lake margin land but all that land drained by the Halswell and No.2 rivers. The board has two major tasks. One is to drain all the land not affected by the change in lake level but which because of its lack of relief and low elevation becomes water logged unless artificially drained. The other is to prevent the recurrent flooding by the lake of the margin lands either by means of a temporary or a permanent outlet. It is the second of those tasks that is of interest here.

The bad feature of existing and past methods of dealing with the lake drainage problem has been the necessity for the lake to be allowed to rise to a certain level before it can be let out. This causes the inundation by saline water of much of the adjacent land for lengthy periods. As the use of more modern methods has enabled the pilot channel to be made deeper and in a shorter time the level at which the lake can be let out has been lowered.

There has been only one departure from the method of letting the lake out by cutting a pilot channel through the shingle bank whenever the lake was at a sufficiently high level. This was the construction of a bottomless wooden culvert through the shingle bank at Taumutu. This was an attempt to lower the level at which the lake could be let out periodically rather than an attempt to establish a permanent outlet. Because a smaller amount of shingle had to be removed each time there was less time for shingle to pile up at the entrance to the channel. This scheme was only partially successful as the cost of building and maintaining the culvert was greater than the value of the betterment of the land. The culvert was seriously damaged in 1925 and from then on till 1932 horse drawn scoops were again used for the cutting of a pilot channel.

According to the Ellesmere Lands Drainage Board records, in the period between 1906 and 1929, the lake

was let out thirty eight times. The average height of the lake above mean sea level at the time of opening was four feet five inches. Since 1932 the use of power scoops operated by winches mounted on crawler tread tractors has enabled the board's workmen to let the lake out at a much lower level. From 1931 to 1943 the lake has been let out twice yearly at an average height above mean sea level of two feet ten inches. The highest level to which the lake has risen before an outlet was able to be cut was four feet eight inches above sea level. This occurred when continued heavy seas blocked the pilot channel as soon as it was open and before the lake was able to scour out a channel. The channel remains open to the sea from one to seventeen weeks according to the roughness of the seas during the period. The average length of time it has remained open during the last fifteen years is five and a half weeks. Under favourable conditions the narrow pilot channel is widened to as much as nine chains by the outrushing lake waters. The level of the lake when the channel becomes blocked varies from twenty one inches below mean sea level, when it is blocked at low tide, to sixteen inches above mean sea level when it is blocked at high tide.

The blocking of the channel is caused by the accumulation of shingle brought up by the northerly

flowing current and deposited at the channel mouth. It is this constant drift of shingle up the east coast and its deposition along the shingle bank which has been the major problem in any scheme for a permanent outlet of the lake.

Though various schemes to provide a permanent outlet have been submitted to the controlling bodies ever since about 1870, no scheme has yet been attempted. In 1931 the Public Works Department made a detailed survey of the area in connection with the problem of constructing a permanent outlet. In their report to the Ellesmere Lands Drainage Board they advised the building of a permanent outlet at Taumutu as Bray had advocated in 1875. However, they also incorporated in the scheme the reclamation of twenty nine thousand acres of the lake bed. This was to be achieved by the building of a stop bank to enclose the considerably reduced lake. The water in the area to be reclaimed would have to be pumped into the lake. This would always be necessary since much of the reclaimed land would lie below sea level. The total estimated value of the betterment of the present marginal lands is £211,000[1].

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1. Public Works Estimates
This total is made up in the following manner.

LAKE ELLESMERE DRAINAGE SURVEY, 1931.

GENERAL PLAN, SHOWING CONTOURS.

SCALE:- 26 Chains to an inch.

DIAGRAM SHOWING RELATION BETWEEN DRAINAGE BOARD GAUGE AND CONTOUR LINES.

LEESTON S.D.

HALSWELL S.D.

SOUTHBRIDGE S.D.

ELLESMERE S.D.

South Pacific Ocean.

3203/4

)See Contour Map.)

Contour Levels	Area in Acres.	Present value per acre	New value per acre.	Total estimated betterment.
100 - 101	3,000	£2	£6	£12,000
101 - 102	4,000	3	7	16,000
102 - 103	4,000	4	16	48,000
103 - 104	5,000	6	20	70,000
104 - 105	5,000	7	20	65,000
	21,000			£211,000

The soil analysis[1] carried out by Mr. B.C. Aston of the Agricultural department indicates that the reclaimed land would prove very fertile. It is thought that the estimated value of twenty pounds per acre would be a very conservative one when the land was brought into full production.

The total cost of building and maintaining the permanent outlet plus the cost of the reclamation works is estimated at £580,000. The estimated value of the reclaimed land plus the value of the betterment to the marginal lands is £790,000. Therefore, unless the actual costs or the actual value of the betterment to the land differed widely from the estimated figures

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1. B.C. Aston - Soil Analysis of the Lake Ellesmere submerged Lands. N.Z. Journal of Agriculture, June 1933.

for both, the scheme would be well worth while undertaking.

The Ellesmere Lands Drainage Board fully approved of the scheme but it was not till 1938 that they obtained permission from the Government to raise the necessary money by loan. The outbreak of war in 1939 made them temporarily abandon the scheme just as it was about to be commenced. Further investigations made by the Public Works Department have resulted in the Drainage Board abandoning this scheme in favour of draining Lake Ellesmere by way of Lake Forsyth. This is not, however, the same scheme as that rejected by Bray, as the outlet to the sea is to be by a permanent channel through the shingle bank enclosing Lake Forsyth. The channel is to be kept open by the construction of a mole out to sea as was planned for the permanent outlet at Taumutu. The reclamation of part of the lake floor is not embodied in this scheme. The lakes are to be kept permanently at mean sea level. Tidal fluctuations will be prevented by the use of sluice gates, at the mouth of the channel through the shingle bank.

There are two major advantages of this scheme over the Taumutu one. Firstly the cost of building the mole will be lessened as the source of supply of the rock will be much nearer[1]. Secondly the simultaneous

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1. The rock to build the mole is to be obtained from Birdlings Flat.

drainage of Lake Forsyth will result in the betterment of much of the land marginal to this lake. The additional cost of cutting and maintaining the channel between the two lakes will be more than offset by the abandonment of the reclamation scheme[1] which was estimated to cost £400,000.

There seems little doubt that this latest scheme will be commenced as soon as labour becomes available. This is unlikely to occur until after the war but it would prove an admirable project for the employment of returning servicemen. The building of the mole and the two channels would temporarily absorb considerable numbers of men.

There remains the question of the effect on the bird and fish life if such a scheme were carried out. According to Professor E. Percival[2] there is at least

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1. The reclamation scheme has apparently been abandoned because the engineers are now doubtful whether the cost of such a scheme would be outweighed by the value of the reclaimed land. Further investigations have resulted in the estimated cost of £400,000 being considered much too small an estimate.

2. Professor Percival is Professor of Zoology at Canterbury University College.

ten times more food in the lake than is required to feed the existing fish and in his opinion anything which would do away with the periodic rise and fall of the lake level would be advantageous.

Since it seems that Lake Ellesmere will be permanently drained as soon as is practicable after the war ceases, the following discussion of the future of the lands adjacent to the lake seems appropriate.

In the past bad farming and recurrent inundation of much of the region by lake water has resulted in its actual productivity being greatly below its potential productivity. With the permanent drainage of the lake the major problem confronting the farmers in this limited region will be solved.

The lines along which future agricultural practise will develop depend partly, of course, on developments beyond the borders of this small region. However, judging by present farm practises and experience in land utilisation, dairying will be the major farm economy of the greater part of the area. With the prevention of recurrent flooding of the lake shore land the salinity of the soil would gradually decrease and much of this area could be ploughed and sown in high fertility grasses and dairy cows would naturally replace sheep. On the land not at present subject to direct inundation by the lake, farming techniques could be greatly improved along the lines suggested

previously. Thus, the region which now supports approximately four hundred people should be able to support at least one thousand people.

In his struggle against nature man has already achieved much. By the straightening, widening and deepening of the rivers and the digging of artificial drainage channels he has converted what was formerly a swampland into a land of grassy pastures on which graze sheep and cattle. However, not until he has controlled the rise and fall of the lake waters will he be able to make the greater part of this pasture land a rich smiling countryside dotted with farm houses, haystacks and farmyard buildings.

From this brief reconnaissance survey it would seem that the expenditure of a large sum of money in the permanent drainage of Lake Ellesmere would be justified by the greatly increased productivity of the land adjacent to the lake. However, a much more detailed soil, land use, and farm management survey should be undertaken before the full potential value of permanent drainage of the lake could be demonstrated. Such a detailed survey is beyond the present writer's resources of time and funds.

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An aerial view of the eastern edge of Lake Ellesmere from Waikaha (in the foreground) to the sea beyond the shingle spit and Lake Forsyth. The photograph was taken immediately after a heavy snowfall and when the lake was at a very high level. The railway embankment is surrounded by water which also reaches to the main Akaroa highway. The cliffed spur ends of Banks Peninsula and the alluvial valley lowlands are clearly depicted.

An aerial view of Lake Ellesmere. The shingle spit enclosing the lake is very narrow near Taumutu at the western edge of the lake. Part of Banks Peninsula is shown in the right background.

An aerial view of the eastern part of Lake Ellesmere, with the wide shingle barrier in the foreground. Beyond the lake is part of Banks Peninsula with Lyttelton Harbour. Pegasus Bay and the distant snow-capped Kaikoura Ranges are also distinguishable.

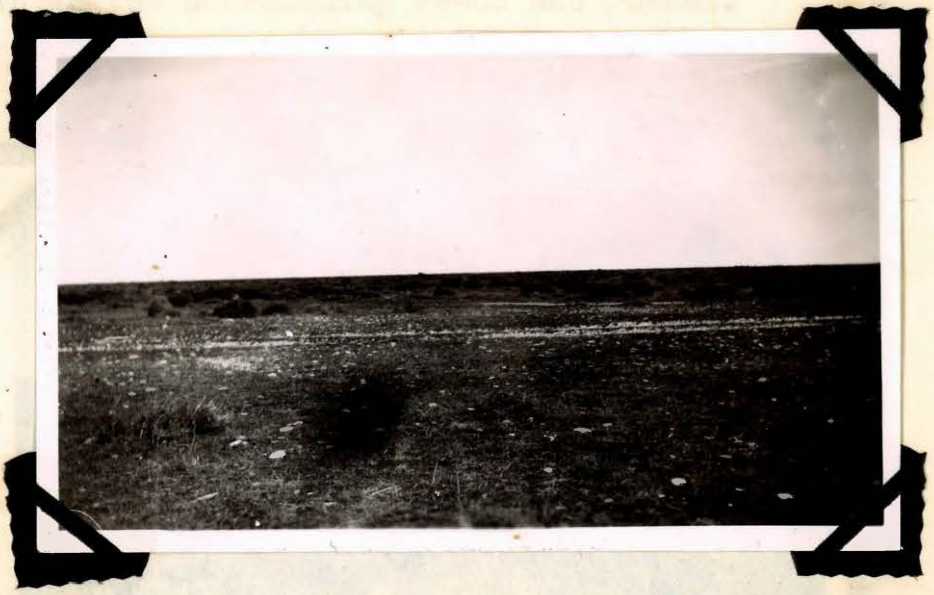
The beach near the outlet of Lake Forsyth at the eastern end of the spit looking east with the wave cut cliff of a Banks Peninsula spur in the background. The pure shingle of this part of the beach and the form of the pebbles is clearly shown.

A shingle pit near the sea shore at the eastern end of the spit. The stratification is well marked.

A view of the barrier beach at its eastern end. The steep slope from the swampy ground on the lake side is clearly visible.

The old shingle barrier lying across the mouth of Birdling's Valley. In the centre the bare shingle is visible, on the left it is covered with gorse and on the right Pinus insignus trees have been planted.

The spit looking south towards the sea. The vegetation consists mainly of Muehlenbeckia ephedroiedes. In the background can be seen some fishermen's huts.



A view of the spit at the eastern end further inland than the previous view showing how the prostrate Muehlenbeckia shrubs have given way to native grasses. The stony nature of the soil is very marked.

Looking across the Kaituna lagoon to the spit in the background. In the foreground can be seen the marshy vegetation of reeds and rushes which is typical of the whole lake edge. On the lagoon can be seen the swans which have their nests in the surrounding reeds and rushes.

A raupo swamp on the edge of the Kaituna lagoon. On the left of the picture the better drained land is covered with good exotic native grasses.

This lake shore land which is now dry enough to graze sheep is frequently inundated by lake waters. Between the rushes are good native and self sown exotic grasses.

A view of a herd of dairy cows grazing on a long rotation ryegrass and clover pasture in the inner marginal land. In the background are numerous clumps of macrocarpa trees.

The first tractor used for cutting the pilot channel at Taumutu. In the background is the wooden culvert which had been damaged by high seas and was unusable.

A view of the temporary opening cut through the shingle barrier enclosing Lake Forsyth after it had been blocked by shingle again. The cut through the shingle barrier enclosing Lake Ellesmere is of similar size. In the background are the wave cut cliffs of the Banks Peninsula spurs.