

1920.
NEW ZEALAND.

TAIERI RIVER

(REPORT OF RIVERS COMMISSION ON).

Presented to both Houses of the General Assembly by command of His Excellency.

REPORT.

To His Excellency the Right Honourable Arthur William de Brito Savile, Earl of Liverpool, Member of His Majesty's Most Honourable Privy Council, Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Knight Grand Cross of the Most Excellent Order of the British Empire, Member of the Royal Victorian Order, Knight of Justice of the Order of Saint John of Jerusalem, Governor-General and Commander-in-Chief in and over His Majesty's Dominion of New Zealand and its Dependencies.

MAY IT PLEASE YOUR EXCELLENCY,—

Your Excellency's Commission, dated 8th April, 1919, directed us to inquire into certain matters in respect of the Clutha, Orari, Rangitata, Waimakariri, Ashley, and Maerewhenua Rivers, and such other rivers as might be added thereto from time to time. Your Excellency's further Warrant, dated 22nd July, 1919, added to the Commission the Waihi, Wairau, Waiau-uha, Taieri, and Aparima Rivers. The time within which we were required to furnish our reports was extended by Your Excellency to the 7th June, 1920. The present report deals only with the Taieri River. The reports on the Maerewhenua, Clutha, and Aparima Rivers have already been presented to Your Excellency. The reports upon the remaining rivers will be submitted in due course when the requisite data have been collected.

Your Excellency's Commission directed us, in respect of each river,—

- “(1.) To inquire into the cause or causes of the silting-up of the channel, the flooding of the adjacent lands by the said river, the erosion of its banks, and the damage to the surrounding country ;
- “(2.) To ascertain the nature and extent of the damage done to the lands adjacent to the said river, and what area of land is affected by such floods or erosion, or both, and whether it is practicable at reasonable expense to prevent such flooding or erosion, or both, either wholly or partially ;
- “(3.) To ascertain the best method of providing for the control of the said river and its tributaries so as to safeguard the lands affected, and to provide for the effective control and improvement of the said river and its banks ;

- “(4.) To ascertain the nature and extent of any drainage-works that may be required, and the best method of carrying out such works ;
- “(5.) (a.) To furnish estimates of the cost of such remedial measures as you may recommend should be taken for the effective control and improvement of the said river and its banks ;
- “(b.) To report, in the case of each river; what area or areas of land should be constituted a district in respect of which a rate may be levied to secure and pay the interest on and provide a fund for the repayment of any loan that may be raised to carry out any river-improvement works which you may recommend should be undertaken ;
- “(c.) To report your opinion as to what matters, if any, should be adjusted by legislation ; and
- “(d.) Generally, to report your opinion on all matters arising out of or touching the premises, including the question as to whether or not one or more competent authorities shall be appointed to control the whole or any portion or portions of the said river, and what statutory powers should be possessed by such authority.”

Your Excellency's Commission also required us to report separately in respect of each river.

INVESTIGATIONS MADE.

Sittings, Evidence, and Inspections.—A sitting of the Commission was held in the Courthouse at Mosgiel on the 5th March, 1920, when the evidence of seventeen witnesses was taken. On the 9th March your Commissioners made an examination of the river from the West Taieri Bridge above Outram at the outlet of the upper gorge across the plain and down to the lower gorge, and also inspected the levees, drains, and contour channel which have been constructed by previous Boards and the present Board, and the bridges, the condition of the channel generally, and particularly the low ground at the place where the river is joined by the Silverstream and the Waipori River. On the following day an inspection was made of the river from Outram to the Maniototo Plain.

PREVIOUS REPORTS.

Your Commissioners carefully perused the reports which have been made in the past on the subject of the Taieri River floods by engineers at various periods, extending over fifty years, and from these were enabled to form a very clear conception of the problems to be met.

Their investigations were also facilitated and shortened to a very considerable extent by the fact that they were furnished with copies of all the plans and proposals embodied in the report made by Messrs. Thompson, Vickerman, and Hunter in 1917, together with much valuable data collected by them.

Your Commissioners are also much indebted to the Western Taieri Land Drainage Board for the loan of a valuable contour plan of the flooded area, made by their late Engineer, Mr. Elliot.

All these plans and data enabled your Commissioners to see clearly the reasons for the various phenomena which have been observed in connection with the floods, and the effects of the failure of any part of the protective works, either existing or proposed.

In this report your Commissioners propose dealing mainly with that portion of the Taieri River between Outram and the sea.

RIVER NOMENCLATURE.

For the purposes of this report the two rivers, the Taieri and the Waipori, will be referred to separately ; and, following on the lines of the 1917 Commission's report, the same river nomenclature will be adopted, as follows : The Taieri River from its source down to Kokonga will be referred to as the “ Upper Taieri,” from Kokonga down to Outram as the “ Middle Taieri,” from Outram down to Henley

Ferry Bridge as the "Lower Taieri," and from Henley Ferry Bridge down to the sea as the "Lower Taieri Gorge." The Waipori River from its source down to the Dunedin City Corporation electric-power dam will be referred to as the "Upper Waipori," from the power-dam down to Sawmill Creek as the "Middle Waipori," and from Sawmill Creek down to Waipori Lake as the "Lower Waipori."

PHYSICAL CHARACTERISTICS OF THE RIVERS AND LAKES.

The physical features of both the rivers with their tributaries and the lakes have been so fully described in previous reports that your Commissioners feel it is unnecessary to again refer to them, except incidentally and where necessary later on.

FLOODS.

In connection with floods and the question of flood-discharge, tidal influence and its effect on flood-discharge, silting-up of the river and lake beds, your Commissioners endorse the conclusions arrived at and expressed in the report of the 1917 Commission, which, briefly stated, are as follows:—

- (a.) That a flood-discharge of 50,000 cubic feet per second in the Taieri River at the Outram Gorge represents a big flood, and one that is only rarely exceeded. This quantity, under very exceptional circumstances, may be augmented to the extent of about 10 per cent. by a simultaneous flood in the Silverstream drainage area.
- (b.) That a high tide accompanied by a south-east wind has a considerable effect in retarding the flood-discharge through the Lower Taieri Gorge, and as a consequence ponding up the flood-waters in the Waihola and Waipori Lakes and their vicinity.
- (c.) That a very considerable silting-up of the river and lake beds has taken place since the start of mining operations on the Upper Taieri and its tributaries and the Upper Waipori, and that this silting is most noticeable in the Taieri River between Allanton and Henley, and in the Waipori River and lake-bed below Sawmill Creek.

The estimated flood-discharge of the Waipori River referred to in the 1917 Commission's report requires to be modified, as a few months after that report was made a flood occurred in the Waipori River which was estimated to be 20,000 cubic feet per second. This your Commissioners regard as the largest flood that need be considered.

The trouble on the Taieri Plain may be said to be of a threefold nature. Firstly, the plain is covered in times of heavy flood by the hitherto unsuccessfully controlled waters of the Taieri River itself. Secondly, the Waipori River, bringing down large quantities of detritus, and being almost entirely unregulated, has caused a great deal of trouble in the Berwick district; and, furthermore, has actually contributed very largely to the waters lying on the plain, the levels on the plain being such that waters from the Waipori, if uncontrolled, may run from the vicinity of Berwick up the plain for many miles. Evidence of the flood of May, 1917, showed that before the waters of the Taieri River itself had invaded the low country lying along Lee Creek and Kirk's Road the water from the Waipori had covered a considerable portion of this area. Thirdly, the Silverstream itself, by discharging into the Taieri above Allanton, may augment the flood-discharge in the latter river. It also does a certain amount of damage by itself, by flooding and washing shingle on to the low area adjacent to the point where it joins the Taieri.

The very low area which lies at the mouth of the Silverstream has always acted as a kind of reservoir, which has to a large extent mitigated the effects of floods below Allanton, for the reason that as soon as the flood below the Outram Railway-bridge rises sufficiently to top the banks, either natural or artificial, the waters pour into the depression surrounding and including the swamp at the bottom of Duke's Road, and consequently reduce the peak of the flood farther down the river. Until all this area is filled up to levels corresponding with the flood-slope, conditions below are improved, provided that the peak of the flood coming from up-country does not occur after this regulating-area is filled. If, on the other hand, the peak of the flood occurs after this area is filled, this storage reservoir has no effect either in

increasing or decreasing the height of the peak, but it results in a longer-sustained high river below while the flood-waters are re-entering the falling river through the mouths of the Silverstream, the new cut, and Owhiro Creek. This action accounts for the fact that at Otokia the flood may rise steadily long after it has commenced to fall at Outram. If this low area did not act as a regulator in this way the levees at Otokia would be breached more frequently, and the high water which has been known to burst the levees at Otokia after the flood had begun to subside at Outram would not be any lower, but would arrive and probably burst the banks somewhat sooner. In other words, the low area at the mouth of the Silverstream may be of great benefit to the land below, and cannot under any circumstances make its conditions worse.

The capacity of the lower gorge to discharge the water which has been known to pour on to the plain from the back hill country is inadequate. Various investigators have assessed its capacity at figures in the vicinity of 37,000 cubic feet per second, while the maximum flood has been probably in the vicinity of 60,000 cubic feet per second, and may even have been slightly more.

Prior to the erection of any levees along the river-banks below Outram the excess of flood-water which the river-channel was unable to carry overflowed the river-banks and spread over the plain in all directions. The excess flowed into and was stored in the Waihola and Waipori Lakes and the low-lying flood-plain. As the lakes rose, the water-slope from Henley Ferry Bridge down to the sea increased, and as a consequence increased the rate of discharge through the gorge, until the discharge on to and the outflow from the plains balanced.

Later on, after the levees were built, similar conditions obtained, except that the flood-waters being more confined to the river-channel it was only when the levees were breached in the vicinity of Allanton, or higher up, that the flood-waters invaded the plain on the western side, or when the Waihola Lakes became raised to such a height as to overtop the levees at the lower end of the plain, and so flood the plain by backwater from the lakes.

In order to induce more water to run through the lower gorge its fall must be increased. As the sea cannot be lowered, the water at the upper end must be raised; and if an adequate channel is provided to carry waters from the hills into the lakes, and if the levee protecting the plain from inundation either from the river or by backing up from the lakes is provided, the water of the lakes will rise possibly a little higher than heretofore; but the combined influence of this storage, together with the increased discharge through the lower gorge obtained by the greater fall, will enable the floods to be successfully conveyed from the hills to the sea under control and without damaging the region which it is so desirable to protect.

In connection with the discharging-capacity of the present river-channel special reference must be made to the existing bridges, practically all of which—and one or two to an extreme degree—are quite inadequate to cope with the maximum flood-discharge. The worst offender in this respect is the Otokia Railway-bridge, the discharging-capacity of which, based on the 1908 flood-level and flood-slope, amounts to about 25,000 cubic feet per second only, or less than half what is to be expected during high flood. From this instance alone it will be seen that breaching of the levees higher up, with consequent flooding of the plain, is inevitable under present conditions. The Otokia Traffic-bridge would offer a greater restriction still were it not for the fact that the excess flood-water can get round the ends of the bridge, whereas at the railway-bridge the railway embankments form an effective barrier to the flood-waters.

On looking into the works that have been done, and examining the previous reports and plans, your Commissioners ascertained that a comprehensive scheme for draining and controlling all the flood-waters from the Maungatua hillsides had been devised by the late Engineer to the Taieri Drainage Board, Mr. Michael Elliot, M.Inst.C.E., and had been approved by the Board and commenced. Unfortunately, it has not been executed in accordance with those plans. This is most regrettable, as the scheme appears to have been well conceived, and had it been carried out the occupiers of the plain would probably have been very much better off than they are to-day.

Your Commissioners examined all available records both on plans and in documents, and found that the flood of 1908, which was that so very carefully examined by the 1917 Commission, had been exceeded in 1868; and from a perusal of all the data available your Commissioners are inclined to the belief from the figures taken by the Commission of 1880 (Messrs. Bell, Higginson, and Blair) that 62,500 cubic feet per second can be assumed as the highest discharge with which it would be reasonable to attempt to cope.

MINING.

The evidence is conclusive that the channel of the river at and below Outram, and more especially between Allanton and Henley, is very much smaller, both in width and depth, than it was when the plain was first settled. This is popularly ascribed principally to detritus from the mining carried on in the higher reaches of the river, and an examination of the character of the silt leads your Commissioners to believe that this popular belief is well founded. The silting-up has been greatly accelerated by the luxuriant growth of willows along the banks and on islands in the channel, which encourage the deposit of silt and also heavier material, but even without these willows it is probable that very considerable silting-up would have occurred. The other agencies of man in connection with agricultural and pastoral pursuits, referred to in several of our reports, cannot, in the case of this river either, be held blameless. Suffice it to say that the artificial conditions created by industries and settlement farther up the river have caused or are mainly responsible for the silting-up referred to.

With reference to the Waipori, it may be taken that mining is almost entirely responsible for the debris which has choked its channel and caused the regrettable condition that now exists in the region of Berwick. The transportation to the plain and the deposition thereon of this detritus has been greatly aggravated in later years by the establishment of the hydro-electric works at the Waipori Falls. The weir by which the water is lifted from the river acts as a settling-pond for the heavier particles throughout the week. Periodically, generally weekly, the dam is emptied by sluice-gates near the bottom. The outrushing waters carry with them an enormous charge of silt, and being large in volume, comparable to a small flood, they carry the detritus down the steeper portions of the river; but on arrival at the plain the force of the waters is spent, and, the sluices being again closed in order to fill the dam for the resumption of power-production, there is no force of water to carry the material seaward, and it deposits in the lower reaches of the river and in the Waipori Lake.

This detrimental effect to the plains caused by the works of the Dunedin City Corporation is what justifies your Commissioners in recommending the contribution by the Dunedin City Corporation set out under reference No. 5 (*d*).

The channel connecting the small Waipori Lake (variously known as the "Little Waipori Lake," "Maori Lake," and "Lake Tatawai") with the main Waipori Lake has become so shoaled up and constricted that Maori Lake is now practically tideless. Waipori Lake itself has shoaled up so that portions which forty years ago were deep are now above the water-surface, and growing grass. The outlets from Waipori Lake into the Waihola channel, and also from Waihola Lake into the same channel, have shoaled up so much that even flat-bottomed boats have a difficulty in navigating them; while the evidence shows that in the early days of the goldfields steamers plied between Dunedin and Waihola, and large barges navigated close up to the town of Berwick. Practically all this shoaling must be ascribed to the mining-debris.

Apart from the question of aggravating floods, this shoaling has had a disastrous effect upon the lower water drainage.

In common with the rest of Otago the mining operations within the watershed of the Taieri River have decreased now to very small dimensions, and are still decreasing. However, the damage is done, and even though the mining ceased absolutely to-day it would be many years before the effects would be no longer felt.

When the Waipori River was proclaimed a sludge-channel some of the owners along its banks were compensated, but from the evidence given to your Commissioners it appears that all were not compensated, and those who did receive compensation only received what in their opinion was totally inadequate. In this

latter respect, as far as your Commissioners could judge in the absence of personal knowledge as to the original conditions, their contentions seemed well founded.

LOCAL BODIES INTERESTED.

The controlling bodies interested consist of the Western Taieri Land Drainage Board, which controls all the land lying between the hills from Outram to the lakes; the Silverstream Commissioners, who deal with the portion which is known as East Taieri; and the Taieri County Council.

In the past there has been a multiplicity of bodies dealing with river matters, but in 1908 these bodies, who had been continually contending one against the other, were abolished, and a combined Taieri Drainage Board was formed. However, the inhabitants of East Taieri were dissatisfied and petitioned Parliament, with the result that the district was divided up, the West Taieri being placed under the Western Taieri Land Drainage Board, and the control of the Silverstream was taken over by two Commissioners appointed by the Government.

No body at the present time undertakes the flood protection of the eastern side of the plain. The Taieri County Council has no control over the river, its functions consisting practically of repairing the damage done when a flood occurs, without being in any way able to carry out works to prevent such damage occurring in the future.

Certain lands in the vicinity of the lakes come within the Bruce County Council's jurisdiction; and if the works recommended by your Commissioners are carried out a small portion of these lands should be included in the area controlled by the body charged with the duty of carrying out the protective works.

The Dunedin City Corporation, being responsible for the aggravation of the damage in the Waipori due to its system of weekly flushing of the pond at the back of its diversion weir, is also interested in this question.

LAND SETTLEMENT AND TENURE.

Within the area damaged by floods there is very little Crown land, but some of the land is held by large landowners who lease it to tenants with the proviso that the tenants must pay the drainage rates.

There is no doubt that were the menace of floods removed, a considerable amount of further settlement by the subdivision of the present large areas would take place, and the productivity of the plain would be much increased. Under present conditions the fear of damage by floods prevents much work being done which otherwise would be undertaken if the farmers could feel confident of being able to reap where they had sown. Furthermore, the adequate draining of the lower levels would result in their actual productivity, apart from their potential productivity, being greatly increased. At the present time the ground-water level is too near the surface to permit vegetation attaining its maximum development.

In addition to the productivity being diminished by the rise in the subsoil water, evidence showed that through the floods the land has been, of late years, frequently rendered entirely useless, being covered by water as long as six months at a time, with the result that the valuable vegetation is entirely destroyed. The fact that these settlers, though struggling, have been enabled to carry on despite their inability to use large areas of their sections for considerable periods shows that the plain has great potentialities.

SURVEYS.

Your Commissioners, having before them the result of the surveys made by the Commission of 1917 and those of other previous investigators, as well as the before-mentioned valuable plan of the Western Taieri Land Drainage Board, have been enabled to draw up their report without the necessity for further surveys. Accordingly, after taking evidence and making their inspections, your Commissioners proceeded at once to formulate their report, and now beg respectfully to submit their findings under the various headings in the order of reference, as follows :—

REFERENCE NO. 1.

To inquire into the cause or causes of the silting-up of the channel, the flooding of the adjacent lands by the said river, the erosion of its banks, and the damage to the surrounding country.

The silting-up of the channel is due in a great measure to the debris coming down from mining operations in the upper reaches, and, secondly, to uncontrolled growth of willows in the channel below Outram, which greatly encourages the deposit of the debris.

The flooding of the lands and consequent damage to the surrounding country are due partly to this silting-up, but primarily to the fact that the natural banks of the river are not sufficiently high; in other words, the cross-sectional area of the natural river-channel is not sufficiently large to carry the floods to which this river is subject.

Such erosion of the river-banks as has been experienced is small in extent and cannot be ascribed to any special cause; in fact, it may be neglected.

REFERENCE NO. 2.

To ascertain the nature and extent of the damage done to the lands adjacent to the said river, and what area of land is affected by such floods or erosion, or both, and whether it is practicable at reasonable expense to prevent such flooding or erosion, or both, either wholly or partially.

The nature of the damage is as follows:—

(a.) Where the water issues in a large volume from the river, either by the bursting of levees or the overtopping of the banks, quantities of silt of an infertile nature are carried on to the land in the vicinity, and over a considerable distance back from the river. Great difficulty is experienced in regrassing the area so covered.

(b.) Where actual breaches occur areas of land are torn out by the rush of the waters, sometimes to a depth of 20 ft., and the land consequently ruined for farming purposes.

(c.) The flood-waters gravitate into the lower portions of the plain, submerging in the past areas sometimes as large as 18,000 acres, and even recently 15,000 acres, many thousands of acres remaining under water for long periods, extending up to six months. This long submergence kills the grass, necessitating reploughing and resowing, and only a short submergence or the mere rushing-over of the water is usually sufficient to destroy cereal crops and greatly damage root crops. The extent of the damage varies with the time of the year at which the floods occur. In February, 1919, a large flood occurred which almost breached the levees, and it was stated in evidence that had a breach then occurred the damage could not have been repaired for £200,000. The two floods which occurred in 1917 were stated to have resulted in a loss of £300,000, and the flood of August, 1919, caused damage estimated at somewhat less than half this amount. These figures given by the inhabitants of the plain may be somewhat overstated, but they afford an indication of the immense amount of damage that is done whenever a flood occurs.

(d.) Apart from the loss of crops and of the use of the land, very considerable expense is incurred by the Drainage Board in pumping out the flood-waters after they have subsided to as low a level as will not permit of their further being run out by gravitation.

(e.) In addition to damage to landowners, the railway-line between Dunedin and Invercargill, as well as the Outram Branch Railway, is submerged for considerable periods, all traffic being suspended.

(f.) Although not much physical damage is done to the railway property, very considerable damage is sometimes sustained by the roads and bridges controlled by the County Council. After the flood of 1908 it was estimated that the cost of repairing the damage would be £8,000, and it is probable that the actual cost considerably exceeded that sum. Road traffic through the district was also interrupted for varying periods, according to the locality.

(g.) Damage is also done to house property, and furniture is damaged in the low-lying houses.

(h.) When floods have occurred before adequate warning could be given the loss of stock has been heavy.

The total area affected by floods is 30,000 acres.

While it is practicable at reasonable expense to prevent such flooding or erosion on the major portion of this area, there are some places, which will be dealt with more particularly later on, which could not be protected except at a cost in excess of their value.

REFERENCE No. 3.

To ascertain the best method of providing for the control of the said river and its tributaries so as to safeguard the lands affected, and to provide for the effective control and improvement of the said river and its banks.

The works recommended by your Commissioners are shown on plans Nos. 1, 2, and 3 attached, and consist of—

(a.) The setting-back of the existing levees at certain points where they unduly constrict the passage of flood-waters. These points are notably in the region of Allanton and between Otokia and Henley. At the present time the small levee on the East Taieri side, which runs from the hills opposite Outram to a short distance below the railway-bridge on the Mosgiel-Outram Railway, is breached in several places. If this were not so it would undoubtedly constrict the waters to such an extent as to make disaster certain on one side of the river or the other. Therefore your Commissioners consider that at present this levee should not be repaired; or, alternatively, if it be repaired, then it or the levee on the western side should be set back on such an alignment as will eliminate the constriction existing at this crossing, and the railway-bridge must be extended to span the opening so left. The greater part of this work would be a charge against a small portion of the East Taieri district, and from the evidence your Commissioners doubt if at present the benefit to be derived by the comparatively limited area would justify the expense. If at a later date a comprehensive scheme for the complete protection of the East Taieri is decided upon, the removal of the constriction at the railway-bridge as just mentioned must form an integral part of such scheme.

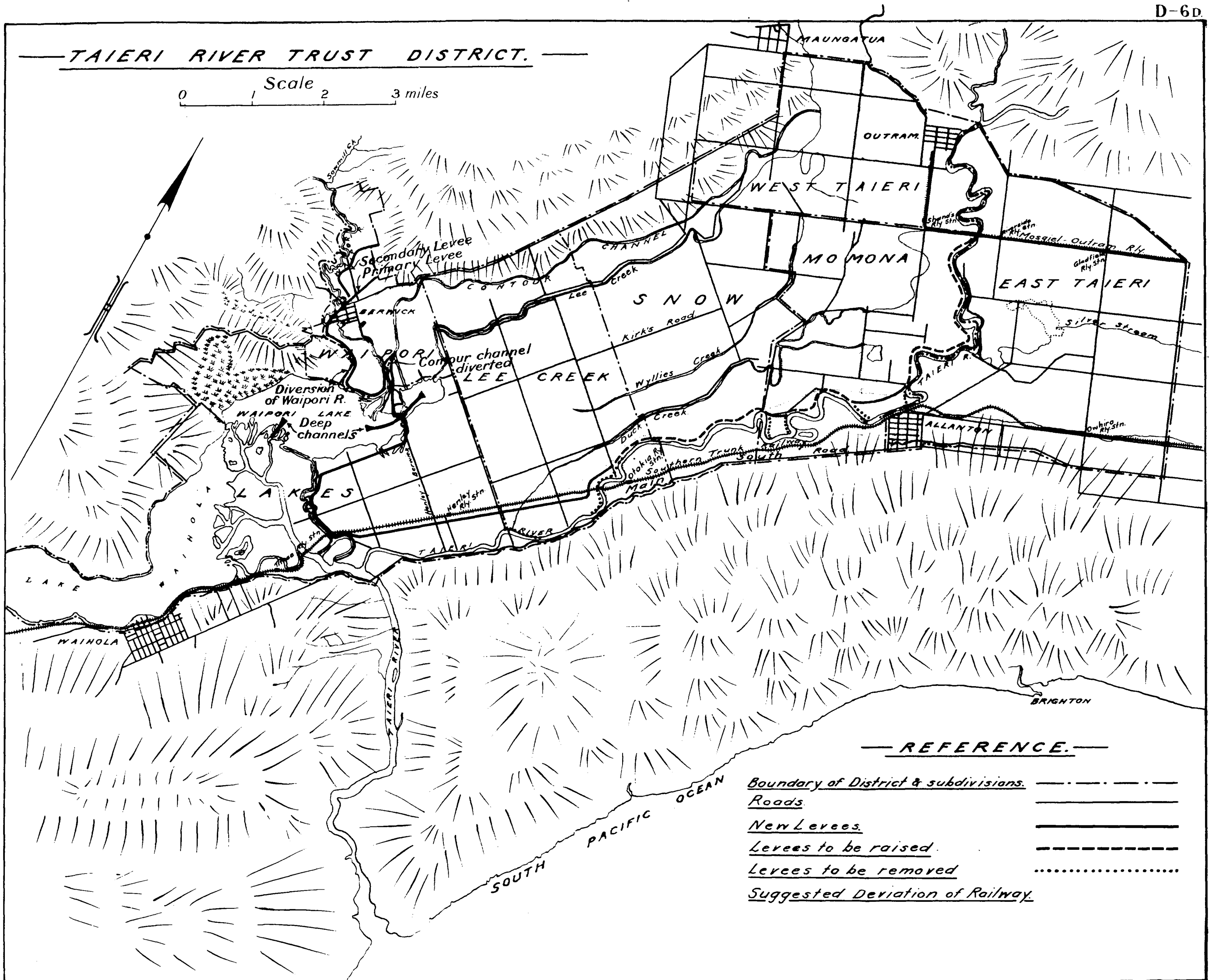
(b.) From the Outram Railway-bridge to the Otokia Railway-bridge, a distance of about nine miles and a half, the levees must be raised to a height of 1 ft. above the flood-slope shown on plan No. 2, which has been drawn from information obtained by the 1917 Commission as to the height of the flood of 1908.

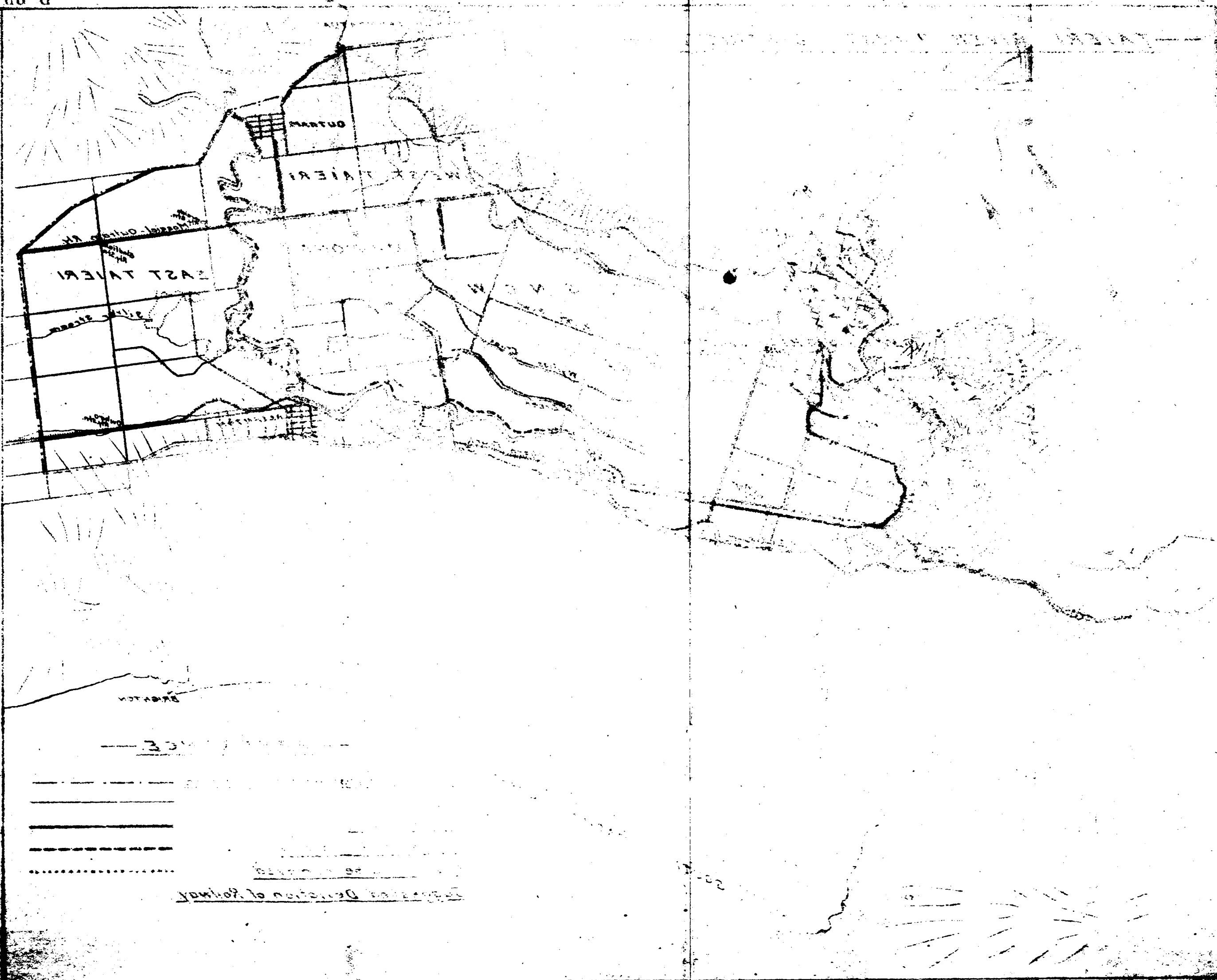
(c.) A suggestion has been made that from the Otokia Railway-bridge to a point one mile and a quarter below Henley Railway-station the existing line should be utilized as a levee, the present flood-openings in it being replaced by box culverts protected against inflow by flood-gates, and that sufficient of the existing levee at each end should be removed to enable the flood-waters to flow over the flat land lying between the railway and the bank of the river. A certain amount of raising of the railway-line would be necessary, and there would then be an adequate channel for the passage of flood-waters. But there is a doubt as to whether the Railway Department would view with equanimity the prospect of running trains over an embankment which had not been built specially for a levee, and which might be subjected to the pressure of a considerable head of water for some time. The Chief Engineer, when interviewed in regard to this aspect of the matter, expressed himself as prepared to consider such a scheme, though he could not commit his Department to it without maturer consideration.

As an alternative to this scheme of utilizing the railway the present levee might be set back sufficiently far, as indicated by the third alternative on plan No. 3, to allow adequate waterway. The witnesses from the plain expressed the opinion that if the Railway Department would not allow their line to be utilized the levee should be shifted back close to the fence of the railway reserve, so as to utilize as waterway the whole of the strip of land previously mentioned, the argument being that the lowest ground lies close to the railway, and that most of the floods would be able to pass along this low ground without actually endangering the lives or property of the people who now live close under the shelter of the existing levee on the river-bank. On the other hand, if this embankment were only shifted back to approximately half the distance to the railway, these people would

TAIERI RIVER TRUST DISTRICT.

Scale 0 1 2 3 miles





LONGITUDINAL SECTION OF TAIERI RIVER.

REFERENCE.

LOW WATER LEVEL, 1915.

FLOOD GRADE, 1908.

RAILWAY FORMATION

GROUND LINE UNDER RLY FORM.

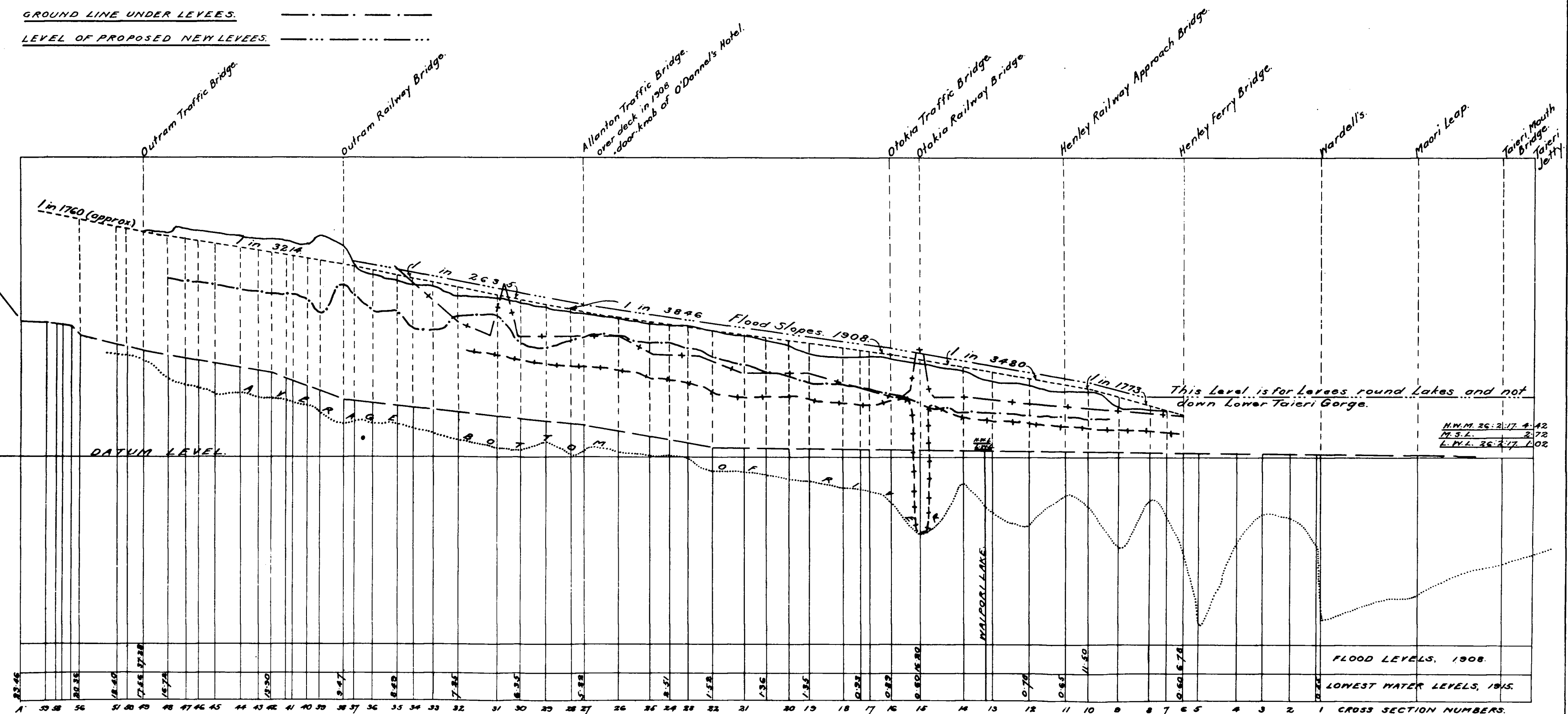
EXISTING LEVEE LEVEL.

GROUND LINE UNDER LEVEES.

LEVEL OF PROPOSED NEW LEVEES.

Scales

Horizontal 0 2 4 6 miles
Vertical 0 20 40 60 feet



be placed in such jeopardy that it would involve the expense of removing the whole of their buildings and other improvements to a new location behind the new levee. The opinion was expressed that if the railway-line, or a line adjacent to it, were adopted for the levee little or no compensation would be demanded by the owners thereby left outside the protection, provided their land was withdrawn from the Drainage and River Board area and they were relieved from the payment of further rates.

Which of these alternatives should be adopted depends, firstly, on the attitude of the Railway Department, and, secondly, on the question as to which is the more economical. Before an absolute decision can be reached it will be necessary to canvass the owners to ascertain from them and obtain in writing a statement of the compensation which they would claim under each of the alternatives. Secondly, it would be necessary to make definite surveys of the proposals for raising the railway-bank and for the levees in each of the alternative positions.

If the Railway Department will agree to the raising of the railway and its adoption as the levee, and the owners of the land between the railway and the river will confirm the verbal statement *re* non-claiming of compensation, then the first alternative should be adopted, even though it should be somewhat more expensive in first cost, because the combined levee and railway-bank would be under constant careful supervision, and would therefore have a better chance of being in first-class order when a flood occurred.

Whichever alignment is taken for the levee, your Commissioners consider that the controlling authority should, if claims for compensation are made, acquire all the land lying between it and the river. This would extinguish all claims for damages; and no doubt the Board will be able to lease the land, probably to the present occupiers, at such a figure as would return reasonable interest on the investment. If, however, the large capital outlay for land-purchase which would be required is likely to jeopardize the carrying-out of the whole scheme, then the only other alternative is to enact such legislation as will give the controlling authority full power to prevent any landowner doing or erecting anything which would obstruct the free flow of flood-waters over the land in question.

(d.) When the levee at Allanton is shifted back the present bridge approach must be reduced to ordinary ground-level and the road graded up over the levee in its new position, so as to leave the necessary waterway; or, alternatively, the bridge must be increased in length so as to span the whole channel. The extension of the latter would not, in the opinion of your Commissioners, be warranted, as the loss due to the shutting-off of access would not be equal to the continual interest and maintenance charges on the increased length of the bridge.

(e.) The railway-bridge at Otokia must be lengthened by an addition of 840 ft. on its southern end, and all the embankment, including the stone protection, which would be rendered unnecessary by the erection of this extension, must be removed down to ground-level. The levees when fixed in their new alignment must connect with the abutment of this bridge, which should be strongly protected by rock against scour.

Although the Otokia Traffic-bridge and the Henley Traffic-bridge are totally inadequate, yet under the scheme for the removal of the embankment at the latter, and in view of the fact that at the former the flood-waters have an unrestricted passage over the railway and the land lying between the bank of the river and the Main South Road, the extension of these bridges is not necessary.

(f.) From the point previously mentioned, where the railway would cease to be the levee, or, alternatively, where the new levee would cross the railway at Bull Creek, a new levee should be erected running along the eastern side of Bull Creek, thence along the western boundaries of Section 34, and on to connect on a practically straight alignment with the Henley-Berwick Road. From the point of connection with the Henley-Berwick Road this levee should follow the said road until it links up with the system of banking in connection with the Waipori Stream and contour channel to be referred to later. The whole of this bank should be raised to a crest-level of 10 on the datum adopted by the Western Taieri Land Drainage Board, which is approximately low water, spring tides. This will necessitate a bank 8 ft. high in places, but averaging considerably less than this. One of the

reasons for not adopting the existing levees in the vicinity referred to is that these have not been well constructed in the past. They are of small dimensions, and the material for them was obtained from excavations so close to the levee that it would come within the limits of the new work, the result of which would be that there would practically be no saving by making the new levees enclose the old; and, furthermore, the ground where it is now proposed to construct the levees is more likely to be solid and reliable for a high bank than it would be close to the edge of the water in the lake or channel.

(g.) The danger of wave-action is also an argument for keeping back from the lakes, but wave-action can be coped with by growing willows in a belt parallel to the waterside. This is a situation in which willows will not interfere with flood-discharge, and consequently are not objectionable.

(h.) The area of land lying in the valley of the Waipori Stream above the Berwick-Outram Road is too small to justify the large expense that would be involved in improving the Waipori channel sufficiently to prevent this land being flooded. Your Commissioners therefore recommend that a levee be constructed on the lines indicated, to a sufficient height to prevent any possibility of the Waipori River escaping on to the main plain across this levee. This will necessitate a bank about 10 ft. high.

(j.) As a defence against small and fairly frequent floods a bank of moderate height could be carried up some distance from the present stream, as indicated on plan No. 3, to a point on the north-eastern corner of Section 45, Block II, Maungatua Survey District. This will give a fair amount of protection to a very fertile piece of country at a low cost.

(k.) The waterway at the Berwick town bridge must be increased by the excavation of the rock on the hillside sufficiently to give room for another 40 ft. span, and the material under this span ought, under the existing circumstances, to be excavated down to water-level, and the channel enlarged sufficiently to carry 20,000 cubic feet per second, for a distance of at least 5 chains up-stream and down-stream.

(l.) From the sharp bend lying to the southward of the township a sufficient channel should be excavated for the river to run into the Waipori Lake to the west, about a quarter of a mile to the west of the Meggathburn. It is not proposed that this channel should be sufficient to carry the largest flood anticipated, but the excavation should be sufficient to build a specially strong levee, which would give a safe carrying-capacity between itself and the neighbouring hills, to carry floods safely to the lake. This levee should follow the shores of the lake and the edge of the old Waipori channel till the same reaches the Henley-Berwick Road, and would there connect with the right-hand levee forming the Maungatua contour channel. The Henley-Berwick Road, raised as set forth in paragraph (f), would connect with the left-hand bank of the contour channel.

(m.) All the willows and other vegetation at present injuriously affecting the channels of the Taieri from Outram to the Henley Ferry Bridge, and affecting the channel of the Waipori between its point of diversion mentioned in paragraph (l) and a point 20 chains above the Berwick Bridge, must be removed after being poisoned so as to prevent their springing up again. A belt of willows to prevent erosion of the levees by current or wave action must be planted on the river-side throughout, including the river-side of the railway embankments wherever they are used as levees. These willows must be kept under control and cut periodically so as to form a thicket, and must not be allowed to grow into large top-heavy trees, as these are only a source of weakness.

(n.) In the event of an independent levee being constructed between Otokia and Bull Creek it will be necessary to regrade the Main South Railway where the levee crosses over it near Bull Creek, so that it will pass over the new levee when raised to its final height of 10 ft. above datum with reasonable grades.

As an alternative to the protective measures already described between Allanton and Bull Creek, a suggestion was put forward by Mr. W. E. McLean, Clerk to the Western Taieri Land Drainage Board, which is, shortly, that the railway be diverted so as to cross the river at Allanton and run in a fairly direct route along the general line of the river on the western side, joining in to the existing

alignment a little to the south of Otokia Railway-bridge; the whole of this railway-deviation, approximately six miles, and also the line from the point in the junction of Bull Creek, to be constructed and raised to such a height as would enable it to act as a protective levee throughout its entire length. If this were done the whole railway would be protected against floods, while under the scheme previously mentioned it would receive no protection between Owhiro and Otokia.

Whether this scheme should be put in hand or not will depend entirely on the attitude of the Railway Department thereto, and on the amount which they would be prepared to contribute towards the cost of the works. If they are prepared to pay what extra expense would be involved by this second suggestion, then it should most certainly be adopted. On the other hand, if they would prefer to suffer the damage which they now periodically sustain rather than pay this extra expense, then the remedial measures as set out at length in paragraphs (a) to (n) hereof should be adopted.

In considering the possible remedial measures your Commissioners looked into the question of flood-storage reservoirs in the upper reaches of the river, which had been much stressed by previous investigators, notably the Commission of 1880, and which was fully considered with the aid of detail surveys by the Commission of 1917. Your Commissioners agree with the finding of the 1917 Commission, which is, shortly, that a careful study of all the conditions based on more recent surveys and data shows that such a scheme is economically unjustifiable, and need not be further considered.

Your Commissioners wish to emphasize the importance of the lengthening of the railway-bridge at Otokia, and are of opinion that whether any of the other recommendations made in this report are followed or not the first action to be taken should be the lengthening of this bridge.

REFERENCE NO. 4.

To ascertain the nature and extent of any drainage-works that may be required, and the best method of carrying out such works.

The contour channel should be diverted from the bend 40 chains above its junction with the lake to the present old channel of the Waipori, from which, under the flood-protection scheme, the river-water will be diverted. This channel should have adequate levees so that its capacity shall be equal to the largest section of the contour channel at present. The fact that the contour channel has been breached more than once in the past, although apparently the flood-waters have never filled it, indicates that its construction requires to be carefully looked over; and where after levelling it is found that the lower side of it is below such a line as will give a uniform channel, the low places should be raised. Furthermore, wherever streams from the hills now join the channel the lower side of the channel should be raised 2 ft. above the general grade for some distance above and below, and the direction of the incoming streams should be altered so that they strike the contour channel not at right angles, but as near tangentially as possible. The importance of carefully maintaining this contour channel with an unimpaired carrying-capacity cannot be too strongly emphasized. The controlling authority must recollect that almost all water escaping from the contour channel has to be removed from the plain by pumping, and is consequently a source of great expense.

Where the Waipori Lake joins the Waiholā channel the present shallow, narrow, and tortuous channel must be dredged to a cross-section not less than 60 ft. wide and 6 ft. deep; and where the channel joins the lake the former should be gradually shallowed and splayed, so that the water may have as unobstructed a passage as possible from the shallow wide sheet to a comparatively narrow and deep outlet.

The advantage which would be derived from a dredged channel from the new outlet of the Waipori River to the outlet of the lake would soon be lost by its liability to silt up very quickly under the influence of wave-action on the muddy bottom, especially in view of the shallowness of the water and the unstable nature of the material forming the bottom of the lake.

From the Maori Lake a channel twice as large in carrying-capacity as the combined drains (excluding the contour channel) which now enter it should most

certainly be cut from the centre of the lake well out into the deeper parts of the Waipori Lake, with a splayed outlet into the shallow water, as described above for the outlet of Lake Waipori.

From the upper end of the channel just described similar channels should be cut connecting with the mouth of Lee Creek, the main drain, and any other drains now existing or to be constructed.

Where the main channel just described crosses the Henley-Berwick Road (now the main levee defending the plain against backwater from the lakes when in flood) sluice-gates of sufficient sectional area must be provided, through which the drainage from the plain could be discharged into the Waipori Lake on any occasion when, through stress of weather or other cause, the water in the Maori Lake was higher than that in the Waipori Lake.

In the vicinity of these sluice-gates a powerful low-lift pumping plant should be erected, capable of discharging the water from the bottom of the excavated channels in the Maori Lake against the highest head likely to be encountered in the Waipori Lake for any length of time. This may probably be taken as 7 ft. on the Drainage Board's datum.

Your Commissioners ascertained that the efficiency of the centrifugal pump installed by the Drainage Board at their present pumping-station was extremely low, and it will be necessary when fitting up the new pumping-station to ensure that similarly inefficient machines are not installed.

When the flood-waters have been pumped down to a fairly low level, the existing main drains apparently are not able to bring the water to the present pumps as fast as the pumps can discharge it into the lake. It will be realized, then, that if more powerful pumps are provided it will be advisable, if they are to be utilized to their fullest extent, that the main drain, including the Lee Creek, be deepened and possibly widened. This is not an absolutely essential work, but is desirable; and the question as to whether it is better to spend money in deepening or, alternatively, in having a pumping-station standing by waiting for the water to come, must be considered by the Board's engineer.

When the Maori Lake has been dredged as outlined, and its waters are kept permanently at the lowest level practicable—probably 1 ft. or more below low-water mark—there will be an appreciable reservoir into which the drains can discharge while pumping is not in progress. The result of this will be that, while adequately draining the land, it will yet be possible to store the water during the day and only pump after midnight, when electric power can be obtained at a minimum of cost.

The scheme of draining and pumping above outlined is practically that set out in Mr. Michael Elliot's report of the 14th February, 1910, which was apparently partly carried out and then abandoned, owing, it is stated, to opposition by the Maoris to the drying of the lake over which they have, or are alleged to have, fishing-rights. Your Commissioners cannot conceive that such a consideration as fishing-rights in a lake which is almost dry, and which could therefore have no commercial value to any one, should be allowed to weigh against the enormous benefits, financial and otherwise, which would accrue to the settlers and the State if the Maori Lake were utilized for the purposes herein indicated, and in which capacity it would be doing a service infinitely greater than ever it will do as a fishing-ground for Natives. Your Commissioners are of opinion that the lake is of no financial value to the Natives; but, even so, it would be better to waive this point and, even in opposition to strict justice, to take the lake and pay the Maoris some compensation in order to wipe out their opposition for ever. If their demands are extortionate, then by the provisions of a special Act their rights should be extinguished and Parliament should fix a sum, which should be a purely nominal one, to be paid to any Natives who could establish the fact that at present they are making any substantial use of the lake.

Certain lands, which will under the scheme outlined above be outside the main defences, require improved drainage in order that the flood-waters by which they will be covered in flood-time may run off as quickly as possible, but it did not appear to your Commissioners that detail matters of this kind should be dealt with by them.

REFERENCE NO. 5.

- (a.) *To furnish estimates of the cost of such remedial measures as you may recommend should be taken for the effective control and improvement of the said rivers and their banks.*

Your Commissioners estimate the approximate cost of the works outlined at £80,000.

- (b.) *To report, in the case of each river, what area or areas of land should be constituted a district in respect of which a rate may be levied to secure and pay the interest on and provide a fund for the repayment of any loan that may be raised to carry out any river-improvement works which you may recommend should be undertaken.*

The area to be constituted a district in respect of which a rate may be levied to secure and pay the interest on and provide a fund for the repayment of any loan that may be raised to carry out the river-improvement works recommended by your Commissioners is the portion of the Lower Taieri Plain shown on the accompanying plan No. 1. The area embodied in this district comprises approximately all the land which would be subject to damage by flood-waters of the Taieri and Waipori Rivers, assuming that there were no adequate levees or other protective works existing.

It is further recommended that for the purposes of representation this district should be divided into seven ridings, as indicated also on plan No. 1 attached.

The control of Silverstream below the boundary of the Lower Taieri River District (as suggested) does not seem to be a work of great magnitude, and there seems to be no reason why a small body, called the "Silverstream River Board," should not be formed to deal with it. It seems expedient that at this time the interests here involved should be entirely separated from the Taieri, even should it mean the creation of a very small Board; alternatively the Taieri County Council might be declared a River Board in respect of this stream. Possibly the present system might remain in operation. Eventually, no doubt, this area would come into the main river district on its own petition if ratepayers there realized that they would only be rated for work done on the Silverstream directly benefiting them.

They might now be constituted either a river district or a drainage district, or even be defined as an "outer area of the Lower Taieri River District," with the right to ask the main Board to give them schemes and estimates, classification rates, &c., for their work, and then do the work or not, as they liked. In this case, being an outer area and not contributing to the administration rate, they would have to pay the main Board the actual cost of making reports, &c., plus, say, 10 per cent.

- (c.) *To report your opinion as to what matters, if any, should be adjusted by legislation.*

Your Commissioners consider that the whole of their findings as set forth in this report should be enacted in special legislation, to be called the Lower Taieri River Improvement Act.

- (d.) *Generally, to report your opinion on all matters arising out of or touching the premises, including the question as to whether or not one or more competent authorities shall be appointed to control the whole or any portion or portions of the said rivers, and what statutory powers should be possessed by such authority.*

Your Commissioners consider that for the purpose of carrying out the works described generally under reference No. 3, and ensuring their proper maintenance in the future, also for the proper control of the river and for the better protection of the interests of the whole community, one controlling authority should be appointed.

The district to be controlled, and over portions of which rates may be struck to raise moneys required for the construction of protective works, should comprise the whole of the area already referred to and described under reference No. 5 (b), and this district should be termed "The Taieri River Trust District."

The Trust controlling the district should be composed of seven local representatives, one member being elected from each river riding, and also of three Government representatives, called "River Commissioners," appointed for three years by the Minister of Public Works, one of the Government nominees being well versed in local-body work, the second an engineer with expert knowledge of river-control, and the third preferably the District Engineer for New Zealand Working Railways.

Your Commissioners further recommend that the duties of this controlling authority be clearly set out as follows :—

- (1.) To have detail surveys, plans, estimates, and specifications made for carrying out the works recommended above. These plans, &c., should be approved by the Government nominees on the Trust.
- (2.) The Trust, having adopted any scheme of works, should fix the special area to be benefited by the proposed works, and should cause to be made a classification of the benefits to be derived by each property, for the purpose of paying interest and sinking fund on the loan to be raised. Such rates on each property to be in the ratio of the individual benefit to the total estimated benefits in each special area.

In the carrying-out of remedial measures for the mitigation or total prevention of damage from floods it is almost inevitable that the works should proceed from the up-stream end and be finally completed down-stream. In thus carrying out the protective works it follows that the property-holders up-stream are protected, either wholly or partially, from floods at a much earlier date—it may be some years—than the settlers living down-stream are similarly protected. If the settlers in a district are rated as a whole, and from the commencement of the construction of the works, it follows that the down-stream settlers may be paying full rates for many years without receiving protection, whereas the up-stream settlers may receive protection after having paid rates for only a very short time. This does not appear to your Commissioners to be an equitable arrangement, and it is suggested that some method should be adopted whereby the rating may be so adjusted that settlers should not be fully rated until such time as it can be shown that they are individually receiving some distinct benefit from the construction of the works, either partially or as a whole. If this recommendation is adopted, then interest should be charged to loan account during the construction of works. This would tend to expedite the completion of the works, and at the same time relieve the inequitable arrangement referred to above.

- (3.) To submit the proposals to the ratepayers and obtain their authority by poll to raise the necessary loan. In voting for or against any proposal to raise a loan each ratepayer should exercise one vote only, and the proposal should be carried by a bare majority in its favour.
- (4.) To carry out the necessary work, either by contract or direct labour, in as expeditious a manner as possible.
- (5.) To maintain the works efficiently, and to do whatever extra work may be necessary to improve the regimen of the river and secure the fullest protection for the district from floods.
- (6.) To maintain all existing works (as well as new works) within their area controlling flood-waters of rivers and their tributaries, and, further, to maintain all artificial drains, pumping plant, flood-gates, &c., and to carry out all pumping operations.
- (7.) To take all necessary observations and keep records that will assist in the study of the hydrology of the river, changes in its regimen, heights and duration of floods, &c.

The Trust should have all the powers of a local body; and further should have complete control of the Taieri River and its banks from Outram Gorge down, including the Waiholo and other lakes, with their channels and beds; also of the

Waipori River and its banks up to Sawmill Creek ; with authority to make diversions, deepen and widen channels, erect levees and other protective works on private lands, to divert, raise, lower, or alter roads, bridges, and culverts where, in the opinion of the Trust, they interfere with the proper discharge of flood-waters : and generally to take such steps as the Trust may consider necessary or advisable to protect the district from flood-damage.

Further, proposals for all drains emptying into the river, all locks, tide-gates, bridges, ferries, wharves, &c., should be submitted to and approved by the Trust before being carried out. No planting or cutting of willows should be done except by authority of the Trust.

It is further recommended that all existing Acts in respect of either river-control works or drainage-works on the Taieri River and Taieri Plain below Outram should be repealed, and that all existing liabilities and rating in respect of such works already done or in course of execution should continue in force as at present, and the financial and administrative control of all such works be handed over to the River Trust to be formed as above described.

The Trust should have all the powers of a Drainage Board over the whole or any portion of the district.

River-improvement and flood-protection works should be considered by the Trust as entirely distinct from drainage-works, and separate loan, administrative, and maintenance accounts should be kept for each.

Maintenance.—The method of fixing rates for the purpose of paying interest and sinking fund on loans has been indicated under clause (2), reference 5 (*d*), and it is recommended that a separate rate be struck for maintenance charges only. For the estimated cost of maintenance, repairs, and flood-damage to works on the western side of the Taieri River, other than for maintenance or damage to the railway-works, the rate should be a uniform one on the unimproved value struck over the whole of the rateable area on the west side of the Taieri River. In like manner, for the maintenance of all works on the east side of the Taieri River, a similar but not necessarily an equal rate should be struck on all rateable lands in the district east of the river.

Administration.—The payment of general administrative charges that are of common interest to the whole district should be met by a uniform rate on the unimproved value over the whole of the rateable area.

The uniform maintenance rate would be fiercely objected to by the ratepayers on the upper plain, especially when their levees burst and the lower men were swamped, and there would be a large pumping bill. But if it could be established the uniform rate would pool the interests, and it would render the upper men quite as anxious about the safety and proper maintenance of the levees as the lower men. In any case, it would not be a heavy rate.

It should also be borne in mind that though at first under the uniform rate the incidence of taxation might bear unduly on the upper men, yet as the lower properties increased in value as a result of protection the lower men would (on revaluation) pay more and more, and so ease the burden on the upper men.

Your Commissioners are of opinion that no payment of compensation should be made for loss of riparian rights if such be interfered with.

Allocation of Costs.—With regard to the allocation of the costs of remedial measures your Commissioners agree with the recommendations of the 1917 Commission, on the grounds that in view of the national interests at stake, and particularly in view of the damage done to the rivers by mining and other operations, it would be equitable that a contribution from the consolidated revenue equal to one-third of the total cost of river-improvement and flood-protection works should be made.

Your Commissioners further consider that in the event of the Government subsidizing the cost of the works to this extent it should not be called upon at any future time to pay any maintenance charges or any compensation for flood-damage.

Regarding the contribution to be made by the Dunedin City Corporation (referred to on page 5 hereof), your Commissioners are of opinion that the contribution which the Corporation should make towards the work of protecting the Taieri Plain is that it should erect, with as little delay as possible, a new impounding-

weir at its hydro-electric station at Waipori. Your Commissioners understand that this is the present intention of the Corporation, and they merely include this reference in their report with a view to strengthening the hands of the Corporation and emphasizing the importance of this work.

This our report, which has been unanimously adopted, we have the honour to respectfully submit for the consideration of Your Excellency, together with the transcript of the evidence taken by us in the course of our investigations, and the following plans illustrating our report :—

Plan No. 1 : Lithograph showing proposed district and subdivisions.
Scale, 1 mile = 1 inch.

Plan No. 2 : Longitudinal section of Taieri River from Outram Gorge to the sea. Scales—horizontal, 1 mile = 1 inch ; vertical, 10 feet = 1 inch.

Plan No. 3 : General plan of Taieri Plain, showing proposed works.
Scale, 20 chains = 1 inch.

(Given under our hands and seals this 21st day of May, 1920.

F. W. FURKERT, Chairman.

ASHLEY JOHN HUNTER,¹
F. C. HAY, } Commissioners.

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