

1920.
NEW ZEALAND.

RANGITATA RIVER

(REPORT OF RIVERS COMMISSION ON).

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

REPORT.

To His Excellency Sir Robert Stout, the Administrator of the Government of the Dominion of New Zealand.

MAY IT PLEASE YOUR EXCELLENCY,—

The Governor-General'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. The Governor-General'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 the Governor-General to the 7th June, 1920, and further extended by Your Excellency to the 7th December, 1920. The present report deals only with the Rangitata River. The reports on the Maerewhenua, Clutha, Aparima, and Taieri Rivers have already been presented to the Governor-General. The reports upon the remaining rivers will be submitted in due course when the requisite data has been collected.

The Governor-General's Commission directed us, in respect of each river,—

- “(1.) To inquire into the cause or causes of the silting-up of the channels, the flooding of the adjacent lands by the said rivers, the erosion of their 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 rivers, 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 rivers and their tributaries so as to safeguard the lands affected, and to provide for the effective control and improvement of the said rivers and their 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 rivers and their 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 rivers, and what statutory powers should be possessed by such authority.”

The Governor-General's Commission also required us to report separately in respect of each river.

INVESTIGATIONS MADE.

Sittings, Evidence, and Inspections.—Your Commissioners made a preliminary inspection of the river on the 3rd July, 1919, and on the 5th idem held a sitting of the Commission at Rangitata, when ten witnesses were examined. Subsequently your Commissioners discussed the state of the river with the District Engineer, Public Works Department, Christchurch, and the District Engineer, New Zealand Railways, Christchurch. The Engineer to the Ashburton County Council was also interviewed by your Commissioners with the object of ascertaining the past conditions of the river at the Arundel Bridge, which was visited and examined by your Commissioners. The County Engineer advised that the County Council had no records of the original bridge, or of its extension (approximately in 1883), nor any plans of the structure as it was partially rebuilt about twelve years ago, nor any plans or information of the bridge as it exists at the present time. Apparently a bridge was built in the early “seventies” and suffered damage in 1876, after which heavy protective works were erected at both ends, but in 1878 these were washed out and the bridge rendered unusable. Negotiations for its re-establishment extended over several years, it finally being decided to extend the bridge all the way to the North Terrace, which work was completed in 1883. In 1899 one of the cylinders disappeared in a flood; it is not known whether it broke off or was entirely undermined. A number of the 3 ft. cube blocks are now lying several chains down-stream; these were part of the protective works erected in 1876.

On the 10th July, 1919, your Commissioners paid a visit to Rangitata Island, and met and discussed flood-levels at Rangitata Bridge with the Bridge Inspector and ganger of the Railway Department, both of whom had an intimate knowledge of the Rangitata Bridge since its erection, the former having assisted at its construction. The ganger reported having seen the water washing the railway beams at one or two spans, the transoms being submerged. (NOTE: The District Engineer, New Zealand Railways, Christchurch, expressed the opinion that this statement was probably a gross exaggeration. However, it was the evidence of an actual eye-witness. He may have called the top of the splash the flood-level.) In support of the ganger's statement, though not absolutely conclusive, your Commissioners found silt in the interstices of the transoms in question. It is possible that this might have been transported by wind. The current strikes the piers, especially at the south end of the north bridge, at an angle of 45° , and it is in this locality that the high level has been recorded, the level at the north end being many feet lower. Silt was found on the lower caps 5 ft. below the railway level on the second span from the south end of the north bridge. The fact that the bridge is not at right angles to the axis of the river (of the North Branch particularly), and also the fact that the river itself does not run parallel to its banks, but frequently at a very sharp angle thereto, no doubt accounts for the apparent anomalies in the flood-levels observed at various points on the bridge, which is a very long one. Another point which makes evidences of flood-marks hard to reconcile is that the levels of the river-bed alter very much locally, though on the average over the full width of the river there appears little alteration. Flood-marks indicate that the river rises several feet in flood-time, while one paint mark on a pile, which was shown to your Commissioners as the height of the 1918 flood, was only 14 in. above the water-level in that vicinity at the time of our inspection. It is quite evident that an alteration

in the level of the river-bed must have taken place at this point. The evidence of eye-witnesses also shows that the surface of the water is not level along the bridge either at low or flood level.

Your Commissioners were met at Rangitata Island by the settlers and conducted over the island, visiting various properties where erosions had taken place and where protective works had been erected.

On the following day your Commissioners met the settlers on the south side of the river, and were shown evidences of erosions at various points, and also places where the flood-waters had overflowed the banks of the river and found their way into the Kapunatiki Creek, and by that creek to the sea.

On the 13th July your Commissioners visited the heavy protective works erected by the Railway Department in 1887 on the south side of the Rangitata River, about four miles below Arundel. These works consist of a levee approximately parallel to the axis of the stream, composed of gravel and boulders taken from borrow-pits immediately alongside, the largest stone being placed on the outside. The levee is protected at intervals by up-stream groynes of a similar character, with their outer ends protected by heavy rockwork. The whole space between the groynes was thickly planted with Lombardy and silver poplars, also a few other trees. One of the groynes had been protected by a timber crib. No evidence was found that any portion of this work had failed, but from the evidence contained in the Railway Department's files it appears that the work now visible is that which was proved to be necessary after damage had been done to the works as originally constructed, the principal addition being the placing of the heavy stone at the ends of the groynes. The cost of the work carried out at this point by the Railway Department was in the vicinity of £10,000.

RIVER NOMENCLATURE.

For the purposes of this report the river down to a point about three miles above the Main South Railway-line, and where it bifurcates, will be known as the Rangitata River. From where it bifurcates to the sea the river runs in two main channels, which are known respectively as the North Channel and the South Channel. Just below the railway-bridge across the South Channel it has a minor bifurcation, a small stream between the two main streams, being known as the Middle Channel. The land lying between the North Branch and the Middle Channel is known as Rangitata Island, and the land lying between the Middle Channel and the South Branch is known as Ruddenklau's Island. The Middle Channel runs into the South Branch again, and the North and South Branches join close to the sea, and flow into the ocean at what is known as Rangitata Mouth.

Closely adjacent to the South Branch, and probably derived from soakage from this branch through the intervening land and augmented by the overflow from the river in flood-time, is a small stream known as Kapunatiki Creek. This gradually increases in size by the augmentation of water from springs, and eventually finds its way into the sea some miles south of the mouth of the river. It is into this creek that the settlers fear that the whole river may turn, with disastrous results.

PHYSICAL CHARACTERISTICS.

The physical characteristics of this river are very similar to those of the majority of Canterbury rivers. It issues from the Southern Alps through the gorge on to a plain composed entirely of shingle brought down by the existing and other rivers in former ages. The watershed of the river covers an area of 683 square miles down to Arundel Bridge. The river has, in past geological ages, run at several different levels, all higher than the present one. As it has cut through and denuded the mountains the slopes have become easier, and therefore the amount of detritus brought down has become less, so that in time the stream has been able to corrode the bottom of its bed at a faster rate than that at which fresh material came down from the hills. As a result its bed has gradually lowered until the gravel plains on which it originally ran are now many feet above the present water. This cutting-down through the plain may be to some extent due to uplift of the land, and partly to coastal erosion.

Though there was a feeling among the local residents that the river-bed was rising (this is a widespread popular misapprehension), your Commissioners found no direct evidence of this. The shingle carried in this river is extremely coarse, and the moving down-stream of the 3 ft. concrete cubes formerly used in the protective works at the Arundel Bridge shows that the river in flood has tremendous transporting-power. It has an average fall of about 33 ft. to the mile, which in a river of this magnitude must be considered tremendous, especially in view of the fact that the fall is maintained almost down to high-water mark.

Where the river bifurcates the changes in the shape of the bed cause varying amounts of water to be deflected into the channels, so that in some years nearly all the water flows in the North Branch, and in other years, before the shortening of the south bridge, a very considerable proportion flowed in the South and Middle Branches. At one time the river so persistently flowed in the North Branch that the railway-bridge over the South Branch was shortened by 50 per cent., and, further, the complete filling-up of this channel with an embankment was considered, though the idea was not adopted. A few years ago a change took place, and it appeared almost as if all the normal water would come down the South Branch. However, this fear was not realized, and at the present time there is not as much water flowing in the South Branch as there was a year or two ago. Conditions are not stable, and the amounts of both flood and normal flow vary from time to time.

The shortening of the bridge practically closed the entrance into the Middle Branch.

FLOODS AND FLOOD-DISCHARGE.

Floods in this river are fairly frequent, and the following have been specially recorded :—

1868 : The largest flood ever known in the river, when the rainfall at Mount Peel is said to have registered 8 in. in twenty-four hours.

May, 1876 : Flood said to have been level with the top of the cylinders of the Arundel Bridge. (NOTE : Bridge was not at that time its present length.)

September, 1878 : Flood washed out the protective works at one end of the Arundel Bridge, leaving the same isolated; also, as a result, threatened the railway. The flood-water flowed into a channel on the south side above the railway. This channel carried the water across the Rangitata Station and found its own outlet to the sea between the Rangitata and the Orari, partly, no doubt, through the Kapunatiki Creek. The flood at that time is said to have been 2 ft. 6 in. below the cap of the railway-bridge, or about 7 ft. 10 in. below the rail-level, and about 2 ft. above the formation-level of the Rangitata Railway-station.

November, 1886 : This flood did not affect the railway, but below the railway three distinct outbreaks discharged water from the South Branch into the Kapunatiki Creek. Above the railway up to trig. station on Rural Section No. 23927 the river showed no tendency to break over, but from that point upwards there were several points where in high floods the banks were overtopped, and the escaping water did not, on account of the configuration of the ground, return to the present river-bed.

1899 : This flood destroyed one cylinder of the Arundel Bridge, but was 6 in. below the 1913 flood at the railway-bridge over the North Branch. For reasons already pointed out, measurements of floods within 6 in. on this river cannot be made with certainty.

March, 1913 : This flood is said to have been 3 ft. below the rails at the middle of the railway-bridge over the North Branch, and 12 ft. 6 in. below the rails at the north end of the same bridge, and 10 ft. below the rails at the south end. The railway-bridge was damaged, some of the piles being scoured out.

It must be pointed out that the proportions of the water which run through each branch in flood-time have no relation to the proportions which flow there at periods of normal flow.

To arrive at a definite measurement of the volume of water passing is a very difficult matter in a river of this kind, in which the river-bed alters appreciably during floods, and which is so wide that its width, in conjunction with the irregularities of the bed, results in the surface of the water not being level.

Large masses of shingle are moved down the river during floods, and it is conceived that these masses of shingle travel more or less in the nature of waves, the crest of which may take years to pass over the distance from the hills to the sea, and while the crest of the shingle-wave is passing any point the flood-level there is unduly raised. After the passage of that wave of shingle, floods of a greater volume may not have so high a water surface. The propagation of these shingle-waves depends upon the weather conditions in the mountainous regions at the head of the river. When many avalanches have occurred as a result of a severe winter or series of winters, a great deal of detritus is brought down into the river-bed, and while this is being carried to the sea it raises the bed of the river progressively, as indicated above. A number of bad years is usually followed by milder weather, during which less material is discharged into the river and its tributaries, and in this way it is able to gradually relieve itself of the masses of shingle with which its bed has been encumbered. Later on, when the cycle is repeated, another mass of shingle starts on its way to the sea.

As the result of consideration of data available your Commissioners have come to the conclusion that it is impossible, with the data at their command, to form other than an approximate estimate of what constitutes a big flood-discharge in this river. Your Commissioners are of the opinion, however, that a discharge of 88,000 cubic feet per second may be considered to be a big flood, and that it is very unlikely that this discharge will be exceeded during any period of years which it would be reasonable to consider.

CHANGES OF REGIMEN.

The evidence did not point to any violent change having taken place in the character of the river within historic times, except that the South Branch has become very much larger than it was fifty or sixty years ago. In some old records it is referred to as the "Rangitata Creek": this in itself would indicate that it was not as large as the other portion of the river, and old maps show it with a very much narrower river-bed than it has now. This was probably only the result of a phase in the periodic oscillations of the flow between the North Branch and the South Branch, which has lasted long enough to enable vegetation to take possession of the river-bed of the South Branch, which had been abandoned for a time by its water.

In 1912 the greater bulk of the water had been running in the North Branch so long that the South Branch river-bed was very much overgrown with vegetation, with quite a small channel winding its way through, which could be easily crossed in a motor-car. It is quite conceivable that the same thing might occur again in either of the branches.

In 1859 the South Rangitata Creek is stated to have been bridged at one point by a 36 ft. stringer. It is further stated that extra water was led into the creek in order to make it act as a sheep-boundary. The South Branch was stated to have been in 1873 100 ft. wide of actual water. In 1886 almost the whole of the river was running in the South Branch, while evidence goes to show that in 1898 the river had practically been running entirely in the North Branch for several years. In 1916 the water commenced to increase in the South Branch, until early in 1918 there was considerably more water under normal conditions in the South Branch than in the North. The Middle Branch has been practically dry since the Railway Department shortened the bridge over the South Branch, about 1900. The embankment that was put in to replace the bridge had the effect of blocking the ingress of water to a great extent into the Middle Channel, but during freshes a portion of the water in the South Branch, after having passed the bridge, still finds its way into the Middle Branch.

The shingle in this river-bed is so rough that it does not favour the growth of willows, and consequently not much damage has been done by islands formed round stranded willows, as is so common in other rivers in New Zealand, but a very considerable growth of gorse and broom has spread over a large portion of the river-bed, thereby encouraging the deposition of small shingle and sand, and tending to force the river to cut new channels for itself. There is said to have been no gorse prior to 1873.

No direct evidence was brought forward as to the excessive denudation of the hills, which would be likely to cause a greater travel of shingle down the river than in the past before settlement took place; but, in view of the fact that the whole of the upper reaches are devoted to agricultural or pastoral operations, there is no reason to suppose that the farmers who occupy this land pursue a very different policy to that which has been so detrimental in Otago. This refers particularly to tussock-burning. The burning may not have been so widespread or so ill-timed, but there is no reason to suppose that its effect could have been otherwise than harmful to the condition of the river farther down.

EXISTING WORKS.

Protective works have been constructed on the river-bank at various points. The farthest up-stream of which it is necessary to take note were those built to protect the ends of the Arundel Bridge. These were very massive, and from what appears at the south end one would judge them to have been adequate. However, in 1878, from some cause of which there is no record now, the north approach to the bridge was completely washed away, and rather than go to the expense necessary to restore it the authorities in control decided to lengthen the bridge very considerably, and its north end is now so far from the main stream that practically no protection to its approach is necessary.

After the floods of 1878, when the railway in the vicinity of Rangitata Station was damaged and it appeared as though the river might take a permanent course in that direction, very strong protective works were erected at a point about three miles and a quarter above the railway-bridge. These works cost about £10,000, and extend along the river for about three-quarters of a mile. The works are of an extremely substantial character, and there is no doubt that they will be able to withstand any flood which may occur.

The trouble with rivers of this nature is that their point of attack on the bank shifts from time to time, so that the railway protective works are not now being subjected to any stress. To expend the sum of £200 to the chain on the river-banks is not warranted, nor is it necessary. The railway-work was done along a portion of the river where the natural bank is lower than the average, and where it was quite conceivable that the river might take a permanent course across country which would have created widespread devastation not only to the railway but to the country generally. Therefore the heavy expenditure was quite justified.

At the north end of the railway-embankment between the North Branch bridge and the South Branch bridge a very considerable amount of protective work has been done from time to time by constructing short groynes and tipping in heavy rock in order to save the railway-embankment in that locality, the river for a number of years having taken a course almost parallel to the railway prior to going through the bridge.

The south end of the same embankment has required a certain amount of protection of late years, and since the bridge has been so much shortened, owing to the return of a large volume of the flood-waters running parallel to the upper side of the embankment before entering the south channel. During an ordinary high fresh the water runs on to the island above the bridge near the point of bifurcation of the channels, and runs down on top of the island at a higher level than the water in the Main South Branch. When these waters meet the railway-embankment they are ponded up until they can run parallel to the railway and join the north or south channel again. This has necessitated a considerable amount of willow-planting and fences on the upper side of the embankment to catch the debris and also to prevent scour.

Various protective works have been constructed by the settlers on the island, some dating back as far as forty years. The works on the north side of the island are said to have cost £1,600, while the bridge over the flood-channel on Mr. Hearn's property cost £400.

In October, 1918, the settlers on the south bank of the Rangitata River built a groyne at a cost of about £1,000 near the point of bifurcation at the top of the island in an endeavour to prevent the waters of the South Branch increasing, as set out above. This groyne appears to have had no appreciable

effect, as, when recently seen after a fresh, the bulk of the water was running down the South Branch and the groyne was partly wrecked.

From time to time small works have been erected by individual settlers along their own frontages, but little effect has been produced by them.

LOCAL BODIES INTERESTED.

The boundary-line between the Ashburton and Geraldine Counties runs down the middle of the river to the head of Rangitata Island, and from that point to the sea the line runs down the middle of the North Branch. Rangitata Island comes within the Geraldine County, but it is controlled by the Rangitata Island River and Road Board.

The Ashburton County Council takes no interest in the question of river-protection, because the left bank of the river is high and has not been eroded to any appreciable extent for a great many years.

No direct evidence was tendered of any damage on the north side, but settlers on the south side pointed out one locality near the mouth where considerable erosion had taken place on the north bank many years ago.

LAND SETTLEMENT AND TENURE.

The greater part of the land affected by this river is freehold. The largest exception to this is the part of Rangitata Island above the railway, this being a railway reserve.

The rateable value of Rangitata Island is £73,000, and the population about one hundred.

A decided opinion was expressed that if it were not for the fear of floods and the damage they cause there would be a considerably larger population on the island. It was also stated that the development of the island was being retarded by the absence of a road-bridge, as settlers cannot go to and fro at will. Although not within the order of reference, your Commissioners feel bound to endorse the opinion of settlers as to the urgent necessity for a traffic-bridge crossing the South Branch of the river.

SURVEYS.

As no recent plans of the river existed from which its present condition could be arrived at, your Commissioners found it necessary to adjourn their deliberations for some months in order to have fresh surveys made. These surveys were made with the object of ascertaining what land had actually been washed away, and, if possible, what was the ordinary discharging-capacity of the various channels.

It had been suggested by more than one witness that the South Branch might be closed up altogether, and all the water sent through the North Branch. It was further stated that the closing of the middle channel by the shortening of the South Branch railway-bridge was sending more water into the South Branch than it could reasonably carry.

A considerable amount of levelling over the countryside was also necessary to see whether there was any real ground for the belief that the river, if once it got over its banks on the south side, might change its course permanently.

Your Commissioners perused all the plans to which they were able to obtain access, including some accompanying a report made by Sir Julius von Haast at the time that he was Provincial Geologist.

REFERENCE No. 1.

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

Your Commissioners found no definite evidence that silting-up of the channels as a whole had occurred in this river. Many channels had become completely filled up, but simultaneously an equal cross-section would be eroded by the river somewhere else within the limits of the river-bed, so that on the average it may be taken that no great alteration has taken place within historic times other than could be accounted for by the action of gorse, broom,

and other exotic vegetation in preventing or retarding the natural causes, but is aggravated in places by the formation of resistant islands protected by gorse, broom, &c., which tend to throw the water against the more natural travel of the shingle seawards during floods. In a river so wide as the Rangitata it is difficult to detect filling-up until the same has become very pronounced.

The flooding of the adjacent lands is caused by the fact that along some stretches the natural banks are lower than the grade of a high flood, and furthermore to the fact that the river, in common with most other Canterbury rivers, is running on a "fan," and once the flood-waters get over the immediate river-bank they tend to follow old channels which lead away from the main channel, and do not return lower down, as is the case with valley rivers.

The erosion of the banks is chiefly due to natural causes, but is aggravated in places by the formation of resistant islands protected by gorse, broom, &c., which tend to throw the water against the more easily eroded unprotected banks.

REFERENCE NO. 2.

To ascertain the nature and extent of the damage done to the lands adjacent to the said rivers, 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.

Between the Arundel Bridge and the sea an area approaching 800 acres has been destroyed since the original issue of the titles. Besides this area actually washed away there are considerable areas of good land which is under water in time of flood, and consequently cannot be used for cropping or anything more profitable than rough grazing. There is a danger that if it is ploughed the soil may be washed away before the new grass has time to bind it. Erosion is occurring in a number of places, but nowhere is the erosion proceeding at a very rapid rate.

Your Commissioners are of the opinion that it is practicable at reasonable expense to prevent flooding and to gradually so train the river as to eliminate erosion to a very considerable extent in the future, but to construct works at present sufficient to wholly prevent erosion would involve an expenditure not justified by the amount of damage being done.

REFERENCE NO. 3.

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

As previously stated, it is not practicable, at reasonable expense, to prevent all the damage that occurs along this river, but it would be reasonable to erect levees at some distance back from the river-bank along portions where the flood-grade comes above the natural bank. These levees should be grassed over so as to withstand the flow of flood-waters along them, and should, of course, be kept free from rabbit-holes, which are such a frequent cause of trouble on similar works.

Wherever active erosion is taking place it is usually impossible to stop this, except at a cost out of all proportion to the area of land likely to be lost; but a great deal might be done by a local organization fully alive to the problem, by a system of anchored and weighted trees, which should be placed close together along the stretch on which the water impinges violently. *Cupressus macrocarpa*, *Pinus insignis*, and any other bushy trees will do quite well, as it is not likely that the attack on any one stretch of river-bank will last until these trees rot. Each tree should be hung by strong cables to logs sunk in the ground some distance back, and should be weighted either by blocks of weak concrete or by nets of stones, the former for preference. The current of the Rangitata is so fierce that it is quite likely that this class of work would be breached in places, but the general effect of a continuous fringe would be sufficiently good to justify its being carried out. At any point where a dangerous situation arose the class of protective works adopted by the Railway Department above the bridge some forty years ago would be found quite satisfactory. The very considerable expense of this method is such that it should only be

resorted to in extreme cases. The local body might also meet matters by training the river away from the dangerous spots with light temporary protective works, and by encouraging the growth of a dense belt of trees all along the river. The class of trees to be adopted should be the subject of careful experiment, but it is probable that if a strip, say, a chain wide, of Lombardy and silver poplars, backed by another chain of *Pinus insignis*, were planted, this would effect all that is necessary except in extreme cases. These trees should be planted sufficiently behind points where erosion is now taking place to enable them to become established before the erosion progresses far enough to uproot them. This belt might be made much wider than 2 chains with advantage, and if worked on proper silvicultural lines would, after coming to maturity, become a greater source of revenue than anything else which could be grown on the same area of land, while at the same time acting as a splendid protection against the incursions of the river. After the protective belt has become well grown the trees along any threatened portion should be connected together by strong wire cables, so that when the first row was overturned by the caving of the banks they would not be swept away, but would act as a protection for their neighbours. Upon the subsidence of the floods this outer row should be securely weighted, either by concrete blocks or by stones in wire nets, thus increasing their efficacy to withstand further erosion.

Should a violent erosion occur above the railway so that it appears likely that the river may break over the railway, as it did in 1878, then similar work to that carried out three miles and a quarter above the bridge would be necessary. But, as previously stated, work of this kind should only be put in hand as a last resource.

The growth of scrub of any kind within the river-bed proper should be prevented. Fortunately, this river, owing to its stony nature, does not favour such growth; nevertheless, unless constantly watched and eradicated, the growth will gradually tend to increase until it is a much greater menace than it is at present. The clearing of the river in the first place will be probably a work of considerable magnitude, but afterwards it should not be difficult, by burning at the proper time, to keep the river reasonably clear.

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.

No drainage-works would be required as the result of the previous recommendations, but there are, at the lower end of the island, moderate areas which require ordinary drainage. There are no drainage-works necessary of greater magnitude than could be attended to by the settlers themselves.

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.

It is impossible at the present time to furnish an estimate of the cost of carrying out all the works indicated above. The works will not be done in one operation, but, as indicated above, constant watching of the river, and the construction of small works at propitious times and in suitable places, must be carried out.

Your Commissioners consider that the controlling authority should aim at a regular income of £1,000 per annum, which should be sufficient to pay the interest on any loans, and also to provide a sum of money sufficient to enable work to be promptly put in hand whenever circumstances require. As the river becomes more and more controlled, and loans become gradually paid off, this sum may be continually reduced.

In the above figures, although purchase of necessary land is taken into consideration, nothing has been allowed for the cost of planting, in view of the fact that the protective plantations will very soon become a source of revenue rather than of expense to the controlling authority because of the scarcity of bush, particularly in Canterbury, and the very large and increasing demand for sawn timber and firewood.

- (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 which 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 the river-improvement works recommended herein by your Commissioners is that defined in the First Schedule to the Rangitata River Act, 1918.

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

The Geraldine County Council should be constituted a River Board for the purposes of this river, and in order that it may have control over both banks of the river its boundaries should be altered so as to include sufficient of the Ashburton County to bring this about. It should not be necessary to absorb more of the Ashburton County than the first row of sections bordering the river. It must be quite clearly understood that no river rates should be levied on these sections unless some work was done from which they would benefit. Legislation may not be necessary to bring this about, provided there is no opposition from the people who would be affected by the change of boundaries.

Legislation should be enacted laying it down distinctly that no other organization shall have any control over the river, or shall have power to construct any works within its boundaries, and which might be likely to affect its flow, unless the works have been approved by the Geraldine County Council acting in its capacity as the River Board.

- (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.*

As indicated under reference (5) (c), your Commissioners are of opinion that the Geraldine County Council should be constituted a River Board, and in that capacity should have sole control over the whole of the river and its banks.

Your Commissioners further recommend that the duties of the Geraldine County Council, as the controlling authority with respect to the river, should be clearly set out as follows:—

- (1.) To keep a record of all damage done in its district by flood-waters.
- (2.) 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.
- (3.) To have detail surveys, plans, estimates, and specifications made for carrying out the necessary protective works in the district.
- (4.) To forward annually a statement of works, with plans, to the Minister of Public Works, Wellington, for reference and record.

This our report, which has been unanimously adopted, we have the honour to submit for the consideration of Your Excellency, together with the transcript of the evidence taken by us in the course of our investigations.

Given under our hands and seals this 31st day of July, 1920.

F. W. FURKERT, Chairman.

ASHLEY JNO. HUNTER, } Members of
F. C. HAY, } Commission.

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