1920.

NEW ZEALAND.

WAIHOU 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,—

The task entrusted to us is governed by the following terms of reference :—

Reference.

(1.) To inquire into the best means of controlling the Waihou River below the Ngahina Bridge so as to mitigate or prevent, either partially or entirely, the flooding of adjacent lands.

(2.) To report on the schemes which have been devised by the Public Works Department to prevent such flooding.

(3.) To report on any other matters which may be brought before you in connection with the questions referred to and which in your opinion have any bearing on these premises.

Your Commissioners' investigations have been completed and all available data collected, and they have now the honour to submit to Your Excellency the result of their work and the conclusions they have arrived at regarding the matters referred to them.

INVESTIGATIONS.

Sitting at Paeroa.—The Commission, having publicly advertised the holding of the inquiry, sat at Paeroa on the 29th and 30th September, 1919, and took evidence on oath from the following sixteen witnesses: M. H. Wynyard, representing Auckland Chamber of Commerce; Isaac Robertson, secretary Hikutaia Farmers' Union, Hikutaia; H. Morrison, farmer, Hikutaia; S. Loughlin (settler on river-bank), Paeroa; J. Dunlop (owner of Sections 6A and 6B), Komata North; D. Courtenay (settler on river-bank near Komata Creek), Hikutaia; A. Vowels (farmer

at Waimarie Bend), Netherton; R. B. Dunlop (owner of portion of Waihou West 1B); W. J. Thomas (settler on river-bank), Hikutaia; R. Stock (farmer at Ngahina on river-bank), Paeroa; S. C. Weston (settler, western bank, Waihou), Paeroa; W. H. Gavin, Inspecting Engineer, Public Works Department; G. T. Murray, District Engineer, Public Works Department; Captain Freeman, s.s. "Taniwha"; P. R. Hubbard, settler, Paeroa; D. C. Potts, agent Northern Steamship Company, Paeroa.

A precis of the local and Public Works officials' evidence is attached (Appendix A).

Mr. E. W. Porritt, solicitor, represented the Thames Valley Drainage Reference Board.

Mr. T. A. Moresby, solicitor, represented the settlers living on the river-bank whose interests are affected by the river-works, and the Ohinemuri County Council.

Mr. L. E. Cassrells, secretary of the Thames Valley Drainage Reference Board, attended the Commission.

Mr. Jackson, of Waihi, attended the Commission, representing the Waihi Borough Council, but withdrew as soon as it became clear that the question of finance did not come within the Commission's order of reference.

On the 9th and 14th October respectively the evidence of Messrs. C. R. Vickerman and William Ferguson, members of the Waihou and Ohinemuri Rivers Commission, 1910, was taken in Wellington, and is attached hereto (Appendices B and C).

The representatives of the Thames Valley Drainage Reference Board asked to be supplied with the data on which the Public Works Department had computed the flood-discharges of 1910, in order that they might have the same reviewed by an engineer of their own selection to ascertain whether he agreed with the values computed by the Department. The Commission obtained the information from the Department and supplied it accordingly, but up to date no results of the outside engineer's investigations have been communicated to the Commission, although they have been asked for.

Inspection of River and Works.—On the afternoon of the 30th September and the whole of the 1st October the Commissioners inspected—(*a*) The lower Waihou, between Ngahina and Hikutaia, and adjacent lands; (*b*) the upper Waihou, from Tirohia to Ngahina, and the construction-works in progress; (*c*) the Ohinemuri River, from Paeroa to Waihi, visiting the Public Works gauging-stations and investigating the physical characteristics of the river and its drainage area.

Consideration of Problem.—On the 2nd October the Commission proceeded to Auckland, and there made preliminary investigations and calculations of flood-discharge from the data so far obtained. On the 29th October the Commission met in Wellington, and went exhaustively into the engineering problems involved, making estimates and designs of works to control floods of varying magnitude, valuations of the flood risks, and study of the economics of the question of flood-prevention.

All available data bearing on the subject in the possession of the Public Works Department, secured as a result of work done under the Waihou and Ohinemuri Rivers Improvement Act, 1910, or from field observations, was obtained, existing plans inspected, proposed Public Works schemes analysed in regard to cost and design, and new plans illustrative of the Commission's findings and recommendations compiled.

Previous Commission.—The Commissioners had before them the evidence given in 1910 before the Waihou and Ohinemuri Rivers Commission, as well as the various departmental reports, &c., bearing on the subject of their Commission.

Plans and Data supplied by Public Works Department.—Plans and data were supplied by the Public Works Department, enabling the Commissioners to arrive at independent estimates of the maximum flood-discharge and the discharging-capacity of the lower Waihou in its present condition, and also the improved discharging-capacity as the result of suggested improvements by dredging and stop-banking.

The Commission regrets that its investigations were rendered difficult, and of less value than they might have been, by the absence of much data which should have been available. Your Commissioners wish to stress very forcibly the necessity

for all possible data as to floods, such as heights, velocities, and duration at various gauging-stations on the river, being recorded in a concise and systematic manner as they occur. The value of this work, if carefully done, would be enormous, not only in connection with the Waihou and Ohinemuri Rivers improvement, but in connection with every other river-control problem in the Dominion. The results obtained by the recording-gauges now installed will be very valuable in the future, and had they been installed ten years ago works could now be designed with very much greater confidence. The results of the work on the rivers must be carefully watched as the works proceed, in order that any unforeseen effects which may require a modification of the first design may be promptly and intelligently provided against. Records of damage done by floods, expressed in pounds shillings and pence if possible, should also be collected, so that the value of protection may be assessed.

Rainfall Records.—The Meteorological Department supplied the Commission with particulars of the rainfall during all the large storms which have occurred during the past twenty years. These are interesting as showing by how much the intensity of the storm of March, 1910, exceeded that of all other storms in the series. A graphic representation of these average intensities is attached (Appendix D).

Value of Lands affected by Floods.—No information is available as to the value of lands so affected, and the Commission has had to sift the evidence given before the 1910 Commission in order to arrive at the fair average value of the lands affected.

Damage caused by Big Floods.—No fresh evidence has been adduced with respect to this, and the Commissioners rely on the evidence given before the 1910 Commission in arriving at an average value for same.

Economic Aspect of Remedial Measures.

Your Commissioners very carefully went into the economic side of the question, and came to the conclusion that the amount of money which might with justice be expended on a scheme to keep floods off the areas affected by the Waihou below Ngahina is strictly limited, otherwise the annual charges due to interest and sinking fund on the cost of and maintenance of the flood-control works would exceed the monetary damage due to floods divided by the number of years between floods, or would exceed the monetary benefits which might be derived on account of immunity from such floods.

The paucity of the information as to areas affected, the present and probable improved values of same, the cost of drainage and improvements required (exclusive of flood-control works), and the actual extent of the damage caused by floods, either small or large, render any definite conclusion as to the justifiable expenditure extremely difficult.

Your Commissioners sifted all available data, and from their own inspection formed the opinion that adequate works, as recommended below, to control the largest flood likely to be experienced within a period of fifty years can be constructed at a cost not in excess of what the land can reasonably carry.

From all the available data your Commissioners calculated the volume of waters in floods which had been recorded in the past. It is found that the flow in the Ohinemuri River at the peak of the 1910 flood was not less than 30,000 cubic feet per second, while that of the Waihou in flood is probably, at its maximum, 12,000 cubic feet per second. The peaks of the floods would not occur simultaneously in both rivers. In calculations of this kind it is impossible to guarantee results within 10 per cent. either way, and for the Waihou the character of the channel is such as to make a determination more difficult than usual. For the Ohinemuri the data was more precise, and the results therefore ditto. The results of your Commissioners' investigations accord with the results obtained by the Public Works Department within the usual limits of such problems. This probably represents the greatest flood that need be expected for fifty years. If one-hundred-year periods are to be considered, then floods of about 10 per cent. additional are likely.

From the fact that the greater the flood the less frequently does it occur, it follows that the annual risk of damage is relatively less for big floods at long intervals than for smaller floods at frequent intervals, even taking into consideration the fact that the damage done by the big flood may be several times that done by smaller floods.

Your Commissioners hold the view that, whatever the character of the ultimate works, partial protection—viz., protection against medium floods—should be provided as early as possible, especially as this can generally be done without unduly, if at all, increasing the ultimate cost of any complete scheme for dealing with larger floods. Absolute immunity from *all risk* of damage by floods is not obtainable.

Existing Remedial Works above Ngahina.

Although not included in the order of reference, a brief review of these works is necessary as bearing upon the lower Waihou below Ngahina. Previous to the erection of the stop-banks on the west or left bank of the upper Waihou above Ngahina a considerable portion of the flood-water from big floods, such as that of 1910, overflowed the left bank and found its way across country, rejoining the Waihou River lower down, about five or six miles below Ngahina. When the left river-bank above Ngahina has been effectively stop-banked (work approaching completion) it is obvious that in the event of another big flood the whole of the flood-discharge will be by way of Ngahina, and that consequently the settlers for about six miles below Ngahina, and also those in the direction of Hikutaia, will be in a worse position as regards flooding than they were previous to the construction of the works above Ngahina. The value of their lands must therefore continue to be further depreciated until such time as more or less adequate protection is afforded them.

Physical Character.

For some distance below the Ngahina Bridge the present channel, without overflowing its banks, would not accommodate more than 25 per cent. of the maximum flood-discharge, and for some twelve miles has only about 50 per cent. of the required discharging-capacity. This capacity can be increased in three ways: (1) By dredging the channel until its cross-sectional area multiplied by the velocity equals the desired discharge; (2) by building levees to enclose the flood-waters, thereby increasing the height of the floods and consequently the cross-sectional area until it is adequate; (3) by a combination of the above methods, striving to balance the amount of material dredged with that required for the levees. The levees may be placed close to the existing banks, thus necessitating the greater raising of the floods, or may be placed some distance back, thus involving less disturbance of the natural conditions by raising the flood levels. In this connection it must be remembered that the value of the waterway over the berms is small as compared with the deep water in the main channel, while it involves interference with large areas of the best land. In common with most rivers running through alluvial lands, the best land is immediately along the banks.

Under the provisions of the Waihou and Ohinemuri Rivers Improvement Act, 1910, the betterment principle operates in such a way that the riparian owners have to bear all the loss of land without adequate payment, while those more remote from the river whose physical betterment is greater (generally much greater) obtain this without any loss of land.

Navigation.

The Commission is of opinion that the improvement of the river from the sea to Paeroa to give 5 ft. minimum depth at low water, and the proper maintenance of the channel to this depth, is of supreme importance not only to the lands between Ngahina and the sea, but also to the whole district; and, as the country grows in value and becomes more thickly populated, the river, interconnected by canals with the Piako and other rivers, as a highway for internal communication and for the export and import trade of the district will become much more valuable. No scheme for river-control below Ngahina should be entertained which does not contain as an integral feature the development and improvement of the river for navigation.

The evidence and their own investigations have convinced your Commissioners that they are justified in stressing the question of navigation, even though it is not specially mentioned in the order of reference.

Reference No. 1.

To inquire into the best means of controlling the Waihou River below the Ngahina Bridge so as to mitigate or prevent, either partially or entirely, the flooding of adjacent lands.

After full consideration your Commissioners conclude that a combination of dredging and stop-banking will be most advantageous. The Commission advocates placing the stop-banks within approximately 2 chains of the river-bank. This distance may be less in places, but must be sufficient to enable material to be excavated and the bank built to the ultimate dimension. The works should be constructed in stages, as below :—

Stage 1 : Very temporary stop-banks with natural batters approximately 1½ to 1 and a top width of 4 ft. should be constructed on both sides of the river from borrow-pits along the river-side of the proposed final levees. These would give temporary partial protection at the earliest possible date ; the banks so formed would be part of the final banks, and would serve to retain the dredgings by which these latter would be made. At the same time their cross-section would be such that there would be no chance of the impression getting abroad that it was a finished work. The temporary bank would be graded from a top level of 108·25 at Ngahina Bridge to a top level of 100·00 at a point twelve miles below. These levels are in terms of the Ngahina Bridge datum—B.M. 30 on left bank of river 2 chains above bridge, 1½ chains from bank, reduced level 102·14. The banks should be aligned as shown approximately on plan numbered (1) herewith, the distance apart of the two stop-banks being about 440 ft. just below Ngahina Wharf, and gradually diverging down-stream. The minor irregularities of the natural bank would not be followed.

The present bridge at Ngahina, particularly the central pier of the swing span, offers such an obstruction to the flow of the water that it would not be possible to bring in the banks to the spacing of 440 ft. recommended until a short distance below the new Ngahina Wharf. Unless ample width of waterway is allowed at this bridge by considerably lengthening the present structure a further raising of the flood level of the river above Ngahina cannot be avoided.

Culverts with flood-gates must be provided where necessary to deal with the drainage of adjacent lands. Pending the final construction of the stop-banks to their ultimate heights, widths, and slopes these sluice-boxes or culverts may be of a temporary character, and constructed of timber at a small cost. If no delay to the rapid construction of the temporary banks will thereby be occasioned these culverts and gates could be built of a reduced length, but of full cross-section and of permanent material. If, however, any delay is likely, then they should be built in a temporary manner as above.

As the whole essence of your Commissioners' recommendations is the provision of rapid temporary protection, all available ploughs and scoops should be started at the down-stream end on the low banks, and two small (18-ton) steam shovels of 50-cubic-yards-per-hour capacity and with a working radius of 25 ft. should be ordered at once by cable, and on arrival should be started at the Ngahina end, working down-stream to meet the scoop gangs. These steam shovels should have traction wheels or caterpillars ; otherwise they should be similar to those now successfully being used on railway-construction. When their work at Waihou is done they should be good value for transfer to other construction-works.

The work indicated above, provided the steam shovels are delivered within six months, should eas ly be completed in two years. These banks would give fair protection against floods not exceeding 20,000 cubic feet per second, but would not be of nearly sufficient strength to be secure against breaching in places, even if not actually overtopped.

The witnesses who appeared before the Commission expressed their readiness to give, free of cost, the land for the stop-banks if these were placed as suggested herein, and your Commissioners consider that it would not be unreasonable to expect all the riparian owners to do likewise.

The original owners should be given grazing-rights and access to the river, but should not be permitted to plant trees or erect anything which might obstruct the flood-waters. Nothing but the very lightest of boundary-fences should be allowed.

Stage 2: As soon as the temporary work indicated above is completed, or simultaneously with its construction (if this can be done without the chance of any delay to the temporary work), the raising of the banks to the permanent levels and dimensions could be put in hand. The permanent levels are as follows: Top level at Ngahina 112·00, and top level at a point thirteen miles below Ngahina Bridge 100·00. This work should be done by dredging from the present river-bed as uniformly as possible in such a way as to increase the central depth without unnecessarily widening the channel. This is indicated on the cross-section herewith. The dredged material should be deposited at the back of the temporary banks by hydraulic filling, and carried to the heights and slopes necessary to form the ultimate stop-banks. As a large amount of material has to be dredged, no economy would result from skimping the cross-section of the bank. If constructed with a top width of 20 ft. and side batters of 3 to 1, the material required for them will practically balance the amount to be moved by the dredges. Where, owing to the amplitude of the present cross-section of the river, less dredging is required, the banks might be reduced to 8 ft. on top, with the same batters. In order that the work of erecting the final banks should be completed within a reasonable time two pump dredges should be obtained and worked continuously from the Ngahina end. Before commencing the continuous dredging-work referred to one or both of the dredges should be employed for a short time, and at as early a date as possible, in deepening the worst of the shoals which exist at the present time, more especially just below Ngahina Bridge, and at points seven, eleven, and fifteen miles below the bridge. This work is not in the interests of navigation only, because these shoals are obstacles to the free flow of flood-waters, and if they are removed and an approximately even bottom grade of the river thus obtained a great deal more natural detritus and mining tailings will be carried to sea than is now the case.

In addition to the benefit which the dredging will afford to navigation and flood-discharge, there is another aspect which, although not coming under the head of flood-discharge, is a matter of vital importance to the district—that is, the necessity for maintaining an adequate low-water-discharge level for land-drainage. If by reason of shoals or otherwise the low-water level rises to such an extent that an adequate outfall cannot be obtained for the purpose of draining the land, then the value of the flood-protection works would be practically negligible. Evidence was given that shoaling had already caused a rising of the low-water level which was perceptible in the past ten years.

As the main dredging proceeds, the permanent culverts and flood-gates should be installed ahead of the work, if not done under the preliminary stage, and all regrading of roads necessary to give crossings over the stop-banks, &c., should be done as much as possible with the dredged material. Although the Commission's order of reference does not touch on the drainage-works and the floods in the tributaries of the river below Ngahina Bridge, it will be necessary to deal with these questions as the final work proceeds down-stream.

Temporary stop-banks as recommended for the main river should be carried up the sides of Komata and Hikutaia Creeks as far as may be necessary to prevent flood-waters backing over the land through the openings presented by the outlets of these streams.

As the permanent river levees are raised, the same should be done with the temporary banks along these streams; but this work could probably best be done with ploughs and scoops or the small steam shovels previously referred to. The material to be used being entirely different from the loose river-sand, these banks would be adequate if built with a width of 5 ft. on top and side slopes of 2 to 1.

It may be argued that the cross-sectional area obtained by the dredging referred to will fill up with natural detritus and tailings coming down the river, but your Commissioners consider that the regrading of the river to an even grade, and the confining of the flood-waters to a regular width, combined with the deeper midstream channel obtained, will so improve the transporting-power of the river

that any filling up, if it should occur as has been suggested, will be very long delayed, and may be coped with by a moderate amount of dredging from time to time as conditions appear to dictate.

The future maintenance dredging thereby required will not, in our opinion, nearly approach in expense the interest and sinking fund on the cost of the works and land taken, which would be necessary if the whole of the flood cross-sectional area were to be obtained by high levees placed a long way back from the river-bank, as suggested under the Public Works Department's scheme. It is possible that the improved tidal scour may be such that no further dredging will be required.

Reference No. 2.

To report on the schemes which have been devised by the Public Works Department to prevent such flooding.

The schemes devised by the Public Works Department may be considered as of a twofold character: firstly, the original scheme to deal with a flood at least as great as that which occurred in 1910, with a reasonable factor of safety; and, secondly, one to deal with a flood approximately of half that magnitude.

Scheme 1: This scheme depends almost entirely upon levee-building, raising the flood level to such a height up-stream as would considerably increase the flood grade, and therefore the velocity, and enable the floods to be safely passed. Provision for ample freeboard was made, and the additional cross-sectional area in the channel due to the dredging out of the material for the stop-banks was not considered as available to any great extent for the discharge of flood-waters. In order to obtain the necessary cross-sectional area without unduly raising the flood heights the levees were to be placed a very considerable distance from the natural banks of the river, and the land on which these banks were to be placed was to be taken from those at present holding it. All the land between the stop-banks and the river was to be also acquired, the compensation to be paid being assessed in accordance with the Waihou and Ohinemuri Rivers Improvement Act, 1910. All the necessary outlets for side drainage and banking of tributary streams were provided for.

Your Commissioners are satisfied that if the works as indicated were carried out the district would be safe from a flood of the same magnitude as that of 1910, and, so long as they were maintained continuously with the freeboard provided in the scheme, they would be adequate for a very considerably greater flood. Your Commissioners consider that the Department was not justified in assuming that no appreciable advantage could be reckoned on from the dredging, and that to obtain all the cross-sectional area necessary by banking, instead of by a judicious combination of dredging and banking, was not the most economical proposal. Particularly was this latter the case as it necessitated setting back the levees so far from the natural banks of the river to avoid excessive raising of the flood level. Taking all the land between the river-bank and these widely placed stop-banks involves a hardship to the riparian owners which your Commissioners consider is not justified. If the provisions of the law at present are such that the riparian owners may receive practically no money in exchange for the land taken from them, and any compensation due to them is to be offset largely or wholly by betterment in which many others share, then the law should be amended. A great many of the subsidiary works which will require to be carried out in connection with the drainage of the adjoining land are included in the Public Works Department's schemes, but as they do not come within the Commission's order of reference your Commissioners have nothing to say in respect of them, except that there is no reason to suppose they are other than adequate.

Where your Commissioners particularly criticize this major scheme is that it does not provide any appreciable protection to the lands affected until it is practically finished, and its magnitude is such that it would take a great many years to complete; also it is too costly, the Department's estimate being £308,160.

Your Commissioners obtained no definite information as to the length of time within which the Department propose to complete the works, but they judge from the progress in the past that the completion of the work will involve a length of time which it would not be reasonable to expect the landowners to wait.

Scheme 2: With regard to the modified scheme for dealing with partial floods, this is open to the same criticism as the major scheme as regards the position of the levees. Your Commissioners do not consider that the stop-banks should enclose a large area of valuable land, even though the drawing-in of the levees close to the banks may necessitate slightly higher and consequently more expensive banks.

Your Commissioners further criticize the modified scheme in that, as far as can be ascertained by them, there was no intention to concentrate on an effort to obtain a through connection with a temporary bank of small size; also it is unnecessarily costly for a partial scheme—estimate, £128,730.

Generally, the Commission is of opinion that the importance of navigation, and the inseparable way in which it is bound up with the other river-improvement works, has not been sufficiently appreciated by the Department; neither has the necessity for a low-water river-level for drainage purposes been entirely recognized.

REFERENCE NO. 3.

To report on any other matters which may be brought before you in connection with the questions referred to, and which in your opinion have any bearing on these premises.

The question of the importance of navigation and its intimate connection with the flood-protection works has already been stressed in this report. Your Commissioners can only reiterate that no scheme can be considered satisfactory which does not, simultaneously with providing protection from floods, also contemplate the improvement of the river for navigation.

The importance of drainage to the low-lying land along the Waihou is such that every endeavour must be made to keep the low-water level as low as possible. In other words, aggradation of the river-bottom must be prevented. Suitable works to improve navigation can be made also to improve drainage and assist flood-discharge. Maintenance dredging may be necessary, but its magnitude cannot be forecasted.

Your Commissioners consider that the betterment principle as laid down by the Waihou and Ohinemuri Rivers Improvement Act, 1910, is inequitable and should be amended, it bearing unjustly on the riparian owners.

The works recommended by your Commissioners will not be effective unless the works on the Waihou and Ohinemuri Rivers above Ngahina are completed simultaneously in accordance with stage 1 and stage 2 of our recommended programme of works.

This our report, which has been unanimously adopted, we have the honour to respectfully submit for the consideration of Your Excellency, together with the appendices and the plans illustrating the works recommended by us, enumerated below:—

Appendix A: Precis of evidence given by local witnesses and Public Works officials.

Appendix B: Letter from Mr. C. R. Vickerman, member of Waihou and Ohinemuri Rivers Commission, 1910. (9th October, 1919.)

Appendix C: Notes of interview with Mr. William Ferguson, Chairman of Waihou and Ohinemuri Rivers Commission, 1910. (14th October, 1910.)

Appendix D: Graph showing the relative intensity of storms during past twenty years.

Plan No. 1: Waihou River below Ngahina. [Not printed.]

Plan No. 2: Longitudinal section, lower Waihou River. [Not printed.]

Plan No. 3: Typical cross-sections. [Not printed.]

Your Commissioners also have the honour to return herewith Your Excellency's Commission.

Given under our hands and seals, this 5th day of December, 1919.

F. W. FURKERT, Chairman.
ASHLEY J. HUNTER,
F. C. HAY, } Commissioners.

APPENDICES.

APPENDIX A.

PRECIS OF EVIDENCE GIVEN BY LOCAL WITNESSES AND PUBLIC WORKS OFFICIALS.

(i.) *Evidence of Local Witnesses.*

Public Works scheme :—

Stop-banks too far apart, and of too liberal a cross-section, necessitating the taking of a large area of valuable land, shifting buildings adjoining the river, and making the scheme excessively costly.

Policy of Public Works Department :—

Stressing the fact that the Department has not taken them into its confidence as to the necessity for increasing the works above those recommended by the 1910 Commission, and is apparently altogether overlooking the question of improving the river for navigation.

Objecting to the alteration of the original scheme to one costing half a million pounds.

1910 Act :—

Perfectly satisfied if the proposals of the 1910 Commission were carried out as per Act.

Dredging ; navigation :—

Stressing the importance of dredging the river for navigation purposes, the river being a most important highway, and essential to be kept as such, for the proper development of what will ultimately become a rich and productive country. Evidence that the river is silting up in parts and hindering navigation.

Public Works scheme :—

Apprehensive that the Public Works Department do not contemplate dredging or improvement of the river for navigation in their scheme.

Freight data :—

Schedule of tonnage and freights on water-borne goods, Auckland to Paeroa, supplied to Commission.

Land to be taken ; betterment :—

Strenuously opposed to the taking of their river frontages, and to the values offered them for their land, and to the assessment of the betterment in arriving at the price offered, and to the fact that no consideration is given them for severance or for the reduction of their holdings from areas on which a living is possible to areas so greatly reduced that they are insufficient to provide a livelihood.

Land valuation and assessment : betterment :—

Pointing out that the valuation of the betterment is difficult, and that it is settled by the Public Works Land Purchase Officer without the settlers' interests being sufficiently considered.

Betterment :—

Pointing out that the betterment principle applies to all lands protected from floods, but to a greater extent to the low-lying lands away from the river-bank not required for the scheme ; that when an owner of valuable river lands has a large portion of his river frontage taken, and has the betterment principle applied to reduce the purchase price, he is in an infinitely worse position than the owners of the swamp lands behind him. The incidence of the betterment bears with undue severity on the riparian owner.

Pointing out that the riparian owner has also to bear his share of the interest, upkeep, &c., of the works.

Pointing out that no silt has been deposited on river-banks during last twelve years.

Local ideas :—

Suggesting (Wynyard) that stop-banks 9 ft. wide on top, built of solid material, can be built for 6d. per cubic yard with suitable machinery, or £1,000 per mile.

Suggesting that light stop-banks below Ngahina, 6 ft. above flood level, be built at once—to be increased when ready to dredge the river.

Suggesting not necessary to take the land, nor to erect stop-banks more than 1½ chains from river-bank.

Expressing willingness to give easements up to 1½ chains back from river-bank, and not build obstructions on berms other than light boundary-fences.

Willingness to give land free if stop-banks put in close.

From Hikutaia Farmers' Union : If stop-banks 4 ft.–6 ft. above highest flood erected and immediate dredging Waihou from mouth to Ngahina Wharf carried out, will indemnify the Government against any loss through overflooding. Also will urge the formation of River Board, as provided for in Act, to expedite completion of works.

Flood data :—

Asking that readings and data obtained by Public Works Department be submitted to Drainage Reference Board Engineer to check flood-discharge. Undertake to get an engineer at once if data supplied.

(ii.) *Precis of Evidence given by Public Works Officials.*

The evidence of the Public Works officials was to the effect that a flood of 29,000 cusecs was that estimated for the Ohinemuri River in 1910, and that on that basis the works were designed. They estimated the flow in the Waihou above the junction at 18,000 cusecs, though it was admitted that any definite measurement of this river was extremely difficult. The value of n in Kutter's formula had been determined at 0·037 by measurements of the slope, cross-section, and velocity as obtained by current-meter readings. In designing the works it had been assumed that a flood of half the maximum might occur in the Waihou simultaneously with the 29,000 cusecs flood recorded for the Ohinemuri. This gave 38,000 cusecs to be dealt with at Ngahina Bridge, and with the advent of Komata Creek 39,000 cusecs below its junction. The stop-banking was designed on the assumption that any dredging done in the river-bed would not be reckoned as available cross-section for flood-discharge. Originally a scheme was devised with levees approximately 1,000 ft. apart, and of a height and cross-section adequate to contain a flood-flow increasing from 38,000 at Ngahina Bridge to 40,000 at Hikutaia. Later, when the local residents ascertained the magnitude and character of the works, they asked that something less ambitious should be designed, and accordingly a scheme to deal with approximately 20,000 cusecs below Ngahina was formulated. No credit was taken, however, for the value of the dredged cross-section in the modified scheme. In other words, the cross-sectional area necessary to discharge 20,000 cusecs was computed above the existing river-bottom, except in one or two places where the channel is specially constricted. Information was also supplied as to the cost per cubic yard of the works which have been done up to the present.

APPENDIX B.

LETTER FROM MR. C. R. VICKERMAN, MEMBER OF WAIHOU AND OHINEMURI RIVERS COMMISSION, 1910.

SIR,— 6 Central Terrace, Kelburn, Wellington, 9th October, 1919.

In reply to your letter of the 8th October: The evidence submitted to the Commission of 1910 on Waihou and Ohinemuri Rivers *re* silting is to be found in C.–14 papers, and the exhibits were handed over at the time the Commission reported, which is now nine years ago. Mr. William Ferguson, of Wellington, was Chairman, and there were three other Commissioners, of whom I was one.

I do not know what became of the notes I took. However, the evidence submitted was not so much regarding the height of the floods as the damage done by the silt deposited, and the idea was to confine the river to a dredged-out and thus deepened channel, and to increase the speed so as to make it carry the finer ground tailings right out to sea, and so get rid of them, and at the same time prevent the valuable lands on the Waihou River or Thames Valley being damaged by further deposits of tailings.

As far as I remember, none of the engineers who gave evidence submitted cross-sectional areas with a view of determining the water that went down, but only to show how much the deposit of tailings had reduced these areas, and that is why in that stop-bank clause you refer to it was specially mentioned not less than 95 ft. clear from the old bank, before these deposits narrowed it.

If you refer to page 359 of evidence you will get Mr. F. R. W. Daw's measurements of the river he got in the Ohinemuri at Karangahake in 1904. (He was starting work at the Crown Battery then.) But that would not give you the height of the water in flood of 1910, when about 12 in. of rain fell at Waihi in about the same number of hours.

That Commission of 1910 had to take just what evidence was available from local people, as it only sat from 17th May to 10th June.

Neither river is very wide till after they junction, and then not till some distance down, the width being necessary more for the tidal than for the fresh waters. Till the silt began to settle in the Waihou below the junction, the action of steamers tendered to widen the channel; but about the time of the 1910 Commission the Ohinemuri had pretty well risen its bed to low-water level, and all the old deep holes– some 20 ft. deep or more– existing previously had been filled in, as well as the cross-section of the banks much added to; and the same began to take place in the Waihou and caused the outcry.

The great difficulty is that a big tide runs in right up to the junction, and if a north-to-west gale and spring tide occur with heavy rain you get an abnormal amount of water to contend with. That is why the Commission adopted 4 ft. high above the highest known flood level; of course, meaning to so raise the banks that the fresh flood-water would still continue running out at highest tides, which it does not do now.

The 95 ft. back from the old bank to the river side of the stop-bank was stated as the least additional width allowable anywhere, whilst in certain places it was likely that greater width might be wanted. But this was stated to meet individuals who wanted the stop-banks put right at the old bank site, and we wanted them to understand that this could not be done at all.

You will get the speed of the river from Mr. Adams's evidence, page 147—see particularly top page 150. He also makes out ten times more water in the Waihou (where the tide is) than in the Ohinemuri. I do not know that there is much to help you that you can rely on.

After our Mr. Young was put on he was supposed to get the flood cross-section for the Ngararahi cut on the Waihou, and to fix his cross-section of new channel and stop-banks to suit this. It always appeared to me that he had got unduly wide, but it was a good fault there, as it serves as an expansion basin, where the tidal and fresh waters meet and adjust themselves. When you get down below Waimarie bend the great width of the tidal river should easily take the flood-water if it is banked up 4 ft. above the present highest flood level, and I do not think you will find much wrong with the 95 ft. back there. It is only higher up that it may be a little close, but as I point out it was not a final width but the least allowance anywhere.

I think you had better satisfy yourselves on the points you ask, as no survey was actually made then to determine details, and it is so long ago too. It depends a good deal, too, on the depth you can get by dredging, and whether it will maintain that depth without excessive expense.

Of course, like all New Zealand Rivers running through low land and bush, both these rivers have built up their banks higher than the back land, and so any stop-bank put up must be fit to hold the water up safely—the Ohinemuri particularly so.

There is going to be a difficulty—at least I thought so—in depositing the dredgings in the proper form of a stop-bank from the 12 in. pumping main, and this perhaps influenced us in suggesting only keeping 95 ft. back, or I think it was a chain and a half and by some means converted into 95 ft.

Of course, too, the estimate was got up on a general knowledge of the river more than on proper actual surveys and levels, and the price of things at that time was quite one-third to one-half less than at present, so you cannot expect after all these years of slow progress and consequently maintenance to finish the work for anything like the estimate.

I meant to have noted before—you seldom get a flood in both rivers at the same time. Waihi floods in easterly weather, which the main range cuts off from the Waihou, and the latter in north-westerly and westerly.

Yours faithfully,

CHAS. R. VICKERMAN.

F. W. Furkert, Esq., Chairman, Waihou Rivers Commission, 1919, Wellington.

APPENDIX C.

NOTES OF INTERVIEW WITH MR. WILLIAM FERGUSON, CHAIRMAN OF WAIHOU AND OHINEMURI RIVERS COMMISSION, 1910.

Wellington, 14th October, 1919.

THE gist of Mr. Ferguson's statement was to the following effect :—

Commission, 1910, recommended that Pereniki cut be made in Ohinemuri River.

Regarding position of stop-banks, the distance back from the river-edge of 95 ft. was intended to be a minimum set-back above Ngahina.

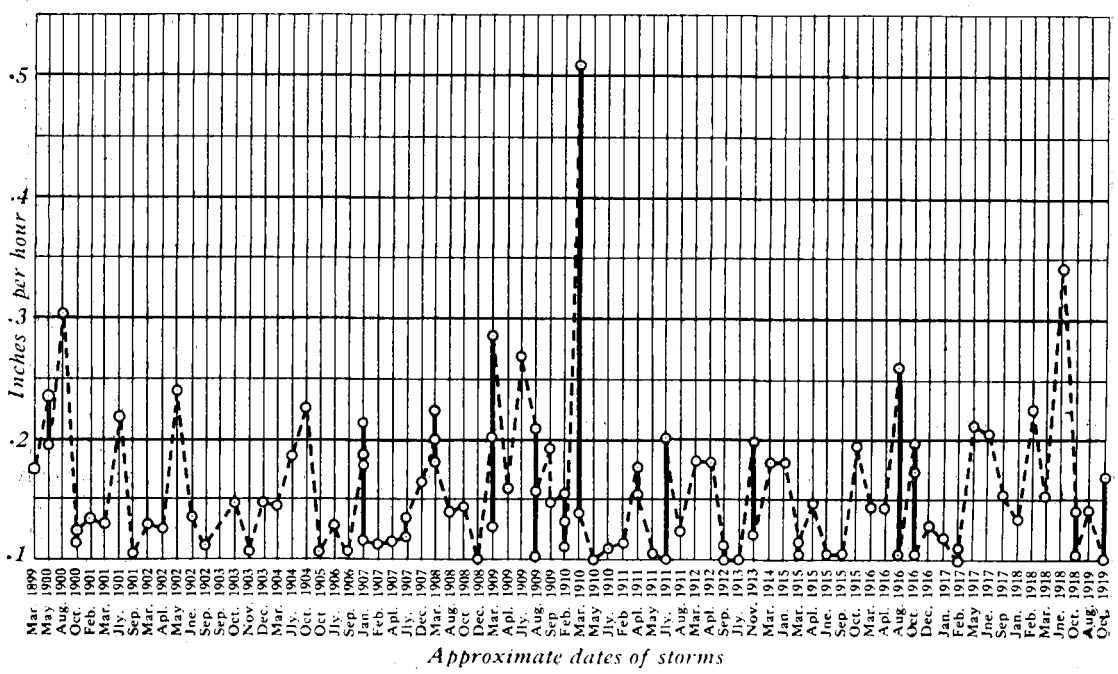
The 1910 Commission had no data available on which to form a definite engineering scheme, and its recommendations were general in character only.

The 1910 Commission was fully alive to the value of the river for navigation purposes, but the Commission dealt principally with the question of silting as the result of mining operations.

Mr. Ferguson deems it to be unnecessary to resume large areas of the river frontage.

APPENDIX D.

GRAPH SHOWING THE RELATIVE INTENSITY OF STORMS DURING PAST TWENTY YEARS.



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