SESSION II.
1921.
NEW ZEALAND.

AUCKLAND CANALS AND INLAND WATERWAYS COMMISSION.

(REPORT OF THE).

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

REPORT.

To His Excellency the Governor-General of the Dominion of New Zealand and its Dependencies.

MAY IT PLEASE YOUR EXCELLENCY,—

Your Excellency's Commission, dated 8th December, 1920, directed us to inquire into and report as to the establishment of a system of canals and inland waterways, and otherwise improving the means of transport, in the Auckland District, and with special reference to the following matters :—

(1.) What should be the route or routes of one or more canals ;
(2.) The dimensions of these canals and the class of vessels to navigate them ;
(3.) The character and quantity of probable traffic thereon and the revenue to be derived therefrom ;
(4.) The estimated cost of works considered necessary ;
(5.) The working-expenses of these canals, including maintenance, interest, and sinking fund ;
(6.) What effect the construction of a canal or canals will have upon the revenue of the Government railways ;
(7.) The contingent works necessary to enable the canals to be fully developed and used, such as roads, railways, wharves, and stores ;
(8.) As to the form of control or management of any such works as we might recommend ;
(9.) As to the finance, construction, and maintenance thereof ;
(10.) As to whether any concession should be granted by the General Government or local governing authorities ;
(11.) As to whether the adjacent districts should be subject to rating to provide a guarantee for loans which might be necessary to provide funds for construction purposes, and as to whether those districts should be rated to provide for losses in working ;
(12.) As to the effect which the construction of canals or the improvement of existing waterways from a traffic point of view may have upon the drainage of any existing swamp lands and on lands adjacent thereto ;

(13.) The improvement of the navigation of the Waikato River and its tributaries, the effect on such rivers and on the adjacent swamp lands of the improvement works proposed or already executed by the Waikato River Board, and generally as to the navigation of those rivers;

(14.) Whether a bridge should be constructed across Waitemata Harbour connect the City of Auckland with the northern districts;

and generally to inquire into and report upon such other matters as might come under our notice in the course of our inquiries, and which we considered required to be investigated in connection therewith.

Investigations.

Your Commissioners met in Wellington on the 4th and 5th March, and inspected the files and data that had been collected for them by the Secretary, Mr. A. E. Briggs, and interviewed some of the departmental Heads with a view to obtaining information as to the data available for the inquiry. The Commission held its first public meeting in Auckland on the 4th April, and spent the time between that day and the 5th May in taking evidence and in visiting various localities. Public meetings were held in Auckland, Mercer, Ngaruawahia, Hamilton, Pirongia, Cambridge, Waiuku, Helensville, and Onehunga, and, in addition, the Commission visited the routes of the suggested canals and works, and the navigable portions of the Waikato and its tributaries.

Evidence was tendered by 126 witnesses, but it was upon the whole incomplete and unsatisfactory, and it was clear that the interest in, and the enthusiasm for, the question of inland waterways on a large scale in the Auckland District that existed some years ago had greatly decreased. Beyond general statements as to the advantages to be gained by waterway communication, there were few or no statistics furnished (except in respect to part of the trade or suggested trade on the Waikato River) with the intent of proving that such schemes might be commercially successful. Promises to prepare and furnish statistics to the Commission were made, but have not been adequately fulfilled, and the motive underlying a great deal of the evidence given was undoubtedly (*a*) a desire to have public moneys spent in the various districts, irrespective of whether the schemes proposed were likely to be commercially successful or not, and (*b*) a feeling that if water communication existed the dealings of the Railway Department with the public might be placed on a different and more satisfactory footing through the passing-away of a monopoly of transit.

A copy of the evidence that was taken upon oath is attached hereto [not printed], but in addition there was necessarily a large amount of information obtained from individuals met by the members of the Commission in the course of the inquiry which could not be placed upon record. A list of the witnesses and of the places at which they gave evidence is prefixed to the evidence and forms an index thereto.

As the question of the navigation of the Waihou River had been dealt with and reported upon by a Royal Commission so recently as in December, 1920, we did not deem it to be necessary to sit at Thames or to deal in any way with that river.

The Commission restricted itself to inquiries as to proposed canals (*a*) between the Waitemata Harbour and the Kaipara Harbour at Helensville; (*b*) between the Waitemata and the Manukau Harbours by alternative routes known as the Whau and Tamaki routes; (*c*) between the Manukau Harbour and the River Waikato; (*d*) between the Waikato River and the Thames Gulf, through the Mangawara Creek and the Piako River. The Commission also inquired into the navigation and possible canalization or improvement of the Waikato River and its tributary creeks, and as to the effect of the works carried out by the Waikato River Board; also into the question of the connection of the northern and southern sides of the Waitemata Harbour by means of a bridge.

The Commission met finally in Wellington from the 10th August to the 15th idem to take further evidence and to consider the detailed investigations of a technical character that had been made by the two engineering members of the Commission, and to consider the terms of the report.

Waitemata–Kaipara (Helensville) Canal.

The Auckland Harbour Board, in the years 1914 and 1915, had surveys and sections made under the supervision of Mr. W. H. Hamer, M.Inst.C.E., and the plans and sections, having come into the possession of the Government, were available to the Commission. They are recorded as M.D. 4452 and 4453 respectively, and give particulars of the country that would be met with in carrying a canal from deep water at Mount Rex, on the Kaipara River, past Helensville and up the valley of that river, but providing for the straightening thereof by the replacement by easy curves of its present winding bed and of that of its upper portion known as the Kumeu River. The survey gave four alternative routes across the saddle lying between the Kaipara and deep water in the Waitemata. The shortest route crosses a ridge 274 ft. above the datum (Auckland dock-sill), and leads into the Waitemata near Riverhead. The route apparently favoured by Mr. Hamar as the most satisfactory leaves the bed of the Kumeu River near the Government railway-station of that name, and, crossing the saddle at a height of 135 ft. above datum, reaches the Waitemata at a creek half-way between Riverhead and Brigham's Creek. Two other routes were surveyed and particulars shown on the plans and sections, crossing the saddle at heights respectively of 169 ft. and 173 ft. above the datum.

It has been suggested that the canal might be either (*a*) large enough to take steamers of not less than the class now trading between Helensville and Dargaville and the Wairoa, or (*b*) of a size to take barges that could be safely and comfortably navigated across the Kaipara Harbour, where exposed at the entrance, or, in the Waitemata, to the Auckland wharves. In the first case the total length of the canal from deep water at Mount Rex, in the Kaipara, to deep water near Greenhithe, in the Waitemata, would be more than 21 miles, though in the second case it would be shorter, depending upon the draught of vessel provided for and the extent to which the bends in the beds of the Kaipara and Kumeu Rivers were straightened.

We have considered the volume of trade that would be likely to be carried by a canal of either class, and, although the data that we were able to obtain as a guide in that respect was somewhat meagre, we easily concluded that there would not be at the present time any justification for a canal, and have therefore not worked out any scheme in detail. Any canal upon this route would not only be costly to construct, but, owing to the upper reaches not having any natural water-supply, the cost of working would be great, as the volume of water required to supply the lockages and waste would have to be pumped from a lower level.

Mr. Hamer in his evidence stated that he had worked out, in 1915, a scheme for a barge-canal on this route having a depth of water of 10 ft., and had made an approximate estimate that (at pre-war prices) the cost of such a canal would have been something in the neighbourhood of £1,600,000. We are of opinion that a much smaller sum would be much better spent in improving the facilities for transhipment at Helensville and upon the railway connection between that port and Auckland.

There is, however, one portion of the scheme that, in our opinion, ought to be carried out if it can be financed, and that is the straightening of the Kaipara below Helensville. In 1907 the District Engineer of the Public Works Department in Auckland reported that he estimated that the cost of making two cuts to give 8 ft. depth at low water for a channel 60 ft. wide at the bottom with 3 to 1 slopes would then have been, exclusive of the cost of the land required, £20,328. This proposal is shown on plan P.W.D. 22582. By making two cuts, each of about 21 chains in length, there would be saved about 110 chains of navigation round two awkward and shallow bends of the river. The straightening of the river below Helensville would enable the railway-wharves to be navigated up to and used in a more satisfactory manner than is possible at present, and would largely reduce the cause for the present complaints of those interested in the Dargaville trade. The lands to be taken are only some 15 acres in extent, and the cost of acquisition should not be great. If the channel could now be cut for a cost not exceeding £40,000, and the districts interested are willing to be rated therefor, we are of opinion that the work should be carried out, and the sinking fund and interest provided by a rate to be struck, in a manner to be determined, over the districts surrounding the Kaipara Harbour.

WAITEMATA–MANUKAU CANAL.

The waters of the Waitemata Harbour, on which Auckland is situated, on the north-east coast of the Island, are separated at two points by only narrow necks of land from the waters of the Manukau Harbour on the western coast. At one point the tidal waters of the Manukau are distant little more than 3,000 ft. from the tidal waters of the Otahuhu branch of that arm of the Waitemata Harbour that is known as the Tamaki River, and the dividing land is of low elevation, rising only to some 40 ft. above high-water level. This neck of land is crossed by the Auckland South Main Trunk Railway, by the Great South Road, and by the Panmure Road, which railway and roads would have to be considered in connection with any canal scheme across this isthmus. The proposal to construct a canal at this spot, where a Maori portage used to exist, is by no means a new one, and there remains in the possession of the Crown, for the purpose, a canal reserve 2 chains in width. A report dated 1st February, 1860, and made by Colonel Thomas R. Mould, R.E., who was then Inspector of Public Works, is contained in the Journals of the Auckland Provincial Council. Colonel Mould provided for one lock and gates at each end of the canal, a depth of 8ft. 6in. in the canal at high-water, a width of 18 ft., and a tow-path 6 ft. wide; also for cutting channels through the shallow water on both the Manukau and Tamaki sides, and for two wooden road-bridges over the canal; and he estimated the cost at £22,876, whilst if the canal were carried down to 10ft. 6in. below high water Colonel Mould estimated the cost at £27,500.

In January, 1887, Mr. W. N. Blair, M.Inst.C.E., reported that a canal for coastal steamers upon this route could be then constructed for the sum of £250,000.

Mr. J. E. Taylor, of Mangere, in the year 1907, being much interested in the proposed scheme for a canal on the Tamaki route, very public-spiritedly, at his own expense and labour, drilled a series of six boreholes, 600 ft. apart, along the canal reserve, five of which he carried down to a depth of 24 ft. below high water, and the sixth, being that bored at the highest point of the section, he carried down to a depth of 45 ft. below high-water level; and in no case was any hard material found. A plan and section showing the locality and borings were published by the Auckland Harbour Board in a small book issued in December, 1908, a copy of which is forwarded herewith.

This book also contains reports about, and particulars of, a proposed ship-canal known locally as the Whau scheme. This latter canal is proposed to be built between the branch of the Waitemata Harbour known as the Whau River and a point on the Manukau Harbour known as Karaka Bay, about 5½ miles to the west of Onehunga. The Whau route was promoted by a company, which, in 1905, had surveys made and levels taken and borings and shafts sunk upon the proposed line of the canal, in order to determine the character of the country that would be passed through. In 1907 Mr. W. H. Hamer provided that company with plans and estimated the cost of the canal as designed by him, exclusive of land-purchase, at about £788,000. These plans provided for a canal having 20 ft. depth of water below low-water spring tides in the locks and in the harbour approaches thereto at each end, with a depth of 20 ft. below high-water neap tides in the canal itself. It was proposed that the locks should have a length of 350 ft. between the outer gates and a width of 60 ft. If the depth were increased to 25 ft. Mr. Hamer estimated the then cost at an additional £100,000.

The distance between tidal waters in the two harbours at this point is about 6,900 ft., and Mr. Hamer proposed to put a lock on the Waitemata side near the top of the Whau Creek, excavating a channel in the creek to the required depth from the deep water of the harbour. On the Manukau side a lock was proposed to be placed near the shore-line. The greatest depth of cutting is given in the description of the canal proposed by the company as being about 131 ft., and the scheme was intended to provide for vessels up to a length of 350 ft., the canal and approaches being so laid out and curved as to render navigation easy by vessels of that size. The line of the canal is crossed by the North Main Trunk Railway, and the Great North and two other lines of road. It was proposed to provide for the railway by a swing bridge, and for the Great North Road in connection with the Whau lock, a single high-level bridge to take the traffic of the other two roads.

The representatives of the company courteously permitted us to see the plans, but as they have a proprietory interest therein we have refrained from using the plans, having found it sufficient for our purpose to deal only with the particulars as contained in the book published by the Harbour Board. Mr. Hamer in his evidence stated that he estimated that prior to the war the cost of a ship-canal by the Whau route would have increased from his former estimate to £1,150,000, and that the present cost would be very materially increased thereon. It may be assumed that, under present conditions of the cost of labour and materials, that pre-war estimate might be increased to at least £2,000,000, and that a canal for barge traffic only would probably cost not less than £1,000,000 by this route. We have therefore taken those figures as a sufficiently close approximation in investigating the probabilities as to whether such schemes would be payable propositions.

It appeared from the evidence of Mr. D. B. Russell, of Avondale, that in 1913 he obtained a concession from the Auckland Harbour Board, subject to ratification in details and by legislation, under which he anticipated obtaining capital outside New Zealand to build the Whau canal as part of a scheme for the shipment of Waikato coal to foreign ports, but the scheme was not proceeded with.

We are of opinion that the popular view that there would be a considerable saving in time and money through the construction of a ship-canal by the Whau route for vessels trading from Auckland to Australia is fallacious. The saving in distance to Sydney of from 70 to 75 miles would be fully offset by the risk involved in navigating the Manukau bar by deep-draught vessels and by the canal dues that would have to be paid. The saving in time, owing to the slow navigation through the canal and locks and in the shallow waters of the harbour, would be negligible.

Little statistical information being supplied by witnesses or by any representative public body upon the question as to the amount of tonnage either of vessels or of goods that would be likely to pass through either the Tamaki or the Whau barge-canal, if constructed, or the Whau ship-canal, we have been compelled to fall back upon our own general knowledge, and we have concluded that there appears to be no present justification for the construction of the heavy and costly work needed for a canal, either for large vessels or for barges, upon the Whau route.

With regard to the Tamaki route there appears to be more justification, and we have looked into the matter in more detail. The Auckland Harbour Board in 1915 had surveys, soundings, and sections made from the Mangere Bridge, in the Manukau, by two alternative routes, to the bridge which crosses the Tamaki Creek at Panmure. Route "A" was the shorter in actual length. It left the Manukau Harbour at St. Anne's Bridge, and, running through ground rising only to 44 ft. above the datum of Auckland dock-sill, but known to contain rock, joined the Tamaki River about 60 chains above the Panmure Road Bridge. The length from the Mangere Bridge over the Manukau Harbour to the Panmure Road Bridge by this route would be about 25,000 ft., of which nearly 7,000 ft. would be in earth and rock excavation; and the route has the disadvantage that near St. Anne's Bridge it would seriously clash with the proposed diversion of the Main Trunk Railway-line past Panmure. Route "B," which passes through the canal reserve, has a total length between the Mangere and Panmure Road Bridges of about 33,000 ft., but has only about 2,700 ft. of excavation above high-water level, running through ground rising to about 53 ft. above datum. It has, however, the objection that it would require somewhat more dredging and straightening of the bed of the creeks than would be needed for scheme "A." The plans and sections showing these routes are recorded as M.D. 4450 and 4451.

Mr. Hamer in his evidence stated that he had made an approximate estimate before the war that a barge-canal having 10 ft. depth and a bottom width of 35 ft. could have been constructed for £300,000 on route "B."

We propose that the Upper waters of the Manukau should be impounded at the Mangere embankment and bridge, and a lock put there so as to form a lake of the lands now largely dry at low water, thus materially reducing the dredging that would be required on the Onehunga side, as well as improving the sanitary condition of a large stretch of foreshore. We have worked out in detail estimates for this work on the assumption that it might be carried out shortly, and therefore at prices

approximating to the present cost of work. We are satisfied that a barge-canal having a depth of 6 ft. and a bottom width of 30 ft., with locks 30 ft wide and 8 ft. deep and 150 ft long inside, could be constructed for less than £300,000. The scheme as detailed would involve the substitution of a double Bascule swing or rolling bridge for two spans of the present Mangere Bridge, the staunching of the existing approach embankment to the present bridge, and the closing of the present bridge by a bank containing a lock and having a wharf adjacent. Provision has been made for carrying the railway over the canal, and a clear headway of 10 ft. above the water-level can be obtained. It is, however, possible that in the regrading of this portion of the railway it may be desirable to raise the rail-level at this point, and any increase in head-room so gained would be valuable from the point of view of the canal. The Great South Road would be carried over the canal, and tow-paths by a three-span br dge at its present level ; but it would be proposed to fill up a depression in the Panmure Road, and thus carry it over the canal at a sufficiently high level. A lock would be formed, with adjacent wharves, in the upper end of the Otahuhu branch of the Tamaki Creek at a point about 20 chains to the eastward of the Panmure Road.

The distance between the Auckland wharves and the Onehunga Wharf is practically the same by the Whau route and by the Tamaki, but the barges would be in a more exposed portion of the Waitemata Harbour by the Tamaki route than by the route through the Whau inlet. As, however, any barges that would navigate the canal would have to be capable of navigating the rough waters of the Manukau Harbour, this objection is of little moment.

As the control of the Waitemata and Manukau Harbours is vested in the Auckland Harbour Board, it appears clear that the construction and management of the canal should be in the hands of that body. We therefore recommend that powers be given to the Auckland Harbour Board to carry out the work and to levy tolls on vessels and goods passing through the canal.

We are of opinion that the present indications point to the low-lying lands surrounding the upper portion of the Manukau becoming largely a manufacturing district. The impounding of the tidal waters above the Mangere Bridge under the proposed scheme, by giving an extensive water-frontage capable of being served at all times by barge traffic, would be of great benefit, and would produce a trade between that district and the Auckland wharves that would warrant the construction of the canal. We therefore recommend that the Auckland Harbour Board should proceed to draw up a scheme for the reclamation of a portion of the lands now covered at high water within the impounded area and adjacent to the present water-frontage, including in such lay-out the provision of road and railway-siding access to the manufacturing building-sites that would be thus brought into existence. The Government should give every assistance by special legislation for the execution of this work, and it is believed that the asset so brought into existence would ultimately provide security for the interest and sinking fund on the loan necessary to carry out the works, including the construction of the Tamaki canal.

We draw attention to the letter from the Auckland Harbour Board, marked " Appendix A," containing the considered views of that Board as to the construction of the canal.

Waiuku–Waikato Canal.

Although the Tamaki barge-canal is of importance as giving Onehunga and the harbour of the Manukau water communication with the wharves at Auckland, its value would be very much increased if barge traffic could be established with the Waikato. If this could be done, coal and agricultural produce could be loaded on barges upon the river or its tributaries, and delivered without transhipment at the wharves in the Waitemata.

The proposal to construct a canal from the Waiuku River, a branch of the Manukau Harbour, past the Town of Waiuku and through a comparatively low saddle to connect with the Awarua Creek, which falls into the northern channel of the delta of the Waikato River, is a project that has been under consideration for many years.

In the year 1902 Mr. A. B. Wright, an officer in the then existing Roads Department, ran levels across this line and reported that a cut could be made

between the Waiuku and the Awarua to carry barges at a cost, for excavation only, of a little more than £100,000.

In April, 1915, Mr. Hamar, Engineer to the Auckland Harbour Board, utilized the information obtained by Mr. Wright, and also information obtained by Mr. J. B. Thompson, Chief Drainage Engineer of the Lands Department, and, adding to it soundings taken by the members of his staff, placed on record the data available on plans and sections deposited with the Marine Department and recorded as M.D. 4454. From the data thus recorded, and after an inspection of the locality, we have worked out two alternative proposals for connecting the Manukau Harbour with the Waikato River. One scheme is for a canal of a similar character to the proposed Tamaki barge-canal, carrying high water through the hill, and the other is for a railway to carry barges over the hill from Waiuku to the upper end of the Awarua, that stream being improved by deepening and straightening until it discharges into the Waikato. The suggestion for a barge railway was made in evidence by Mr. M. H. Wynyard, a member of the Auckland Harbour Board.

In both schemes it is proposed to impound the waters at high tide in the upper end of the Waiuku River by the construction of a bank across the channel at a point about 3 miles below the town of Waiuku, locally known as the Needles, where the Ohorua and Moeatoa Points approach to within about 450 ft. of each other. On the Manukau side of these points the channel has good depths. Some local Waiuku residents urged that the bank connecting the east and west sides of the Waiuku channel should be placed farther to the northward, but we are satisfied that the advantages resulting from this to the residents in the Awhitu Peninsula and to be obtained by closing a large area at high-water level would not justify the additional cost.

The bank at the Needles would contain a lock similar in dimensions to those proposed for the Tamaki barge-canal, so that the same-sized vessels could be navigated right through from the Waitemata to the Waikato. A roadway would be formed across the top of the bank, with a light rolling bridge across the lock, so that the settlers on each side of the Waiuku River would have a more direct road communication than at present, and a wharf would be provided adjacent to the lock.

The divide between the Waiuku and the Awarua only rises to a height of some 70 ft. above the datum of the Auckland dock-sill, which datum corresponds to a depth of 12 ft. 7 in. below ordinary high-water neaps, at which level (high-water neaps) it is suggested that the impounded water should be kept. It is proposed to place a lock on the Awarua side of the hill about 140 chains from the commencement of the cutting at Waiuku, at a point adjacent to where the main road would cross over the canal. At the Town of Waiuku a road would be closed and diverted so as to be carried, with another road, over the canal, and a high-level bridge would also be required to carry a county road across a point near the deepest part of the cutting. Between the Awarua lock and the Waikato River there would be required considerable dredging and excavation so as to straighten and deepen the existing creek. This would have a material benefit in assisting the drainage of the surrounding low-lying lands.

The estimate for such a barge-canal, including the land required, amounts to about £475,000 at present-day prices.

The alternative scheme would be for a railway of special broad gauge designed for a cradle adapted to carry barges having a dead-weight of 100 tons, and hauled by electric locomotives which would derive power from the public supply. The ground lends itself admirably to such a proposal, as moderate grades can be obtained at comparatively small cost for earthworks, and without entailing serious alteration to the roads, which can be crossed on the level. There could be obtained a rising grade of 1 in 75 from Waiuku to the summit, at a level of about 65 ft. above datum. For a length of about 10 chains at the summit the railway would be level, and a crossing-place would be provided there, with locomotive-sheds, &c. On the down grade to the Awarua there could be obtained three grades of 1 in 83, 1 in 200, and 1 in 75, finishing in a dredged canal to the Waikato River, as in the canal proposal. These schemes are shown in outline on the accompanying plan marked M.D. 5354/B [not printed]. The estimate for such a barge-railway and

the canal-works at each end, including five carriages or cradles and three electric locomotives, with the necessary electric cables, but not including any share of the cost of providing power, amounts to £300,000.

Taking interest and sinking fund at 7½ per cent. there would be required a sum of £22,500 per annum to meet those items, over and above the cost of maintenance and working-expenses. We are of opinion that the traffic would not for many years to come exceed 100,000 tons per annum, and as a rate of 4s. 6d. per ton would be required on such a basis to provide for the standing charges ouly, without allowing for working-expenses, we are reluctantly compelled to advise that the time is not yet ripe for this proposal. It is possible, however, that the time will come when the construction of the canal may be justified, and we recommend that steps should be taken to prevent any building being erected upon any lands that might be required in the future for canal or barge-railway, and that any works to be carried out should be considered in relation to these proposals.

If it should be determined that the canal or barge-railway is to be proceeded with, we judge that, as Auckland is interested to the greatest possible extent in obtaining access to the trade of the Waikato River district, and as the Auckland Harbour Board has control of the Manukau Harbour and will be the controlling authority of the Tamaki barge-canal, that body should be empowered to undertake the construction and management of any works for the connection of the Manukau and the Waikato. As the efficiency and success of such canal schemes must be largely locked up with the navigation of the Waikato River, we deem it to be desirable that as soon as the Waiuku connection is started the Auckland Harbour Board should have representation upon any body having control of works affecting that river.

As the utility of the Waiuku canal depends wholly upon the possibility of so improving the Waikato River as to make it navigable at all seasons for any vessels using the Waiuku canal or railway, we recommend that no steps be taken in furtherance of such a scheme until it is definitely certain that improvements in the Waikato River can be permanently effected.

Mangawara–Piako Canal.

For many years the idea has been entertained that a canal could be constructed between the upper portion of the Piako River and the Mangawara Creek, which discharges into the Waikato River at Taupiri. If such a canal were constructed of a suitable size, direct communication by means of small coastal steamers could be obtained via the Thames Gulf between Auckland and the Waikato. Above the junction of the Mangawara Creek with the Waikato, that river, with its tributary the Waipa, is for many miles navigable by vessels of moderate draft, without shoals or other difficulties.

This scheme having been brought under our notice, we visited the locality, and were sufficiently and favourably impressed by our observations as to cause us to investigate the proposal in detail. Plans and sections of the Mangawara Creek from Littlewood's Landing—about 5 miles up the creek—to a point 15 miles farther up have been prepared by Mr. H. R. Young, Assoc.M.Inst.C.E., for the drainage scheme of the Mangawara River Board. These plans have kindly been placed at our disposal by that River Board, and copies accompany this report, marked M.D. 5354/D [not printed].

Mr. J. B. Thompson, Chief Drainage Engineer of the Lands Department, on request made to him, had the levels continued over the watershed and down on its eastern side to connect with the River Piako near Tahuna and he has kindly supplied us with a plan and section, which are attached hereto, marked M.D. 5354/C [not printed], thus enabling a tentative scheme for a canal and system of lockage to be prepared, upon which an approximate estimate of the cost has been made.

The result of the investigation has proved to be somewhat disappointing, as the saddle, in a length of some 2½ miles, rises to a height of about 180 ft. above the ordinary water-level in the Piako River where the canal would junction with it; but the inquiry shows that, although costly, the proposal is quite feasible, and worthy of consideration as an alternative to the construction of the Waiuku canal

and the improvement for navigation of long reaches of the Waikato River between Huntly and Mercer, which latter may be a problem of considerable difficulty and expense.

The total length of the canal, following the present Mangawara Creek, would be about 27 miles from the Waikato River to the point of junction with the Piako River. This length might possibly be reduced by some 3 miles by discarding the present tortuous channel of the Mangawara and by cutting a more direct canal through the swamp lands. The construction of such a new channel would materially improve the navigation by eliminating the sharp bends in the creek, and if there is any probability that the canal might be constructed the matter ought to be carefully investigated before the works of the Mangawara River Board are proceeded with. If the proposed Orini cut in the Mangawara Creek be made, the length of the canal would, by that work alone, be shortened about $1\frac{1}{4}$ miles, and by other works of straightening the creek the canal could be materially reduced in length and improved for navigation. The upper reaches of the Mangawara, with its tributary the Waiti, would supply ample water to the topmost reach of the canal. The canal could be built with eight locks, of a lift of about 10 ft. each, on the Mangawara side, and with ten locks, of about 10 ft. 6 in. lift each, upon the Piako side. If borings show that the construction of a deep cut of about 80 ft. at its greatest depth is, owing to the presence of hard rock, likely to be costly, then it might be necessary to raise the level of the top reach of the canal by increasing the number of locks, and to pump the supply water for a few feet in height. The estimate is based upon the number of locks suggested above, and it includes a sum to cover the improvements in the Piako River that Mr. Thompson considers to be required to render it available for steamer traffic.

On the assumption that the canal would be built with a width at the bottom of 30 ft., with side slopes of 1 to 1 and a water-depth of 8 ft., and having locks 150 ft. in clear length and 30 ft. in width, the estimated cost amounts to £983,000, which, being necessarily approximate, may be considered for the purpose of this inquiry as £1,000,000.

Whilst we see no prospect of a sufficient revenue being derived for many years to come from such a canal, we believe that if and when the expenditure of a million of money is justified in connecting the Waikato coalfields and agricultural and producing districts with the sea, in view of the fact that the great bulk of the Waikato traffic has its source southwards of Huntly, it would be more safely spent in constructing a canal suited for the navigation of small steamers from the Waikato to the Piako than in any serious attempt to connect the Manukau Harbour, via Waiuku and the Waikato River, with the upper Waikato.

We are reluctantly compelled to advise that the scheme of constructing a canal from the Waikato River by the Mangawara Valley to the Piako River is, at the present time, not economically desirable.

Waikato River Navigation.

As the question of the navigation of the Waikato River, with the attainment and maintenance of a summer channel sufficiently deep for boats of moderate draft, is intimately connected with the proposals for canal-construction, and is, in fact, largely the basis upon which depends the desirability or otherwise of the construction of the Waikato-Manukau connection, we have devoted considerable attention to the matter.

In addition to the question of improving the river so as to permit of through-barge communication with the Waitemata, there was placed in evidence before us the fact that if a satisfactory summer depth could be obtained throughout the Waikato River there would be developed to a considerable extent a traffic by small steamers and barges, throughout the whole navigable length of the Rivers Waikato and Waipa, with transhipment at Port Waikato to and from sea-going steamers of a size suitable to navigate over the Waikato and other west coast harbour bars. It was pointed out that hitherto it had been impossible to place the steamer trade upon a satisfactory basis owing to the uncertainty and delays arising during a large portion of the year from the shoal reaches of the river. We were strongly urged to make recommendations such as would afford as great and as early a relief as

possible, independent of any scheme for permanent improvement of the Waikato navigation; but we regret that we cannot make any recommendation that would be of any value in the direction of rendering early and temporary relief.

The detail survey and cross-sections of the river between Rangiriri and Maioro Bay, inside Waikato Heads, made in 1913 under the supervision of Mr. J. B. Thompson, have afforded us very valuable data on which to base our conclusions as to the feasibility of improving the river for navigation. Unfortunately, the survey did not extend up the river above Rangiriri, but from our own observations and the evidence tendered to us we are justified in the assumption that the river-conditions existing between Rangiriri and Huntly, a distance of about 9 miles, are on a parity with those obtaining for a distance of about 12 miles below Rangiriri. These 21 miles of the river in length, together with about 7 miles between the Devil's Elbow and Maioro Bay (through the delta, to be hereafter mentioned), present the greatest difficulty to navigation, on account of the numerous shoals.

The Waikato River has its origin in Lake Taupo, a lake having an area of about 238 square miles, with a drainage-area of about 995 square miles, a considerable portion of which is high land, and from which the run-off of water is at times very considerable, due to the melting of snow and other causes. The length of the river below Lake Taupo is about 220 miles, and the total area of the river-basin, including its tributaries, is some 5,400 square miles. The greater portion of this area is overlain to a considerable depth by rhyolitic and pumiceous sands, with the result that there is a continual supply of light and easily shifted sands, which, entering the river, are carried down it to a very considerable extent. Examination of the bed of the river shows a constant down-stream movement of a thin layer of fine pumice and quartz sand, with small rolling lumps of pumice, and this is apart from the silt which is carried down in suspension during every fresh in the river.

Above the Town of Cambridge the question of the navigation of the river may be dismissed, on account of numerous rocky shoals and small rapids.

Between Cambridge and Ngaruawahia the river is, upon the whole, good, and offers very few impediments to safe navigation for boats drawing up to 4 ft. 6 in. Between Ngaruawahia and Huntly the river, which now has the added waters of the Waipa, is also safely navigable to vessels of that draught. From Huntly down to Meremere the banks of the river widen out and the depth of water becomes less, the resulting shoals and moving sand-bars making navigation during the periods of low-water level in the summer months exceedingly difficult for all but small and very shallow draught boats.

Below Meremere and down to and below Tuakau the river, even at low summer level, is fairly good for navigation, provided that the deepest channels are followed. Under normal conditions the tidal effect is felt as high as Tuakau, a distance of some 18 miles from the heads, while under very low summer conditions the tidal effect is observed as high as Mercer, 7 miles farther up. From Kaitangata, for a length of about 6 miles, to Maioro Bay the river becomes a true delta river, with numerous channels. It is probable that in the early history of the river it discharged directly into a very much larger inland bay, extending over what is now known as the Aka-aka Plain. The river now presents the unique feature of a delta river discharging into an inland or enclosed bay; and this feature is a most important one to be considered in connection with any projected scheme of river-improvement in the lower reaches.

Another noticeable and exceptional feature of the Waikato is that the beds of most of the creeks flowing into the river below Ngaruawahia are, near their outlets, at a lower level than the bed of the river itself. In the case of the Whangamarino Creek this difference in level amounts to some 14 ft. or 15 ft., the bed of the creek being 11 ft. below mean sea-level. This points to a general land subsidence having taken place within recent geological times, and this view is confirmed by the fact that the old river-bed was found to be, when sinking the cylinder piers for the railway-bridge at Hamilton, at a depth of some 46 ft. below the present mean sea-level.

The existing deposits of sand in the bed of the river may have been due to such land subsidence having caused a flatter river gradien twith an insufficient velocity

to cope with the heavy detritus, or the deposits may have been due to some abnormal increase in the quantity of sand brought down the river in more recent times, or probably to both causes combined. The idea which has been repeatedly put forward, that the bed of the river below Mercer can be brought back to its original depth through some system of groynes or other river-works, is, in our opinion, utterly fallacious. The river below Mercer has a summer fall to mean sea-level of only 4 in. to the mile, and no practicable scheme of training would result in producing an increased bottom velocity sufficient to provide the required scouring-effect.

The sand constantly rolling down the bed of the river is deposited at the foot of the delta, forming a sand-bank in Maioro Bay, which is gradually moving seawards. This is well shown on the plan forwarded herewith and recorded as M.D. 5354/E [not printed], on which is indicated approximately the relative positions of the end of the bank as surveyed in 1862 and in 1913. From this it appears that the toe of the delta has extended some 200 to 250 acres into the bay during the intervening years, and if it were not for the tidal scour in and out of the bay there is little doubt but that the bay would be rapidly filled in by sand from the river. It appears to be unquestionable that the process of shoaling is continuing at the present time, though at a very slow rate of progress. The tidal energy is largely dissipated in Maioro Bay and in the numerous delta-channels, with a consequent reduction in the scouring-effect upon the bed of the river as high as the head of the delta at Kaitangata, and owing to these conditions the tidal problem in this river is a very complex one.

The Waipa River junctions with the Waikato River at Ngaruawahia, but differs much from it in character. The drainage-area discharging into the Waipa, and the country through which it flows, are of a more stable and less easily eroded nature, and consequently there is a much less quantity of moving sand than in the Waikato. At times, however, there is a large quantity of fine silt carried down in suspension.

The Waipa has deep water for some 25 miles of its length, and, except for a few sand-bars and shoals in the upper portion, it is easily navigable for boats drawing 4 ft. 6 in. to 5 ft. as far up as Pirongia, a distance of about 35 miles by river above Ngaruawahia. The river-banks, which, generally speaking, are high, are in places badly overgrown with willows, of which the branches overhanging the stream fall into the river and choke it. In the early days of settlement this river was largely used for the transmission of goods up to Pirongia and even as far as Te Kuiti.

The principal creeks discharging into the Waikato River below Ngaruawahia are the Mangawara, the Onetea, the Whangape, the Opuatia, the Whangamarino, and the Mangatawhiri. There are also the Aka-aka, Awarua, and Otaua Creeks which discharge into the northern channel through the delta and therefore practically into Maioro Bay.

The Mangawara Creek is navigable with a good depth of water in summer for about 4 miles of its length, above which, owing to its tortuous course, it becomes difficult for navigation even for small launches. This creek has already been dealt with in connection with a suggested canal to the Piako, utilizing its valley and waters.

The Onetea Creek has a length of only about $1\frac{1}{4}$ miles, and connects Waikare Lake, which has an area of about $13\frac{1}{2}$ square miles, with the Waikato River. It has a good depth of water, except where it junctions with the lake, but is badly choked by willow-growth on its banks.

The Whangape Creek is the outlet from the Whangape Lake to the Waikato, and has a length of about 2 miles. It has deep water up to within a short distance of the outlet from the lake, but is much choked through the growth of willows. At the western side of the lake the Awaroa Creek enters it, and is navigable with considerable difficulty in summer by light-draught launches only for a distance of about 10 miles. The lake itself has an area of some 2,800 acres, but is shallow and badly overgrown with weeds. There should be dredged a channel across its width of about $2\frac{1}{2}$ miles, which, with a moderate amount of dredging in the Whangape and Awaroa Creeks and clearing of willows, would give a satisfactory and valuable waterway for launch traffic. This work should be undertaken, as there is a considerable amount of settlement in this district which is almost wholly dependent on water carriage for goods to and from the railway at Rangiriri.

The Opuatia Creek is another valuable waterway suitable for launch traffic, and is navigable, with a good depth of water, up as far as Glen Murray, a distance by the creek of between 7 and 8 miles. There is a considerable traffic at present upon this creek, but it ought to be improved by the removal of a few snags and some overhanging and sunken willows.

The Whangamarino Creek, with its tributary the Maramarua Creek, offers great facilities from a navigation point of view, having ample width with plenty of water and easy curves. The Whangamarino is navigable for deep-water launches a distance of 9 miles up to the Falls, whilst its branch, the Maramarua, is navigable from the junction for a distance of some 6 miles to a point where a shallow canal was constructed some years ago from the creek to the old Miranda Coal-mine. When that mine was worked a shallow-draught stern-wheel steamer brought down coal to connect with a railway-siding near the mouth of the Whangamarino. It is unfortunate that these tributary creeks of the Waikato, being the most suitable naturally for navigation, do not pass through or tap any really good country. The swamps through which they flow, though probably of a rich character if unwatered, lie so low as not to be amenable, or only partially so, to drainage by gravitation. So far no attempt has been made to embank these swamps and unwater them by mechanical means, and it is questionable whether any such action should be permitted without careful consideration of the effect of such proposals upon the Waikato River, as the low-lying lands are now available to receive flood-waters in times of high flood in the river.

The Mangatawhiri Creek is, so far as we are aware, not utilized for navigation, as the settlers in its valley are better served by the railway service.

The Aka-aka, Awarua, and Otaua Creeks are all tidal, and are all navigable for some distance at high water. The settlers in the swamp lands served by these creeks would be benefited by any improvement in the northern branch through the delta of the Waikato or by the construction of the Waiuku canal.

The Waikare and Whangape lakes, together with the low-lying Whangamarino swamp area, form valuable flood-overflow or impounding reservoirs, and in their absence the height of floods at and below Mercer would be greatly increased.

The discharge of Lake Taupo into the Waikato River is approximately an average of 5,000 cubic feet per second. The low summer or minimum flow of the Waikato River at Mercer is estimated to be about 9,000 cubic feet per second, whilst the big flood-discharge in 1907 is estimated to have reached 60,000 cubic feet per second. As a large proportion, if not the great bulk, of the high floods are probably derived from the mountain country above Lake Taupo, it seems to be desirable that the question whether it is feasible or advisable, by the construction of headworks at the outlet from the lake, to regulate and to an extent control the floods in the lower river should be investigated. Owing to the large area of Lake Taupo—238 square miles—a comparatively small increase in its height caused by storing the waters until they could be let off slowly would have an enormous effect in reducing the peak of the floods in those reaches of the river where the surrounding country is low, and in a corresponding manner the storage could be utilized to increase the minimum summer flow, to the benefit of navigation. We have not the data before us upon which to come to a conclusion, nor do we think that such an inquiry, which must necessarily be a long one, is within the scope of our reference, but we recommend that a recording-gauge should be erected at the outlet of the lake to the river, and that recording-gauges should be erected at various points on the river, including one at or near Hamilton (or Ngaruawahia) and one at Mercer, so that simultaneous observations may be taken over an extended period of time, and data obtained from which it could be determined whether such regulating headworks would be financially justified. Such a storage in Lake Taupo might permit of the reclamation of certain swamp and lake areas which now perform the function of flood-overflow reservoirs.

The settlers in the district adjoining Lake Waikare have formed a Waikare Drainage Board, and have brought forward a scheme for the drainage of the lake by closing up the Rangiriri and Onetea Creeks, which now connect the lake with the Waikato River, and providing for its reduction in level and the drainage of the surrounding lands by the construction of an artificial canal, 40 ft. in width, to

connect the lake with the Whangamarino Creek. On request by the parties interested, the Lands Department, through its Chief Drainage Engineer, had a survey made and levels taken with the object of demonstrating the practicability or otherwise of such a scheme. By the courtesy of Mr. J. B. Thompson we have been supplied with copies of the plans showing drainage-levels, areas, &c., which are forwarded herewith and recorded as M.D. 5354/H [not printed].

The objective aimed at is not only to shut out the flood-waters of the Waikato River and to reclaim the large area of swamp lands adjoining the lake and to unwater the greater portion of the lake-bed itself, but also to provide a main outlet-channel into which the settlers owning swamp land in the southern portion of the Whangamarino swamp district might drain their lands. Whilst realizing that such a scheme is feasible, and if given effect to would enable a large area of land to be reclaimed and brought into use, it appears to be clear that such benefit can only be obtained at a corresponding risk of loss, by increased flooding, to other settlers owning low lands abutting upon the Waikato River, and to those occupying the swamp lands in the northern end of the Whangamarino. Lake Waikare, with its low-lying adjacent lands, acts as a valuable relief reservoir when the river is in flood. Through the courtesy of Mr. W. H. Hamer we have been supplied with a diagram showing river-gaugings observed at Mercer over the four years 1915–18. From this diagram, which is recorded as M.D. 5354/F, it is shown that a rapid and uniform rise of the river to a height of 7 ft. or 8 ft. above the summer level is not infrequent, and may be looked for at least once a year. In 1915 the river rose twice to a height of 4 ft. in eight days. In 1916 rises took place of 4 ft. in four days and of 5 ft. in seven days. In 1917 a rise of 4 ft occurred in three days, and in 1918 rises of 4 ft. took place in eight and twelve days respectively, such rises being in all cases above the normal flow observed before and after the flood. It is therefore certain that with the river at its usual winter level a rise of 4 ft., with a uniform increase of 6 in. in height, in each twenty-four hours is an event that may frequently occur. Of the flood-rises above mentioned, six of them reached to within 1 ft. or less of the level of the railway-line at Mercer, whilst one just overtopped it. These floods must have been very much worse had it not been for the relief given by the flood-waters flowing into Waikare Lake, as each foot in depth of water introduced into that lake represents a storage capacity of from 375,000,000 to 400,000,000 cubic feet. The accompanying hydrograph [not printed] of the river at Mercer (M.D. 5354/E) shows the river-discharge at different heights between low summer level and a level 8 ft. above it, at which latter level the river overflows its banks in many places.

We are of opinion that were it not for the relief afforded by the flooding of Waikare Lake and district, and of the swamps adjacent to the Whangamarino and Maramarua Creeks, there would be a considerable rise in the flood-height at Mercer. It would appear from calculations that a 3 ft. rise of flood above ordinary winter river-level, taking a period of six days to reach the maximum height, would, if Waikare Lake were cut off from the river, result in the flood-level being raised at Mercer to 1 ft. higher. At the same time the flood-level on the Maramarua swamps would be similarly raised. With a 4 ft. flood the result would be proportionately greater.

It is very obvious that the closing and drainage of Lake Waikare, or the enclosure of any portion of the Maramarua and northern Whangamarino swamp lands from flooding from the Waikato, must inevitably augment the flood-discharge of the river past Mercer and result in an increased height in flood-times, not only at that point but also for a considerable distance down the river.

The advantages to be gained by the reduction of the water-level in the Waikare district, thus enabling large areas of land to be brought into cultivation, and the banking-out of floods from the Whangamarino swamp lands, must be set against the cost of stop-banking the main river in the neighbourhood of and below Mercer at those points liable to flood, and the provision of mechanical means of keeping such enclosed districts free from those land-waters which now find a natural outlet to the river.

We have not at our disposal the information that would enable us to determine whether such a course would be feasible or profitable, but we strongly urge that

no steps should be taken to prevent Waikare Lake, and the swamp lands adjacent thereto and to the Maramarua and Whangamarino Creeks, from acting, as they do at present, as flood-relief reservoirs, until the question can be investigated as a whole by a competent authority after full data have been first obtained. From the limited information and data before us we are of opinion that everything should be done to keep down the flood-levels in the Waikato by permitting the surplus waters to spread over those areas over which they have spread in the past.

We are of opinion that either the law or its application is defective in allowing Drainage Boards to be formed having for their object purely local improvements, without any consideration as to the effect that such local works may have upon other portions of the watershed. We are of opinion that the whole of each river-basin should be dealt with as a whole by a competent authority representing the whole district, who should be advised by men skilled in the subject and capable of considering the questions that arise, both of drainage and of navigation, from other than a purely local aspect.

The works carried out by the Waikato River Board appear to be an example of works started on insufficient data and without a due appreciation of all the conditions appertaining to the river and its surroundings. The works were promoted with the desire that the water-level should be lowered at and above Mercer, so as to enable land-drainage works in that district to be effected; but insufficient cognizance was apparently taken of the effect which the works might have upon the navigation of the river or upon the land-drainage operations in the Aka-aka district. The work executed consists mainly in the construction of river-training groynes in the delta portion of the river at and below Kaitangata. These are indicated as "A," "B," "C," and "D," on the attached plan, recorded as M.D. 5354/E [not printed]. The groynes marked "A," "C," and "D" are not likely to do any good if they are left as they are, nor are they likely to do any harm, and they may be looked upon as a failure. In the case of groyne B, we concur in the instructions that, we understand, have already been given by the Government, but which up to the time of our visit had not been acted upon, that groyne B should be entirely removed so as to permit the northern channel of the river to revert, if possible, to its original condition.

We desire that fresh cross-sections should be taken in the delta portion of the river, upon the same lines as those taken in 1913 by the Land Drainage Branch of the Department of Lands so that an actual comparison might be made as to the change, if any, in the river-bed during the past three years, and so that conclusions might be drawn as to what effect, if any, the groynes built by the Waikato River Board have had. As the summer season, in which these sections would best be taken, passed without the work having been done, we decided not to seek a further extension of the time in which we have to report, but to reach our conclusions without such data. We are of opinion, after careful consideration of all the conditions, that there is no present justification for the expenditure of any large sums of money in an attempt to improve and deepen the river below Kaitangata so as to render the navigation of that part of the river independent of the tides.

It has been suggested that, when the Waiuku canal is built, if the trade increased to such a degree as to warrant its being done, it might be feasible to extend the canal from the Awarua Creek across the Aka-aka swamps so as to join the Waikato River, through lockage, above the Devil's Elbow, and thus avoid the difficult navigation through the channels in the delta. A similar extension of the canal system to the westward to a point in Maioro Bay, below the end of the present sand-shoaling of the river, might provide a canalization to permit of small craft reaching Port Waikato independently of tidal work and the troublesome navigation of the delta-channels. This necessity is so remote that we only place it upon record.

Between the Devil's Elbow, near Kaitangata, and a point above Mercer, the river, even at summer level, is navigable for steamers of moderate draught, and it is not until the stretch of river between Meremere and Huntly is reached that serious difficulty is experienced. It is upon this portion of the river, about 21 miles in length, that we are of opinion that improvement works might be carried

out. The country is of a character that would permit of a locked canal being constructed either within or parallel to the river-bed, but it is evident that the trade is insufficient to warrant so large an expenditure for very many years to come. The trade, actual and prospective, is, however, sufficient to warrant the expenditure of a considerable sum in experimenting in an attempt to confine the summer flow of the river within a narrower channel than it now occupies, whilst leaving the whole width of the present bed available for the winter flow and floods.

The design of the work which it is suggested should be tentatively tried is indicated upon the annexed sketch-plan marked M.D. 5354/E [not printed]. It is believed that some such system of low-level and permeable spur groynes, run out from the banks at distances apart to be determined by experience, would have the effect of concentrating the summer flow into a central channel, which it is suggested should have a width of about 10 chains, and that the flow of the water being concentrated therein would have the effect in time of deepening the channel so as to permit of the summer navigation of the river by boats drawing up to 4 ft. 6 in. It is recommended that the experiment should be tried at first upon a stretch or stretches of from 2 to 3 miles. It is probable that no hard bars exist within this portion of the river, but there are the remains of standing timber and other snags which may have to be dealt with by a snagging plant.

It is anticipated that the action of such works as are proposed would be slow, and that no immediate effect on the river would be apparent. It is felt that the more slowly the improvement is effected the more likely it is to be of a permanent character, and that an increased depth in one place may result temporarily in a decrease elsewhere. For this reason it is important that the control of the execution of the work should be placed in the hands of those who are not likely to be swayed by local influence.

The cost of the works indicated, if carried out on the portion of the river between Meremere and Huntly, is estimated as not being likely to exceed £60,000 if judiciously carried out, which estimate includes a moderate amount of snagging in the river, but nothing in the way of dredging. In addition to this sum required for the main river, a further expenditure of £10,000 is urgently required for the clearing of willows, removal of snags and sand-bars, and otherwise improving the tributary creeks and the Whangape Lake for launch traffic; and this expenditure should be carried out within a couple of years, so as to give as speedy relief as possible.

Once the training-works are completed and a success, the cost for maintenance thereof ought to be small, and an annual sum amounting to 10 per cent. of the expenditure, or £7,000, should cover interest, sinking fund, and upkeep. As the watershed below Cambridge will benefit more or less by the improvement of the navigation, the best method of covering the cost appears to be to strike a rate over the areas benefited. The capital value of the three counties of Waikato, Waipa, and Raglan, with the contained boroughs and Town Boards, appears from the 1920 Year-book to be over £16,900,000, upon which, if levied equally over the whole district, a rate of one-tenth of a penny in the pound would suffice. As, however, the whole of these counties would not benefit, the rate should be imposed only on those districts that did benefit, and upon a classification basis, to be determined after the degree of benefit has been inquired into and ascertained.

The Taupiri Coal-mines (Limited) brought under the notice of the Commission a proposal that it has under consideration, to pump sand from the bed of the Waikato River for the purpose of filling up the existing workings of the company's mines, and, by thus supporting the roof, to enable the coal left in the pillars to be removed. Without expressing any opinion as to the feasibility or otherwise of the scheme, we think that if this project eventuates no charge should be made to the company for the material, provided that the dredging of the sand is confined to the middle third of the river. Any such removal, by deepening the channel and forming a trap to impound the travelling sand, must be beneficial to navigation, and should be encouraged. It is recommended that, as a general principle, provided sand or pumice can be removed from the centre of the channel under suitable supervision, no charge should be made therefor as has been done in the past. The trade of obtaining material from the river-bed should be encouraged, rather than discouraged by the imposition of a royalty.

We have considered from various aspects the question whether, and how far, increasing the facilities on the Waikato for the safe navigation of shallow-draught steamers, launches, and barges is likely to affect the traffic on the railways. We have come to the conclusion that the railway earnings, either at present or in the future, would not be reduced, but, on the contrary, that increased navigation, especially of the tributaries, would have the result of bringing into cultivation or increased cultivation a large area of land, by giving better access thereto, and that this would tend to an increase in the railway traffic.

In Appendix B is given, for the year ended 31st March, 1921, the earnings for goods-carriage between Auckland and the principal stations the traffic of which might be affected by improvements in the navigation of the Waikato River or by the construction of canals, as well as the rates in force at that date for the carriage of the different classes of goods.

Waikato River Board.

Arising out of clause 13 of the order of reference, concerning the improvement works proposed or already executed by the Waikato River Board, and the further instruction to report upon matters relating thereto, we feel that we must, in addition to what we have already set out, advise that the present Waikato River Board should be abolished, and a new River Conservation Board constituted, consisting of members having power to deal with all questions relative to river-improvement, land-drainage, or other matters, within the whole watershed of the Waikato and its tributaries. If it is deemed to be desirable to permit Drainage Boards to deal with special districts, then the powers of such Boards should be limited to carrying out such work as has met with the approval and sanction of the proposed River Conservation Board. We are satisfied that the operations of the existing River Board have been faulty throughout, having been based only on a desire to provide for improved drainage of certain lands in the Whangamarino Swamp. It is also certain that, in undertaking certain portions of the work which they executed or tried to execute, they did not sufficiently consider how their proposals would affect other drainage schemes. The Board, although it has been in existence since September, 1911, has failed to obtain or record any particulars as to the height or duration of floods and of low water, or other data relating to the river within its jurisdiction, and by its neglect valuable time has been lost. The works so far carried out by the Waikato River Board appear to us to have been started on quite insufficient data, and without due appreciation of all the conditions pertaining to this river. The Chairman of the Board stated in evidence that the members of the Board desired to be relieved of their duties, and there is every reason why this should be done. He requested that if so relieved the new authority to be constituted should take over all the debts and responsibilities of the Board. We do not approve of this suggestion, and are of opinion that the districts now rated for the loan which has been spent should continue to bear the burden.

The history of this Board should be a serious warning that matters relating to river control and improvement require expert knowledge and training, and should not be placed under the sole management of local men elected by the ratepayers unless there is some thorough control by an authority having special knowledge and ability to deal with the problems under consideration.

We recommend that a Waikato River Conservation Board be set up, which should consist of seven members, partly nominated and partly elected. We recommend that two Government nominees be appointed by the Minister of Public Works, one to be an engineer with expert knowledge of river-control, and the other to be either a Stipendiary Magistrate or some person skilled in local-body law who should act as permanent Chairman. Five other members should be elected, one jointly by the ratepayers of all boroughs and Town Boards within the watershed, and one each by the ratepayers of those portions of the Counties of Franklin, Raglan, Waipa, and Waikato that will come within the rating-area. In order to save expense, the elections should be held at the same time as the local elections for Councillors. If the Waiuku canal scheme be proceeded with, an additional member should be nominated to this Board upon the selection of the Auckland Harbour Board.

We recommend that the duties of this controlling body should include the following:—

(1.) To have detail surveys, plans, estimates, and specifications made for any works proposed to be carried out on the streams or rivers, or works of drainage or reclamation, within the watershed of the Waikato, or, where Drainage Boards exist within such area, to have power of veto or of consent in respect to any works proposed to be carried out by such Drainage Board:

(2.) To determine the districts liable to be rated for any works; to assess the total sum to be derived from each district, and to fix the rates on all properties in each such district, on a classification basis in the ratio of the benefits to be derived according to the principles laid down in the River Boards Act, 1908, and its amendments:

(3.) To submit the proposals to the ratepayers, and obtain their authority by poll to raise any necessary loans:

(4.) To carry out the necessary works:

(5.) To maintain the works efficiently, and to do whatever work may be necessary to improve the regimen of the river and its tributaries, and to secure the fullest protection from floods and the unwatering of low-lying lands, consistent with the efficient maintenance of navigation in the navigable portions thereof:

(6.) To take all necessary observations, and keep records that will aid in the study of the hydrology of the river, changes in its regimen, height and duration of floods, &c.

The River Conservation Board should have all the powers generally granted to a local body, and, further, should have absolute jurisdiction over the channel and banks of the river; and all proposals for drains to empty into the river, for locks, tide-gates, bridges, ferries, wharves, &c., should be submitted to and approved by the Board before being carried out. No planting or cutting of willows or other trees within a chain of the bank of the river or of any of its tributaries should be done, except by or under the direction and license of the Board.

Any Drainage Board now existing within the district of the Conservation Board, or hereafter to be formed, to do the drainage work of any particular area or district should be permitted to use the staff of the River Conservation Board, upon terms to be mutually arranged; to prepare reports, plans, and estimates of drainage-works; and the River Conservation Board should be enabled, upon request from the Drainage Board, to carry out such works at the expense of such Drainage Board. No work of river-control should be carried out by the River Conservation Board unless and until the plans of the same have been first submitted to and approved by the Minister of Public Works.

The duty should be cast upon the Board of forwarding to the Minister of Public Works at Wellington copies of all valuable data collected relating to rainfall, floods, and the regimen of the river, so that same may be placed on reference in the Government archives.

We recommend that legislation be passed enabling this Waikato River Conservation Board to be set up, including powers to pay such fees to the nominated members of the Board as may be mutually agreed upon between the Minister of Public Works and such nominees, such payment to be made out of public funds.

Bridge Across Waitemata Harbour.

Considerable evidence was placed before the Commission upon the desirability of the construction of a bridge across the Waitemata Harbour to connect the City of Auckland with the northern districts. It was, however, largely of a general character, showing the inconveniences under which residents in the northern suburbs suffer, largely due to alleged deficiencies in the harbour ferry services and more especially in the ferries dealing with vehicular traffic. We visited the northern boroughs and districts in order to satisfy ourselves as to probability of reasonable routes of communication being formed if a bridge could be shown to be economically possible, and as to how far such routes would fulfil the object of enabling the access to be improved in point of time and of convenience.

Three sites have been suggested for a bridge crossing the Waitemata Harbour. These are indicated upon the plan forwarded herewith and marked M.D. 5354/I [not printed], and are thereon marked "A," "B," and "C" respectively. Site A, known as the Point Chevalier–Kauri Point site, is the only one on which detailed soundings have been made. These were made some years ago under the supervision of Mr. W. H. Hamer, and the longitudinal section shown on the accompanying plan (marked M.D. 5354/I) [not printed] has been plotted from the information then obtained. The length of a bridge upon this site would be some 10,600 ft., or about 2 miles. Site B, between Point Erin and Northcote Point, is about 5,000 ft. in length; whilst site C, between the north-west corner of the Freeman's Bay reclamation and Northcote Point, is approximately 1 mile in length.

The sections B and C are only approximate, having been plotted from the soundings given on the Admiralty Chart as being nearest to the sites, but are accurate enough for the preliminary rough sketch-plans, which have been prepared with a view to ascertaining a tentative design upon which approximate estimates of cost could be founded. Taking into consideration the relative cost of the deep-water piers required to that of the superstructure, the sketch design shown, having two cantilever spans of 900 ft. over the deep-water channel, with spans of 250 ft. for the remaining portions of the bridges, has been adopted as being sufficiently near the most economical spans for the purpose of this inquiry.

As the bridge proposed would cross the fairway of the Auckland Harbour, the views of the harbour authorities carry great weight and must be carefully considered. We therefore record a summary of the views of the Harbourmaster, Captain H. H. Sergeant, as given in evidence: (*a.*) A considerable amount of large steamer traffic now goes up and down the harbour to the Sugar Company's wharf at Chelsea (forty-nine steamers in 1920). (*b.*) There is a possibility that the portion of the harbour-front between Chelsea and Kauri Point may be required in the future as a naval coal-depot, in which case large-steamer traffic up the harbour would be much increased. (*c.*) In view of deep water obtaining close inshore from Chelsea to and above Kauri Point, and the fact that the Harbour Board own a large area of land abutting on the waterfront there, nothing should be permitted that would prevent the practical use of such deep-water frontage. (*d.*) Any bridge to be erected so as not to interfere with the traffic should have at least 80 ft. to 100 ft. clearance above high-water level, or else should be provided with a movable span of ample width, to permit of the passage of large vessels. (*e.*) If a bridge has to be constructed, site A is the most suitable as interfering to the least extent with the traffic of the port.

Site A, considered as the site of a bridge to afford rapid access between Auckland City and the suburbs of Birkenhead, Northcote, Takapuna, and Devonport, would be practically of little value, but it would give a more direct and shorter railway and road route to the country north of Auckland. The saving in length, assuming the construction of a new railway-line to join the existing line at or near Kaukapakapa, is stated to be some 18 miles as compared with the existing railway via Helensville to the north; but, in the absence of any surveys or definite information having been put before us, we are unable to say if the saving would be as is stated, or whether such a line is practicable from the point of view of gradients and other engineering considerations. As the traffic that will be brought into Auckland when the North Main Trunk line is completed and connected with Whangarei will be considerably increased in volume, we suggest that the routes from Kauri Point and from Northcote to Kaukapakapa, or other suitable point, on the existing northern line should be surveyed and investigated, as it may be found that, even if saddled with part of the cost of a bridge across the Waitemata, such a route, by reason of its saving of distance, opening up of a new suburban district, and obtaining better grades and alignment, might be worthy of consideration in preference to undertaking heavy works for the improvement of the existing route through Helensville.

As a means of giving access to the rapidly-growing suburbs on the north side of the harbour, a bridge on site B offers much greater facilities than one on site A, although, to make it of value to Devonport and the district lying between that borough and Takapuna, there would be required very considerable additional

expenditure to construct approach roads across the shallow portion of Shoal Bay to connect Northcote with O'Neill's and Stanley Points. Even if the bays were cut off by the construction of such roads, the distance from Queen Street to the centre of Devonport by way of a bridge on site B would be between 6 and 7 miles, as compared with a little over 2 miles by the present ferry service. A scheme was submitted for the formation of such access across both branches of Shoal Bay for the purpose of connecting Birkenhead, Takapuna, and the northern portion of Devonport. We are of opinion that some such scheme of forming roads carrying tram services would be an essential adjunct to the bridge, but that these works should be designed and executed so as to reduce as little as possible the tidal compartment of the harbour.

Notwithstanding the objections that can be justly made as to interference with the full use of the harbour if a high-level bridge were constructed on site B, we are of opinion that unless the exigencies of the Railway service demand that site A must be chosen for the bridge, site B is the site most suited for a connection across the Waitemata, and that the inconvenience to the shipping if a large-span high-level bridge were built would have to be borne, in view of the public convenience.

Site C does not appear to us to be worthy of consideration, because of the great difficulty and enormous cost that would be involved in obtaining access to and constructing approaches to a high-level bridge from the Freeman's Bay site, and a low-level bridge could not be entertained owing to interference with the shipping.

For a roadway-bridge, with provision for carrying tramways, upon site B, the estimate shows that the cost would be approximately £950,000. Present-day prices for labour and material have been adopted in estimating, but if there should be any considerable reversion to pre-war conditions, then a corresponding reduction in cost might be expected.

If provision be made for a single line of railway in addition to the roadway and tramways on the bridge, the cost on site B would be raised to not less than £1,500,000.

Upon site A the estimate for a combined bridge to carry a single line of railway as well as a roadway shows that the cost could not be considered as less than £2,000,000.

In view of the probability of a main arterial road being constructed from some point near Northcote to the far north, and also in view of the advent of increased electric current for tramway-extension purposes, we are inclined to the opinion that a bridge erected on site B, constructed to carry a single line of railway with a roadway above the line of rails, having a width of 40 ft. and with provision for a double track of tram-cars, would probably be the scheme best suited to all the conditions. Such a bridge, exclusive of road approaches and of the tramways and railway, might be erected at a cost which for the purpose of this inquiry should not be taken at less than £1,500,000.

The cost of management, maintenance, and upkeep on such a bridge would be a fairly heavy one, probably 1½ per cent. on the total cost; and, assuming that the money could be borrowed at 6 per cent., with a sinking fund of ½ per cent., the annual charge would amount to £120,000. This sum would have to be obtained partly from special rates struck over the area to be benefited, and partly from such moneys as might be derived from tolls on vehicular, tramway, and railway traffic.

However desirable it is from many aspects to construct a bridge over the Waitemata, the expediency must be judged by the question as to how the annual charges can be met. Whilst some evidence was tendered from residents on the northern side of the harbour of their willingness to be rated in proportion to the benefits they would derive, no material evidence was received from the citizens of Auckland in support of the proposal, and it is therefore reasonably assumed that they do not look for any substantial benefits to be derived by them from the construction of a bridge, and consequently would not be willing to be rated for it.

The population of the boroughs of Northcote, Birkenhead, Takapuna, and Devonport may be put down at 17,000, and the scattered country population

within a radius of 20 miles north of the bridge may be roughly assessed at 4,000, making 21,000 in all resident to the north of the bridge who would be benefited by its construction. Of this number it may be safely assumed that not more than two-thirds, or 14,000 persons, in these districts would be directly benefited to an extent assessable by any system of taxation. A more difficult question to determine would be the extent to which residents on the south of the bridge would be benefited to a taxable extent. Probably the number of such individuals would not exceed 10 per cent. of the population, or, say, 10,000, who would be likely to derive any actual advantage over and above what they now possess from the present ferry services; but as such individuals would be resident in scattered districts there would seem to be no direct method of taxing them as apart from a general rate over a large district.

There remains a large proportion of the total population of Auckland and neighbourhood, and of the country lying farther north, which would be benefited in a greater or less degree by direct through communication if a main arterial road and a direct railway route should be constructed.

The total capital value of Auckland City and the boroughs of Newmarket, Onehunga, Mount Albert, and Mount Eden, according to the 1920 Year-book, amounts to £30,827,465. The capital value of the four North Shore boroughs of Devonport, Takapuna, Northcote, and Birkenhead amounts to £3,694,531. The capital value of the country lying to the northward and likely to be more or less benefited by bridge communication may be roughly assessed as an additional £3,500,000. In all, the capital value of the total area likely to be affected may be assumed to be not less than £38,000,000. Any rating would necessarily be roughly proportional to the benefits likely to be gained; and, assuming that the proportions would be approximately in equal shares of unity, two-thirds, one-third, and nothing, then by a unit rate of 1d. in the pound annually there would be produced—

	£
1d. in the pound on £9,500,000	39,583 per annum.
$\frac{2}{3}$d. in the pound on £9,500,000	26,388 per annum.
$\frac{1}{3}$d. in the pound on £9,500,000	13,194 per annum.
Nil in the pound on £9,500,000	Nil.
	£79,165, or, say, £80,000.

The balance to make up the annual charge of £120,000, or £40,000, would have to be derived from the Railway Department, from a contribution from the tramways, and from charges or tolls upon vehicular traffic.

We have insufficient data before us on which to form anything more than rough estimates, but it appears to us to be fairly obvious that a maximum rate of 1d. in each pound of the capital value would be considered excessive in proportion to the benefits to be derived. It is impossible for us to say to what extent it would repay the Railway Department to contribute a large sum towards the cost of the bridge, how far it would suit Auckland City to contribute for the purpose of obtaining tramway communication to the northern suburbs, and whether the population of the districts affected, taken as a whole, would consent to being rated to anything like the extent that would be necessary.

As the prospect of the construction of such bridge appears to be remote, we have not proceeded with the inquiry, particularly as the final decision must rest with the ratepayers, and could only be determined by submitting the question to a poll based upon some definite scheme complete in all its details, and including the whole development and lay-out of the suburban districts on the northern side of the Waitemata.

Summary of Conclusions.

Having dealt with the inquiry as a whole, we now reply specifically to the questions set before us.

(1.) *What should be the route or routes of one or more canals?*

We recommend—

(*a.*) That a barge-canal should be constructed by the Auckland Harbour Board, by the Tamaki route, between the Waitemata and Manukau Harbours, and that the waters of the Manukau Harbour east of the Mangere embankment and bridge be impounded:

(*b.*) That the route for a barge-canal, or joint barge-canal and barge-railway, to connect the Manukau Harbour and the River Waikato, be by the Waiuku arm of the Manukau, which should be impounded at the Needles; that this canal should connect with the Awarua Creek (which should be improved), thus giving access to the northern channel of the River Waikato:

(*c.*) That the route for the connection of the River Waikato with the Hauraki Gulf by a canal should be by the Mangawara Creek and Piako River.

(2.) *The dimensions of these canals, and the class of vessels to navigate them.*

(*a.*) The Tamaki and Waiuku canals should be suitable to carry barge traffic and small towing steamers and launches. The canals should have a depth of 6 ft., with a bottom width of not less than 30 ft., and with such side slopes as the quality of the ground passed through will require or permit. The locks should have a depth on the sills of 8 ft. (so as to permit of future deepening of the canals to that depth) and a clear width of 30 ft., with a length of 150 ft. inside the gates.

(*b.*) If a barge-railway be adopted across the Waiuku Hill, it should be made capable of taking barges having a gross weight of 100 tons.

(*c.*) The Mangawara canal (if and when constructed) should be 30 ft. wide at the bottom, and have a water-depth of 8 ft., with a view to carrying steamers of the class navigating the Piako River and barges of a size and character capable of being towed across the Thames Gulf. The locks should have a clear length of 350 ft., with a width of 30 ft., and a depth on the sill of 8 ft.

(3.) *The character and quantity of probable traffic thereon, and the revenue to be derived therefrom.*

(*a.*) On the Tamaki canal the traffic would include not only through traffic from the Waikato via the Waiuku canal, but also a considerable volume of goods of all classes sent from the Waitemata for transhipment at the Onehunga Wharf to steamers trading out of the Manukau Harbour, and, in addition, a considerable future traffic to arise from industries situated on the water frontages of the proposed impounded area east of the Mangere Bridge. We have had insufficient reliable data placed before us to determine the quantity of the traffic that would pass through this canal or the revenue to be derived therefrom. We are, however, satisfied that at a cost not exceeding £300,000 the construction of the link to connect the two harbours now under the jurisdiction of the Auckland Harbour Board is justified.

(*b.*) Through the Waiuku canal or over the barge-railway, if constructed, there would be carried coal in considerable quantities, particularly from mines to be developed on the western side of the Waikato and Waipa Rivers. There would, in addition, be agricultural produce from the Waikato to Auckland, and in return heavy goods, including manures, iron, and other requirements of the farmers on land served by the Waikato River and its tributaries, and a considerable quantity of the goods required by the residents in the towns. We are unable to reduce to figures the quantty of the probable traffic on this proposed canal or to furnish any figures as to the revenue to be derived therefrom.

(*c.*) If the Mangawara–Piako canal were constructed there is no doubt that large quantities of coal would be carried through it from the Waikato mines to all the districts abutting on the Hauraki Gulf and the Waitemata Harbour. As the navigation of the River Waikato above the junction of the Mangawara Creek is excellent, there is little doubt but that a steamer connection with Auckland for the carriage of goods would be at once constituted, but it is not possible to determine at present the quantity of traffic or the revenue likely to be derived therefrom.

(4.) *The estimated cost of works considered necessary.*

If the schemes eventuate we estimate the cost to be :—

	£
(*a.*) Tamaki barge-canal between Waitemata and Manukau Harbours	300,000
(*b.*) Waiuku barge-canal between Manukau Harbour and the Waikato River	475,000
In the alternative, the Waiuku barge-canal and railway	300,000
(*c.*) Mangawara–Piako small-steamer canal between the Rivers Waikato and Piako	1,000,000

(5.) *The working-expenses of these canals, including maintenance, interest, and sinking fund.*

We report that in the absence of data and other conditions relating to the trade of the canals we are unable to determine what the working-expenses would be likely to be. In respect to maintenance, we estimate the maintenance of canals at 1 per cent. per annum on the capital value. We advise that ½ per cent. per annum is sufficient for sinking fund.

(6.) *What effect the construction of a canal or canals will have upon the revenue of the Government Railways.*

We are of opinion that the construction of canals upon the routes suggested would not adversely affect the net railway returns, but would in some cases add thereto.

(7.) *The contingent works necessary to enable the canals to be fully developed and used, such as roads, railways, wharves, and stores.*

We have in our estimates for the construction of the canals included the roadworks and wharves necessary for the working of such canals. We are of opinion that no alterations to the railway system would be required at first, and the extent of the provision for stores could only be determined as the traffic developed.

In the event of the Mangawara–Piako canal being carried through, the railway, where it crosses the creek, would have to be raised to an extent sufficient to give head-room for navigation thereunder of the vessels that would be using the canal.

(8.) *As to the form of control or management of any such works as the Commission may recommend.*

(*a.*) The control of the Tamaki canal should be undertaken by the Auckland Harbour Board.

(*b.*) If the Waiuku canal or barge-railway be constructed, then the control should likewise be vested in the Auckland Harbour Board.

(*c.*) If the Mangawara–Piako canal be constructed, its control between the Waikato River and its junction with the Piako River should be placed under the River Conservation Board herein described for the control of the Waikato River.

(*d.*) We are of opinion that all works connected with river-improvement, flood protection, and drainage within the Waikato basin should be placed under the control of a special Waikato River Conservation Board, to have the constitution set out hereinbefore and be subject to the Minister of Public Works.

(*e.*) In view of the fact that the scheme for a bridge across the Waitemata is not likely to be proceeded with for many years to come, we consider it premature to formulate any system of control, and therefore make no recommendation.

(*f.*) If the Mount Rex–Helensville river-improvement be carried out, the control and management should remain as at present under the Marine Department.

(9.) *As to the finance, construction, and maintenance thereof.*

(*a.*) We are of opinion that the Tamaki canal should be financed, constructed, and maintained by the Auckland Harbour Board. We have indicated in the body

of the report a direction in which it is believed that the cost of the canal can be largely covered through a scheme of reclamation.

(*b.*) In respect to the Waiuku canal or barge-railway, as our opinion is that the time is likely to be very remote when such a project would be economically successful, we prefer not to express now any views as to how the works should be financed, but think that the construction and maintenance would be best under the control of the Auckland Harbour Board.

(*c.*) The construction of the Mangawara–Piako canal is so remote that we deem it unnecessary to report as to the methods of financing the project or as to its construction and maintenance.

(*d.*) The works of improvement of the Waikato River and its tributaries should be financed by the security of rates, to be levied over such areas within the four counties of Franklin, Raglan, Waipa, and Waikato as may be determined to be affected.

So far as the experimental work in the construction of groynes as recommended by us is concerned, the Government might assist by a subsidy of £1 for £1 up to, but not exceeding, £5,000. We advise that after the experimental works have been proved to be successful the whole of the cost of any further extensions should be borne by the districts to be benefited.

The construction and maintenance of all works within the watershed of the Waikato River and its tributaries should be under the control of the River Conservation Board that we recommend in the body of the report should be formed.

(*e.*) The same reasons which cause us in the previous paragraph to report that it is premature to deal with any scheme for control of the proposed Waitemata Bridge govern the questions of finance, construction, and maintenance thereof.

(*f.*) It is recommended that the necessary legislation be enacted to enable the Marine Department to do the Mount Rex–Helensville river-improvement works and to enable the local authorities bordering on the Kaipara Harbour to provide, subject to a vote of their ratepayers, the interest and sinking fund on the cost of the work.

(10.) *As to whether any concession should be granted by the General Government or local governing authorities.*

We see no present reason why concessions should be granted to any person or corporation in connection with any of the works that are the subject of this inquiry, but if at any time hereafter any proposals are made, we are of opinion that they should be considered on their merits.

(11.) *As to whether the adjacent districts should be subject to rating to provide a guarantee for loans which might be necessary to provide funds for construction purposes, and as to whether those districts should be rated to provide for losses in working.*

(*a.*) We have already recommended that the construction and working of the Tamaki canal be a charge upon the revenues of the Auckland Harbour Board.

(*b.*) In respect to the Waiuku canal, the Mangawara–Piako canal, and the Waitemata bridge, as the construction of these works is so remote, we deem it unnecessary at the present time to answer the above question.

(*c.*) In respect to improvement-works on the Waikato River and its tributaries, we are of opinion that any losses in connection with these works must be borne by the districts rated.

(12.) *As to the effect which the construction of canals or the improvement of existing waterways from a traffic point of view may have upon the drainage of any existing swamp lands and on lands adjacent thereto.*

None of the works considered by us, if carried out in a proper manner, should have any detrimental effect upon the drainage of lands adjacent thereto.

(13.) *The improvement of the navigation of the Waikato River and its tributaries, the effect on such rivers and on the adjacent swamp lands of the improvement works proposed or already executed by the Waikato River Board, and generally as to the navigation of those rivers.*

We recommend that in that portion of the River Waikato between Huntly and Meremere experimental work should be carried out on the lines already described, and that the Waipa River and all the navigable creeks running into the Waikato be improved by snagging, dredging, and willow-cutting.

We are of opinion that the works carried out by the Waikato River Board have had the effect of very slightly raising the level of the river-surface for some short distance above their groynes, but that such raising has not had any material result upon the adjacent swamp lands.

The works of the Waikato River Board have not in the slightest degree affected the drainage of the Whangamarino and Maramarua Swamps, and, as they have not improved either the navigation or the drainage, the money spent thereon has been wasted.

We think it possible that with an expenditure that should not be excessive an improvement in the navigation of the shallow portions of the river above Mercer may be effected sufficient for the summer traffic of vessels drawing up to about 4 ft. loaded. In respect to a length of about 7 miles of navigation within the delta, we advise that it would be unwise to make any expenditure therein, and that the navigation of this portion of the Waikato River must continue to be tidal during the summer season.

(14.) *Whether a bridge should be constructed across Waitemata Harbour to connect the City of Auckland with the northern district.*

We are of opinion that with the present population the expenditure that would be necessary is not justified.

General.

We were also required to report generally upon such other matters as might come before us in the course of our inquiries, and consequently make the following recommendations :—

1. That self-recording gauges be erected at various points within the Waikato basin, with the object of affording data (*a*) as to the changes of level of the river and its discharge, (*b*) as to the rainfall ; and that these gauges be installed at the expense of the Government.

2. That the Waikare Drainage Board be not permitted to construct any works that will have the effect of preventing the district from acting as a flood-water relief reservoir to the Waikato River until full information and data have been obtained and the effect of the proposals upon the flood river-level has been carefully investigated.

3. That investigations should be instituted as to the possibility of regulating and controlling the discharge from Lake Taupo into the River Waikato, with the object of equalizing the flow throughout the year so as to partially reduce the flood-levels and to provide an increased water-depth during the summer. We are of opinion that this work is one of national importance and should be undertaken by the Government.

4. That the removal of material from the centre of the River Waikato should be encouraged and no royalty charged thereon.

5. That the existing Waikato River Board should be abolished and a Waikato River Conservation Board be constituted ; that the existing debt of the present Board remain a charge upon the districts now responsible therefor.

6. That groyne B across the entrance to the north channel through the delta of the Waikato River be forthwith removed.

7. That flying surveys be made from Kauri Point and Northcote to the Main Trunk line near Kaukapakapa, with the view of determining the feasibility of a railway connection.

Mr. James Begg wishes it to be recorded that, not having professional engineering knowledge, he has accepted the technical details provided by the two engineering members of the Commission.

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, &c., illustrating our report [evidence and plans not printed] :—

(1.) Locality-plan, marked M.D. 5354/A.
(2.) Plans and sections of a proposed Waitemata–Kaipara canal : M.D. 4452, 4453.
(3.) Plan of proposed cuts in Kaipara River : P.W.D. 22,582.
(4.) Book entitled "Proposed Waitemata–Manukau canal," published by the Auckland Harbour Board in December, 1908, and containing lithographed plans and sections relating to the Whau and Tamaki canals.
(5.) Plans and sections of a proposed Tamaki–Manukau canal : M.D. 4450, 4451.
(6.) Plans and sections of a suggested Waiuku–Waikato canal : M.D. 4454.
(7.) Plan and section of suggested Waiuku–Waikato canal or alternative barge-railway, dated 1921 : M.D. 5354/B.
(8.) Plans and sections of a suggested Mangawara–Piako canal, with details of improvements in the Piako River : M.D. 5354/C.
(9.) Plans and sections of proposed drainage-works for the Mangawara River Board, prepared by H. R. Young, Esq., Assoc.M.Inst.C.E. : M.D. 5354/D.
(10.) Set of plans and sections relating to the Waikato River and suggested improvement, including a hydrograph of the river-flow at Mercer, and sketch-plan of suggested permeable groynes : M.D. 5354/E.
(11.) Diagram showing river-gaugings at Mercer, prepared by W. H. Hamer, Esq., M.Inst.C.E. : M.D. 5354/F.
(12.) Survey of lower portion of Waikato River, made in 1862 : M.D. 5354/G.
(13.) Plans and levels of Waikare Lake district, prepared by J. B. Thompson, Esq., Chief Drainage Engineer, Lands Department : M.D. 5354/H.
(14.) Plans and sections of suggested bridge across the Waitemata Harbour : M.D. 5354/I.

We also forward the attached appendices :—

A. Copy of letter from Secretary, Auckland Harbour Board, dated 11th May, 1921, containing resolutions passed by the Board.
B. Statistics furnished by the Railway Department.

We return herewith Your Excellency's Commission.

Given under our hands and seals, this 25th day of August, 1921.

WILLIAM FERGUSON, Chairman.
ASHLEY HUNTER,
JAMES BEGG, } Commissioners.

APPENDICES.

APPENDIX A.

Auckland Harbour Board, Auckland, 11th May, 1921.

The Secretary, Auckland Canals and Waterways Commission,
30 Aurora Terrace, Wellington.

DEAR SIR,—

With reference to the evidence which was given by the Chairman of the Board to the Commission during its sittings in Auckland, and his promise that the whole question would be considered by the Board, I have the honour to inform you that the Board in Committee sat yesterday afternoon and passed the following resolutions :—

1. That when prices of material and other economic features have become more normal than at present, connection between the Waitemata Harbour and Waikato River for carrying barge traffic capable of plying on that river should be made for the purpose of opening up transport facilities for the rapidly growing trade between Auckland and the country tapped by the Waikato River and its tributaries, in the interests of both the city and the country districts affected.

2. That the connection between the Waitemata and Manukau Harbours be by barge-canal and two locks, on what is known as the Tamaki route at Otahuhu, giving access at all states of the tide on the Tamaki side, and for about two hours before and after high water on the Manukau, to barges capable of plying on the Waikato River.

3. That if the construction of a canal between the Manukau and Waikato at Waiuku is, by reason of the cost, not warranted, the connection be made by a line of railway with cradle trucks to carry standard-sized barges, with a weight loaded of, say, 100 tons, and with terminal slipways going below low-water level to enable barges to float on and off.

4. That the Board believes that with the present rate of progress of the trade of the province, and particularly of the wealthy Waikato district, and the coal deposits in the Waikato Valley, a reasonable estimate of the trade which would be carried over the routes after, say, the first year following construction would be 100,000 tons per annum, with steady increase.

5. That if and when the cost of the connections between the Waitemata and Waikato should be made for a sum in the neighbourhood of £300,000, and assuming the cost of works in the Waikato River would not render dues on that river *unduly prohibitive*, the prospect of trade would warrant the construction of the communications, and the dues for the use of the works could reasonably be met after, say, two years by the traffic which would be carried.

6. That with regard to control, the Tamaki canal should be constructed and controlled by the Auckland Harbour Board, as the Waitemata and Manukau Harbours are both within the jurisdiction of the Board; that the connection between the Manukau and Waikato should be constructed and controlled by the Board; but, seeing the benefit the district served by the Waikato River would derive from the barge communication with Auckland, and that the districts served by the Waikato are now represented on the Auckland Harbour Board, then, upon communication with the Waikato being established as proposed, the Auckland Harbour Board should have at least one representative on the Waikato River Board.

7. That the Auckland Harbour Board should have rating-powers in order to provide interest and sinking fund on any loan raised, and for the purpose of providing security for the loan, and should also obtain a Government grant in aid; that the rating-area should include the districts as present represented on the Board on a classification basis; such portion only (if any) of the rate being collected each year as is necessary to meet any loss till the works become self-supporting.

8. That the Board does not consider there is anything at present to warrant the view that the cost involved on the construction of a canal between the Manukau and Waitemata Harbours suitable for ocean-going vessels capable of crossing the Manukau bar would have any chance of being remunerative.

9. That, owing to the demand for transit facilities to meet the growing trade of the Auckland–Waikato district, it is considered that the construction of barge communication with the Waikato will not detrimentally affect the trade of the Government railways.

I enclose also for your information statements regarding the trade of this port during the past ten years which were placed before the Board yesterday, and which it was considered might be of use to the Commissioners in compiling their report.

Yours, &c.,
H. B. BURNETT, Secretary.

APPENDIX B.

[*Statistics supplied by Railway Department.*]

TARIFF RATES FROM AND TO AUCKLAND STATION.

(April, 1921.)

To	A.	B.	C	D.	E.	F.	H.	K.	M.	N.	P.	Q.
Mercer	28/2	23/6	19/10	15/8	6/11	21/9	3/3	2/–	26/6	8/8	6/9	4/10
Rangiriri	34/6	29/4	25/2	18/11	8/–	25/–	4/4	2/4	33/	10/4	8/1	5/11
Huntly	38/3	32/4	27/5	21/2	8/9	27/3	4/7	2/7	37/6	11/1	8/8	6/6
Taupiri	40/2	33/10	28/8	22/4	9/2	28/6	4/9	2/9	40/–	11/6	9/–	6/8
Ngaruawahia	41/6	34/10	29/6	23/–	9/4	29/6	4/11	2/11	41/4	11/10	9/3	6/10
Horotiu	42/10	35/10	30/2	23/8	9/6	30/6	5/–	2/11	42/8	12/1	9/5	7/–
Frankton Junction ..	45/2	37/7	31/4	24/7	9/10	32/3	5/3	3/–	45/–	12/4	9/8	7/4
Hamilton	45/–	37/10	31/6	24/9	9/10	32/6	5/3	3/–	45/4	12/5	9/8	7/4
Cambridge	49/7	41/8	33/9	26/8	10/6	36/3	5/8	3/2	50/3	13/–	10/2	8/–
Te Awamutu	49/4	41/6	33/7	26/6	10/5	36/–	5/7	3/2	50/–	13/–	10/2	7/11
Onehunga Wharf ..	4/3	4/3	4/3	4/3	4/–	9/–	..	0/8	15/–	3/6	2/6	1/9

Each rate is subject to 40 per cent. additional, with the exception of—Class K, which is subject an increase of one-seventh; flour, which is subject an increase of 10 per cent.; sugar, which is subject an increase of 10 per cent.; wheat, which is subject an increase of 20 per cent.; and fresh meat and fish, which is subject an increase of 10 per cent.

SUMMARY OF GOODS TRAFFIC AT AUCKLAND STATION FOR THE YEAR ENDING 31ST MARCH, 1921.

Outward.

Station.	Cattle.	Pigs.	Timber.	Minerals.	Other Goods.	Carriage.			Wharfage.		
	No.	No.	Sup. ft.	Tons.	Tons.	£	s.	d.	£	s.	d.
Mercer	2	..	23,500	25	1,153	1,202	14	5	49	1	3
Huntly	13	..	76,700	43	5,569	7,963	19	6	..		
Taupiri	5	..	13,900	85	1,895	2,370	10	1	..		
Ngaruawahia	2	..	140,800	132	2,605	4,996	19	8	..		
Frankton	12	2,619	34,000	730	6,400	10,281	11	11	..		
Hamilton	1	..	406,000	2,173	16,942	33,315	12	8	..		
Cambridge	17	..	429,100	1,869	8,411	18,099	3	3	..		
Te Awamutu	4	..	212,500	305	5,610	10,833	16	3	..		
Onehunga Wharf	2	..	85,300	6,786	16,831	6,059	14	0	420	2	8

Inward.

Station.	Cattle.	Sheep.	Pigs.	Timber.	Minerals.	Other Goods.	Carriage.			Wharfage.		
	No.	No.	No.	Super. ft.	Tons.	Tons.	£	s.	d.	£	s.	d.
Mercer	6	39	..	2,455,100	1,899	2,442	5,833	0	7	174	5	0
Huntly	7	..	..	..	70,141	319	31,453	13	2	..		
Taupiri	..	..	..	2,000	..	788	1,136	1	4	..		
Ngaruawahia ..	8	30	68	4,300	9,590	8,907	20,197	6	4	..		
Frankton ..	27	..	..	4,000	..	2,337	4,337	13	6	..		
Hamilton ..	48	58	..	42,700	813	4,668	8,235	3	2	..		
Cambridge ..	11	120	..	18,000	8	389	702	2	6	..		
Te Awamutu ..	16	..	..	2,000	..	732	1,253	5	5	..		
Onehunga Wharf ..	..	..	..	128,400	4,208	6,084	1,992	2	4	361	14	11

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