1908.

NEW ZEALAND.

POLLUTION OF THE KAIKORAI RIVER AND THE DRAINAGE OF THE KAIKORAI VALLEY

(REPORT BY COMMISSIONER SHORT ON THE).

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

REPORT.

Department of Roads, Wellington, N.Z., 4th July, 1908.

To His Excellency the Right Hon. William Lee, Baron Plunket, Knight, Governor and Commander-in-Chief in and over His Majesty's Dominion of New Zealand.

MAY IT PLEASE YOUR EXCELLENCY,—

I have the honour to submit for Your Excellency's consideration the following report on the subject of the pollution of the Kaikorai Stream and the drainage of the Kaikorai Valley, pursuant to the terms of a Commission issued under the hand of Your Excellency in Council and dated the 23rd May, 1908.

This Commission instructs me to report upon the following matters, viz. :—

I. The pollution of the Kaikorai River;
II. The best means of preventing such pollution;
III. What authority should be set up to carry out such means of prevention; and
IV. How the cost of any works to be carried out should be apportioned among the several local authorities interested in the matter.

It appeared from the departmental papers handed to me by the Health Department that the following local authorities, &c., were interested in this matter — viz., Taieri County Council; Dunedin City Council; Dunedin Drainage Board; the Green Island, Mornington, Roslyn, and Maori Hill Borough Councils; and the Health Department—and all these parties were therefore cited to appear at the Arbitration Court, Dunedin, on the 24th June last, on which date the inquiry was commenced, and the parties were all represented. The inquiry was concluded on Tuesday, the 30th June; but before it was commenced I went with Dr. Ogston, the local Health Officer, over the ground, and both at that time and subsequently I saw the state of the stream. A large amount of evidence was given at the inquiry by or on behalf of the local authorities, and also by persons who are interested in the principal industries carried on in the Kaikorai Valley.

The parties to the inquiry were represented as follows :—

Taieri County Council, by Mr. Hosking, K.C.

Dunedin City Council, by Mr. Richards and also by Mr. J. MacGregor, solicitor.

Dunedin Drainage Board, by Mr. Gore and also by Mr. Stevens, solicitor.

Green Island Borough, by Mr. Geddes, Mayor.

Mornington Borough, Roslyn Borough, and Maori Hill Borough, by Messrs. Duncan and MacGregor, solicitors.

Health Department, by Dr. Ogston.

A copy of the notes of evidence and of the contentions of parties will be found in the addendum to this report.

The facts of this case will be fully set forth in dealing with each of its four divisions, and as this report must (in the nature of the case) be somewhat lengthy I will without further remark now deal with each division separately.

Division I.—The Pollution of the Kaikorai River.

The Kaikorai River is a small stream that takes its rise from several places in the high lands at the head or sides of the Kaikorai Valley. The main stream commences in the hills near the Dunedin Asylum grounds, and it flows down a subsidiary valley until it is joined, not far from Ross and Glendining's Roslyn Woollen-mills, in the Borough of Roslyn, by another branch of the stream that takes its rise within or in the vicinity of the Boroughs of Mornington and Maori Hill. The stream then flows right down the valley until it loses itself in a swamp that exists in the vicinity of the Borough of Green Island; and the waters from the swamp ultimately discharge themselves into the sea, which is separated from the swamp by a belt of shifting sand. The position of the river and its tributaries is shown on the map included in the addendum to this report (Exhibit I).

The main branch of the river, from the Asylum grounds to where it is joined by the other branch from Maori Hill, &c., near the Roslyn Mills, is comparatively pure and clean. It may not be sufficiently pure for human consumption, as there are some houses not far from its banks, and cattle graze in the adjacent paddocks along part of its course; but it is no doubt pure enough for all necessary purposes other than for human consumption. I saw it after several days' continuous rain, and even then it was almost colourless; but the tributary that joined it from the vicinity of Maori Hill was very dirty, thick, and filthy, and from the point where this tributary joins the main stream, near the Roslyn Mills, right down to where it loses itself in the swamp near the sea, it is nothing but an open sewer carrying sewage, factory refuse, and filth of all descriptions, which are, I should consider, highly detrimental to health, and which are likely to lead to very serious results should an epidemic start in the vicinity. It is, however, right to say that no evidence was adduced to show that any serious outbreak of disease had so far been traced to the stream; but evidence was brought which amply proved the filthy condition of the stream. It was also proved that its filthy condition and the foul smell that sometimes comes from it in the Green Island Borough have a very prejudicial effect on the value of land in that district.

It was also proved that the dirty water of this stream is used over and over again for manufacturing purposes, and I can only assume that the various chemical substances which are used in the process of manufacture check and neutralise to some extent the noxious bacterial life that must otherwise exist in the water and which is inseparable from the filth that enters it. Otherwise it is very difficult to understand why a serious outbreak of malignant disease has not already been caused by the conditions of things at present existing.

The following brief statement will show how the stream becomes polluted, and why it is so difficult to prevent its pollution.

The stream was in years gone by of greater volume than it is at present. The loss of volume may be easily accounted for by the destruction of forest at

the head of the valley, and also by the fact that many of the manufactories on its banks use some of the water for steam purposes, which water is of course not returned to the stream. The Kaikorai Valley is within very easy reach of Dunedin. The main railway system passes across the bottom of the valley, and probably coal is cheaper here than at any other place in the Dominion; and, as the stream supplies a considerable quantity of water suitable for manufacturing purposes, the valley is looked upon as a favourable place where certain industries can be conveniently located. There are now many important industries in this valley, and as time goes on there will probably be very many more. It is probably the largest manufacturing centre in the Dominion; the stream is essential to its prosperity, and anything that can reasonably be done to improve the purity of the water in the stream will assist that prosperity.

These industries consist of the Roslyn Mills, several wool-washing establishments, some tanneries, a gut-factory, iron-rolling mills, large chemical works, a big fat-rendering establishment, slaughtering and freezing works, flour-mills, Dunedin City Abattoirs, and cement-works (just starting), and other works, most of which use for some purposes the water of the stream.

The causes of the fouling of the stream are as follow :—

1. There is at present no drainage system, other than street-surface drainage, in the portions of Maori Hill, Mornington, Green Island, and Roslyn Boroughs that are within the watershed of the Kaikorai Valley, and there is also a considerable population in these districts, especially on the hills and at the upper end of the valley.

2. The surface and rain water from these places that is not evaporated by the atmosphere or absorbed by the ground finds its way by the street drains into the stream; and, as this surface water contains house-slops, droppings of animals on the roads, drainage of all descriptions, and all sorts of impurities, the condition of the water when it reaches the first wool-washing factory in the Borough of Roslyn (above Ross and Glendining's mill) is of a very filthy character.

3. A large quantity of this polluted water is used in the first wool-scouring factory on the stream, and after such use the water is returned to the stream; consequently when it leaves this factory it is still further polluted. It then reaches Ross and Glendining's mill, after it has joined the main stream, which main stream of course dilutes it. Ross and Glendining's mill has a separate water-supply of its own, but, as this is not sufficient for all its purposes, it also uses large quantities of the water of the Kaikorai Stream for wool-washing, dyeing, and other purposes; but a large proportion of the water from their own supply, as well as a great deal of what is taken from the stream, is placed in it or is returned to it after it has been used. The woollen-mill owners make some endeavour to purify the water before returning it to the stream. This is done by means of settling-tanks and filter-beds; but it was admitted by the mill people themselves that they cannot get all the dye out of the water, and they also admitted that the urinals and water-closets of their six hundred workpeople empty into a cesspit, the effluent from which discharges into the stream.

4. As one gets further down the valley there are other wool-washing factories and tanneries and a gut-factory, in all of which the water is used and most of it is returned to the stream. I visited one of these tanneries and found a primitive sort of settling-pit, intended to arrest the more solid particles of matter that might be held in solution, after which the water was allowed to enter the stream; but the water was of a dark-brown colour, with an ill-looking scum on top.

5. Further down the stream the water is used in connection a tallow-factory. Some of the water which is used there is placed in a "digester," and the filthy liquid coming therefrom (technically known as "soup") is pumped on to some hills adjacent and allowed to flow over the land; and it is apparent that even if none of it finds its way back again into the creek, the rain must wash a good deal of the filth into the creek. It was admitted that the decaying matter on

the ground emitted " a vile smell," and as the soil is mostly stiff clay, it would appear that it has very little deodorising or absorbent effect upon the " soup."

6. Some of the water is similarly used and pumped up as " soup " on to the hills by the freezing company in the same way as in the case of the tallow-factory; and it was admitted that a lot of the water is used to wash down the premises and slaughteryards, and that when this is done the water flows back again into the stream with all the impurities it has gathered and which may not have been stopped by settling-tanks.

7. The water is also used for the purpose of washing down the premises of the Dunedin City Abattoirs; but in that case a more elaborate method is used to try to purify the water. In these works the water is treated by steam, for the purpose of coagulating the blood it contains, and it is also chemically treated and made to pass through settling-pits and through a series of filter-beds. This rids the water of a good deal of its impurity, but when I saw the effluent emerging from the last filter, just as it passed again into the stream, it was hot and of a brown colour, and looked like beef-tea or thin soup, but it is probable that it was sterile. Both the freezing-works and the abattoirs have an independent supply of clear water for the purposes of washing the carcases, &c., but this supply is insufficient for all purposes, and they have to use the stream-water as already indicated.

8. The water of the stream is used for steam or condensing purposes at a flour-mill and also at Kempthorne and Prosser's chemical-works. It is not contaminated by these processes, as what is used for steam becomes evaporated, and what is used for condensing purposes is practically returned to the stream in the same state of purity or impurity which it had when taken therefrom; but evidence was given that the water is sometimes almost too bad for steam purposes.

The stream is still further polluted by surface and household drainage from the Green Island Borough. They have no proper system of drainage, and all slops and other liquid refuse, except nightsoil, are thrown out on to the ground, and some of it, no doubt, finds its way into the stream.

It is alleged that some of the factories are in the habit of turning the filth from their settling-pits into the stream on Saturdays and Sundays, as the smell and condition of the stream at these times is alleged to be worse then than at any other time, but no definite proof of this was given.

It will be seen from this statement that the stream is a polluted stream, and that it is high time something was done to purify it.

Division II.—The best Means of preventing such Pollution.

A great deal of evidence was given on this subject, and it appeared that for several years past efforts have been made to devise some scheme of drainage that would be satisfactory to the various interests concerned; but, so far, no scheme has been suggested that meets with the approval of a majority of the local authorities concerned.

The fact is that no really efficient means of drainage can be devised that would be a radical cure of the evils that exist and at the same time allow most of the present industries to continue without a very much increased water-supply, and to obtain such a supply would mean the expenditure of a very large sum of money. The local authorities have not been indifferent to this matter, and they have tried from time to time to come to some understanding among themselves about it, and money has been expended by them in formulating schemes of drainage, but without success.

Three main schemes and two subsidiary schemes of drainage have been formulated, and they are known respectively as—

(*a.*) The Caversham Tunnel scheme,
(*b.*) Leslie Reynolds's scheme,
(*c.*) Hay's scheme,
(*d.*) Septic-tank system,
(*e.*) Green Island scheme.

(a.) Caversham Tunnel Scheme.

The Caversham Tunnel scheme was designed to carry away the drainage from some of the larger factories in the valley and from the freezing-works and abattoirs, and also to drain part of the Green Island Borough. This scheme was a gravitation one, and it was proposed that the sewage should be taken through the Caversham railway-tunnel and joined to the Dunedin City scheme of drainage, which empties in a different direction. Several of the factory-owners promised to give special contributions amounting to about £800 a year for a few years towards the cost of this scheme, but it came to nothing, and the representatives of the Dunedin Drainage Board testified at the inquiry that the Board was opposed to this scheme, as its works were not designed to cope with so much foreign sewage, and it appeared also that a part of Green Island Borough was too low to be drained by this scheme unless by pumping. It does not appear that any consent was ever obtained from the Railway Department to utilise the tunnel for the purpose indicated, but it was assumed that when the new tunnel (now in course of construction) is completed the old one would be handed over to the local authorities. This scheme is only a partial scheme. It does not propose to deal with the drainage from Mornington and Maori Hill, neither does it propose to deal with the drainage from many of the factories. It was not seriously supported by any of the local authorities, and, as it is opposed by the Dunedin Drainage Board, it must therefore be discarded.

(b.) Leslie Reynolds's Scheme.

A scheme was designed by Mr. Leslie Reynolds, C.E., to take the sewage of the whole of the Kaikorai Valley to the sea. This scheme, which was estimated to cost £14,640 without compensation to riparian owners, is a gravitation scheme. It was a much more comprehensive scheme than the Caversham Tunnel scheme, as it provided for a main sewer from the upper portion of the valley to the sea, into which sewer the sewage of the whole valley and the refuse from all the factories and drains could be discharged directly on to the sea-shore at high-water mark; but, as a great deal of the land at Green Island is very low-lying, the sewer was intended to be carried above the surface of the ground in those places, and by a tunnel through the sandhills between that place and the sea so as to get sufficient fall. This scheme would entail the pumping of a considerable amount of sewage from the portion of Green Island that would lie below the level of the sewer. It is most likely also that the discharge of the sewage directly on to the beach at high-water mark would create a great nuisance, and this proposal was condemned by the Health Department. It appears that sewage has a higher temperature, and is lighter, than sea-water. It would therefore float for some time on top of the sea (see Exhibit 22), and, as the evidence showed that the tide generally sets strongly inwards towards the shore at this locality, the effect would be the distribution of much of the sewage along the beach, which is used to some extent as a pleasure resort. This scheme did not appear to be favoured by any of the local authorities represented at the inquiry, none of whom produced Mr. Reynolds or any witnesses in support of the scheme, and it may therefore be put aside as unpopular and insufficient.

(c.) Hay's Scheme.

This scheme (see Exhibit II) is somewhat similar to Leslie Reynolds's scheme. It is formulated by Mr. Hay, M.I.C.E., of Dunedin. He proposes that a sewer should be constructed from Balmacewan (near the head of the valley) to a point in the lowest part of the Borough of Green Island. This scheme would serve the whole valley, as the various local authorities, factories, freezing-works, and abattoirs could connect their sewers and drains therewith, and this would effectually drain, by gravitation, the whole valley. The sewer would, however, end in a large pit or tank, and the sewage would therefore require to be all pumped out on to the sandhills near the sea, and it is proposed that the sewage should there be utilised for the purpose of a sewage-farm, in the same manner as is done in Christchurch, and that the effluent there-

from should be led on to the sea-beach, or be allowed to soak through the sand into the ocean. It is contended that no nuisance would be created by this method. The cost of the pumping would, however, be an important item in the annual charges of working any effective scheme of drainage at this place. The prime cost of this scheme is estimated at about £22,000. This sum does not, however, include compensation for loss of riparian rights, land, way-leaves, or other claims or reticulation in the various districts, and the cost of pumping would amount to about £600 per annum, in addition to which there would be cost of maintenance and administration.

The principal difficulty in the adoption of this scheme is the fact that it would take most of the water out of the stream, and this would be fatal to the factories, and would give rise to enormous claims for compensation from the factory and all riparian owners, and Mr. Hay freely admits this (see his report, Exhibit II).

This scheme was proposed by the Taieri County Council, and, as a scheme, it was not shown to be at all impracticable; but the local bodies did not support it for reasons hereinafter set forth: that is to say, the Green Island Borough objected to the cost of pumping, and suggested that the expense of the proposed sewage-farm could be obviated by running the sewage on to the swamp, and then, as the sewage accumulates, covering it up with sand from the sandhills; but no evidence was given as to the cost or efficacy of such a procedure, or that it would be any better than the proposal to level an area of the sand from time to time, and run the sewage on to that area with the view of purifying the sewage and inducing vegetation to grow on the sand. The Borough of Green Island also considered that any interference with the sandhills would result in disaster, owing to the action of the wind thereon, and, as the sandhills are vested in them as a Domain, they objected to their being interfered with.

As regards these objections, it appears that the Domain contains 385 acres, and that more than 300 acres are barren sandhills with very little vegetation thereon, and that the sand from these sandhills is even now encroaching upon and destroying valuable land. The action of a sewage-farm is likely to end in the permanent establishment of vegetation, which is about the only thing which will satisfactorily arrest moving sand, and if vegetation can be made to grow on these sandhills it ought to be an advantage and not a detriment to the Domain and adjacent district.

(d.) Septic-tank System.

The Boroughs of Maori Hill, Mornington, and Roslyn had a drainage scheme of their own, which will, they contend, obviate any necessity for Hay's scheme, so far as they were concerned. Their scheme is the adoption of septic tanks. The portions of the Boroughs of Maori Hill and Mornington that are within the Kaikorai watershed have now obtained from the Dunedin City Waterworks a water-supply *sufficient for household purposes*, and the Borough of Roslyn either has or can obtain a similar supply. They propose to lay down sewage-drains in their various areas, which are to lead to a septic tank close to the Kaikorai Stream at a point near where the main branch of the stream joins the one from Maori Hill just above Ross and Glendining's mill, and they contend that if this septic tank is properly managed the effluent therefrom, which they propose to discharge into the stream, will be pure and innocuous, and this being so they contend that they are not interested in any general scheme of drainage for the whole valley, and that they are not liable to contribute towards the cost of any sewer or other work further down the valley, and that each district should be responsible for its own drainage and sewage.

This is all very fine, and in theory it looks splendid, but it makes no provision for the pollution of the stream by the wool-washing establishment or the Roslyn Woollen-mills within the Borough of Roslyn; neither does it take into account the pollution or otherwise of storm or surface water that may come into the stream from these districts, or from their septic tanks if not satisfactory. They propose to get over these difficulties by compelling the factory-owners to properly filter the water they use, or else to treat it chemically in such a manner

as will render it innocuous before it is returned to the stream, and to compel all people in their districts to connect with their sewage system, and they assume that the effluent from their septic tank will always be clean and pure. If all this were properly done or satisfactorily arranged it would to a considerable extent be sufficient. The fact, however, is that even now they do not appear to take any steps whatever to compel these factory-owners to purify the water before it is returned to the stream. It is very probable that they have not sufficient power to do so; at any rate they have not done so hitherto, although the nuisance has been pronounced for a considerable time. In any case, whether they have power or not, there is no power at present for any of the districts lower down the stream to compel the local authorities of those districts that are higher up to see that the effluent from the factories and septic tanks in their districts is kept clean and innocuous. The result would probably be, if the proposal of the three hill boroughs were approved, that, so long as the effluent from the septic tank or factories was no nuisance to themselves, none of these three boroughs would care very much or take any more interest in improving matters than they do at present, no matter how much the people lower down suffered therefrom—and it is the people lowest down who suffer most.

To allow, therefore, a septic-tank system to be established by the Boroughs of Maori Hill, Mornington, and Roslyn, without any power being constituted to see that all premises are properly connected with drains leading to the septic tank, and that the effluent from the tank and factories in these districts is properly treated and is rendered entirely innocuous before it is returned to the stream, would in my opinion be most unwise.

A good deal of evidence was given in support of the septic-tank system, both for household and for factory sewage, and it appears that if this system is adopted in connection with proper precautions and with filter-beds, and if the filtrate is then allowed to flow over suitable land, the effluent therefrom is thus rendered, comparatively speaking, harmless; but Dr. Ogston stated that it was doubtful if the septic-tank and filter-bed system alone was capable of altogether eliminating colon and typhoid bacilli, if such were present in the sewage, and that the effluent ought to be made to flow on to land specially prepared to receive it (see Exhibit 22). He admitted, however, that the effluent from a properly constituted system was generally harmless. There seems, however, from the evidence to be some difference of opinion as to whether factory-sewage can always be dealt with satisfactorily on this system. Dr. Ogston said that this system had been abandoned in Germany for purifying factory-sewage.

These three hill boroughs made a great point of the fact that several boroughs in New Zealand had adopted the septic-tank system, and that, as the Government had allowed them to do so, there was no reason to suppose that any objection whatever would be made to the proposal to construct one in the Borough of Roslyn. I do not, however, believe that the conditions in those cases are at all like those that exist in the present case, and unless some power is constituted to see that the system is properly and efficiently carried out I do not think it could be adopted here without very great risk and danger to the interests of people lower down the stream.

At present the drainage from these three hill boroughs is evidently much contaminated; but it is at present only directly contaminated to a small extent by human excreta, as these are now removed by the pan system or buried or placed in pits in the ground; but when the districts are reticulated with proper drains, as they will be shortly, all the excreta will be brought directly to the vicinity of this stream, and if the effluent from the septic tank is to be discharged therein it ought only to be so allowed after the most careful and thorough treatment, and the question as to whether this treatment is careful and thorough enough ought not to be left solely to the *ipse dixit* of the body or bodies who wish to make use of the stream to dispose of such effluent.

All this goes to show that it would be much better to run the sewage from these three boroughs directly into a main sewer, as proposed in Hay's scheme, than to attempt to purify it by the septic system; and in so far as this may be

the best means of disposing of the polluted water from factories many of the factory-owners or representatives supported the same idea, *provided that their supply of water is not thereby interfered with or that they got another supply of water at no greater cost to themselves*, which means, of course, that they should get such water for nothing.

A main drain, as proposed in Hay's scheme, would also take all sewage and the polluted water from the freezing-works, abattoirs, tallow-factory, and other factories and mills lower down the stream; and the evidence shows that it would enable the sanitation of Green Island Borough and the small portion of Taieri County that is in the Kaikorai watershed to be properly attended to, and as there would thus be sufficient liquid placed in the sewer, and as there is a proper grade, the sewer would thus be self-acting, and it would effectually drain the whole valley.

The cost of this scheme is moderate, and at first sight it seems to be ideal; but its effect on the factories would be disastrous. Thus the effect of Ross and Glendining's mill, in taking, say, 30,000 to 35,000 gallons of water a day, and in not returning it to the stream, would be that in summer-time little or nothing would be left for factories lower down, and even in ordinary times the abstraction of so great a quantity of water would be severely felt. If, therefore, any water were left after Ross and Glendining's mill had taken what it wanted out of the stream, the remainder would be used up by the next one or two factories, and the large and important works lower down would get none at all. This would give rise to enormous claims for compensation, and would mean the closing-down of many of the factories and consequent loss of employment to many persons. This would be most unpopular, and would never satisfy the people or local authorities of the districts. It is quite clear, therefore, that, unless Hay's scheme is strictly limited to household sewage, it is impracticable without a water-supply much in excess of that now provided by the stream. To limit it, moreover, to household sewage would be to rob it of much of its usefulness.

If, therefore, this scheme is to be carried out in its entirety, a proper and sufficient water-supply for the purposes of the factories is absolutely essential, and it is this question of water-supply that has a great deal to do with the difficulties that have arisen between the local bodies. They know that if they take the water out of the stream and put it into a sewer they will be met with enormous claims for compensation for loss of riparian rights, and that the loss to the factories if compelled to close down would spell ruin to parts of their districts. They know also, on the other hand, that the cost of a sufficient water-supply for the factories is beyond their means.

I endeavoured to ascertain what a sufficient water-supply would cost, or whether one could be obtained from any stream in the vicinity, but I was unable to get any definite or reliable information without going to considerable expense, and I had no authority for this. It was asserted by some of the witnesses that the various boroughs were entitled to take water from the Silverstream, which is the source from whence part of the water-supply for the City of Dunedin is obtained, and that, failing this, the water could be obtained from Lee Stream.

Exhibit No. 23, being a memorandum on the subject from the Dunedin City Solicitor, shows the position from the point of view of the City Council. From this memorandum it will be observed that the Boroughs of Maori Hill, Mornington, and Roslyn have made arrangements with the city for connection with its water-supply and that the Borough of Green Island has possibly a right either to obtain water from the city supply on payment at the rate of 6d. per 1,000 gallons, or else to tap the Silverstream and supply itself with water. It will, however, be seen from this memorandum that it is contended that such water-supply is only intended for domestic purposes, and that any attempt to utilise it for factory purposes would be resisted, on the ground that the supply is only sufficient for domestic purposes for 45,000 people, and there is even now a population of 58,000.

As to the suggestion that a water-supply could be obtained from the Lee Stream, the memorandum shows that this is out of the question, both on the

grounds of expense and also because the stream has been hypothecated for electric-power purposes. The cost of bringing this water into the City of Dunedin is estimated at from £100,000 to £150,000. It probably would not cost quite as much to bring the water to the Kaikorai Valley, but, seeing that the inhabitants of the four boroughs in that valley have either now obtained or can obtain water for domestic purposes from the city supply, it is hopeless to expect that they would sanction any larger loan for the purpose of bringing in water for the use of the factories. The factories also could not themselves afford to pay for such a scheme, and, moreover, they would not, I think, be willing to do so, as in any case several of the largest of them have already obtained private supplies of clean water for the purposes for which such water is required, and the water of the Kaikorai Stream, although filthy, can be used by all of them without cost to themselves for all other purposes.

If a loan of £25,000 were raised at 5 per cent. interest over the whole of the land in the watershed of the Kaikorai Valley, whether it benefited or not, to cover the cost of Hay's scheme, and if an annual charge of £500 were added to cover cost of pumping, it would mean a yearly rate of nearly 1s. in the pound on the annual value of such land, not counting cost of maintenance and supervision; and this is a pretty heavy rate and it would press severely on the ratepayers, and if in addition a loan of, say, £100,000 were raised for a water-supply at 4½ per cent., this would require a yearly rate of over 2s. 3d. in the pound; so that the two rates together would amount to about 3s. 3d. in the pound on the annual value, and this rate would, I consider, be absolutely prohibitive at the present time.

(e.) Green Island Scheme.

In addition to these four schemes the Mayor of Green Island proposed that the difficulty as to the fouling of the stream by the factories could be surmounted by the construction of a large pipe or carrier running from above the factory highest up the stream right through the valley, and that into this carrier the water of the stream should be led at its upper end; and then that the water in the carrier could be taken therefrom and used by all the factories in turn, provided that after they had used the water they returned it again to the carrier. By this means it was contended that the water could then be used again and again as at present, but without danger, until in the end the carrier would discharge the water into the swamp near the sea without creating any nuisance. This scheme would if carried out keep the polluted water from the factories out of the stream, and still allow them to use it, and it is possible under certain conditions that, so far as the factories are concerned, this scheme might possibly be useful. This scheme was not, however, supported by any other of the local authorities and no estimate of its cost was given. No evidence was given by any engineer or competent person as to its feasibility, neither was it shown how the factories in the middle and lower down the valley would be able to return the polluted water to the carrier. It is manifest that the water would have to be forced by them into the carrier by mechanical power, as there is a considerable fall in the valley right through, and the point would very soon be reached when it would be impossible to return the water to the carrier by gravitation. The cost of forcing the water into the carrier under pressure would be considerable, and the factory-owners would undoubtedly object to have to pay for the same. The bulk of the water in the stream would, moreover, have to be placed in the carrier, because any smaller quantity which would be used over and over again under this scheme would become so absolutely filthy by the time it reached the abattoirs, freezing-works, and other factories at the lower part of the valley as to be unfit for any use whatever.

The scheme, moreover, does not make any provision for the sewage from dwellings and places other than factories in Mornington, Maori Hill, Roslyn, and Green Island Boroughs. Its adoption also would probably give rise to very serious claims for loss of riparian rights, for it is not only the factory-owners who would be put to more expense and who would no doubt be able to make claims, but also every owner of land which fronts on to the stream or through

which the stream flows could equally make claims if he thought fit to do so, whether he now uses the water or not, if the volume of water that now runs through or past his land were seriously diminished in quantity; and this effect would undoubtedly follow under this scheme.

For these reasons I cannot recommend this scheme. It is possible that some modification of it might be workable if proper safeguards were made, and if the whole thing were controlled by one local authority, but as to this I offer no opinion.

General.

The evidence clearly shows that the only thing that will effectually and permanently prevent the pollution of the Kaikorai Stream is the adoption of Hay's scheme, or of some similar scheme, together with a water-supply scheme; and this is what ought to be done. It appears, however, that the cost of the two schemes is at present beyond the means of the districts concerned; but it does not follow from this that the districts will never be able to finance such schemes. I consider that the time will come when they will be able to do so, owing to the very favourable conditions that exist in this valley for factories of all kinds, and to the fact that even now new industries are starting therein.

If, therefore, in the meanwhile some method can be devised whereby the evils which now exist can be minimised, and the water of the stream sufficiently purified to enable it to be safely used for manufacturing purposes, this would probably be all that can be done at this time, for "half a loaf is better than no bread," and the present position of matters is a public scandal and disgrace. I think it is possible to adopt some such method and also to make provision for the construction of the sewer and water-supply works in due course when the district is able to afford the same, and this method will be set forth in the next division of this report.

Division III.—What Authority should be set up to carry out such Means of Prevention.

There are several local authorities exercising jurisdiction within parts of the watershed of the Kaikorai Valley—viz., Taieri County Council, Maori Hill, Mornington, Roslyn, and Green Island Borough Councils, and the Dunedin Drainage Board. The Dunedin City Council has also an important interest in the valley in the shape of the City Abattoirs. The Kaikorai Stream is vested in the Taieri County Council by virtue of a Warrant under the hand of Your Excellency, dated the 12th October, 1906, in the *Gazette* of the 18th October, 1906. The stream was then vested in the Council in the hope that the Council would be able to formulate some effective scheme for the purification of the stream; but the Council has been unable to formulate any scheme that is satisfactory to the parties, although it has tried to do so. The County Council has no power to compel the other local authorities to contribute thereto if it undertakes the work itself, and, as the boundaries of the Borough of Green Island are about to be extended so as to take in most of the factories and residential parts that exist in the portion of Taieri County in the Kaikorai Valley, the Taieri County Council has now very little interest in the matter, and it is manifest, therefore, that it would be unfair to expect the County Council to spend its ratepayers' money in constructing works that will be of no benefit to them. The Council, moreover, has no power to compel the other bodies to purify the stream, or to keep it pure, within their respective districts. It can only proceed, if at all, against the persons who pollute the stream, and, as there are so many that do it who cannot be identified, it would have to spend its ratepayers' money to obtain convictions (even if they could be obtained by the county under the present law, which is doubtful), and this would not benefit many people in the county. It will thus be seen that the vesting of the stream in the Council is useless, and that, unless the Council is given far greater powers than it now has, it cannot deal with the other local authorities or control the stream in any effective manner whatever. None of the other local authorities are in any better position for dealing with the question than is the Taieri County Council. Their interests

are, for the most part, mutually antagonistic, so far as this question is concerned. The district of the Dunedin Drainage Board extends only a small distance into the watershed of the Kaikorai Valley—that is to say, although parts of the Boroughs of Mornington, Maori Hill, Green Island, and Roslyn are within the Dunedin Drainage District, the Drainage Board has very little power over those parts that are in the Kaikorai watershed, as by section 25 of "The Dunedin Drainage Act Amendment Act, 1902," the power of the Board to rate those parts was taken away.

The Dunedin Drainage Board could, no doubt, manage the drainage of the Kaikorai Valley in addition to its own particular duties if proper power were granted; but it appeared that this would not be at all popular with the Kaikorai people, who prefer to manage their own affairs. In any case there would have to be proper representation granted on the Board to the people of Kaikorai, and no doubt the main interests of the Dunedin Drainage Board lie altogether in another direction, and I am afraid, therefore, that if the drainage of the Kaikorai Valley were placed under the Board it would not result very satisfactorily.

I was solemnly assured that the Boroughs of Maori Hill, Mornington, and Roslyn had come to an absolute and unanimous agreement that their sewage and drainage should be dealt with jointly by them on the septic-tank system, as already indicated, and that consequently they did not want to have anything to do with any other authority or Drainage Board, and that such a Board was not necessary, so far as they were concerned; yet towards the conclusion of the inquiry the Borough of Maori Hill went altogether back upon this agreement. They then contended that their drainage could be taken by the Dunedin City drainage system, and that they had entered into negotiations with the Drainage Board to take their drainage. If this were done it would not come into the Kaikorai Stream at all. It is quite possible that their sewage can be taken that way, but this does not affect the question very much, as the area of the Borough of Maori Hill in the Kaikorai watershed is very small, and up to the present time the Dunedin Drainage Board has refused to take them in and provide for their drainage. These facts show that some of these bodies hardly know their own minds, and that, as any general agreement between them is apparently hopeless, some paramount controlling authority is required.

For these reasons, therefore, and although I regret having to suggest the creation of any additional local authority, I feel compelled in this case to recommend the creation of a River and Drainage Board to manage the Kaikorai Stream and the general drainage of the watershed of the Kaikorai Valley. There really ought to be one local authority for the whole valley, not five or six as at present, and it may be that the creation of a United River and Drainage Board would assist in the ultimate creation of one large comprehensive borough to take in all the present ones, and also the duties of the proposed Drainage Board. Be this as it may, it is, I think, quite apparent from the facts of this case that some controlling body must be constituted.

It is therefore recommended,—

(1.) That a River and Drainage Board should be constituted, in which the stream and its tributaries should be vested, and that this Board should be empowered to manage the sewage and drainage of the whole of the watershed of the Kaikorai Valley, and that the small piece of the Dunedin Drainage District within this watershed should be taken from such district. This will not affect the Dunedin Drainage Board, as it has no power to rate that area.

(2.) The Board should consist of eight members, to be appointed directly by the local authorities concerned from time to time—viz., two each to be appointed by the Roslyn and Green Island Borough Councils, and one each to be appointed by the Mornington and Maori Hill Borough Councils, the Taieri County Council, and the Dunedin City Council (as representing the abattoirs), such nominated members to remain members only so long as they are members of the Council which has nominated him. This, I gather, would be much more satisfactory to the parties than the election of the members by the ratepayers,

and it is on the lines strenuously advocated by the various local bodies who appeared before me last year in the Christchurch district drainage inquiry. This scheme would give four members for each end of the valley, and it would thus equalise the balance of power.

(3.) The Boroughs of Maori Hill, Mornington, Roslyn, and Green Island, and the Taieri County Council, should be left to arrange for the reticulation of drains in the roads and streets in their own districts respectively within such time as the River and Drainage Board may determine, and they should also be allowed to dispose of their sewage by septic-tank, filter-bed, and sewage-farm, or on any other principle that the Board may approve; but the septic tank, filter-beds, and sewage-farms connected therewith should be constructed and maintained to the satisfaction of the Board or by the Board, at its option, and if done by the Board, then at the expense *pro rata* of each local authority concerned, and if more than one district drains into the same septic tank, then in proportion to the annual rateable value of so much of the area of each local body concerned as is within the limits of the Kaikorai watershed. The Board also should have power to compel the various local bodies to reticulate their areas and to connect the drains therefrom with the septic tank or with any main drain or sewer which the Board may construct within such reasonable time as it may determine, and if the work is not done within that time the Board should in such case be authorised to raise a special loan without poll on the security of a special rate over the district affected, and to construct the necessary works and to maintain them out of the proceeds of such a rate over that district as may be sufficient for the purpose; and, if any dispute arises as to whether or not the reticulation or the septic tank, filters, and farm are or are not properly constructed and maintained, or as to the sufficiency or otherwise of the rate, then any such dispute should be referred to Your Excellency, and Your Excellency's decision should be final and conclusive and without appeal, and the Board should have power to obtain an injunction or mandamus of the Supreme Court to enforce such decision.

(4.) If after due trial of the septic-tank system in the case of any of the boroughs the Board is advised by the Minister of Public Health that the effluent therefrom is prejudicial to health, or that it pollutes the stream so as to make it dangerous to health or unfit for manufacturing purposes, and Your Excellency directs that the sewage or effluent be placed in a sewer and not in the stream, or if at any time or from time to time a resolution is passed at a special meeting of the Board convened for that purpose that a sewer or main drain should be constructed throughout the whole or through any part of the length of the Kaikorai Valley, then and in any such case the Board should have power to construct and maintain such sewer or main drain and all necessary works connected therewith, and for any of these purposes to raise a loan over the whole district or over such part or parts of the district as may be concerned in such sewer or main drain and as the Board may determine, and to establish and maintain a sewage-farm on the sandhills near the ocean in the manner set forth in Hay's scheme, including pumping machinery and all necessary appliances; and in such case the Board should have the right to enter upon and use without payment of compensation any portion of the sandhills that may be required; and when any portion of the sandhills shall have been rendered fertile and productive the Board should have the right to lease the same and apply half the rents in reduction of the expenditure or liabilities of the Board and to hand over the other moiety to the Domain Board for the improvement of the rest of the Domain, and the Board should have power to lay its drains or sewers through any land on payment for surface damage only.

(5.) The power to raise special loans referred to in the two preceding paragraphs should not be exercised unless at a special meeting of the Board especially called for the purpose, but upon resolution passed at such meeting the Board should without any poll of the ratepayers be authorised to raise the loan and strike a special rate or rates in the manner provided by the Local Bodies' Loans Act as security for the loan, together with a general rate sufficient for the main-

tenance of the work. Such special rate and general rates should be levied over such portions of the district only as will, in the opinion of the Board, be likely to drain into or to benefit by the existence of the sewer or main drain, and in making such rates the Board should have power to make differential rates as between lands (*a*) directly benefited, (*b*) generally benefited, and (*c*) benefited only to a small degree, and to exclude lands that do not benefit.

(6.) The Board should also have sufficient and ample power to prevent any local authority, person, or company from allowing foul liquid from its district or from his or its premises to enter the stream, and the Board should be empowered to obtain an injunction or mandamus of the Supreme Court or otherwise to restrain any of these things from being done.

(7.) These recommendations, so far, are intended in the first place to apply only to surface drainage and household sewage and to provide some means whereby the stream will not be polluted thereby, but they could afterwards be applied to foul liquid from the factories. The principal source of pollution at present is, however, from the factories, and these require special treatment, because, unless a vastly increased water-supply is provided, it will be impossible, for reasons already given, to allow the water used for manufacturing purposes to be placed in the sewer.

(8.) The comon law on the subject briefly is that every riparian owner has a right to use the stream for watering animals and for domestic and many other purposes so long as he uses it in such a manner as not to prejudice other riparian owners below him. He may therefore use the water for manufacturing purposes, and for such purposes he may even consume a reasonable quantity of the water, provided he does not thereby impede the flow or sensibly diminish the volume of the streams, but he must return the water he does not consume to the stream after he has done with it in the same state of purity in which it came to him. If he turns water into some other channel, or if he does not return it again to its original stream, or if he consumes an unreasonable quantity according to the size of the stream and thereby causes loss or thereby does something that may cause loss to a riparian owner lower down, he is liable to such lower riparian owner, and his action may also be restrained by process of law. (See Coulson and Forbes on Waters, 2nd edition, cap. iii; and Angell on Watercourses, 7th edition, cap. iv.)

(9.) If therefore the Board is to escape liability, it must be able to throw the onus of purifying the water on the manufacturer who pollutes it, and it should be distinctly provided in any Bill to give effect to this report that the Board shall not be liable to any riparian owner for anything done by the Board or ordered to be done by it in connection with the water, somewhat in the same way as is provided in "The Taieri Land Drainage Act, 1908." The manufacturers are, for the most part, the people who pollute the water, and these are the parties who by law ought to be made to return the water to the stream in as pure a state as it is in when they receive it.

(10.) The Board should therefore, in my opinion, be empowered to make rules and regulations providing for the purification of the water, and to enforce a penalty for the breach of such regulations, and also if necessary to obtain an injunction or mandamus of the Supreme Court to compel the various manufacturers to adopt such measures as the Board may from time to time consider to be necessary to purify the water by means of such septic tanks, filter-beds, or chemical treatment, or otherwise as will in each case render the effluent as pure as it was when it entered the manufacturing works from the stream, and the onus of proving that the effluent is as pure as the water was when it came into the manufacturer's premises should be on the manufacturer. This purification will no doubt be a difficult and somewhat expensive thing to undertake in some cases, but no manufacturer has a right to pollute the stream to the detriment of his neighbour, whether that neighbour be a manufacturer or a private person. All I suggest is that the Board should have the power to enforce the common law on behalf of all the riparian owners, but I do not suggest that the right of riparian owners should be taken away, otherwise than as may be absolutely necessary in the interests of all. What is required is not absolutely

pure water, such as is required for human consumption, but what is required is water that can safely be used for manufacturing purposes, and which will not at the same time cause any nuisance, or loss, or damage to health; and the evidence showed that it is possible to do this in most cases. If a manufacturer cannot do so, then it is clear that his business is not one which can be safely carried on in the district, and that if he contravenes the provisions of the common law in so doing, then in such a case he has only himself to blame if the law is enforced against him.

(11.) In addition to these powers the Board should have the power to take land for the construction of drainage and waterworks and lay and maintain pipes, sewers, and drains on roads, streets, and also through private lands on payment of compensation, for surface drainage only, except in cases where actual land is taken and vested in the Board. It may be that, without going to any very great expense, the Board could, by constructing a drain or drains in connection with the upper part of the main Kaikorai Stream, or in the upper parts of some of the subsidiary streams, very greatly assist the local industries by storing a plentiful supply of water; and if this were done it might then be possible to allow the effluent from some of the factories to be turned down the sewer when it is constructed, and provision should therefore be made accordingly; but the onus of placing as much water in the stream as is taken out of it should be thrown upon the person who takes out such water.

(12.) The Board should also have the general powers of a Drainage and River Board, with power to levy a small rate over the whole district to meet general expenses and maintenance and to improve and cleanse the river and for other necessary purposes, and it should also be empowered to raise special loans, subject to a poll of the ratepayers, for the purpose of any additional water-supply or water-supplies in case such are required, and for that purpose it should have power to declare any portion of its district to be a special district in the manner provided by the Local Bodies' Loans Act.

(13.) The Board should have power to regulate, and if necessary to prevent, the pumping of "soup" on to any ground. This effluent can be disposed of without creating any nuisance at all—viz., by evaporation, as is done by Kempthorne and Prosser's works, or it can be purified by septic tanks and filter-beds or by chemical processes.

(14.) The Board should also have power to make by-laws for the administration of the stream and to provide a severe penalty for their infringement, and also to prosecute criminally any person deliberately placing foul matter in the stream, and it should also have power by its servants to enter upon any premises for the purpose of seeing if any nuisance is being created or if the Act or regulations under which the Board works are being contravened; and, subject to and within the limits of the special work which it is proposed that the Board should undertake, it should have similar powers to those granted under "The Dunedin District Drainage and Sewerage Act, 1900," and its amendments.

Division IV.—How the Cost of any Works to be carried out should be apportioned among the several Local Authorities interested in the Matter.

It will be gathered from the former part of this report that in my opinion a special River and Drainage Board should be set up to deal with this matter, and that it should have power to levy rates over the district for the purpose of managing and cleansing the stream; and also, if it be found necessary to do so, that it should have power to levy special rates for the purpose of constructing main drains or sewers and water-supply schemes. If this is provided for, then it will not be necessary that any apportionment of the cost of these works should at present be made as against the several local authorities, because the necessary funds will in such a case be collected in the form of rates from the persons whose premises are drained or who are within the proposed river and drainage district. It might, however, be provided that the Board should have power either to collect these rates itself or else to require the rates to be collected in the different

districts by the local authorities of such districts, as is provided for in section 45 of "The Christchurch District Drainage Act, 1907." That, however, is a matter of detail, as it depends upon whether or not it would be cheaper to collect the rates itself or to get them collected by the other local authorities.

Conclusion.

In conclusion, it will be seen that this case is surrounded with difficulty. It is manifest that the best thing to do would be at once to provide a main sewer to take the sewage and drainage from all the districts and from the factories, as is provided in Hay's scheme. This will have to be done sooner or later, but I have shown that it cannot be done at present, except for household sewage, unless an adequate water-supply is first of all provided to make up for the water of the Kaikorai Stream which is now fouled by the factories, and which would be diverted to the sewer. Such a water scheme is beyond the financial power and ability of the districts to undertake at the present time, and it would not, moreover, improve matters very much so long as the manufacturers are still allowed to foul the stream, and the cost of constructing a main drain for household sewage alone would be a very heavy one.

The next best thing to do in lieu of a main sewer is to try to devise some means whereby the effluent from the proposed septic tanks could be purified and rendered innocuous and at least fit for manufacturing purposes, and this can probably be done at moderate cost, but it requires that the process should be carefully watched by some competent and independent authority. The other thing to do is to endeavour to compel the factories which use the water to purify the same and return it after use to the stream in as pure a state as it is when it reaches them. It is probably possible to do these things, but it may be a difficult matter, and there is some difference of opinion as to whether it can be thoroughly done, but there is no doubt that the stream can be made much less dangerous to health than at present. Consequently it is recommended that a special River and Drainage Board should be created, and that the wide powers already indicated should be given to this Board which would enable it to compel all parties (including the manufacturers and the local bodies) who use the stream for any purpose whatever to do their share in seeing that the water placed in it or returned to it by them or from their districts is made as pure as possible. This alone would very greatly improve the condition of things, and nothing further will, it is hoped, be required until the district is better able to finance a large loan for the necessary works. If, however, after fair trial it be found impossible to keep the effluent from the septic tank sufficiently pure to be innocuous, then I have suggested that the Board should by Your Excellency's direction or on its own motion have power to raise a special loan and construct the sewer, pumping-works, and sewage-farm as in Hay's scheme. These works would keep the household sewage out of the stream and still leave the stream to be used by the factories, and it would not preclude the factories from sending their foul liquid down the sewer when and so soon as they can be supplied with more water to take the place of that which they now take from the stream. It is also suggested that the Board should have power, with the approval of the ratepayers, to raise a special loan or loans for a proper water-supply, or even for one or more local supplies, to assist the industries in the district when and so soon as that is necessary and the ratepayers so choose, and when a proper water-supply has at last been obtained it may then perhaps be found to be possible to carry all foul water, whether for sewage or otherwise, right out of the district by means of the sewer, thus leaving the stream clean and pure from end to end.

What I have endeavoured to suggest is the creation of a representative Board with power at very little present cost to the ratepayers to commence by greatly improving the condition of things as they exist now and to increase the present water-supply from local sources, and with power later on to carry out a progressive policy and proper scheme of drainage with an abundant water-supply from some distant source as further factories start in the district and as the value of the district increases and the ratepayers are better able to bear the expense of such schemes.

A Board constituted as is herein proposed would not interfere with the local authorities more than the health and safety of the whole district requires, and its members would moreover be in direct touch with all the local authorities. The recomendations herein made are not intended to suggest that the Board should have any other function or jurisdiction than to control the stream, and the main sewer and sewage-farm, and, if necessary, such additional water-supply works as may be required in connection with the sewer or factories or places that either use the water of the stream or wish to place water in it. If, however, any of the local authorities will not connect their drainage or sewage to the Board's system, then it is proposed that, in the interests of all, the Board should have power to do the work at their expense. The scheme I propose will, I think, enable each local body to manage and pay for its own internal drainage, and none of the inhabitants of the different districts will under any circumstances be required to contribute more towards any works than is proportionate to their interest therein.

I have been obliged to recommend that the construction and control of the septic tanks, filters, and sewage-farm be placed in the hands of the proposed Board, as I am of opinion that if they were left under the control of the boroughs who specially advocate their use, the result would be constant irritation and fighting between the local bodies lower down the stream and the proposed Board and themselves.

In these recommendations I have sought to meet the desires of the various local bodies, so far as it is possible to do so, in view of the known difficulties of this case and of the conflicting interests that exist, and bearing in mind also the good of all. In doing so I have tried to suggest a plan which, though not ideal, is, I believe, workable, and which will not interfere unduly with the rights and aspirations of the various local bodies concerned, and which will give them direct representation on the proposed Board, and which is capable, under good management and with greater financial resources, of development into a more perfect system.

The exhibits, and a copy of the notes of evidence at the inquiry, are included in the addendum hereto attached.

I have the honour to be
Your Excellency's obedient servant,
W. S. Short,
Commissioner, Wellington.

P.S.—I have held back the foregoing report at the urgent request of the Borough of Maori Hill, which has been endeavouring to make some arrangements with the Dunedin Drainage Board to take the drainage of the part of their district that lies within the Kaikorai watershed. The Drainage Board at first refused to have anything to do with the matter, but at a subsequent meeting rescinded the resolution to that effect, but no definite arrangement has yet been made between the two bodies. Under these circumstances it is quite impossible to know what arrangements will ultimately be made, and I cannot therefore hold back this report any longer.

If the Dunedin Drainage Board does agree to take the drainage from Maori Hill Borough, this would, I believe, still leave the surface drainage in the portion of the Borough of Maori Hill within the Kaikorai watershed to find its way down to the Kaikorai Stream, as the Dunedin Drainage Board would only take household sewage.

The area of the Borough of Maori Hill within the Kaikorai watershed is very small (about 50 acres), and I cannot see that it is a very serious matter one way or the other. Personally, I am of opinion that the whole of the area within the Kaikorai watershed should be dealt with by one local authority, and nothing that the Borough of Maori Hill has yet been able to bring forward has in any way altered the opinion which I have expressed in the foregoing report.—W. S. Short, Commissioner. 7/9/08.

Approximate Cost of Paper.—Preparation, not given; printing (1,400 copies), £5 11s 6d.

By Authority: John Mackay, Government Printer, Wellington.—1908.

Price 6d.