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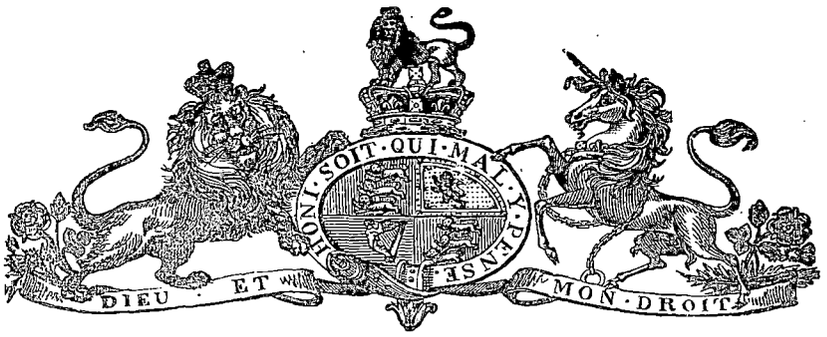
PARLIAMENT OF TASMANIA.

THE RIVER CLYDE:

REPORT BY MR. A. MAULT.

Presented to both Houses of Parliament by His Excellency's Command.



THE RIVER CLYDE.

To the Honourable the President and the Members of the Central Board of Health.

GENTLEMEN,

DURING last summer the condition of the water in the River Clyde, which is the source of the supply of the inhabitants of Hamilton, was a matter of serious concern both as regarded its quantity and its quality. This concern was increased by the occurrence of a fatal case of typhoid fever in the month of January. With the notification of this death, the Secretary to the Local Board of Health wrote—"The water supply of the township is, from the late dry weather, very bad. The Clyde has almost ceased running, and portions of the stream are said to be very offensive." On receipt of this information instructions were sent to obtain a sample of the water for analysis. The sample was taken by the Superintendent of Police on the 30th of January, and was submitted to Mr. Ward, the Government Analyst. The following is his report:—"The sample of water taken from the Clyde, at Hamilton, has been analysed with results as follows:—

Free Ammonia	0·32 parts in a million
Albumenoid Ammonia	0·54 „ „
Nitrogen as Nitrates	none
Chlorine in Chlorides.....	3·8 grains in a gallon
Total solid matters.....	14·0 „ „

This water is undoubtedly contaminated with sewage, and is consequently totally unfit for drinking purposes." This report was communicated to the Local Board of Hamilton, but as the Clyde was the only scource from which the inhabitants could be supplied, the sanitary authority could do no more than recommend that the water should be boiled and filtered before use. On the matter being reported to you, you instructed me to inspect the river, and I have the honour to submit to you the following report of the inspection.

1. The River Clyde drains a comparatively narrow basin. As a river bearing this name it takes its origin in Lake Crescent, which in turn is supplied by Lake Sorell with the greater part of its water. Lake Sorell is chiefly replenished with the drainage from the rainfall of the hills and marshes to the northward of it as far as the hill called Molly York's Nightcap. From this point, which is the real source of the river, to its confluence with the Derwent below Hamilton, it runs a course of about 76 miles, of which about 62 are below its outlet from Lake Crescent. The whole of the upper part of this course and much of the lower part lies in the greenstone formation; the rest being in the upper coal measures. There are but few affluents, and they are unimportant, and seem mostly to be dry in summer.

2. The inspection of the river began at Hamilton on the 12th March. Through the greater part of the township a mill-race runs between the houses and the river, in position such as in ordinary weather to take whatever drainage may flow from the town. As the inhabitants are forbidden to take water from this race, its pollution should not make much difference, but practically it must be impossible to prevent people taking this water. They are not likely to pass it on their way to farther and lower watering places, especially as it is a running stream at times when the river is a series of apparently stagnant waterholes. All through the township the river channel is much obstructed with willow trees, the roots and branches of which back up the water and cause the apparent stagnation. The river was very low, but the water pretty clear. I roughly estimated that at the time about 230 cubic feet a minute were passing in it, and 200 in the mill-race.

3. The river in the neighbourhood of Hamilton for a length of about ten miles was carefully examined. Outside the town there was no apparent source of pollution, except a few dead rabbits floating in the water. Only a very little water was coming down the affluent rivulets, but when a little rain falls I can imagine that the bodies of the poisoned rabbits left on the runs might materially affect the quality of the small quantity of water in the river. In the town there was no visible drainage or soakage going into the river or the mill-race, as there had been a long spell of dry weather; but in wet weather there must be some, especially from the houses, stables, and piggeries at and between Cleland's and Langdon's Inns, which drain into a water channel in the valley which runs into the mill-race. There was a drain also at Bailey's that required cleansing. But for the moment there was nothing found to account for the pollution shewn by the analysis to exist in the water which had been taken from the river and not the mill-race.

4. Between Hamilton and Bothwell, especially in the neighbourhood of the latter town, there is a considerable extent of land irrigated by water taken from the river. From evidence taken before a Parliamentary Committee last year, from 900 to 1200 acres are now laid out for irrigation. It is said to be all grass land, and the water used upon it is more likely to be purified by the process than polluted. The water in the river is raised by dams so as to flow through the irrigation channels; and in the township there are two water-mills. On the 14th and 15th March, the water was turbid and of a slaty colour, and from a rough guaging about 350 cubic feet of water were passing in a minute. From the town itself at that time no drainage was passing into the river; but there was a small fellmongery, carried on by Mr. Bowden, on Mr. White's land close to the river. The skins were steeped in a stone tank, from which the water was in dry weather allowed to run into a waterhole close to the stream. The water in this hole was very offensive, and must eventually pollute the river. The wool was also occasionally washed in the river. It was arranged with the local authorities that this source of pollution should be removed; but its nature and extent were at no time such as would account for the pollution of the river water at Hamilton.

5. On the 25th March two samples of water were obtained from the river; No. 1 from *above*, where the water is usually taken by the carts which supply Bothwell, and No. 2 from *below*, and the following is Mr. Ward's report upon their constitution :—

	No. 1.	No. 2.
"Free Ammonia	0·10	0·11 parts in a million
Albumenoid Ammonia	1·14	1·00 „ „
Nitrogen in Nitrates	0·07	0·06 „ „
Chlorine in Chlorides	1·35	1·35 grains in a gallon
Total solid matter	12·50	12·50 „ „

Both these waters are exceedingly foul and unfit for consumption. They also contain an excessive proportion of iron." It will be seen that this water is worse than that taken seven weeks before from Hamilton. The very large quantity of albumenoid ammonia in comparison with the chlorine pointed to a vegetable source for the organic impurity. But the quantity of free ammonia is too high for it to be probable that pollution is entirely vegetable.

6. The river was next seen in the neighbourhood of Lake Crescent. It was yet more turbid than at Bothwell, and it was roughly estimated that about 450 cubic feet of water were passing in a minute. At the outlet from Lake Crescent there is a badly constructed rubble stone dam, allowing water to pass everywhere as well as by the sluice. This sluice was fully open, and, from the evidence given before the Parliamentary Committee last year, it appears that it had been kept thus open for many months. The consequence was that the surface of the lake was four or five feet below its usual level, and great banks of black and fetid mud were exposed. Some years ago a channel some four or five yards wide was cut through this mud to allow more water to get to the sluice. This channel was in part obstructed by branches, which, when at the surface of the water, stopped the slight current sufficiently to cause it to be covered with a thick scum. The black mud is composed in all probability by the deposit of clay washed from some of the borders of the lake, and that brought by the Interlaken River from Lake Sorell. On this deposit, in the neighbourhood of the outlet, immense beds of reeds grow and decay annually, mix with the mud, which is of such a consistency that great quantities of it are scoured away when the water is so low, and give it the slaty colour noticed at Bothwell, and still more marked here. When the Lake is full the scour does not take place, and consequently the water all down the river is more limpid than when seen in March.

7. It is to be regretted that it was impracticable to obtain a sample of the water while in this condition, as a constable could not be spared to take one before the 5th April. Three days previous to this, His Worship the Warden of Bothwell, in writing to me, said that a marked change for the better was preceptible. When the water arrived I noticed that is appeared much clearer than it did on the 15th March, when the total solids certainly were more than 14 grains to the gallon. The following is Mr. Ward's analysis of the water :—

"Free Ammonia	0·027 parts in a million.
Albumenoid Ammonia	1·48 „ „
Nitrogen as Nitrates	none
Chlorine in Chlorides	1·20 grains in a gallon
Total solids	14·00 „ „

This water is loaded with vegetable matter, living and dead, much of which deposits on standing." This is the worst river water of which I have seen an analysis in Tasmania. It contains fourteen times more albumenoid ammonia than is permissible in any water used for human consumption. What the amount of its pollution was during the summer, and before the perceptible change for the better took place, it is imposible to say. Fortunately for the inhabitants of the towns below, it is at all times greatly improved by its aeration in its twenty miles course over a stony and rapidly falling bed.

8. Lake Sorell was first inspected on the 16th March. It was very low—from the marks on the banks seemingly about four feet below its normal level. I was told that it had greatly fallen within the last week or two before the above date. It is said to be always tawny in colour,

but with the fresh breeze that was blowing, which apparently caused a washing up from the bottom, it was of a full yellow clay colour. A great part of its bed is said to be composed of clay. On many portions of the banks covered with blocks of greenstone, these stones were merely lying on the clay, into which a stick could be pushed down between them to a considerable depth. The Interlaken Rivulet was the only visible connection between Lakes Sorell and Crescent. There is a sluice-frame fixed in it, over which the water was passing, and there was no apparent leakage either below or beside the sluice, and therefore an opportunity was given of sufficiently accurately guaging the stream. On Saturday, with the breeze from the northwards, about 180 cubic feet a minute were passing, and on Sunday, which was calm, about 164. As before mentioned, the guagings taken on the River Clyde were rough approximations, but it is very remarkable that there should be such great difference between the inflow by the Interlaken into Lake Crescent on the Saturday, and the outflow by the Clyde on the Friday. The former was certainly not more than half the latter, consequently Lake Crescent was falling more quickly than Lake Sorell, or there is underground communication. At about a mile and three quarters west of the Interlaken, Mr. Kermode, about the year 1868, cut a channel between the two lakes, but the surface of the water in Lake Sorell had fallen below the level of the bottom of the trench, the mud of which was cracked and dry, as if no water had passed for a considerable time. A man named Tom Sullivan, who had known the Lakes for 30 years, had never seen the water so low.

9. On the 31st March (that is, six days earlier than the date of the taking of the sample from Lake Crescent), Mr. Sutton, of the *Interlaken Hotel*, sent me a sample of the water from Lake Sorell, unfiltered, but taken from before the hotel. The following is Mr. Ward's report of its analysis:—

"The sample of water taken from Lake Sorell forwarded by you has been examined, with results as follow:—

"Free Ammonia	0·02	parts in a million
Albumenoid Ammonia	1·11	„ „
Nitrogen as Nitrates	0·03	„ „
Chlorine in Chlorides	1·00	grains in a gallon
Total solid matter	18·00	„ „

This water is loaded with vegetable matter, much of which is in suspension, and deposits in company with some of the clayey matter after long standing." This water is totally unfit for human consumption. It is not so bad as that taken from Lake Crescent nearly a week later, but it is evident that the undue lowering of the water in the lake had injuriously affected its quality. I confess that I was surprised to learn that there was so great a dosage of organic matter in it, as there is nothing visible in Lake Sorell at all comparable to the mud and reed-beds of Lake Crescent to account for the pollution. But the large quantity of albumenoid ammonia, without any correspondingly large quantity of free ammonia or chlorine, shew that there must be large deposits of decaying vegetable matter in the bed of the Lake itself, for an analysis made of the water of its principal feeder shows that the impurity is not brought down by the stream.

10. To determine whether the impurity of the water of the lakes and of the river was due to the exceptional lowness of the water, samples were again taken in the month of July, at a time when it was thought that the immediate effect of the great rainfall of June had passed, and the analyses gave the following results:—

	Lake Sorell.	Lake Crescent.	Clyde at Bothwell.	Clyde at Hamilton.
"Free Ammonia, parts in a million	0·02	0·01	0·02	0·02
Albumenoid Ammonia „	0·64	0·62	0·24	0·52
Nitrogen as Nitrates „	0·01	0·01	0·016	traces
Chlorine in Chlorides, grains in a gallon	0·70	0·60	1·90	4·30
Total solids „	13·00	13·00	11·00	17·50

"The waters of the two lakes are practically identical in composition, and (as shewn by the composition of the river which flows from them) deposit much of the vegetable impurity in their downward course" to Bothwell. The water at Hamilton, after its still further aeration by its flow over its rocky bed from Bothwell, should be better instead of worse. But it will be noted that the quantity of chlorine, which had augmented at Bothwell, has so much further augmented at Hamilton as to make the other altered feature of the composition of the water at the latter place—the increased quantity of albumenoid ammonia—a matter of great importance. Taken by itself it might be the result of brackish water derived from some affluent, but in connection with ammonia it requires serious attention. Dr. Parkes, in his "Practical Hygiene," says that "it may be taken as an indication of dangerous contamination" when the increased quantity of chlorine is accompanied by increased quantity of ammonia. Dr. Wanklyn also regards the concurrent presence of such quantities of chlorine and ammonia as are above given in the analysis of Hamilton water as a sign of pullution by animal matter. As I have before remarked, whatever sewage comes from Hamilton is received by the mill-race, which falls into the river far below where the sample of water was taken. The question therefore arises—whence is the animal impurity derived? This should be inquired into. Can it be from dead rabbits? The practical outcome of the various analyses is that the water in the Clyde at Hamilton is not fit for use without boiling, but I cannot

help thinking that further inquiry will show that much of the present pollution is preventible, as it must take place below Bothwell.

11. To define as accurately as practicable without a special survey the area of the watershed draining into the Lakes, and to make further observations on the quality of the water, I paid another visit to them in August. Lake Sorell was then about 30 inches higher than when I had previously seen it, and the water was much more limpid, but still of a decided tawny or clayey colour. By the Interlaken River and Mr. Kermode's drain about 1250 cubic feet of water a minute were passing into Lake Crescent, the greater part of which was brought into Lake Sorell by the stream that is locally called the Mountain River. This small river is the outlet for the rainfall of most of the country north of the lake, stretching from the north side of Molly York's Cap round its western and southern flanks and through the Four-mile Marsh. In wet weather a considerable volume of water comes down the stream, and it is never dry in summer. When seen on the 10th August its crystal clearness was in marked contrast to the tawny colour of the Lake, and its quantity was sufficient to make a large patch of transparently pure water round its mouth like a sheet of glass let into opaque earthenware. A sample of the water was taken, and the following is Mr. Ward's analysis of it :—

"Free Ammonia	0·01 part in a million.
Albumenoid Ammonia.....	0·10 „ „
Nitrogen as Nitrates.....	None.
Chlorine as Chlorides.....	0·30 grains in a gallon.
Total solids	2·50 „ „

Except for the quantity of albumenoid ammonia this would be a remarkably pure water, and the quantity of that ammonia is easily accounted for by the fact that the stream runs through marshes and forest. And the almost complete absence of nitrogen in other forms and of chlorine makes this quantity of albumenoid ammonia of less consequence.

12. Lake Crescent was very full and overflowing the marshes on its borders; the sluice-gate at the outlet of the Clyde was closed and the water was running over its top, which had been decreased in height. A great deal of water was also escaping through the weir, although it had been repaired since my former visit. About 700 cubic feet of water a minute were flowing out of the lake, and as this quantity was greatly less than the inflow, the banks were every day being more and more flooded.

13. Samples of water were again taken from both lakes, and the following is Mr. Ward's report upon their analysis :—

	Lake Sorell.	Clyde Outlet.
"Free Ammonia.....parts in a million ...	0·015	0·040
Albumenoid Ammonia „ „ ...	0·580	0·920
Nitrogen in Nitrates... „ „ ...	traces	0·110
Chlorine in Chlorides.. grains in a gallon...	0·7	0·9
Total solid matter ..... „ „ ...	12·0	8·5

"The gradual accumulation of impurity in solution is well shewn by this series" (including the Mountain River), "the diminished solid matter at the outlet being due to the smaller amount of matter in suspension."

14. As the Clyde has thus been traced to its rise, and the quality of its water frequently tested at different points, this quality will be better understood by the following summary, beginning from its source and going down stream :—

	Date of taking samples.	Free Ammonia.	Albumenoid Ammonia.	Nitrogen in Nitrates.	Chlorine in Chlorides.	Total solids.
		Parts in a million.			Grains in a gallon.	
Mountain River...	August 10	0·010	0·100	none	0·30	2·5
Lake Sorell	March 31	0·020	1·110	0·030	1·00	18·0
Ditto	July	0·020	0·640	0·010	0·07	13·0
Ditto	August 11	0·015	0·580	traces	0·07	12·0
Lake Crescent ...	April 5	0·027	1·480	none	1·20	14·0
Ditto	July	0·010	0·620	0·010	0·06	13·0
Ditto	August 11	0·040	0·920	0·110	0·90	8·5
Clyde, at Bothwell	March 25	0·100	1·140	0·070	1·35	12·50
Ditto	March 25	0·110	1·000	0·060	1·35	12·50
Ditto	July	0·020	0·240	0·016	1·90	11·00
Clyde, at Hamilton	Jan. 31	0·320	0·540	none	3·80	14·00
Ditto	July	0·020	0·520	traces	4·30	17·50
Dr. Parke's limit of impurity in *usable* water		0·050	0·100	1·129	3·00	30·00

15. These analyses establish the following points :—(1) That the quality of the water in the Lakes is never very good; (2) that this quality is greatly deteriorated when the water is low;

(3) that the quality of the water of Lake Crescent is worse than that of Lake Sorell; (4) that the quality of the water is much improved by its flow down its rocky channel to Bothwell. The consideration of the second and third of these points must make it evident that any work done at the Lakes which will make the Clyde supply more dependent upon Lake Crescent than it now is, and drawing that supply at a lower level, can only result in deteriorating still more the quality of the water. As this question of the quality of the water does not appear to have been within the scope of the inquiry made by the Parliamentary Committee, I beg to call serious attention to it, and to make some suggestions.

16. To understand the suggestions, the following facts must be borne in mind:—The area of the watershed basin draining into Lake Sorell is 61 square miles, or 39,040 acres, of which 12,300 acres are occupied by the lake itself, and 26,740 acres by land. As the greater part of this surrounding land is mountainous, and as no part of it is more than eight miles from the lake, it may be taken for granted that a considerable proportion of the rain that falls finds its way into the lake, and at a comparatively short time from its fall. Captain Shortt's rainfall returns from the lake begin with 1889, and I have not been able to get any earlier information. From the first January this year to the 31st July rain fell on 65 days, and to a depth of 26·88 inches. Of this more than half fell in thirteen days in the month of June. Of course the greater part of such a rainfall could not be retained in the lake, so the country all down the course of the Clyde was deeply flooded. The real question to be considered is, therefore, not so much the quantity of rain that falls, as the period in which it falls, and the quantity of it that can be stored. As the lake is more than 2000 feet above the sea level, there is in all probability enough rainfall during nine months of the year to keep the level of the lake up to what the River Clyde Act calls its "highest ordinary winter level." The storage capacity is therefore only of vital importance during three months. If the "highest ordinary winter level" be taken from the evident waterworks on the banks, it will probably be found to be 51 inches above the top of the sill of the sluice-frame at the Interlaken River. The Act provides that the water in the lake is not to be maintained higher than within three inches of this level. As the analyses show that the more the water recedes from this level the more it deteriorates in quality, arrangements should be made to prevent it from ever falling lower than 18 inches below this maximum level.

17. But the Parliamentary Committee of last session recommended that, to enable water to be taken by a tunnel from Lake Sorell to irrigate the land eastward of the Tiers, the level of the water of the lake should be raised three feet, and the outlet by the Interlaken lowered thirty inches. The result of this arrangement would be that the eastern plains would get the top water for irrigation, and the Bothwell and Hamilton people the bottom water for drinking. I am sure the Committee did not know that this lowering of the Interlaken outlet would, especially if accompanied by a lowering of the outlet of the Clyde from Lake Crescent, render the water of the river during dry seasons utterly unfit for human consumption all down its valley, and thus vitally affect both Bothwell and Hamilton. I therefore respectfully but urgently recommend that this part of the scheme be abandoned. It will also probably be found that the cost of raising the level of the surface of Lake Sorell by three feet is not only impracticable on account of cost, but undesirable on account of danger. Immensely strong embankments would have to be raised to resist the wash of the water in the northerly and north-westerly gales that sweep the lake. And in case of accident to the embankment and sluices, the whole valley would suffer to an extent incomparably greater than under any flood that can now take place.

18. I therefore assume that the water, from economical motives, will not be raised much above the legal maximum fixed in the River Clyde Act, and, from sanitary motives, will not be allowed to fall more than 18 inches below it. Within these limits of level Lake Sorell will hold 30 million cubic yards of water, and this reserve may be all that can be counted on for three months. In that period it is probable that the evaporation from the lake would be 14 million cubic yards, leaving 16 millions to be disposed of. The Clyde has certainly the first claim upon this water. There are towns and mills and irrigated lands on its banks, and if the mill-power be taken as the guage of water requirements, it will be found that 8 million cubic yards will give the 20 horse-power needed to work the Chamberlen's mill at Bothwell for the period of 90 days, and will furnish all other requirements, including the irrigation of 2700 acres with a quarter of an inch of water a day. Therefore, whatever works are constructed, they should be so designed as to make the provision of this eight million cubic yards for the Clyde during every or any three months of the year a first charge on the water in Lake Sorell, to be taken without lowering its surface more than 18 inches below the maximum fixed by the Act. When this provision is secured the surplus might be diverted to other uses, and that surplus, if a spell of 90 days' drought occurred, would irrigate an equal area of 2700 acres in any other locality. For every inch the water was raised above the maximum fixed by the Act, about 555 more acres would be irrigated during the period named. So if the level were raised nine inches, as it probably might be without danger, nearly 8000 acres could be irrigated eastwards of the Tier.

19. But if the water for irrigation of the eastern plains could be taken from Lake Crescent, there need be no limit to the depth at which it should be drawn, provided that a channel be made for the Clyde supply directly from Lake Sorell to the river. This would have to be about 4000

yards long, and would probably cost from £1200 to £1500. I have been told that surveys have been made in past times that showed the practicability of draining Lake Crescent towards the head-waters of the Blackman River or Mill Brook, and an incidental remark in the late Mr. Calder's report on irrigation (Parliamentary Papers, 1863) seems to confirm this. If so, water could be had for 20,000 acres of land. This arrangement, without interfering with the quantity, would improve the quality of the water in the Clyde.

20. The object I have in view is to secure for the inhabitants of the valley of the Clyde a sufficient supply of water of as good a quality as possible, and the following is a summary of my recommendations:—

(1.) That the provisions of the River Clyde Act with respect to keeping up the water in Lake Sorell to "highest ordinary winter level" be carried out, and the necessary works for doing so be constructed.

(2.) That a channel be cut from Lake Sorell to the Clyde capable of delivering 90,000 cubic yards of water a day, and that during dry weather no water be admitted into the Clyde but by this channel (this would necessitate the construction of a proper weir at the outlet from Lake Crescent).

(3.) That if water be taken from Lake Sorell for irrigation purposes, such water be not taken until provision be made for the above-mentioned 90,000 cubic yards a day, nor from a depth of more than 18 inches below the "highest ordinary winter level;" and

(4.) That after the cutting of the above-mentioned channel any quantity of water be allowed to be taken from Lake Crescent for irrigation purposes.

The above works, so far as they relate to the Clyde valley, would ensure a continual supply for domestic purposes, mill power, and irrigation, and would be well worth the expenditure of the necessary money. With respect to mill power and irrigation, the certainty of having always an ample supply of water would be worth such small additional rating as would be required.

I have the honour to remain,
Mr. President and Gentlemen,
Your obedient Servant,

A. MAULT, *Engineering Inspector.*

Hobart, 9th September, 1889.

WILLIAM THOMAS STRUTT,
GOVERNMENT PRINTER, TASMANIA.