AN EXAMINATION OF THE PROPOSALS FOR DEALING WITH FLOODS OF THE KELANI CANAL IN COLOMBO

BY

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Introduction

The subject is a very vast, and a very old one. Proposals, and counter proposals have been made from time to time during the last fifty years. After the scheme put forward by the Consulting Engineers in London in 1897 for the treatment of the mouth of the river at an estimated cost of £294,000 sterling, which would only reduce the height of the floods by about eighteen inches in Colombo—a totally inadequate result for such a large expenditure of money—Government seems to have given up the idea of doing anything in the matter.

I do not think Government should give up in despair any attempt to mitigate the floods in Colombo, simply because one scheme that has been proposed would not yield results commensurate with its cost. Other proposals, which, I submit, would give much better results at a considerably less cost, have been put forward, as will be shown in the course of this paper, and it is the duty of Government to take up one, or more of these schemes, and persevere to the end. For instance, the Kirillapone flood outlet scheme, on which only about a quarter of the work approved by the late Sir John Coode, the eminent engineering authority, in 1880, has
been so far dealt with, might very well be taken up, and pushed on to completion. The want of a continuity of policy in regard to flood outlets has resulted in schemes being only partially completed, and the full benefits expected from the completion of such schemes in their entirety not being realised—it has resulted, practically, in so much money being thrown away.

It was, I believe, Governor Sir West Ridgeway who, in his Review, when laying down the reins of Government in 1903, stated that the difficult question of floods will have to be faced in the future. That time, I submit, has now arrived; and if my taking up this question, and laying bare the various proposals made from time to time, would create such an interest that, as a member of the Legislative Council once remarked in open Council, "these various schemes may be looked into, so that Government might be able to find some way of doing something practical in the matter," I shall feel fully recompensed for the trouble involved in "hunting up" old records, and summarising the whole situation.

I propose to deal with the subject under the following heads:—

(a) Flood outlets.

(b) Treatment of the mouth of the river.

(c) Flood banks.

Government has for the time being given up the idea of undertaking any work under heads (a) and (b), and is now considering what could be done under (c).

In order that one may gain a full, and clear grasp of the whole flood question, I propose to give in extenso the various suggestions and schemes put forward by Government Officials, Consulting Engineers, and members of the general public from time to time.

To begin with it is necessary that I should give a short description of the river, which is the cause of all the trouble.
The principal source of the Kelani Ganga (see Diagram No. 1) is in Bogawantalawa, near Kirigalpotta, near the Horton Plains, and is known as Bogawantalawa Oya. Not far from the Ginigathena Gap it is joined by the Maskeliya Oya, which rises near Adam’s Peak, and which is its principal feeder. In their course towards their junction, which takes place in the Keldegomunwa Valley, they receive the watersheds of Laxapanagalla, and the surrounding country, forming at this point the Kelani Ganga. A little lower in its course, at Yatiyantota, it is joined by a stream (the We Oya) of lesser magnitude; then by the Guru goda Oya, which drains the western slope of the Doloshage Range, and afterwards, near Avissawella, by the Sitawake river, which rises about ten miles to the south east, and lower down by the Wak Oya.

From its source at Bogawantalawa to its mouth at Colombo the course of the Kelani Ganga is about 84 miles long, and it drains about 692 square miles of the mountain zone and 200 square miles of the low-country.

The width of the river at low water at the railway bridge at Colombo is about 410 feet.

The river slopes two feet in one mile during flood (see Diagram No. 2). During the dry season there is scarcely any fall in the river for a length of 11 miles measured upwards from the sea, and when the upper reaches and tributaries are contributing but little, the flow of the river is languid, the rise of tide even turning it against the stream as it were for a few miles from its mouth.

The area subject to flooding is about 80 square miles, and extends from Hanwella on the left bank of the river to the sea, a distance of 26 miles, and from opposite Kaduwela to the sea on the right bank, about 14 miles.

The mouth of the river is largely blocked by a sand spit (see Diagram No. 3) extending
from the north, having a low water width varying from 100 feet to 330 feet. The sand spit is subject to changes in its configuration, dependent upon the severity of the monsoon seas, and the extent of the flood discharge. It acts as a barrier to the free escape seawards of flood waters, and tends to a banking up thereof. The old and natural mouth of the river is close to the historic mosque at Mutwal point. This silted up about 1885 when a new passage was opened into the sea through the sand-bank during flood. In 1890 a channel was dredged through the silt and the mouth of the river reverted to its original position close to Mutwal point. In 1896 the mouth again changed its position when a cut was made through the sand-bank, and it has remained in that position since. In 1904 the south portion of the sand-bank was planted up with suitable aquatic plants, and bushes, and subsequently with coconuts, by the Director of Agriculture, at the request of the Colombo Municipality, but without any reference to the P.W.D.

I trust I shall be excused for a little digression in regard to the interesting history of the mosque referred to above. It is stated that during the Dutch Government in Ceylon, about the 17th century, whilst some soldiers were chasing a Mohamedan and his younger sister, the man ran towards the rock, which is at the northern boundary of the Christian Brothers' property at Mutwal, and disappeared there. The Dutch Government, to satisfy the Mohamedans, who maintained that the man was a saint, presented about an acre of land in the direction where he had disappeared, to enable the Mohamedans to put up a building in his memory. The Mohamedans, headed by one Mohideen Ibrahim, erected the present building, and called it a mosque. The remaining portion of the land was for sometime being used as a Mohamedan burial ground.

A submerged reef (coarse-grained sandstone) exists extending generally parallel with the sand spit, and at a distance of about 2,000 ft.
therefrom, the depth over its crest varying from 5 ft. to 10 ft. at low water.

Inside the entrance the channel is of insufficient area for the discharge of the floods, the river is in fair train until reaching a point about 5½ miles from the sea, where an abrupt bend exists, the effect of which is to hold back or impound the flood waters to the extent of 12 inches.

At 10½ miles from the sea, and also at Kaduwela, 3½ miles further up the river, sharp bends exist, each of which impounds the flood discharge about 12 inches. Serious obstructions also occur at other points in the river between the railway bridge and Hanwella, which tend to restrict the free passage of outgoing waters in time of floods.

The Kelani Ganga is only navigable for large flat-bottom boats (padda boats) as far as Teligama (Subaragamuwa Province) a distance of 52 miles.

Causes of Floods

The flooding of the low-lying areas may be said to be due to the following causes:

1. To the configuration of the watershed of the Kelani, the upper portion of which is mountainous and subject to an abnormally high rainfall, whilst the land in the vicinity of the lower reaches of the river is flat and but little above the level of the sea.

2. To the extremely low level of the land which is liable to flooding, some portions of which are less than 4 ft. above low water level at sea.

3. To the blocking of the mouth of the Kelani by the sand spit.

4. To the insufficiency of the waterway of the existing channel and to the banking up of the floods by the abrupt bends and also by the obstructions which exist, tending to prevent the ready passage seawards of the outgoing waters.
There seems to be some divergence of opinion amongst officials on the effect of the floods on the inhabitants within the flood area.

In 1895 Mr. R. K. Macbride, D.P.W., made the following statement:

"I have always been of opinion that the damage by the Kelani floods is more imaginary than real and I have seen all the very high floods from 1872."

In 1901 Mr. F. R. Ellis, Government Agent, Mr. F. R. W. P., expressed himself thus: "I have always maintained that the loss caused by G.A., W.P., floods has been greatly exaggerated. The river itself cuts the bar when a certain height of water is attained, and as a rule this keeps the floods to a well-known level, so that people are prepared for the annual recurrence of high water."

The Acting Colonial Secretary (Mr. G. M. Fowler, C.M.G.), who was Government Agent of the Western Province for some considerable time, made the following remarks in a debate which took place in the Legislative Council in December, 1906.

"The effects of the floods are so beneficial as to make up for the inconvenience and suffering to a great extent. I think that anyone who pays a visit to the flooded districts three months afterwards will be convinced of this. The mud houses have all been repaired, and the gardens and fields look better than ever. In saying so I do not wish to lay myself open to a charge of not sympathising with the people; but I do honestly think the suffering and inconvenience is greatly exaggerated by those who are led away by individual instances coming under their notice."

In April 1911 Sir Henry McCallum, Sir Henry Governor, made the following statement in McCallum, the Legislative Council: "A bunding project Governor, was prepared protecting from flood intrusion 1911
a very large area on the south bank of the river, extending in the eastward as far as Hanwella. Inquiry was then made from those whose lands would be thus protected whether—if the project was carried out—they would agree to pay a small assessment per acre to cover interest, sinking fund, and cost of maintenance. The great majority pointed out, however, that far from doing them harm a flood with its fertilising powers did them much good, and many even protested, and spoke of demanding compensation if they were cut off from its benefits.”

Dr. W. R. Kynsey, the Principal Civil Medical Officer, in a report to Government in 1878, however, was quite different. His report was as follows:

“The periodical inundations from excessive rainfall, to which the river Kelani is liable, give rise to the submersion of extensive tracts of land in the neighbourhood of Colombo, and the effects have been most disastrous to the numerous and populous villages situated in the area drained by this important river.

“The evils caused by these annual, or indeed often bi-annual, floods may be divided for convenience of description into primary or immediate, and secondary or after-effects. Under the first heading may be enumerated the injury done to property and crops, entailing considerable loss on a poor and industrious people; houses are frequently submerged, and in many instances swept away; cattle, goats, pigs and poultry have also been destroyed, and the crops suffer to a serious extent; the seed sown is often washed out of the ground, premature and abortive fructification ensues, ending eventually in rot and the total destruction of the grain.

“Besides these may be mentioned the difficulty of travelling owing to the submersion of the roads, the consequent increase in the price of food, the destitution of the people from want of employment, rendering them easy
victims to those diseases which invariably originate subsequently on the subsidence of the floods, due, no doubt, to the putrifying processes in progress and the rise of morbid emanations from the drying earth. When the waters commence to subside, the process of decomposition of the organic matter carried along by the floods and deposited over the country or caused by the destruction of growing vegetation sets in, the soil, saturated with rain-water and improperly drained, forms a ready nidus for the decomposition of animal and vegetable substances and the giving off of mephitic vapours, particularly malaria.

The damp soil gives rise to such diseases as catarrh, rheumatism, diarrheoa, dysentery, and intermittent fever, which frequently become epidemic; attacking a large percentage of the people. This fever is often of protracted duration, leading to organic disease or to anaemia or Malarial cachexia. Different forms of bowel disease become endemic, and are frequently very fatal. They seem to originate from the dampness of the soil, malaria, insufficient clothing and poor diet, to which may be added the contamination of the water supply, owing to the infiltration of the wells with decaying organic matter from the soil, and the use of unwholesome food from the destruction of the paddy and other crops.

"It not infrequently happens that in some districts intermittent fever becomes endemic, due to the mephitic exhalations arising from the swamps left by the floods; and these swamps, I may state, in many places have become permanent, each successive flood enlarging their dimensions.

"From the above remarks, I consider it will be evident that the effects of the inundations of the Kelani River are most injurious to the health of the people residing on its banks or in the vicinity of the flooded districts."

The material effects of normal floods of from 4 to 6 days duration, are not very damaging but extraordinary floods, such as the ones of
1837, 1872 and 1913, which last for a period much over six days are most disastrous in their effects, resulting in complete blockage of traffic, by roads and canals being damaged, culverts and bridges carried away, houses destroyed and cultivations of all kinds completely ruined.

The highest recorded floods of the Kelani Ganga are:

1872 1913 1906 1904 1891
11' 11" 11' 0" 10' 9" 9' 11" 9' 9\frac{1}{4}"
from mean sea level.

The question of averting the disastrous consequences of floods has engaged the attention of Government for the last half century (since the highest recorded flood of September 1872). It is evident that even before this time attention was being paid to the matter, for we find that the Kirillapone canal, popularly known as "Layards Folly," which empties into the sea at Wellawatte (4th mile, Colombo-Galle Road) had been cut to serve as a flood outlet long before 1872.

I am sorry I have not been able to trace any records regarding the cutting of this canal. The then Government Agent of the Western Province, Sir C. P. Layard, evidently, had a great deal to do with it, hence the name Layard; and the following description of this canal in the report of the Flood Commission of 1873 sufficiently indicates why it earned the unenviable sobriquet "Folly":—"The bottom of the canal is 14ft. above high-water-mark near the toll station on the Galle Road, and from this point it slopes downwards in both directions towards the sea, and towards the low-lands near Kotte, until it meets both at the level of high water. If the canal were deepened to this level it would afford ample means for the escape of any water that might accumulate over the low-lands near Kotte." It is evident, therefore, that at the time it was cut, the canal could not very well have acted as a flood outlet and that the title "Folly" was
not quite inappropriate, although at the present time, after further deepening, and widening, it is the best flood outlet of the Kelani Ganga.

The highest flood of the Kelani is reported to have occurred in 1837. The river rising to 13' 6" above main sea level, (a flood of 1834 is also reported to have risen a foot higher than this) but no records of these floods have been kept. The great flood, of which records are available, occurred in 1872 (11' 11" above mean sea level). No serious floods, however, seem to have occurred during the construction of the railway line across the Kelani to Kandy, (portion of this line up to Ambepussa was opened in 1865), and it was the common belief at the time that the immunity from floods during this period was due to the contractors, who were building the railway, taking good care to see that the mouth of the river was kept open during its construction, by not allowing the formation of a heavy sandbank at the mouth of the river. It was also thought by many people at the time that Government would always take this precaution and that damage from floods would be a thing of the past. This belief was however shattered when the river rose 11' 11" in September 1872, and very nearly broke the record of previous floods.

Government was, evidently, greatly alarmed at this flood, and lost no time in appointing a Commission, consisting of the Surveyor General, the Director of Public Works and the Colonel of the Local Detachment of the Royal Engineers, to enquire into and report on the cause of the floods, and on the possibility of affording increased outlets into the sea from flood waters. The problem, however, remains unsolved to this day. The Commission went thoroughly into the whole question, and examined the following proposals put forward by members of the general public:

1. That immediately on the sign of a flood a channel be cut through the sand bar at the
mouth of the river for the escape of flood waters. It being contended that serious floods were to a large extent due to the delay which has hitherto occurred in commencing this work.

2. That a canal be cut at the bend of the river at its mouth from Pasbetal direct through to Kadirana. (See D-E Diagram No. 4.)

3. That the existing Dutch canal, which passes under St. Joseph's Bridge at Grandpass and runs through the Kimbulawala fields at Madampitiya, be extended and opened up to fall into the sea across Alutmawatte, and Mutwal roads. (See F.-G. Diagram No. 4.)

4. That a canal be cut from the Kotte bridge; where waters rush in from all directions, through Kinagaswagara, Nawala, Walapottan Ela, close by the Model Farm to Bambalapitiya and thence through the Cinnamon Gardens to the sea at Kollupitiya between the 2nd and 3rd mile posts on the Galle road.

5. That there be more outlets for flood waters along the Kandy railway embankment.

In regard to the first proposal Mr. H. Byrne, the Provincial Assistant, P.W.D., W.P., had the following interesting remarks to make:—

Sand Spit

"I believe that much misapprehension exists in reference to the effect of what is called 'opening the bar' of the Kelani river when the country above is inundated.

"From all that has lately been said and written on the subject, it would seem to be the common belief that the natural mouth of the river (which is immediately opposite to St. John's Church, about three and a quarter miles from Colombo on the Mutwal road) is generally closed; and that the opening of a mouth through the sand-bank at a point about half a mile further north, and near the
entrance of the Hamilton canal, would result in the immediate discharge of the flood-waters and prevent any further rise in the river.

"But the natural mouth of the river never is quite closed; and a very slight, almost imperceptible, rise in the river is sufficient to open it wide enough for the ready discharge of ordinary floods.

"In deference however to the popular belief in the effect of making a new opening, rather than from any conviction of the utility of the work, it has been usual for many years back, whenever the rise of the river threatened injury to property and interruption to traffic on the roads, to cut an opening into the sea through the narrow strip of sand which forms the right bank of the river for the last half mile or so of its course.

"But in every instance the experiment has failed where the rise of the water above ordinary level at the bridge of boats has not reached seven or eight feet. For, the necessary condition of success is, such a head of water in the river above the mean level of the sea at the spot where the opening is usually made in the bank, as will enable the current to overcome the opposing action of the sea outside; and the experience of many years has shown that this head of water there is not attained until the flood reaches the level which I have mentioned at the bridge of boats.

"On the only two occasions known to me previous to the occurrence of the recent flood, when the opening was successfully made (1862 and 1870) the water at the bridge stood at nine feet and eight feet above its ordinary level. In both instances the water fell soon afterwards, and the popular impression was, that this was the direct consequence of the additional outlet having been opened.

"On the late occasion the water at the bridge stood at seven feet and seven inches above its ordinary level on the day (11th
ultimo) when the work of opening a new mouth was carried out; and, according to the commonly received view the flood ought to have subsided at once. But on the next day it rose to ten feet six inches; on the second day within an inch of twelve feet; on the third day stood at eleven feet five inches; on the fourth day at ten feet seven inches, and it was not till the eighth day that the water fell to the level at which it stood when the new mouth was cut.

"The case of the Kalutara river is pretty similar to this. It has been stated to me by the Superintending Officer at Kalutara, that during a period of at least half a century over which his knowledge of the river extends, a successful opening in the sand-bank has not been made more than five times, though the experiment has been tried whenever a flood occurred. The experiment never succeeded till the water rose to within a couple of feet of the bridge beams, on reaching which level the water fell; and its fall was popularly attributed to the opening made in the bank outside. The last successful opening was made about two years ago. Its position has shifted since then only a little to the southward; but the opening has remained undiminished in width and capacity for discharge; yet notwithstanding its existence before the recent flood came on, the water rose to actual contact with the roadway beams higher, in fact, than it has ever risen since 1837.

"These facts prove, as I think, that the practical effect of making a new opening near the natural mouth of a river of this character, is very small; and that the fall in the river immediately after the opening is made is due, mainly if not wholly, to the timely cessation of rain, or to the limited rainfall in the interior."

In this connection Mr. F. Vine, Provincial Assistant, P.W.D., W.P., also made the following remarks in 1877:
"How far it is practicable to prevent floods by opening the bar may be judged by the experience gained in last May and June. At the burst of the monsoon the river began to rise rapidly, but owing to the heavy surf we were not able to make good the cutting of the bar until the water rose to the 9' 7" gauge at the bridge of boats. This cutting remained open, and a heavier flood came in June reaching 12' 7" by the river gauge, whilst the flood waters were passing through the bar from the commencement."

The Commission could not accept the second proposal as a means of relieving the river of its flood waters, because they did not think it would add appreciably to the cross section of the river and would merely carry the flood water from one part of the river to another.

The suggestion contained in the third proposal was accepted.

In regard to the fourth proposal the Commission were of opinion that the best and most economical method of carrying off flood waters from the low lands between Kotte and the sea would be to deepen the Kirillapone canal.

The fifth proposal was accepted.

The Commission, after going carefully into the rainfall records of several places within the catchment area, made the following observations in regard to the capacity of the Kelani Ganga and the quantity of water it should be capable of discharging. "We may safely assume that an average of eight inches or say .7 of a foot of rain per diem for four days to have fallen over that portion of the mountain zone which is drained by the Kelani Ganga. As this area is estimated at 692 square miles, the river should have sufficient capacity and outlet to carry off 692 x 640 x 4360 x .7 = 13,504,296,960 cubic feet of water in twenty-four hours or 8,377,984 cubic feet per minute."
"On the 9th September the water in the Kelani was 16 feet below the girders of the railway bridge, when the river commenced to overflow its banks, eighteen miles from Colombo. We may therefore take for granted that as long as the water in the river does not rise above this level no serious floods can take place up-country, but under this condition the river can only discharge 2,041,420 cubic feet of water per minute at the railway bridge, a result showing that a river with a capacity nearly five times as great as that of the Kelani at this point, which is about the same size at Kaduwela, would be required to carry off the rain-water falling at the rate of eight inches per diem over the 692 square miles of the mountain zone without flooding the low-country."

Sir John Coode, 1880

With regard to this assumption by the Commissioners Sir John Coode commented in 1880 as follows:—"I cannot regard this view as tenable, seeing that this quantity must be considerably reduced in respect of absorption by the ground and evaporation, a portion of the water so absorbed and evaporated not reaching the rivers at all, or at any rate until after subsequent condensation and discharge in the form of rain. But it is more important to remember that due allowance must be made for the time requisite for the water to find its way either over the surface, or by percolating the ground into the streamlets or minor feeders, thence into the large tributaries, from the latter into the main channels of the rivers along which they run down to the low-country and finally into the sea."

Mr. R. Skelton, 1915

For further and fuller information on this point one could not do better than refer to the excellent memorandum by Mr. Robert Skelton, the late Municipal Engineer, Colombo, printed and published in November 1915, where all necessary data from 20 years daily records of the river are given, and where also the results of his laborious investigations for the discovery of a proper basis for applying rainfall to river.
discharge are recorded. This most useful memorandum concludes with the statement that "the maximum day's rain-storm volume may be three times the greatest volume discharged in one day under conditions of highest known flood, and as an inch of rain on 900 square miles is equal to 2,091 million cubic feet in volume, and an inch of rain per day is equal to a run-off of 25,000 cubic feet per second, these figures may be readily converted to definite units of volume at will."

After an exhaustive enquiry the Commission came to the conclusion that it was not possible to propose any practicable method of preventing a recurrence of the floods, but that their disastrous consequences may however be averted to a great extent.

1st. By increasing the amount of water-way through the raised roads that traverse the country through which the Kelani flows.

2nd. By opening a channel between the Madampitiya fields and the sea, so as to form a spill-water in rock at high-water level.

3rd. By constructing a spill-water between the Colombo lake and the sea near the Police Station on the Galle Face.

4th. By opening the Kirillapone canal.

5th. By reducing the width of the banks of sand that form at the mouth of the river, so that they may be easily carried away by the pressure of water when the river rises considerably above its ordinary level, and also facilitate the operation of making a cutting.

The last recommendation was based on the opinion of the Commission that a very different result from that described by Mr. Byrne would take place if the bank of sand at the mouth of the river was always kept at a minimum width, and that, when the bank of sand is allowed to accumulate at the mouth of the river for some time, and attain a great width,
even when a cutting is made through it, the water washes away the sand at its sides so gradually, owing to its great width, that a considerable time elapses before a sufficiently large channel is made to allow a free exit for the flood water.

But how to keep the sand-bank reduced in width was not stated by the Commissioners.

Thus ended the labours of the Flood Commission of 1873. But very little appears to have resulted from their recommendations.

**Flood Outlets**

Things, evidently, stood in the same position in 1877, as regards flood outlets, as they were in 1872.

In 1877 the late Mr. David Wilson, a Member of the Legislative Council, put forward a scheme to deal with the flood waters of the Kelani Ganga. In recommending the scheme to Government for favourable consideration, Mr. F. R. Saunders, the Acting Government Agent, W.P., made the following remarks:

"The proposal is to obtain a proper outlet for the flood waters of the Kelani Ganga which at present inundate periodically a large portion of the north town and suburbs. It is stated that often when the river is fourteen feet high at the point A (see Diagram No. 4) just below the bridge-of-boats, it is only three feet at the point B, and it is thought that if a large canal were cut the river would never rise to such a height at A, but would discharge itself rapidly through the canal and by its usual outlet.

"I walked over the ground with Mr. Wilson, and I am bound to confess that the proposal seemed to me much more feasible than I had anticipated when looking at the plans. That the work is practicable there can be no doubt, and it is merely a question of what it will cost."
"If this work can be executed for anything at all reasonable, there can be little doubt that it will confer an immense public benefit."

In reporting on the scheme the Acting Mr. J. F. D.P.W., Mr. J. F. Churchill, commented as Churchell follow:- "Mr. Wilson suggests that the Acting outlet of his drainage channel should be D.P.W. within the mouth of the river. This, I think, is objectionable, and that the outlet should be placed outside the river mouth among the rocks nearer to Mutwal point." (This was also the recommendation made by the Flood Commission of 1873.)

"During the flood of 1872 when the river was five feet above mean sea-level at the outlet into the sea, sixteen miles up its course at Nawaganuwa it was thirty-six feet above mean sea-level, and that the surface of the flood had an uniform gradient rising two feet in each mile.

"This drainage channel would shorten the distance for the water to flow from the bridge-of-boats to the sea from three and a half to one and a half miles, or a saving of two miles in distance, and would therefore tend to lower the floods at the bridge-of-boats by about four feet; but this would not extend much higher up the river, for its bed is not large enough to discharge the heavy volume of water coming down the hills."

On this point the opinion of the late Director Mr. F. A. of Public Works, Mr. F. A. Cooper, c.m.g., Cooper, expressed in April 1907 in a communication D.P.W. 1907 to Government was as follows:--

"The construction of a channel from the bridge-of-boats to the sea near the mouth of the Kelani Ganga would not in itself be an advisable work, for unless the sectional area of the river was increased, probably for a distance of about 10 miles, the construction of the canal would probably have little effect on the height of the flood waters beyond a distance of two or
three miles, and would tend to increase the velocity of flow in the river channel to a dangerous extent."

In 1878 matters had evidently been referred to Sir John Coode, the eminent Engineer of the firm of Coode Son & Matthews, the Consulting Engineers, for consideration and report. In the meantime the Acting D.P.W., Mr. J. P. Churchill, suggested to Government that, whilst the proposal for the Kelani flood relief was under consideration by the Consulting Engineers, a complete scheme should be prepared that would effectually bar out all floods from Colombo between a line drawn from the head of the Kirillapone canal and the railway bridge at Kelani, provision being made for independent drainage, provided there were no physical difficulties, for the swamps around Colombo being thoroughly drained, and kept free from floods of the surrounding country. The larger scheme of tapping the Kelani should, he thought, be carried out independently of the minor work, as a means of giving relief to the country generally, and lessening the duration of floods, whilst the minor proposal was a local work for protecting Colombo.

This was approved by Government and in June 1879 the Acting D.P.W., Mr. Churchill, after thorough investigation, and mature consideration, submitted the following proposals. The proposals being "placed in the order of benefit to be derived from them and in which if determined upon, they should be carried out."

No. 1 Outlet.—A channel from the Kelani Ganga at Ambatule, through the Kirillapone canal to the sea, and the drainage of the Colombo Cinnamon Gardens to the sea. (See Diagram No. 4.)

This outlet to be subdivided as follows:

1. (a) The proposed outlet channel to commence at the Kelani river about the 8th mile post on the Colombo and Ratnapura road.
The bed of the channel to be at the ordinary level of the water in the river, passing under the Ratnapura road by a bridge and through the low grounds to the Kotte bridge. This portion of the channel to have a width of 200 feet. (b) From the Kotte bridge a branch channel, 100 feet wide, to lead towards Talangama, to drain off the floods from that direction. (c) From the Kotte bridge the channel to be 300 ft. wide, taking the line of the Kalutara canal into the Kotte lake, and following the line of this canal beyond the lake to where the Kalutara canal branches off, then taking the straight line of the Kirillapone canal to the sea.

2. For the drainage of the Cinnamon Gardens about the Kanatte Cemetery and Horton Place. The proposal being to improve the present drainage channel leading into the stream flowing, through the Alfred Model Farm, the water thus finding its way through natural drainage channels into the Kirillapone canal.

3. The drainage of that portion of Kollupitiya near Turret Road to be carried out by widening and deepening the present channel leading from this swamp into the Colombo lake, from which through the existing sluices and spill waters there is ample escape for all the flood waters. It is very rarely that much inconvenience results from floods in this part of Colombo.

No. 2 Outlet.—Channel at Mabola—at Muturajawela—to the sea. (See Diagram No. 4.) This channel to be cut through the sand-bank between the Hamilton canal and the sea, the point selected as most favourable being the one used by the villagers for the escape of extraordinary high floods.

No. 3 Outlet.—Improvement to the banks of the Kelani Ganga from Poliyagoda to Kaduwela, and improvements to the bends in the river, and clearing bed of obstructions.
The existing small embankment on the right bank of the river commencing near the railway bridge and extending up to the Kelani temple to be repaired and raised, and a further length of nine miles to be embanked in the same way for the protection of the houses, gardens and fields.

The large mass of rocks projecting into the river at certain places in the river to be cleared away, and certain bends at other places to be widened in order to give the river a uniform capacity.

No. 4 Outlet.—From Bolgoda lake to the sea at Talpitiya. This was to relieve the pent-up waters of the Bolgoda lake, and by lowering the level of the water in the lake the waters in the inundated districts were to flow off into the lake. (This work was in hand and nearly completed, at the time this report was made.)

(Here follow other outlets which have no bearing on the Kelani Ganga.)

No. 8 Outlet.—An iron bridge over the Kelani Ganga at Grandpass in lieu of the present bridge-of-boats.

This proposed iron bridge, in long spans supported on iron cylinders, was to be a great improvement upon the present bridge-of-boats, which was an obstruction to the free flow of water in the river during floods.

No. 9. Outlet.—Channel from the bridge-of-boats to the sea near the mouth of the Kelani Ganga, and canals about Colombo. (See A. C. Diagram No. 4.)

The Flood Commission and other scientific opinion in the Colony was against this outlet on the ground that this outlet being so near the mouth of the river was not likely to prevent the river overflowing above, and therefore will be by itself of little use, and on the further ground that if the other works were carried out, this work will be unnecessary.
For the time being, at least, this work was not to be undertaken.

(See the late D.P.W., Mr. Cooper's remarks already quoted in regard to this.)

In July 1879 the plans and surveys and the above report of the Acting D.P.W. were referred to Sir John Coode, of the firm of Consulting Engineers, for consideration and report.

In June 1880 Sir John Coode submitted his report approving of all the proposals above mentioned with the exception of the proposed channel between Kotte bridge and the Kelani, (see 1 a under No. 1 Outlet) which he thought should be postponed at least for the time being. In its place he suggested a channel from the Madampitiya fields passing near Ueland Mills to the sea (see F. H. Diagram No. 4) for the relief of the low-lying lands between Kotte bridge and the Kelani. This being substantially the same line as was proposed by the Flood Commission of 1873 under the second head of their recommendations.

He also thought that the bottom width of the Kirilapone canal, from the sea through Kotte to Kotte bridge, should not exceed 150 feet at first, to be widened hereafter if necessary.

In agreeing to the work under No. 9 Outlet being deferred, at any rate until the amount of benefit derived from the other relieving works had been definitely ascertained, Sir John Coode made the following observation: "The district around Peliyagoda, and to the north-east of it, situated on the right bank of the Kelani, and that also on the left bank now so liable to severe floodings, will not receive the desired, or rather the necessary amount of relief, unless some further means be provided for mitigating the evils."

"After much consideration as to the best means of accomplishing this object I have
arrived at the conclusion that the problem of securing the greatest amount of benefit for a given expenditure would be solved more satisfactorily by facilitating the escape of the flood waters into the sea through the natural channel of the Kelani Ganga, than by making one or more artificial outlets for the river. Obviously, the great impediment is the sand bar which exists at the entrance, and if this can be kept down by the expenditure of a reasonable sum, to such an extent as would very largely increase the discharging power of the natural channel, it will, I think, be admitted on all hands to be a matter of paramount importance that it should be done, and therefore it should, in my opinion, be carefully and maturely considered.

"The heavy seas which prevail upon this part of the coast for so many months in the year cast up the sand causing it to accumulate in the form of a formidable ridge or bar across the entrance of the river; were it not for this bar the upland waters would at all times flow unimpeded into the sea opposite Mutwal. The question therefore which thus arises is, how can the accumulating action of the sea at this particular part of the coast be neutralized, or, at any rate, kept sufficiently in check to allow the fresh water to overpower it."

Sir John Coode was not, he said, in a position to submit a design and consequently to frame an approximate estimate of cost for works which should be best adopted to accomplish the object in view without certain particulars which he indicated in a separate memorandum.

He felt assured however that the bar at the mouth of the Kelani cannot be kept down effectually, permanently, or economically by a dredge vessel either of Simon's patent construction or of the ordinary type.

Government "Marking Time"

Observations such as these from such an eminent authority as Sir John Coode evidently put the Government on its guard. The revenue of the Colony too being seriously effected about
this time by the failure of the coffee industry, Government kept "marking time," and was slow in voting money for works on flood outlets, except for those that seemed to be absolutely necessary.

The further particulars asked for by Sir John Coode were being got together, and evidently no action of a far-reaching kind in regard to flood outlets was contemplated by Government, till these particulars had been forwarded to Sir John Coode, and his further report received.

The financial position of the Colony showing Mr. F. R. signs of improvement, the Government Agent, Saunders, W.P., (Mr. F. R. Saunders) in reporting to G.A.W.P., Government in June 1889 on a request made 1889 by the Director of the Spinning and Wearing Company for a partial opening of the Kirillapone canal expressed himself thus on the great usefulness of this canal.

"The Company had omitted to mention many benefits which a thorough and complete opening of the canal would confer on the public.

"The Kirillapone canal should be opened up as a great flood outlet and waterway, and to prevent the annual loss and inconvenience which the fact of its not being in working order causes to the inhabitants for miles around.

"The Flood Commission I am aware contemplated extensive flood outlets from the Kelaniya to Kirillapone to discharge part of the Kelaniya direct through this channel." I do not ask now for so large a work. All I wish to do is to follow in the footsteps of Sir Charles Layard, and ask that the Kirillapone canal may be so deepened and enlarged, as to serve as the spill for the large mass of water which collects in the low-country about Cotta, and which surcharging the canal tries to get out to the sea, but which owing to the Galle road and Railway embankments is kept back until
it can find its way down the canal to Pana-
dura, or back into the Kelaniya, days after the
floods have subsided.

"The works proposed by the Director of the
Spinning and Weaving Company would do a
great deal towards what I urge, but I would
go further: I would urge the Government to at
once open out the canal (see J. K. Diagram
No. 4) as wide as it can possibly be made con-
sistent with financial considerations; it is not
a long channel, and the opening ought
not to cost very much. It need not
be deepened to its full width for traffic, but
only for a few feet in the middle, but it should
be opened for traffic right up to the Galle road,
or to the Railway bridge. Here, then should
be a sill wall to prevent salt water at high
tides coming in. Sluices must be provided
and if necessary removable boards for raising
the level of water in the canal, such as are
proposed at Talpitiya. Of course a new
bridge on the Bambalapitiya road is necessary,
and also, I think, one on the Galle road. But
if this work is properly carried out it will be one
of the most useful works in Ceylon, doing good
to a very large number of poor inhabitants,
improving the cultivation of large tracts of
paddy land; and preventing inconvenience, and
loss to villagers for miles around. No one, if
such be the result, will grudge the Spinning
and Weaving Company any special advantage
which they might derive from so great a work.
though, I admit, I should be sorry to see a lot
of money spent only to tinker out a small work
that would benefit no one, or very few but the
Company referred to.

"The nature of the work required being
indicated the rest is more a question for the
D. P. Works. This Officer and I have dis-
cussed the matter fully, and I think are in
accord as to what is necessary. All that is
wanted now are plans, and estimates, and a
liberal vote by the legislature.

"I am convinced that by the expenditure of
a much smaller sum than might be anticipated
a very large and lasting benefit would be obtained."

From the above it will be seen that the Government Agent, W.P., very strongly advocated the carrying out of the D.P.W.'s proposal to open up the Kirillapone canal mentioned in his flood outlet scheme of 1879 and which had had the approval of Sir John Coode in 1880.

The financial prospects of the Colony looked Mr. A. R. still brighter the new Government Agent, Dawson, W. P. (Mr. A. R. Dawson) reported to Government in May 1892 the position of affairs in 1892 regard to the several flood outlet proposals which had received the approval of Sir John Coode.

No. 1 Outlet.—An estimate had been sanctioned for works under this head and the following works completed: (1) a spill and two sluices under the railway bridge at Wellawatte, (2) a bridge at Bambalapitiya near the mill of the Spinning and Weaving Company, (3) a bridge further to the north-east to meet the continuation of Kanatte road. The work in the 50 ft. span bridge at Wellawatte at the 4th mile Colombo-Galle road was in hand. The widening of the Kirillapone canal to 40 ft. and its deepening had been included in this estimate, but no work had been put in hand. The other works recommended under this head still remained to be estimated for, and sanctioned.

No. 2 Outlet.—It was now proposed to cut three smaller channels instead of one huge channel. One of these had been cut by the villagers. Land for another had been acquired and nothing had been done regarding the third.

No. 3 Outlet.—No steps had been taken.

No. 4 Outlet.—Completed.

No. 8 Outlet.—The work on this was in hand.
It will therefore be seen from the above that with the exception of the erection of the iron bridge across the Kelani (No. 8 Outlet) which was making fast progress, nothing involving any very heavy expenditure in regard to flood outlets had been undertaken by Government from 1879 to 1892, or for a matter of that even up to date.

**Dehiwala Flood Outlet**—In the course of the above report the Government Agent also recommended the improvement of the branch canal known as Kepu Ela running southward and then westward from a point on the Kirillapone canal into the sea at Dehiwala, and for the lengthening, if necessary, of the Dehiwala bridge where the road to Galle crosses the canal. The strong rush of water, he said, indicated an insufficiency of water-way.

In thanking the Government Agent for the clear and instructive report the Governor (Sir Arthur Havelock) stated that he was of opinion that No. 1 Outlet was the most pressing and important one, and that every endeavour should be made to expedite its satisfactory completion before work on another was undertaken.

**Mr. R. K. MacBride**

As a result of the Government Agent's report the D.P.W. was requested by Government to include a sum of Rs. 100,000 in his estimates for 1893, for the necessary works under No. 1 Outlet, for which he was asked to submit estimates for sanction. The new D.P.W. (Mr. R. K. MacBride) was evidently now in a dilemma. He had not followed the recommendations of Sir John Coode in regard to the width of the canal. (His predecessor, Mr. Churchill, had recommended that the canal should be 300 ft. wide, and Sir John Coode had thought it should not exceed 150 ft. at first.) It was now being widened to 40 ft. only, and an iron bridge was in course of erection at the 4th mile Colombo-Galle road, over the canal, which had a span of 50 ft. only. If, therefore, the wishes of the Governor, as expressed above, had to be adhered to, the 50 ft.
span bridge would have to be removed, and one of a larger span erected in its place, and the width of the canal increased to 150 ft. This was evidently not to his liking, and he seized the opportunity offered him in the report of the Government Agent, already referred to, in regard to the Dehiwala canal, and recommended that the sum of Rs. 100,000 that was being included in his estimates for 1893 be allocated to the improvement of the Dehiwala canal advocated by the Government Agent.

The Provincial Engineer, W.P., (Mr. T. Mr. T. Smith) in submitting his estimates for the Smith, necessary works in this connection made the P.E., W.P., following remarks:

"The Wellawatite outlet has now been opened out to a width of 50 feet; to increase this width would not in my opinion be expedient, as with the Spinning and Weaving Company's premises abutting on one side, together with the great depth of cutting and the cost of acquiring more land on the other side, would I fear render this work a very costly matter.

"It is now proposed to continue the outlet along the Kepu Ela where it branches off from the Kirillapone canal, widening it to 100 feet clear throughout to where there is a natural discharge into the sea at Dehiwala.

"It will be observed from the cross sections that the Kepu Ela is in places very much contracted; when opened out to 100 feet wide there will be a very appreciable relief afforded to the pent-up floods, which at present are only partially carried off by the Wellawatite outlet. This outlet will be further improved by widening the railway bridge, which only measures 40 feet; when this is done the Kirillapone outlet will be practically completed.

"It may be mentioned that preference has been given to the Dehiwala outlet from the fact that it is a natural outlet or channel, and its bed is never silted up as in the case of the
Wellawatte outlet. It may therefore be inferred that as a flood outlet it will prove of much greater service than that at Wellawatte.

"Objections may be taken to the circuitous line of the Dehiwala outlet; this however cannot well be avoided except at very much increased cost."

The D.P.W., in supporting the Provincial Engineer's recommendations stated:

"It was understood that a modification of what is known as No. 1 Outlet should be prepared,.........on the same lines and having for its object the same purpose.

"The only difference between that and the present scheme is that the latter is of less magnitude and discharges at Dehiwala instead of Kirillapone. The works are of a simple character, there is no engineering difficulty, it is merely a matter of labour and supervision; careful observations have indicated that flood waters now escape at the latter when the former is inactive, and this notwithstanding the fact that during the last few years the Kirillapone has been lowered to a falling gradient, and all obstructions have been removed from it. Looking at the map one is immediately attracted by the straight appearance of Kirillapone, yet it is not the natural outfall, because the physical features of the country direct the flood waters towards Dehiwala, as evidence by what occurs on the occasion of every flood—one thing therefore is certain that in adopting the Dehiwala outlet there is practical experience to guarantee its efficiency."

On the above recommendations the Colonial Secretary made the following very apt observations.

"I offer an opinion on such a professional subject with some hesitation, but there appears to me two points which suggest doubt as to their propriety.
"The one is the reduction of the width of the outlet from 300 ft. to 100 ft. and the other is whether the straight outfall at Kirillapone could not be so engineered as to be a preferable outlet to the longer and circuitous one to Dehiwala."

The Governor, however, referred the matter to the Government Agent, who having already recommended the improvement of the Dehiwala canal, approved of the proposals of the D.P.W. The work was thus sanctioned, and completed, to the prejudice of the works approved by Sir John Coode under No. 1 Outlet.

**Treatment of the Mouth of the Kelani**

Whilst awaiting the further report of Sir John Coode on the works necessary to overcome the impediment, i.e., the sand bar across the entrance of the river, Government seized the opportunity of getting an expression of local expert opinion by appointing a Committee composed of the Government Agent, the Surveyor General, the Director of Public Committee Works, and Mr. (afterwards Sir) J. J. Grin- to consider linton, in June 1889, to consider the the quess- general question of the treatment of the tion of the mouth of the Kelani river, and to report upon treatment the matter generally, on a complaint made of the to the Government Agent by certain fishermen mouth of that they had to undergo inconvenience and the Kelani, hardship in consequence of the silting up of 1889 the old and natural mouth of the Kelani river, close to Mutwal Point, caused by a new passage which was cut into the sea at Lansiawatta to assist the flow of flood water.

The Committee met and agreed as a temporary measure to have the silt between Crow Island and the mainland removed, on the lines suggested by the local headmen; the work was executed under the supervision of the Fisher Mudaliyar, acting on the advice of the D.P.W. It was not a success, and was of little or no advantage to the public, as, after a short interval, the silt rapidly reformed. The mouth of the river however reverted to its original position close to Mutwal Point.
After a complete survey of the river and its bed and banks, from the Leper Asylum and a point immediately opposite the Asylum on the left bank of the river to the sea had been carried out, (see Diagram No. 5) the question was considered by the Committee. They could not, however, agree, and so could not join in one common report.

Their separate opinions are summarized below.

Major Day, The Acting Surveyor General’s (Major Day, R.E.; Actg. R.E.) opinion was as follows:—(Owing to the scientific treatment of the question by Major Day his remarks are given here in full.)

"I consider the opening up of the channel between Crow Island and the south bank of the river will be useless, as it is bound to silt up, Crow Island itself having been formed by the back wash from the bar causing a meeting of currents, and therefore a check in velocity and a deposit of silt."

"The points that we have to keep in view are two:—

"(1) That as soon as we check the velocity of a current it will deposit its suspended matters.

"(2) That any bend in a stream of water will check its velocity.

"The plan we must adopt is therefore to keep the direction of the stream as straight as possible, and to open up the bar in the prolongation of the straight run of the river about the point C (see Diagram No. 5). The channel D-E will in time silt up, as also probably the whole area between Crow Island and the river mouth at K.

"The project before us is to keep open a channel through the bar, and before discussing what is best to be done I would suggest that the members of the Committee should read
through the attached series of lectures on the subject, and I would particularly draw their attention to pages 27-31.

"The operation before us will be to keep the opening in the bar clear by means of scour. In this case we have no tide or backwater to help us, and shall therefore have to depend upon the flood water of the Kelani.

"I believe the bar to consist of sand washed up by the sea, and not of suspended matter brought down by the river. We shall therefore have to carry out cribs filled with stones into deep water, where the wave motion does not stir up the sand, in the same manner as has been done in the Danube.

"Fresh water being lighter than sea water even when charged with suspended matter, the fresh water will flow out through the cut and disperse over the sea before the suspended matter is deposited, and will therefore not obstruct the channel.

"In this way I hope to deepen the fairway channel of the Kelani and keep the mouth open. In times of flood the opening will not be sufficient to carry off all the water, and it will therefore pass over the top of the cribs and help to rush the accumulated sand out to sea. In this way, I hope we shall be able to keep the level of the river, even in times of flood, below the top of the banks of the upper reaches, and so enable a large tract of paddy-land to be brought into profitable cultivation.

"May I ask that printed lectures be returned to me as they are out of print, and I therefore cannot replace them."

(It is greatly to be regretted that these lectures cannot now be traced.)

"Sand Bank at the Mouth of the River.—We have unfortunately no chart showing the direction of the currents round the coast of Ceylon, but there is undoubtedly a strong
sand-carrying current working down from the north. Where it first strikes the coast I do not know, but it is in full working order at the Kelani river, and at every river down to the south of the island, for it will be noticed that they are all closed by a sand-bank starting from the north bank end, and the bar extends south until the water escapes by getting an artificial scour through rocks or from some other natural causes. The formation of the sand-bank at the mouth of the Kelani is evidently caused by the sand-carrying current working down the coast meeting the river water working out towards the sea; their junction produces a reduction in velocity and sand deposits, the deposit then goes on as upon an ordinary sea shore and is eventually heaped up by the waves. We find that this bank has thus been extended nearly down to the Whist Bungalow, where the river now escapes through rocks. This is, however, close to the south bank of the river, where the bend in the land deflects the current in a direction practically parallel to the river discharge, which is an additional reason for the opening not sanding up.

"To remove this sand-bank, or rather to prevent its formation, two methods suggest themselves: either the use of the scour of the river to carry away the bank as soon as it forms or to divert the place of formation of the bank to some spot where it will not obstruct the mouth of the river. To produce a scour we want a good rise and fall of tide and plenty of back-water, but in Ceylon the difference between high and low water is not more than two feet so that we cannot keep the channel open by scour. We must therefore try and shift the formation of the bank to another place. To do this we must check the velocity of the current and make it deposit its sand. This can be done by making cribs of rough logs, about ten or twelve feet wide at bottom and three feet wide at top, of trees roughly fixed together and all at open order, floating the cribs out into position and filling them with stones. The water thus checked will deposit its sand.
which will form a bank on the outside of the crib and eventually divert the current outside of the reef. The cribs will have to extend from the main land to the reef. As to the position of the crib, I think they should be placed about 100 yards north of the north end of the sand-bank, and the cribs should, if possible, run end on to the S. W., which will practically be the prolongation of the last bend of the river, as when the river works through the bank it will probably deposit mud, and space should therefore be left for the formation of a mud bank on the inside of the cribs without obstructing the waterway of the river. The sand-bank will now be cut, and the best position for this cut will be in continuation of the last reach of the river, or about as shewn in the tracing, and when once opened this opening will continually widen itself at every flood when the scouring power of the current is increased. This channel and the river, as far as the bridge-of-boats, will have to be dredged so as to deepen it, and will have to be kept dredged so as to give the river water the maximum power of driving itself into the sea. In this way for every foot of flood in the river the discharge power over the whole sectional area of the opening will be increased, and the extra discharge of the river commenced from the moment the flood water begins to rise. I have only suggested one row of cribs at first, but if necessary a second row will have to be constructed on the south side of the opening, but I hope the water will act as a check on this side.

"The Reef. The reef will have in the first instance to be cut through to the necessary width by blasting. It seems to be doubtful whether the reef is soft Pamunugama stone or coral; if the former it will keep itself open, if the latter it might be expected to fill up again, but owing to the channel being subject to the action of fresh water from the river in which the coral insect will not live, it will probably keep itself open and gradually widen out. The reef will not have to be cut much deeper than the mouth of the river."
"In Mauritius there is, I believe, a river about 40 feet wide, and at the point of discharge there is a coral bank three-quarters of a mile out to sea. The river water works out to this bank and has cut its way clear through the bank, and the tendency of the bank is rather to open out than to contract the opening. At the mouth of the Kelani also there is a decided shrinking in the bank, where the flood water must have struck it when the sand-bank was cut open, and near the south bank of the river where the fresh water constantly discharges. I have had several tries at picking up the bank, but had not yet been able to find it when our work was stopped by the south-west monsoon, but I hope to make further investigation as soon as we can get to work. This, however, would seem to show that this reef must be coral. (This was examined by Prof. Seeley, F.R.S., in 1897 and found to be coarse-grained sandstone.)

"The Shallow State of the River at the Mouth. From the tortuous nature of the river there are alluvial deposits in all directions so that the depth near the sand-bank is only about 3 feet, and therefore, if we only cut the bank, the river bed will still bank up the water, and we shall get nothing like our full power of discharge. The channel will therefore have to be dredged out, so that with the increased scouring power thus gained it will probably widen itself at every flood, keeping to the north channel, and the whole area between the sand-bank, the north end Crow Island, and the shore will gradually fill up.

"I do not think that these arrangements will entirely stop floods, as that is an impossibility, but I believe the greater power and velocity of discharge thus obtained, acting with the full power of the flood from the moment the water begins to rise, will very much mitigate the extent of the floods, and so shorten their duration that the land may not be damaged, and even, perhaps, in the future floods of the Kelani may be of similar value to Ceylon as those of the Nile are to Egypt.
and which many of the rivers in China I believe are to its muddy-fields."

In this connection I should like to draw attention to the following remarks which appeared recently in a Scientific Magazine (Industrial India, October 1922).

"The protective action of emulsoid colloids and the precipitating action of salts, are excellently illustrated, on a large scale in nature. Some of the great rivers of the world, like the Mississippi, and the storied Nile, whose turbid waters have from time immemorial carried in their bosom the promise of bountiful harvests are always muddy, whereas other rivers which are even more swiftly flowing, like the Ohio, are, except in times of flood, perfectly clear. In the case of the first two rivers there is much colloidal organic matter, washed into them by which the clay and soils are retained in a state of fine suspension; and it is only when the rivers reach the salt waters of the sea that the suspended matter is precipitated with the production of river bars and deltas. In the case of the river Ohio, however, the water remains clear, owing to the absence of colloidal organic matter and the presence of lime and other salts."

I wonder how far the silting of the mouth of the Kelani Ganga is due to the action of the salt waters of the sea on the waters of the river, which cannot be described as clear.

Mr. J. J. Grinlinton was of opinion:

First.—That "Crow Island" be acquired.

Second.—That the deepening of the narrow channel south-east of Crow Island be abandoned.

Third.—That the main channel north-west of Crow Island from the sand bar right up to the bridge-of-boats be deepened.
Fourth.—Whenever the site of the main channel outside the sand-bank bar shall have been determined (preferably by Sir John Coode), two groins be thrown out from the cutting at the sand-bank bar, which is to be the new permanent mouth of the river, to the coral or sandstone reef, and on to the five-fathom line. These groins will effectually protect the channel from the silt always carried along the coast southward and they will enable the river to be navigated from the main harbour and from the sea.

The cribs proposed by Major Day, and which are said to have been effectual on the Danube, would hardly be sufficiently permanent to resist the force of the waves and wind at the burst of the south-west monsoon, nor would they keep out the sand carried along the sea-coast.

Fifth.—Simultaneously with the construction of the groins, the coral or sand-stone reef should be opened out to a depth of five fathoms in the channel between the two groins.

The paramount objects to be gained by the project suggested are the providing of a permanent and more capacious outlet for the waters of the Kelani Ganga, thus relieving a large tract of country from annual inundations, and also the improvement of the navigation of the river. If the mouth of the river were deepened and protected so as to admit of the entrances into it of sea-going craft, the benefit of such an improvement would be incalculable, as not alone could the lower part of the river be used for the discharge and loading of vessels of comparatively light draught, but the fresh water would enable the barnacles, which are most destructive and impede the sailing of vessels, to be removed from their hulls. The hulls of all vessels, dredgers, tugs, steam launches, cargo and passenger boats used in the Colombo harbour are coated with barnacles, which could be easily removed were it possible to take them into fresh water for a week every six months.
The Director of Public Works, Mr. R. K. MacBride was of opinion:—(1) That the acquisition of Crow Island was not essential to Mr. Grinlinton’s scheme; (2) That the enlargement of the mouth of the river will not make any difference to the floods; (3) That flood outlets must be constructed elsewhere, unless the whole discharging capacity of the river itself, at least as far as Kaduwela were increased—quite a preposterous idea; (4) The removal or lowering of the existing coral reef across the Kelani Ganga mouth might injuriously affect the navigation of the river—in the dry season the less water discharged into the sea the better; (5) The approach of “small craft” during the south-west monsoon and strong northerly winds would be attended with great risk, and the deepening of the Kelani river would not be any adequate relief. Inside the mouth might be made a convenient place for building and repairing cargo boats, and deepening the mouth would facilitate their passage to and from the harbour; but it is doubtful whether the expenditure of public money with this object would be justifiable; (6) The portion of the river between the mouth of the Hamilton canal (to Negombo) across the Kelani river and through the channel between Crow Island and the mainland should be dredged with a suitable Priestman’s dredger (a grab dredger).

The Government Agent, Mr. Dawson’s opinion Mr. Daw- was that the cost of so much of Major Day’s son, G.A., scheme as will facilitate the escape of flood W.P. water into the sea through the natural channel of the Kelani river should be estimated and that if the cost is found to be within the means of the colony that part of the scheme should be adopted and the work carried out, if possible under Major Day’s supervision. That Mr. Grinlinton’s scheme was unnecessarily large and comprehensive, and the proposal of Mr. MacBride too limited to suit the requirements of the case.

These different opinions were forwarded to Messrs. Coode Sons & Matthews, the Consult-
The Report of the Consulting Engineers, and their report awaited. This was received by the local Government early in 1898, the report being dated 14th December, 1897. It stated that when Mr. Matthews was at Colombo towards the end of 1894 he was requested both by H. E. the Governor (Sir Arthur Havelock) and the Colonial Secretary to prepare a Report on the practicability of opening out the mouth of the Kelani, and to furnish an estimate of cost of such works as might appear necessary for the accomplishment of that object. The Consulting Engineers were desired to confine their investigations and report to this subject. No reference is therefore made in their report to the other flood outlet projects, which have been devised, with a view to the mitigation of floods on the low-lying districts in the vicinity of the Kelani. The delay in submitting the report was attributed to Mr. Mansergh having to be consulted after he had paid a visit to Colombo for the purpose of preparing a report on its drainage, as it was considered advisable that the working out of the project for opening the mouth of the Kelani Ganga should proceed simultaneously with the preparation of Mr. Mansergh's drainage scheme for Colombo.

It is greatly to be regretted that the schemes proposed by competent, local authorities, Major Day and Mr. Grinlington, were not criticised, discussed, or closely examined by the Consulting Engineers, for there is only a passing reference to them in their report, as I consider that the scheme projected by the Consulting Engineers is merely a costly elaboration of the proposals put forward by Major Day and Mr. Grinlington.

The works proposed by the Consulting Engineers, which had three objects in view, viz:—The discharge of flood waters, the opening out of the entrance for navigation, and the conveyance seaward of the sewage of Colombo, and which were necessary for permanently keeping open the mouth of the Kelani, were a North Training Bank, (see Diagram
No. 6) commencing at the foreshore of the river, close to the Leper Asylum, and extending therefrom almost in a direct line, until reaching the root of the sand spit at its northern end. The North Mole was to start from this spot, and proceed seaward in a slightly curved direction, until the sandstone reef was reached, where a head was to be formed. The works on the southern side of the channel was to commence almost opposite the Leper Asylum, by slightly widening the river at that spot; but, the South Training Bank was to be proceeded with, at a distance of 550 ft. from the Northern Bank, and be led seaward on a line slightly converging towards the latter, until reaching the sand spit. The South Mole was then to be commenced and extended westward, until passing over the sandstone reef, at a distance of 450 ft. from the termination of the North Mole, thus giving a permanent opening or entrance to the river of that width at low water. In order to protect this entrance from seas during south-west monsoons it was proposed to continue this South Mole in the same line for a length of 450 ft. seaward of a point opposite the outer end of the North Mole, thus giving an overlap, or cover to that extent.

It was proposed to remove the sandstone reef over the area between the bases of the two moles so as to form a channel having a depth of 15 ft. at low water. This work was expected to be of an exceptionally difficult and costly character, due to the exposed portion of the site.

It was also stated that the sectional area of the Kelani was insufficient for the discharge of floods corresponding in extent with that of 1895, putting aside the abnormally heavy freshets of 1872 and 1891 (and of 1913 since). Therefore, if it was desired to mitigate flooding in any material degree by an improved discharge through the entrance works just described, it will be requisite to increase the sectional area of the river from the inner ends of the proposed Training Banks upwards, for a length of
about 12 miles, or to, say, 1½ miles below Kaduwela.

The cost of the works were estimated as follows:

North and South Training Banks and the two Moles as shown in Drawing £ 221,000

Forming channel through the sandstone reef between the moles at the new entrance to the river £ 73,000

Dredging the existing channel of the Kelani and depositing the materials ashore on and adjacent to the banks of the river as may be hereafter arranged £ 120,000

Total £ 414,000

The Consulting Engineers stated that after most careful study of the complete data in their possession they were convinced that the entrance works alone, and the consequent formation of an improved and permanent opening to the river which may be expected to result therefrom, will not of themselves effect the objects desired, and must be supplemented by an improved and deepened channel if the flooding of the low-lying lands is to be relieved to any material and beneficial extent.

After the works above described both for the opening out of the entrance and the enlargement of the channel have been fully executed, the following changes were expected to be effected during a flood corresponding with that of October 1895:—At the old bridge-of-boats the flood would be lowered about three feet. At Kelaniya Temple and Ambatadi the lowering would be two feet nine inches in each case. At Kaduwela 15 inches. Portions of the lowest lands near Colombo would still be liable to occasional submergence. This was inevitable in view of the fact that it is entirely impracticable to reduce the level at the bridge-of-boats, of such floods as that of
October 1895 beyond 6 ft. above low water at sea; whereas certain portions of the lowest areas near Colombo are only about 4 ft. above that level or 2 ft. below the reduced level of the flood. At and about Kaduwela and from that point upwards the proposed works would not exercise any material relief on the submergence of the low-lands. The duration of such inundations however would be less than under existing conditions.

Should however it be decided to undertake the execution of the entrance works alone, the new entrance, unaided by the improved channel, would have the effect of lowering floods corresponding with that of October 1895 to the extent of 15 inches at the bridge-of-boats (as against 36 inches when coupled with the improved channel) and its influence would only extend to just above the railway bridge, showing what an important influence the improved channel would exercise in the discharge of the flood waters.

Altogether, a very poor result for the estimated expenditure. Verily, a case of the mountain labouring, and bringing forth a mouse.

I cannot however help thinking that Sir John Coode had no hand personally in designing the above project. He had retired from the firm of Consulting Engineers about the year 1893, long before all the information he asked for from Ceylon for planning out the scheme were received by his firm (they were actually sent out from Ceylon only in 1896) and it is just possible that the Consulting Engineers had not the benefit of his expert knowledge. The plan Sir John Coode evidently had in mind appears to me to be quite different from what has been projected by the Consulting Engineers, for in his report dated June 1880 Sir John Coode stated: "Obviously the great impediment is the sand bar which exists at the entrance, and if this can be kept down by the expenditure of a reasonable sum, to such an extent as would very largely increase the discharging power
of the natural channel, it will, I think, be admitted on all hands to be a matter of paramount importance that it should be done, and therefore it should, in my opinion, be carefully and maturely considered.

"The first step towards a decision as to the proper remedy is a knowledge of the exact nature of the disease, which in this case is the action of the heavy seas which prevail upon this part of the coast for so many months in the year, and which cast up the sand, causing it to accumulate in the form of a formidable ridge or bar across the entrance of the river; were it not for this bar, the upland waters would at all times flow unimpeded into the sea opposite Mutwal. The question, therefore, which thus arises is, how can the accumulating action of the sea at this particular part of the coast be neutralized, or, at any rate, kept sufficiently in check to allow the fresh water to overpower it.

"Whilst I entertain no doubt as to the principles in which such a neutralizing or controlling work should be founded, or generally as to its position and extent, I do not feel in a position to give a design and consequently am unable to frame an approximate estimate of cost, without the further particulars set forth in the memorandum which is annexed hereto. Furnished with these particulars, I could, if it were desired, frame a design and estimate for such a work as would, in my opinion, be best adopted to accomplish the object in view; it would then be seen whether the cost would be such as would be justified, having regard to all the circumstances of the case."

From the above remarks, I would submit, it looks almost certain that if Sir John Coode had anything personally to do with the designing of works for the treatment of the mouth of the river, an entirely different project would have been the result. I am, therefore, of opinion that Government would be well advised to refer the whole
matter to some expert engineering authority who has specialised in such works, but not an ordinary Civil Engineer, and obtain an opinion as to whether the design submitted by Messrs. Coode, Son & Matthews is the last word on the subject, before giving up the idea of carrying out works at the mouth of the river to mitigate the floods at a reasonable cost.

Now that I have given fully all the different proposals made from time to time since 1873, I shall proceed to state briefly the action taken by Government, if any, in regard to: (a) Flood outlets; (b) the treatment of the mouth of the Kelani; (c) Flood Banks.

(a) Flood Outlets

(1) Kirillapone Canal. The deepening of this canal, to give it a proper fall, was recommended by the Flood Commission of 1873, and the work has been carried out. But the widening of it to 300 ft. recommended by the D.P.W. in 1879 or even to 150 ft. as suggested by Sir John Coode in 1880 has not been done, only a portion of it has been widened to 40 ft., the iron bridge (erected about 1892) over this canal at the 4th mile Colombo-Galle main road being only 50 ft. span. This is the most important and the best flood outlet at the present time, and it is greatly to be regretted that it has not been widened even to the extent recommended by Sir John Coode. If this were done, it will, I think, make a very great difference in the flood inundation of Colombo.

(2) Channel from the Kelani river at Ambatule, to Kotte bridge. This was proposed by the D.P.W. in 1879 and has not been undertaken, nor has the proposal of Sir John Coode in its place.

(3) A Channel from the Madampitiya fields passing near Upland Mills to the sea. This was substantially what was proposed by the Flood Commission of 1873 under Head 2 of their
recommendations. It would not now be possible to carry out this work, as the graving dock has since been built at the point where the channel was expected to enter the sea, and the new railway line to the harbour runs across the Madampitiya fields.

(4) Increasing the water-way through the raised roads that traverse the country through which the Kelani flows. This was recommended by the Flood Commission of 1873. A new railway bridge of a total span of 856 ft. was erected in 1878, increasing the water-way by 400 ft., an iron bridge over the Kelani at Grandpass on iron cylinders in lieu of the bridge-of-boats, which was proposed by the D.P.W. and approved by Sir John Coode in 1880, was completed in 1895. Bridges for the escape of flood waters in the long embankments on the Kandy and Negombo road have also been constructed.

(5) Spill water between the Colombo lake and the sea on the Galle Face. This was recommended by the Flood Commission of 1873 and has been carried out under the new Lake Development Scheme.

(6) Improvements to the banks and bends of the river and clearing bed of obstructions. This was recommended by the D.P.W. and approved by Sir John Coode, but no work has been done.

(7) Subsidiary channel from the river at a point close to the bridge-of-boats to the sea at the river’s mouth near Mutwal. This was persistently advocated by the late Mr. Wilson, M.I.C. This was thought by the Flood Commission of 1873 to be perfectly useless. The D.P.W. recommended that the work be deferred until the relief offered by other outlets is ascertained. Sir John Coode concurred in this opinion in 1880 and the work was not carried out. The late D. P. W., Mr. Cooper, was opposed to this (see previous remarks).
(8) Improvement of the natural drainage channel to drain the Cinnamon Gardens about the Kanatte Cemetery and Horton Place through the Alfred Model Farm into the Kirillapone canal. This was recommended by the P.W.D. and approved by Sir John Coode in 1880 and has been carried out.

(9) Channel at Mahola. Through the sand-bank between the Negombo canal and the sea. This was recommended by the D.P.W. and approved by Sir John Coode in 1880 and has been partially carried out.

(10) Channel from Bolgoda lake into the sea near Talpitiya. This was proposed by the Government Agent, W.P., (Mr. Saunders) in 1878 and approved by the D.P.W. and Sir John Coode in 1880. The work has been carried out, and has proved highly satisfactory.

It would be seen from the above that except for the erection of the iron bridge at Grandpass (Head 4) which could hardly be called a flood outlet except in the sense that it relieved the obstruction to the free flow of water in the river caused by the old bridge-of-boats to some extent, no work of any magnitude on any of the other proposals of the D.P.W. in 1879 has been undertaken by Government. Government was evidently deterred from embarking on any large expenditure on flood outlets by the pronouncement of Sir John Coode in 1880 (already quoted in extenso) that “the problem of securing the greatest amount of benefit for a given expenditure would be solved more satisfactorily “by” facilitating the escape of the flood waters into the sea through the natural channel of the Kelani Ganga than by making one or more artificial outlets for the river.”

After such an unambiguous statement from such an eminent authority Government cannot very well be blamed for going slow in regard to flood outlet schemes, till the Consulting Engineers themselves had examined the whole question, and reported on the sug-
gestion of Sir John Coode. But now that they have done so, and it has been clearly demonstrated by them that works at the mouth of the Kelani, to secure the ends desired by Sir John Coode, could only be carried out at an outrageous cost, and that the benefits to be derived, even after carrying out their recommendations in full, would be trifling; and if carried out in part only, such benefits will be negligent, the time has come for Government to revise its policy in regard to flood outlets.

(b) The Treatment of the Mouth of the Kelani

The "disease" was undoubtedly the accumulation of sand in the form of a formidable ridge or bar across the mouth of the river, extending from the north, and having a low water width varying from 100 ft. to 330 ft. This was caused, according to Major Day, "by a sand-carrying current working down the coast from the north meeting the river water working out towards the sea; their junction produces a reduction in velocity, and sand deposits; the deposit then goes on as upon an ordinary seashore and is eventually heaped up by the waves." The Consulting Engineers seem to agree with this, for in their scheme they speak of "an accretion (that) may be expected northwards of the inner end of the North Mole, due to the south-going drift of the sand along the foreshore. This action is shown by the existence and configuration of the sand spit."

The Flood Commission of 1873 recommended the reduction of the width of the banks of sand by clearing it away from the inside from time to time. But the method of carrying this out was not stated. Sir John Coode, however, "felt assured that the sand bar could not be kept down effectually, permanently, or economically by a dredge vessel either of Simons' patent construction, or of the ordinary type."

The scheme proposed by Major Day to prevent the formation of the sand spit should, in my opinion, be favourably considered, owing
to its comparatively low cost, for it could, I think, be carried out for less than one-third the cost of the scheme projected by the Consulting Engineers with better results.

The question of the navigation of the river should not, I think, be considered for the present, and a scheme which has only the following ends in view; viz: (a) the discharge of the flood waters freely by keeping the mouth of the river permanently open; (b) the conveyance seaward of the sewage of Colombo; should receive consideration. Major Day's scheme in my opinion meets both these requirements and is the one that, I submit, should be entertained.

It must be here mentioned that Governor Sir Henry McCallum, who was an officer of the Royal Engineers, in his message to the Governor, Legislative Council in April 1911, reviewing the position in regard to flood outlets made the following remarks:

"It has occurred to me that it may be practicable at comparatively small outlay to keep an opening through the bank by a small suction dredger stationed there in what are known to be the periods of heavy rainfall up-country, the flood waters being directed to the opening by an inexpensive training wall on the south side, consisting of a rubble bank with concrete facing, similar to works undertaken by me when at Singapore connected with reclamation in the river at that place. The necessary data are not yet at hand for the consideration of this plan."

This scheme, evidently, was not worked out by Sir Henry before he retired from the Island, as no papers in connection with it are to be found at the Colonial Secretary's office. Nevertheless, it would, I think, be worth while for Government to enquire as to what was done by him at Singapore in order to see if the same idea could be adopted here.

After the receipt of the report of the Consulting Engineers in 1898, no further action
in regard to works at the mouth of the river seems to have been taken. The Governor in his remarks in the message above referred to stated definitely that the project of the Consulting Engineers had been abandoned, as the height of the floods at the Victoria Bridge could only be reduced by some 18 inches under that scheme and beyond mentioning that he had in mind a scheme of his own, no further action seems to have been taken.

(c) Flood Banks

Sir Christoffel Obeyesekera

The question of relief from floods was, however, not allowed to drop. Attention was being drawn to it from time to time by questions in the Legislative Council by Sir Christoffel Obeyesekera, late member of Council, who made the subject all his own, but Government was ever ready with the reply that the question never ceased to receive the consideration of Government, and that if a feasible scheme could be devised it will be adopted, even at a heavy cost.

The question of keeping out flood waters from certain areas by flood banks seemed to have engaged the attention of Sir Henry McCallum. The subject had already been noticed by the Consulting Engineers in a general way in their report of 1897. They pointed out that if it was desired to prevent the flooding of the low-lying districts in the immediate vicinity of Colombo this would be practicable, even in the absence of the entrance and channel works already suggested by them, by the construction of embankments along the left margin of the Kelani, where low places exist, and by forming a barrier bank on the eastern margin of the lands proposed to be enclosed.

Sir Henry McCallum was prepared to adopt the scheme proposed by Mr. H. T. S. Ward, the late Director of Irrigation in 1901, to protect from flood intrusion a very large area on the left bank of the river. But as those whose lands would be thus protected refused to agree to
a payment of a small assessment per acre to cover interest, sinking fund and cost of maintenance, the project was abandoned.

Another scheme was also, it appears, prepared under Sir Henry McCallum's direction to protect the area adjacent to the town by raising the Baseline road and carrying it to the river which was to be hauled to the sea. As the benefits were not likely to warrant the expenditure, and as the Municipality too were not in a position to contribute its quota, this scheme was also abandoned.

In July 1901, as already mentioned, Mr. H. T. S. Ward, the late Director of Irrigation, planned out the first definite scheme. The proposal may be described as the raising of a flood bank along the left margin of the Kelani extending from Madampitiya to the 6th mile post on the Grandpass-Avisawella riverside road, (see A. B. Diagram No. 7) following the line of that road and raising it 4 ft. above the highest recorded or reputed floods. At this point the line of embankment was to turn to the south and run along a cross road, till it reaches the New Hanwella road, along which it will run for about 2,000 ft. and then turn off and run in a southerly direction to join the ridge below Mulleriyawa tank at Angoda, on which the new Lunatic Asylum is now built. The total length of the bank was to be 5.4 miles and 18 feet broad on the top, the surface metalled to make a road above the floods in the place of the present one. All the existing culverts, and bridges were to be cut and stopped up. Where the canal enters the flooded country at Grandpass locks were to be built to lock out the floods when the river was in flood.

Through the area within the proposed flood bank run certain sluggish streams and canals which will act as natural drains and run off the rain water, and the Kirillapone canal and Dehiwela flood outlet will assist them and the Kalutara canal to perform the part assigned by Messrs. Coode Son & Matthews to pumping machinery, which would be unnecessary.
The cost of the scheme was estimated at Rs. 225,000. This scheme was not undertaken for the reasons already stated.

The question of raising the Baseline road and making it act as a flood bank to protect a certain area adjacent to the town put forward by the late D.P.W., Mr. Cooper, is referred to in the following memorandum submitted by me to Sir Graeme Thompson, late Colonial Secretary, when he was acting as Governor in March 1920.

MEMORANDUM

Lt.-Col. Jayawardenena, 1920

Mr. F. A. Cooper, Governor, appointed a Committee of four members with Mr. F. A. Cooper, the D.P.W. as President to report on certain projects for connecting the Colombo Lake with the Harbour.

In the last para. of their report dated November 8th, 1905 and published in Sessional paper XIV., 1907, the Committee stated as follows:

"The Committee consider the exclusion of the Kelani floods from the low land west of Baseline road, and its reclamation, as proposed by the Director of Public Works, a work of considerable sanitary and commercial importance."

The proposal of the D.P.W. referred to above was:

Para. 12. At the point J (see Diagram No. 8) a single lock similar to those mentioned in para. 5, is provided. An embankment is carried across the low-lying land, and the Baseline road is raised so as to exclude, when the lock gate is closed, the floods in the Kelani river from the low-lying land traversed by the canal.

Para. 16. On the completion of the whole project the locks at B and J should, under ordinary circumstances, no longer be used
as such, but as flood gates for the purpose of excluding the flood water highly charged with silt from discharging into the harbour.

Para. 17. When the project is completed I would suggest that all material dredged from the harbour should be transported by canal and utilized for filling the area hachured in the plan approximately 240 acres in extent, and I would further suggest that the area be acquired as soon as practicable for the purpose of disposing of such material.

This proposal of the Director of Public Works was referred to Mr. Matthews of Messrs. Coode Son & Matthews, the Engineers, for report when he visited Ceylon in December 1905. It was approved by him as will be seen from the letter dated December 19th, 1905 (Sessional paper XIV., 1907) from the Firm.

Sir Henry Blake, however, did not take kindly to the full scheme, as he was of opinion that "the filling up of the lake would destroy one of the greatest beauties of Colombo, and the obliteration of the lake would have the effect of raising the temperature of the town." With the advent of Sir Henry McCallum as Governor, the question was again revived. Agreeing with Sir Henry Blake "as regards the possible effect which the obliteration of the lake would have on the temperature of the town, and believing that to fill it in entirely would have a bad effect and would considerably impair the sanitation of this town," he prepared a modified, and less costly scheme in which he placed the locks at San Sebastian, instead of at (T), the Kelani river end of San Sebastian canal, as proposed by the Director of Public Works.

The placing of the locks at San Sebastian, which is what has now been done, destroyed the project of the D.P.W., for the exclusion of the Kelani floods from the low land west of Baseline road, and its reclamation which the Committee appointed by Sir Henry Blake
in January 1905 reported as "a work of considerable sanitary and commercial importance."

There was considerable agitation in the Press in Colombo over the project as outlined by Sir Henry McCallum, and to allay public feeling a Commission was appointed by him in March 1909 composed of eight members, with the Hon'ble Mr. W. H. Jackson, (Principal Collector of Customs) as Chairman and the Director of Public Works, Mr. Cooper, as an ordinary member to report and advise upon the scheme as formulated by him.

This Commission, in making its report, again drew attention to the importance of the D.P.W.'s scheme and stated in para. 6 of their report: "Your Excellency's Commissioners would invite especial attention to...... .......and to paragraph 22 (of the Director's letter) in which he brings to notice the importance of raising a portion of Baseline road and the construction of an embankment near Urugodawatte road between Baseline road and Grandpass. This project does not come within the scope of the present reference, but Your Excellency's Commissioners agree with the Director, that it is a matter of great importance and should not be lost sight of."

The following is para. 22 of D.P.W.'s letter referred to above:

"Before concluding this report, I would invite the attention of the Commission to a portion of the project put forward by the Committee appointed by H. E. the Governor in 1905 (Colonial Secretary's letter No. 336 dated January 1905) in their report, dated November 8th, 1905. The portion referred to is the raising of a portion of Baseline road, the construction of an embankment near Urugoda-watte road, between Baseline road and Grandpass, the embankment being provided with the necessary lock or flood gate."
"Though not directly connected with the project now put forward for the improvement of the lake, I am strongly in view of the advantage to be gained by the exclusion of flood water from so large an area within Municipal limits at comparatively a small cost, that this project should not be lost sight of."

Though thus pointedly asked by the Commissioners to give this matter consideration, Sir Henry McCallum, for some reason or other, paid no heed to it. Sir Henry McCallum's scheme, slightly modified by the Commissioners, was sanctioned by the Secretary of State and work is now proceeding under it.

With the commencement of the work of the Harbour Railway Extension, it has, I venture to think, become possible to carry out the idea of Mr. Cooper, the late D.P.W., viz., to exclude the flood waters of the Kelani from the low-lying land west of Baseline road to a much greater extent than he originally proposed, (about 700 acres as against 240 acres under his scheme) by fixing flood gates at certain points in the embankment, (which is now being constructed) to carry the new Harbour Railway Line. The locking out of the flood waters from such a large area would be an enormous sanitary and commercial advantage to Colombo, for this is the only direction in which commercial Colombo can expand.

In addition to the commercial advantages it would be a great blessing to thousands of the very poor of Colombo, who are now put to great distress regularly once or twice a year by the floods that devastate their homes and plantations.

I would therefore ask that a small Committee of Engineers be appointed by H. E. the Governor to examine this project without delay in order that something may be done, if there is any such possibility, before the
Railway works are too far advanced to admit of any alterations to present plans for the purpose of fixing flood gates and locks.

This memorandum was referred to the Chief Engineer, Colombo Lake Development Scheme, who was requested to discuss the matter with the Chief Construction Engineer, Railway Extensions, and myself, and furnish a report on the subject through the Director of Public Works.

After several meetings had taken place and inspections made of the sites, the following report was submitted by Mr. J. Strachan, the Chief Engineer, Lake Development Scheme.

With reference to Lieut.-Col. Jayewardene’s Memorandum of 18th March, 1920, to the Hon’ble the Colonial Secretary, I have the honour to report that several meetings have taken place and inspections made of the sites.

2. After careful consideration of Colonel Jayewardene’s proposal to utilise the embankment of the new Mutwal Railway to hold back any flood water and examination of the details of the banks, bridges, etc., Mr. Cole Bowen, Chief Construction Engineer, Railway Extensions, was strongly against the proposal and the writer as well as Colonel Jayewardene (who as you are aware has considerable engineering experience) agreed.

3. The suggestion of raising Baseline road was also considered and as there were many difficulties to surmount before a satisfactory scheme could be got out, it was abandoned.

4. Colonel Jayewardene then stated that probably a good result may be obtained from raising other roadways.

5. The scheme now put forward for the consideration of Government is shewn on the accompanying tracing. (See Diagram No. 9.)
(a) It is proposed that the height of any new embankment constructed to keep out flood water should be M.S.L. +14.00 feet.

(b) Raise the Madampitiya road between the points A opposite the Treatment Works and B its junction with Victoria Bridge Street.

(c) Construct a flood gate across the stream at B 1.

(d) Regrade Victoria Bridge Street from the point B, in a northerly direction to C.

(e) Raise Victoria Bridge Street from C to E, which is slightly south of Mansergh Avenue. The railway crossing at C 1 will have to be raised about 1 foot.

(f) Nagalagam Street will have to be regarded northwards from D in order to provide a working gradient for Tramcars which run through Nagalagam Street and on southwards past D and E, the portion between D and E being raised as outlined in paragraph (c).

(g) The foregoing paragraphs involve slight alterations to house property but on examination of a map of Colombo, it will be seen that a large extent is not necessary.

(h) Raise the Urugudawatta road from F to the bridge over the San Sebastian Canal and from the bridge over the canal to K, practically at the Wellampitiya Police Station at the corner of the Hanwella road. It will be necessary to construct a flood gate across the San Sebastian Canal where it passes under the roadway. It will be observed that this road crosses the railway at G but the rail level is M.S.L. +15.64 feet and above flood level.

(i) At H and J are two bridges, it is thought these may be abandoned.
(k) The preceding items will prevent water coming in from the north or river side of the area to be protected; the following items are necessary to prevent water entering from the back or south side.

(1) Regrade the existing roads from L Baseline road to N Cattle Market and Quarantine Station.

(m) Construct a flood gate over the street at M.

(n) Construct a new roadway from N to the high ground at Kolonnawa P with A.

(o) Flood gate over the Dematagoda Ela at O.

(p) It will be necessary to construct a flood gate as shown at Q on the Baseline road north of Narahenpitiya.

(q) Flood water is sometimes observed on the west side of the Baseline road near Kanatte.

6. The proposal is to make all roadways where possible 40 feet wide.

7. Filling can be obtained:

(a) From the Mutwal Railway Works, Harbour end and carried along the Railway to sites adjacent to the proposed works.

(b) From the Kelani river.

(c) From the San Sebastian Canal widening and improving.

(d) From improving adjacent streams.

8. The work involves the raising of or the construction of 3 miles of roadway and would protect 800 acres of land from floods, and it is suggested that it enables land on the inside and outside of the bunds or railways to be raised as filling become available.
9. Special measures will be required to deal with surface water drains inside the area.

10. The scheme is outlined without the preparation of surveys, detail levels or consideration of the many small drains adjacent to the proposed bank, and before being carried out would require very careful engineering investigation, as one might easily overlook a stream which at first sight may appear insignificant, but may have a very serious bearing on dammed flood water.

11. In the absence of detail plans, I estimate the cost as being approximately Rs. 1,000,000 inclusive of acquisition of land for the embankments.

12. In consideration of the above, attention is however invited to the disadvantage of buildings erected on low ground surrounded by a bank; and if Government is prepared to entertain a proposal of a large sum of money on works as outlined in the preceding paragraphs for prevention of floods, I suggest the money would be more advantageously spent in reclaiming the low-lying land shown on the tracing, figured 1, 2, 3.

13. The land may be reclaimed from time to time and the Lake Scheme plant could be utilised for any dredging and excavation.

14. The cost of reclamation would be approximately Rs. 20,000 per acre including the acquisition of ground, and for the sum of Rs. 1,000,000, mentioned in paragraph 11, 50 acres of land could be reclaimed.

The above has been shown to Colonel Jayewardene and a copy of his remarks is attached.

It is most difficult to widen and raise a road and keep the traffic even if 40 feet width is adopted, and if 30 feet width is adopted, I suggest, the roadway must be closed for sometime. However, according to the Housing
and Town Improvement Ordinance, roads in Colombo must be 40 feet before any buildings may be erected alongside.

*Remarks by Colonel Jayewardene.* I do not think the road to Hanwella need be as wide as 40 feet. It should be possible to make it 30 feet wide and the total cost of the work reduced proportionately. If any difficulty is likely to be experienced in carrying out the work whilst the road was at the same time opened to traffic, there seems to be no reason why it should not be closed to traffic altogether till the work is completed, as there are two other roads to Hanwella, namely, *via* Dematagodde Road, and Nagalagam Street.

The above report was forwarded to Government in August 1920 by Colonel T. H. Chapman, Director of Public Works, with the following observations:—

The advantage to be gained by such a proposal (as the above) would no doubt be considerable, but the results would not be final; the low-lying area would still remain unfit for habitation and as a corollary reclamation must follow if the full advantage is to be realized.

The need for more land which can be utilized for building is so pressing that money spent in reclaiming the low-lying areas will prove of infinitely more advantage to the population and to the interests of the town than in embanking, apart from being a better investment of public funds.

I endorse the conclusion come to by the Chief Engineer, Colombo Lake Development Scheme and expressed in paras. 12, 13 and 14 of his report.

The matter ended here for the time being, with a letter to me from the Colonial Secretary which concluded as follows:—
"It is not possible at the present time to consider the question of undertaking either the scheme originally proposed by you or the scheme now suggested owing to the lack of funds to meet the cost which either would involve, but they will both be borne in mind for further consideration when funds are available."

"In the meantime His Excellency the Officer Administering the Government desires me to convey to you an expression of the thanks of the Government for the interest which you have taken in the matter and the time you have devoted to it."

The question was however revived by Government in May 1921 by the appointment of a Committee composed of the Government Agent, W.P. (Chairman), the Director of Public Works, the Director of Irrigation and the Harbour Engineer, to consider the various proposals which have been made with regard to the prevention and mitigation of floods in Colombo and to advise Government as to what scheme if any can profitably be adopted.

I immediately got in communication with Lt.-Col. Mr. Fraser, the Chairman, and submitted certain other schemes in addition to those I had already proposed as will be seen from the following letters to Mr. Fraser.

May 15th, 1921. I have been thinking over the two proposals of mine re banks to protect Colombo town from the Kelani floods, viz:——

1. Making use of the railway embankment from the Kolonnawa oil installation to Mutwal.

2. Raising of the cart road, Wellampitiya, Uragodawatte, Victoria Bridge and Madampitiya, and I am of opinion that the two schemes could very well be combined, thus, use the railway embankment (in the first scheme) from Kolonnawa up to the point where it crosses the Victoria Bridge Road, and from
there follow the cart road (latter portion) mentioned in the second scheme. This will protect an additional 200 acres or so from inundation.

May 22nd, 1931. I should like to submit a further scheme for mitigating the floods in Colombo, for consideration, that is, to connect up the Kolonnawa ela with the Kelani river, by cutting a caanal from the former (near about Wellampitiya), to a point of the river, about 200 yards beyond the 6th mile post, at the Kohilawatte-Kelanimulla village boundary, where the river, at present, constantly breaks across the Kohilawatte-Hanwela road (see N. O. Diagram No. 4):

At present, the Kolonnawa ela, which is supposed to act as a flood outlet, does not tap the river till it reaches Colombo (close to Victoria Bridge), but if the ela is made to connect up with the river at a higher point, as now suggested by me, it ought to, I think, be able to take the surplus waters of the Kelani much more readily. (The higher the flood outlets are made to connect up with the river the better, provided the cost is not prohibitive.) My present proposal is not likely to cost very much, as the land through which the proposed ela will run is very low-lying and already partly submerged.

I spoke to Mr. Creasy, the Acting D.P.W. on this matter, and he promised to look into the levels, and see how far the idea could be carried out.

Apart from the above proposal and my other previous proposals, I have a still further proposal to make, and that is to raise the road from Madampitiya (near the Treatment Works) to Kohilawatte (to within about 100 yards of the 6th mile post on the Hanwela road) and from there the cross road to Butgomuwa junction on the Wellampitiya-Hanwela road (see A. B. Diagram No. 7).

This proposal, if not for its cost, would be the best of all the schemes I have put forward,
for it will cut off the floods from the east and south of Colombo town entirely. The cost of the work could be considerably reduced, if the idea of a wet dock for Colombo takes shape, for the excavations from the dock area could be utilized for the raising of the embankment. Besides, this scheme will have the advantage of having only one lock, and the cost of this too might be saved if it is found feasible to shift the present lock at San Sebastian to the mouth of the canal at the Kelani river. A further advantage, and that a big one, would be the solution of the problem of the rain water drainage within the Colombo town area. Under this scheme, the several canals not being locked the rain water could drain into the sea via the Kirillapone canal at Wellawatte.

Now to sum up my schemes:

1. *Flood Bank (F. G. H. Diagram No. 7.)*

Use the railway embankment from Mutwal to Kolonnawa (oil installation), and from the high ground there construct a short length of embankment (G.H.) up to the Cattle Mart and Quarantine Station and regrade the road from the Cattle Mart and Quarantine Station to Baseline road. Fix flood gates where necessary. This will protect about 700 acres of swampy land.

This scheme was opposed by the Chief Construction Engineer, Railway Extensions (Mr. Cole Bowen), on the ground that the earthen bank and the bridge abutments were not of sufficient strength to resist the pressure of the flood waters.

2. *Flood Bank (C. D. E. Diagram No. 7.)*

(a) Regrade the following roads commencing from the Sewage Treatment Works — Madam-pitiya Road, Victoria Bridge Road, St. Joseph's Street, Urugoda-watte Road and Wellampitiya-Hanwella Road up to Wellampitiya Police Station.

From the high ground at Kolonnawa construct a short length of embankment (G.H.)
up to the Cattle Mart and Quarantine Station and regrade the road from the Cattle Mart and Quarantine Station to Baseline road. Fix flood gates where necessary.

This will protect about 800 acres of land now subject to floods.

This scheme was estimated by the Chief Engineer, Lake Development Scheme, to cost approximately Rs. 1,000,000. A prohibitive figure, but I am sure, it could be carried out for very much less. The roadway need not be as wide as 40 ft. as proposed; the roadway in Mr. Ward's Scheme was only 18 ft. Mr. Ward's Scheme, which was for an embankment 5.4 miles, was estimated to cost Rs. 225,000, and this scheme, which provides for an embankment three miles in length only, could, I venture to think, be completed for a like amount with a roadway of 20 ft. It should also be noted that this road which is proposed to be regraded under this scheme is much higher than the riverside road which was proposed to be raised under Mr. Ward's Scheme and will therefore require much less filling.

Under both No. 1 and No. 2 schemes it would be necessary to slightly raise the Baseline road near about Kanatte and fix a flood gate at Q. north of Naharenpitiya (see Diagram No. 9). The flood gate now placed on the canal at San Sebastian could also be removed and fixed at any of the points mentioned in either scheme. Under these schemes the drainage for rain falling within the protected area when the river is in flood will have to be provided for by centrifugal pumps.

3. Flood Bank (A. B. Diagram No. 7.) Regrade the existing road from the Sewage Treatment Works at Madampitiya, across Victoria Bridge road and Grandpass road through Sedawatte up to the 6th mile post. (It would perhaps be preferable to construct an entirely new embankment from the 3½ to the 5th mile post and avoid the bend of the road at Sedawatte and Kohi-
wela, owing to the larger number of houses bordering on this portion of the road) At the 6th mile post the regrading to turn southwards and follow the cross road to Butgomuwa. It was my original intention that the embankment should stop here, but as the new Lunatic Asylum is only about three-quarter of a mile from Butgomuwa junction, there is no reason why the embankment should not be carried by the shortest route to the high ground on which the New Asylum stands.

This flood bank will protect about 12,000 acres from floods.

From a look at the map of this part of the country (see Diagram No. 7) it will be seen that this embankment will completely prevent all flood waters from entering the country south-west of the new Lunatic Asylum at Angoda. The water that finds its way to the low-lying lands on the south-east of the Asylum cannot find its way to the low-lying lands on the south-west of it owing to the high ground (hatched in plan) on which the Asylum stands acting as a barrier. As will be seen the low-lying lands on the south-east of the Asylum are in no way connected with those on the south-west of it.

The great advantage of this scheme over all other embankment schemes is that it will allow all the surplus rainwater within the protected area to be drained to the sea at Wellawatte through channels already in existence, *via* the Kirillapone canal and the Dehiwala flood outlet. This is a very great consideration for it will do away with the necessity, otherwise, of installing expensive pumping machinery.

I have stated this already but it will I think bear repetition in view of the fact that although Mr. Ward, who originally proposed this scheme, took good care to point this out very clearly in his memorandum of 1901 in the following terms:—
"Drainage of Flooded Area. Through the flooded area run certain sluggish streams and canals which will act as natural drains and run off the rain water, and the Kirillapone canal and Dehiwala flood outlet will assist them and the Kalutara canal to perform the part assigned by Messrs. Coode, Son & Matthews to pumping machinery, which I am fully satisfied is unnecessary.

"The greatest rainfall in any one month in 1891, 1892, 1893, 1897, 1895 was 17.67 inches in May 1891, or 1 foot 5 inches. Of this probably half would be absorbed in the ground; and if the other 82 inches ran off into the drainage canals, their area of discharge is ample to give quick and easy discharge for such a flow, amounting as it does to something under 4,500 cubic feet per second for four days."

Colonial Secretary some years later stated that one of the fatal objections to Mr. Ward's scheme was "that a good deal of the floods which overlies the country is due to local rainfall, and that canalization of the river would mean practically the shutting out of the rain flood from its natural and only escape by the river."

One cannot, of course, blame non-technical officers for not following the intricacies of engineering schemes, but now that I have pointed this out as clearly as I could, I trust the point will be borne in mind, for it is a very important one.

4. Flood Outlet (N. O. Diagram No. 4.) Cut a channel from the Kelani river at the 6th mile post to the Kolonnawa ela. This will catch up a great volume of water and take it down to the Kotte lake and the Kirillapone canal and into the sea at Wellawatte.

It will be seen from the above that my No. 3 proposal is exactly the same as that put forward by Mr. Ward, the late Director of Irrigation, in 1901, although at the time I
made my proposal I had not seen Mr. Ward's scheme. It was only about the middle of February last, when I started writing this paper, and had to go to the Colonial Secretary's office to look up some old records, that I came across the scheme in one of the old files. Till then I had not the faintest notion as to what Mr. Ward's scheme was. Under the circumstances, therefore, I cannot claim the proposal as one put forward for the first time, but I am greatly pleased to find myself in such complete agreement with the late Director of Agriculture, an Engineer of such vast experience and ability.

My No. 4 proposal for a flood outlet at Kohilawatte at the 6th mile post on the Colombo-Avisawella riverside road is only original to the extent that the channel is to commence at this point instead of at the 8th mile post at Ambatele, as suggested in his scheme by the late D.P.W., Mr. Churchill, in 1879. The flood waters under both schemes finding their way ultimately into the sea at Wellawatte via the Kotte lake and the Kirillapone canal. In this case too I must state that I had not seen the scheme put forward by Mr. Churchill, in 1879, at the time I made my proposal. I came across the scheme when studying the sessional papers connected with flood outlets for the purpose of writing this paper.

It is very likely that the revival of the flood question and the appointment of the Committee by Government in May 1921 was the outcome of a very able memorandum on the Colombo Town Planning Problem written by the present Mayor of this City, Mr. T. Reid, of the Ceylon Civil Service in July 1920.

Mr. T. Reid,
Mayor of Colombo,
1920

The Mayor argued that the housing problem in the City was the result of lack of land for extension in North and Central Colombo and of the growth of population. He said:

"Colombo City at present covers about 9,000 acres of land mostly flat and low. and is
surrounded on the North and East by swamps, and on the West by the sea. Even inside present Municipal limits, on the North and East about 1,500 acres of swampy undeveloped land exists. The actual City has, therefore, expanded southwards, and the buildings are erected on a long, narrow piece of land to the North and Centre, the built-on land widening out on the South.

"The natural result has taken place. The poor who cannot pay for conveyances are overcrowded in the North and centre where they live to be near their work. Well-to-do people live in the South, in the Cinnamon Gardens and beyond. It would be an exaggeration to say that North and Central Colombo is tumbling into the Harbour on one side and into the swamps on the other; but it would describe the situation roughly.

"The problem of extension in the North and Centre of the City is a most difficult one. The undeveloped land is low and it is flooded by local rainfall; but the most difficult item of all is the Kelani river which spreads the enormous up-country rainfall all over the environs of Colombo City. An ever changing river mouth and varying sea currents make the river and flood problem still more difficult.

"The annexed Map (see Diagram No. 10) of Colombo under flood gives a bird's eye view of the extraordinary position of Colombo."

He made the following observation in the hope that they would form a basis for the solution of the problem:

"If Colombo's population is going to increase to half a million or more, the existing high land cannot accommodate the people unless the garden City area is to be packed with houses. It will, therefore, be necessary to reclaim the low lands of the City, or build on the high lands outside the City and connect them by rail or road with Colombo, if not already so connected."
“Obviously, the possibility of reclaiming the swamps in the City should first be examined, before trying the difficult expedient of inducing people, especially poor people, who work in Colombo to live outside the City.

“The swamps do not promote public health in Colombo, and should be dealt with, if possible. The task, of course, is bound to be costly, but if the Board is assured, for instance, that the correct solution is the raising of low land and that sanitary dwellings can then be erected on the land reclaimed, and that the whole expensive operation will pay handsomely, it is assuredly advisable to deal with the land adjoining the harbour area before moving numbers of the people, who work there, out of Colombo.

“The Board has none of these assurances at present. Engineers have ideas on the subject, and all I urge is that these ideas be worked out in definite facts and figures, before the Board accepts for all time the huge swamp area as a necessary evil of City life.

“And there may be cheaper solutions than filling up the low land. The problem has not been worked out, and it should be with expert aid, if necessary.”

The result of the Committee’s deliberations so far has been the appointment of an Officer from the local Irrigation Department, in the person of Mr. C. C. Harward, Divisional Irrigation Engineer, to take contour levels in the whole flood area and report as to which of the flood bank schemes now submitted, if any, is the most feasible to be undertaken by itself alone, or by its combination with other schemes, or to devise a scheme himself.

The matter is in this state at the present moment.

I should here wish to state that it appears General Remarks to me that flood banks by themselves alone would not solve the flood problem. It must
not be thought that by erecting barriers and keeping floods away from large areas they could be finally disposed of. Unless means are found, either by opening further flood outlets, or by constructing suitable works at the mouth of the river, to keep the mouth permanently open, in order to allow of the speedier discharge of flood waters into the sea than obtains at present, inundations will continue to take place. For, water, if locked out from one area, and cannot find a ready escape into the sea, will spread itself into other areas, and if this is not possible owing to the natural features of the country, or for other reasons, the flood level will be increased. In the latter event would the proposed remedy be any cure for the present disease, or would it not in the long run prove more costly than if works at the mouth of the river had been constructed?

These are very weighty questions which require mature and careful consideration at the hands of those on whom will ultimately rest the grave responsibility of expressing a final opinion on the matter.

I am, therefore, strongly of opinion that before any attempt is made to erect barriers to protect areas of any magnitude from flood inundation, either the Kirillapone canal should be opened up as a proper flood outlet to the full extent proposed by the P.W.D. in 1879, or some works at the entrance to keep the mouth of the river permanently open, should be undertaken and completed, whichever is the less costly.

In the scheme of the Acting D.P.W., Mr. Churchill, in 1879, the proposal was, as was mentioned earlier in this paper, (under No. 1 Outlet) to connect up the Kelani Ganga with the Kirillapone canal by cutting a channel from Ambatala at the 8th mile Colombo-Hanwella road to Kotte bridge. Sir John Coode, to whom the matter was referred, advised the postponement of the cutting of this channel, and suggested in its place a channel from the Madampitiya fields passing near Upland Mills to the sea at Mutwal.
The channel suggested by Sir John Coode cannot now be cut as the point at which it was expected to enter the sea is now part of the Colombo Harbour within the breakwaters.

Therefore, to complete the Kirillapone canal scheme, it becomes necessary to fall back on the idea of the D.P.W. to join up the Kirillapone canal with the Kelani, and the question is, which is the most suitable position for the cut.

In submitting an estimate in 1893 for completing work under the No. 1 Outlet (Kirillapone) project, the late Provincial Engineer, W.P., Mr. T. Smith, stated that the cost of cutting the channel to Ambatale from Kotte will be very heavy (Rs. 141,000) as it would have to be cut across a ridge to a depth of 30 ft. at the summit and that it would have to be 300 ft. wide if appreciable relief was to be afforded in carrying off the flood waters of the Kelani. The late D.P.W., Mr. MacBride, in forwarding the Provincial Engineer’s estimate expressed himself strongly against the scheme in the following terms, “the practical effect of opening a cut from the Kelani to Kotte bridge would be to increase the floods in that part of Colombo, both in their volume and frequency, and as the object aimed at is to diminish the damaging effects of floods and the relief of the low-lying lands, I am of opinion, that the cut in question should be at once and for ever dismissed from consideration in connection with ‘No. 1 Outlet.’ It would do more harm than good, its effects would be more disastrous than beneficial, the duration of floods in the vicinity of Kotte and Talangama would be longer than at present, even with additional flood escapes, for the waters would be discharged much more rapidly into the low-lying lands from the Kelani than from them into the sea.”

Again in July 1896, referring to the same project, he said: “I recommend that no further consideration be given to the proposal, the flood waters unless confined between two
banks would subject the country below Kotte to inundation in excess of anything hitherto known, and if there is any misery and loss caused by existing floods, they would be multiplied tenfold by the "Ambatale cut.""

Mr. Dawson, W.P.,
G.A., W.P.
1896

But the late Government Agent, W.P., (Mr. Dawson) was all in favour of the "Ambatale cut," for in reporting in September 1896 on the effects of the works so far carried out under No. 1 Outlet (Kirillapone Canal Scheme) he stated that "the effect these works have had on the floods at present has been small. The effect of so much as has been executed of the Ambatale Scheme, that is, the deepening of the Kirillapone canal and the lengthening of the bridges, is curative and not preventive. Till the country has been flooded it does not work. When the flood has once occurred it does very good work.

"I would again lay before Government the desirability of cutting the Ambatale canal from the river to the Kotte lake and the Kirillapone canal. This would be not only a curative but a preventive work, tapping the river and carrying away the rainwaters before it had flooded the country, as well as affording very great facility to the escape of the water when the flood had occurred. In case any inconvenience might be apprehended when the river was low, its mouth might be fitted with sluice gates. The fact that the canal would go through low-land and that embankments might be necessary is merely a detail in the scheme and not an objection to it. It is my fixed opinion that this work would have more effect in preventing floods than any work at the actual mouth of the river. It is also clearly indicated that this should be the next work undertaken by Government in connection with flood outlets."

Mr. Dawson was so convinced of the utility of this scheme that in November 1896 he went to the length, as President of the Provincial Irrigation Board, Western Province, of writing to the Central Irrigation Board and saying that he saw no valid reason why if the Govern-
ment cannot find funds to provide for the Ambatâle Canal Scheme and the continuation of the widening of the Kiri llapone canal, the Central Irrigation Board should not go to its assistance and apportion a substantial sum from Central Irrigation Funds. This was however not approved by the Board as it was of opinion that the proposed works would be more appropriately undertaken from General Revenue.

That the present D.P.W., Colonel Chapman, was not opposed to tapping the Kelani would be seen from the following remarks he made in a communication to Government in October 1919:— "The real reason of the floods is the inadequate section of the lower part of the river channel which is unable to discharge the flood water from the catchment with sufficient rapidity; the conditions at the mouth of the river are in themselves a minor consideration in point of effect on the flooding."

"The remedy lies in providing a channel of sufficient section and fall to dispose of all flood water that is likely to come down and this can only be affected by the deviation from the present river of such water into a separate channel or channels."

Before finally leaving the question of this most useful flood outlet, viz., the Kiri llapone canal, I give below a statement shewing what was originally recommended by the Acting D.P.W., Mr. Churchill, in 1879 and the extent to which these recommendations have been given effect to up to date.

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<tr>
<th><strong>Recommendation</strong></th>
<th><strong>Action Taken</strong></th>
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<tr>
<td>Opening the channel 300 ft. wide from the sea to the Kotte lake and to the junction of Kotte road (41 miles). The line of railway to be provided with an iron bridge upon cylinders. A stone viaduct to be constructed over the Galle road.</td>
<td>The channel has been open to a width of 40 ft. only, and to a length of 1½ miles. The railway bridge is only 50 ft. span. An iron bridge of only 50 feet span has been erected.</td>
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### Recommendation

Remainder of the bridges to have plate iron girders with masonry or piled foundations.

A channel 200 ft. wide from the Kotte bridge to the Kelani river at Ambatele.

A branch channel to be cut 100 ft. wide from the Kotte bridge towards Talangama.

### Action Taken

The other bridges are about the same span, viz., 50 ft.

No steps have been taken.

No steps have been taken.

(The Dehiwala canal not mentioned in the recommendation has been completed.)

The objections of the late D.P.W., Mr. Mac Bride, to the Ambatalie channel would apply with almost equal force to my proposal to make the channel from Kohilawatte (6th mile) to the Kolonnawa ela which falls into the Kirillapone canal via Kotte bridge and Kotte lake. But this channel could be cut for about $\frac{1}{4}$ the cost of the Ambatalie channel as it is not much more than $\frac{1}{4}$ its length and the ground through which it will run will be much easier being swampy almost the entire length.

The final question to be decided would be one of cost, viz., what would be cheaper—to complete the Kirillapone flood outlet scheme to the full extent proposed by the P.W.D. in 1879 with the Kohilawatte channel in place of the Ambatalie channel, as originally proposed, or to carry out works at the entrance to keep the mouth of the river permanently open. The answer to this question would again depend on the particular scheme in regard to the latter works, it will be decided upon to adopt. If the scheme put forward by the Consulting Engineers at an estimated cost of £414,000 is to be favoured, it would certainly be cheaper to undertake the Kirillapone flood outlet project. If on the other hand, Major Day’s scheme is to receive favourable consideration, it would be cheaper to adopt it in preference to the Kirillapone project, which if carried out in full as recommended by the Acting D.P.W., Mr. Churchill, in 1879, or even as modified by Sir John Coode in 1880, would be a costly undertaking.
Before concluding I should like to throw out a suggestion to Government, that is, to get the Irrigation Engineer, who is now engaged in connection with the proposed flood-banks in close proximity to Colombo, to make a contoured survey of the area North and South of the Kelani Valley railway line, between Pannipitiya and Homagama, in order to ascertain if there is any possibility of connecting up the flood waters of the Kelani Ganga north of the railway line with the low-lying land on the south, which drains into the Bolgoda lake, particularly, as it has been stated that the Dutch were able to carry much of the overflowing waters of the Kelani across country to the Bolgoda lake.

It will be observed (see Diagram No. 7) that the railway line from Nugegoda to Padukka runs on a ridge which lies parallel to the Kelani Ganga, and that the streams which take their rise on the north side of this ridge fall into the river, whereas the streams which have their source on the south side flow into the Bolgoda lake. It has also been observed that, when the Kelani Ganga is in heavy flood, the rise of water in the Bolgoda lake is only about 12 inches, clearly showing that the ridge separates the two water sheds and that they are quite unconnected.

It would, therefore, I think, be worth while taking a series of levels to thoroughly investigate if the two watersheds had been in any way connected in the past, or if the levels will permit of tapping the Kelani Ganga at any point between Kalluwela and Henpita and a channel constructed from the low-lying land on the north of the ridge to the low-lying land on the south with a short length of cutting across the high ground of the ridge on which the railway line runs, to enable the flood waters of the river to be led into the sea, via Bolgoda lake, which is but very slightly affected by the Kelani Ganga floods at present; the flood waters only finding their way into it via the Kirillapone canal and the Kepu ela, when unable to discharge into the sea rapidly at
Wellawatte and Dehiwala. Unless insuperable difficulties are met with, this channel if constructed, will, I am of opinion, prove much more efficacious, and not more costly, than a cut either at Ambatalale, or Kohilawatte, and the flooding of the country west of such a channel will be very greatly mitigated if not almost completely abated.

Whatever measures are ultimately adopted to tackle the flood problem it should be borne in mind that during floods the river brings down from the highly cultivated lands above a rich silt, with fertilizing powers, highly beneficial to cultivation, which is spread over the valleys; and that to permanently deprive the low-lands, which are largely under paddy, and regularly cultivated, of this half yearly nourishment would be to render them comparatively unproductive.

It should also be borne in mind that the richest lands in the Eastern Province are those subject to periodical flood submergence, and to mention only one other land outside Ceylon; the advantage which Egypt derives from the inundation by the Nile.

This being the position, a scheme that would prevent floods from rising beyond a certain level, but not one that will completely abate floods, should be adopted, for it is only the height and the duration of floods that do all the damage. Duration even more than the height, for inundation when too prolonged is fatal to all growing crops to speak nothing of other damages.

If, then, these two evils, namely, duration and height, could be successfully combated, and floods locked out from areas necessary for the proper development of the city of Colombo, the flood problem could be considered solved.

In conclusion I have to express my thanks to the following:—

Mr. W. T. Southern, Principal Assistant Colonial Secretary, Mr. H. T. Creasy, Deputy
D.P.W., and Mr. E. Reimers, Government Archivist, for giving me every facility to read through all available literature on the subject in their respective offices; and to Mr. A. Woodesa, Architectural Assistant, P.W.D., for the valuable help rendered in the preparation of the diagrams.

Post Scriptum

After I had written the above paper, and it was in the hands of the printer, I came across a flood bank scheme proposed by Mr. E. Elliott, Government Agent, W.P., as President of the Provincial Irrigation Board in 1893. This then becomes the first definite scheme of flood banks proposed in regard to the Kelani Ganga. It takes priority to Mr. Ward’s scheme of 1901. His proposal for the construction of the bank was (see Diagram No. 11):

(a) To raise the road from Madampitiya across Grandpass to the railway embankment with a lock at the end of St. Sebastian Canal to admit of communication with the river for boats.

(b) To utilise the existing railway embankment between the Kelani bank and the Uragodawatte road, filling up the opening for the canal, which is to be deviated as suggested in para. d.

(c) To raise the Uragodawatte road from the railway bank to the 5 1/2 mile. It is only topped by the highest floods in parts and much of it is above all flood level.

(d) This will necessitate the closing of the opening through which the Kalutara canal passes at Kittanpahuna (4 mile) but there is low ground lying between this canal and the Demetapoda canal, which will permit of a deviation being cut at a moderate expense, and which will keep the whole line of the canal within the
protected area and bring the traffic 
via Dematagoda Ella into the St. 
Sebastian Canal.

e) The closing of openings, if any, beyond 
the 5½ mile and which allow the 
Kelani floods to come into the Colta 
fields will, I believe, be small, indeed 
I understand there is only one.

This scheme was referred to the Superin-
tendent of Works, Municipal Council, Colombo, 
(Mr. R. Skelton) for his opinion. His 
remarks, which are given below, are interest-
ing in view of what has already been written 
in this paper.

1. "The scheme proposed by the Govern-
ment Agent, Western Province, is, from an 
engineering point of view, bad, and the bene-
fit which might be secured will be possibly 
out of proportion to the expense of the under-
taking.

2. "In principal it is extremely dangerous 
to resort to embankments, for, no matter what 
height is assumed to be ample under the cond-
tions of known floods, there is always the 
danger of exceptional floods occurring which 
would overtop, or perhaps breach the bunds, 
inundating an area, which under years of 
security from floods, may have in the interval 
become occupied by a considerable population.

3. "The principal cause of floods at 
Colombo is the incapacity of the river, between 
the bridge-of-boats and the sea, to discharge 
the upland waters as fast as they come down; 
and the magnitude of this defect becomes 
apparent when it is observed, that it is possible 
for the river to rise to 12 feet above sea-level 
at a point only 1½ miles distant from the coast.

4. "During the floods of October-Novem-
ber 1891 the river stood at 9' 9" at bridge-of-
boats and 32' 96 at Embulgama, situated 
about 17 miles by river from the sea.
Thus whilst the slope of the river below bridge-of-boats was (average) 2.4 ft. per mile, it was only 1.4 ft. per mile above.

5. "All attention, therefore, should first be directed towards improving the river below the bridge-of-boats. The best method to adopt is not quite evident, mainly on account of the absence of any guide as to the amount of money Government is willing to spend.

6. "By improving the present channel by clearing away obstructions in the bed at Watala, and draining the river to a narrower channel in a more direct line to the north of sand bar, such a flood as that of September 1872, where 12 feet rise at bridge-of-boats was recorded, could be run off with a maximum level at bridge-of-boats of 7' 6" with certainty.

7. "Another and perhaps a more bold scheme, that indicated by line A to B (see Diagram No. 11), consists of making a new river in almost a direct line from the bridge-of-boats to the sea, shortening the distance 1½ miles, and making it possible to run off the worst flood with a maximum elevation at bridge-of-boats of not more than 6 feet.

8. "This latter scheme is very simple of execution as for most of its length the new river would be cut out of soft land almost at sea level, and I estimate all works and land at Rs. 750,000. Either course if adopted would be of most material benefit to Colombo, and also to the whole valley, and under these new conditions every attempt to confine the river to its bed, to straighten that bed and generally to move rapidly bringing down the upland waters would add to the practicability of the works suggested above. But on the other hand, apart from works of improvement below the bridge-of-boats, all undertakings intended to prevent floods above Colombo must tend to this city's injury, for just in proportion as floods are prevented so must the river rise to greater heights in the vicinity of Colombo.
9. "Banking and minor improvements may be good after the greater works suggested have become an accomplished fact, but until then I can only anticipate partial advantage—not apart however from grave risks."

It will be noted that Mr. Elliott's scheme deals, under (d), with the deviation of certain canals. This would, likely, prove a costly undertaking, and it would, I think, be found cheaper in the long run to adopt Mr. Ward's, and my scheme, viz., to raise the Colombo-Avisawella riverside road from Madampitiya up to the 6th mile, than to attempt to interfere with existing waterways.

In regard to the statement by Mr. Skelton (para. 6) that the height of floods could be reduced 4' 6" at the old bridge-of-boats by draining the river in a more direct line to the north of sand bar, it will be observed that the Consulting Engineers (Messrs. Coode, Son & Matthews) stated definitely in 1897 that the reduction in height would only amount to 18 inches under such a scheme... This statement was not challenged by Mr. Skelton after the Consulting Engineer's Scheme was made public.

Regarding Mr. Skelton's remarks in para. 7 it will be noted that Mr. F. A. Cooper, the late D.P.W., and he was no mean authority on questions of this kind, was opposed to Mr. Skelton's proposal to shorten the length of the river below Victoria Bridge (see page 18.)

Since writing this paper Mr. Reimers, the Government Archivist has also put into my hands an old Dutch map (about 1730) of Colombo, and its vicinity, showing the canals that existed in this locality during the Dutch period (see Diagram No. 12). It will be seen from this map that there had been in existence in those early times a canal (A. B.) from the Colombo Lake direct to the Kelani Ganga, at Kohilawatte, at the 6th mile, on the present Colombo-Avisawella riverside road, the very
spot at which I myself proposed to tap the Kelani, and lead a channel to the Kolonnawa Ela (see page 61.)

That I should have struck on the very place the Dutch engineers who, as is well known, are past masters in canal construction, had made a cut in the Kelani, about two centuries ago, and that my proposal should thus receive confirmation, quite unexpectedly, from such high authority, is, naturally, most gratifying to me.
KELANI CANCA FLOODS.

PLAN & SECTIONS SHOWING HEIGHTS OF FLOODS.
THE PLAN, MAIN SECTION AND CROSS SECTIONS ARE TAKEN FROM DRAWINGS PREPARED BY THE SURVEYOR GENERAL, SURVEYS OF THE SEA FROM ADMIRALTY CHART BOOK. OTHER INFORMATION FROM RECORDS USED BY MR. SKELETON, MUNICIPAL ENGINEER WHO COMPILED THIS PLAN.
KELANI GANGA:
SHOWING CHANGES IN THE SAND SPIT:
AT THE MOUTH FROM TIME TO TIME:

PLAN FURNISHED BY
Mr A. D. Prouse Harbour
Engineer.

REFERENCE:
1923
1904 July
1904 March
1903
1895
1891
1885
1883
1873
1831
1861

SCALE OF CHAINS:

Photo Litho Survey Dept Colom.
DIAGRAM No 6

KELANI GANNA

PLAN SHOWING WORKS PROPOSED BY
MESSRS COODE SON & MATTHEWS

FOR OPENING OUT THE MOUTH OF THE RIVER

SCALE OF CHAINS

CHAINS 20 40 50 60 70 80 CHAINS

60 CHAINS
KELANI GANCA

FLOOD BANK, COLOMBO.

PROPOSED BY LT. COL. T.G. JAYEWARDENE

SEE CHIEF ENGINEER, LAKE SCHEME, LT. NO. 576 OF 30.7.20 TO D.P.W
AND D.P.W. LT. NO. 974 OF 9.8.20. TO COLONIAL SECRETARY.

SCALE OF CHAINS

Photo Litho Survey Dept. Ceylon 8 4 XI.
KELANI GANCA
OLD DUTCH MAP 1750
LAKE AND CANNES IN COLONIAL SRI LANKA
DURING THE DUTCH PERIOD
PLANE FURNISHED BY MR E. PEPHER
GOVERNOR GENERAL

Photo Litho Survey Dept Ceylon 6.4.23
DISCUSSION

Col. Jayewardene in introducing his paper said: Mr. President and gentlemen, I crave your indulgence for any shortcomings in this paper which was written in a hurry, in less than a month. You will have noticed that it was not on the list sent you by the Secretary about two months ago of the papers to be read at the present sessions. Even the title of the paper is different to what appears on the agenda. The reason is that it was not my intention at first to read such a lengthy paper. My original intention was to lay before you only my proposals to mitigate floods in Colombo. But on further reflection I felt I could not do full justice to the subject in that way, and that there was the likelihood of my taking credit unwittingly to myself for proposals which perhaps had already been made. This I was anxious to avoid. I therefore thought it best to examine all the proposals put forward from the time that Government began to take serious notice of this vexed question, that is from the appointment of the Flood Commission in 1873. The result is the paper now before you.

The President: Time is getting on gentlemen, before asking you to propose a vote of thanks to Col. Jayewardene for his able and instructive paper, I will call upon you to open the discussion.

Mr. Prouse: This paper is a valuable collection of records shewing the consideration given in the past, from the days of the Dutch in the early seventies until the present time, by those who were interested, to the reduction of the area subject to flooding in the vicinity of the Kelani river mouth.

It seems strange that after this extended consideration and the many propositions put forward for the diminution of the damage and nuisance caused by the flooding of country adjacent to this important river that at the present time nothing has resulted in the direction desired. I believe, however, that it may
not be long before action will be taken with, it is hoped, beneficial results, over certain portions of this area subject to floods.

I am more especially interested in the improvement of the Kelani river, and of the views given in the paper on this question, that of Sir John Coode is, in my opinion, the most valuable, as it coincides with my own practice in all questions of engineering procedure, viz., first find out to what the trouble is due and then devise means of removing the cause of the trouble. In the case of the Kelani mouth, it does not appear that any direct investigations have ever been made to obtain, as Sir John Coode puts it,

'a knowledge of the exact nature of the disease which in this case is the action of the heavy seas which prevail upon this part of the coast for many months of the year, and which cast up the sand, causing it to accumulate in the form of a formidable ridge or bar across the entrance of the river. Were it not for this bar the upland waters would at all times flow unimpeded into the sea opposite Mutwal. The question therefore which thus arises is, how can the accumulating action of the sea at this part of the coast be neutralized or at any rate kept sufficiently in check to allow the fresh water to over-power it.'

Although I had never seen or heard of the report which contains the foregoing, nor was I aware that Sir John Coode had ever written those words until I saw the proof of this paper, yet I have for years past been of the opinion that the state of the mouth of the Kelani river will have an important bearing upon the maintenance of navigability of the northern entrance to Colombo harbour, either in the more or less near or distant future unless the problem of prevention of this deposit in a satisfactory manner has been solved, and I have consequently hoped to make the necessary investigations in order to arrive at the desiderata which this eminent engineer rightly considered to be necessary before even he could
venture upon any opinion as to the right action to take from an engineering point of view. He says, furnished with the particulars set forth in a memorandum prepared by him, "I could if it were desired frame a design and estimate for such work as would in my opinion be best adapted to accomplish the object in view."

I am not aware what the particulars were which Sir John Coode desired should be furnished, but I believe that not even he could give any opinion as to the steps to be taken to ensure a certain cure for what he termed the "disease" without investigations lasting over a considerable period of years. The observations recorded in the first year or two would indicate that action taken upon certain lines might have a beneficial result, but any such action should be embarked upon with the intention of modifying or amplifying the scheme adopted to conform with the conditions which might be revealed as the investigations annually proceeded.

While therefore I am equally of opinion with Sir John Coode that a solution under natural conditions of local forces may be obtainable, yet the problem is one the complexity of which is contributed to by so many governing conditions of nature that without the fullest possible collation of data any attempt at its solution would be merely anticipatory and as likely to end in failure as success; on the other hand the necessity for success in the solution of the problem is such that it ranks in connection with the harbour, in my view, as one of supreme importance to the Colony. Before any attempt at the solution of the problem of natural stability of the Kel constructed river mouth in a condition favourable to all the varied interests dependent upon such condition can be made, a considerable period of close investigation must intervene. From what I now know of this river although there is at present no immediate danger, and although late, it is not too late to successfully attempt this solution. Doubtless if the
attempt had been made some years ago the expenditure involved would have been considerably less and equally doubtless the longer this solution is delayed so much greater will the involved expenditure become.

From a long knowledge of maritime engineering work I cannot urge too strongly that the fullest understanding of all governing conditions; not from text books alone, but from actual personal knowledge of the sea and its ways be obtained before any engineer should venture to give an opinion or put forward a proposition on a question in coastal engineering by which his professional reputation may be either increased or lessened.

The axiom to be borne in mind in regard to any proposed interference with the balance or naturally attempted balance of forces in maritime matters (in the former case existent and in the latter case in process of natural evolution) is, that such proposed interference must be approached and decided upon with extreme caution; otherwise instead of the improvement desired being achieved unexpected results of an adverse nature may be caused by such proposed interference when carried into execution.

In the preface to a treatise on “Maritime Works” dated 1922 by an engineer of professional experience in the maritime branch of civil engineering is written the following:

‘He has dealt successfully with the question of sea and coastal problems which may be said to come within the category of Maritime Engineering and constitute for the Consulting Engineer a somewhat precarious field of enterprise where the measure of success is more often gauged by the fewest number of failures rather than by the greatest number of successes.’

If such is the position of a Maritime Consulting Engineer in respect of these problems of so much complexity, each of which has its
own governing conditions and none of which are alike, how much more difficult is the position of a civil engineer of non-maritime experience when faced with such problems. To him they are veritable traps for the unwary. He may study text books and attempt to apply the knowledge so gained to the solution of the problem, but let him have a care that some governing condition or deviation of a controlling force, however slight, which has been overlooked in his calculations does not turn anticipated success into very real disaster.

The sea will not easily yield up its secrets and Neptune while not troubling over much about mice takes a grim delight in wrecking the scheme of men.

Mr. Harward: Mr. President and Gentlemen, the paper which has just been read is a most interesting and valuable record of the history of the various proposals which have been made in the past for preventing or alleviating Colombo floods, and the diagrams contain a great deal of valuable information about the Kelani river. Anyone with a knowledge of the subject will have no difficulty in realising that the preparation of this paper involved a very large amount of labour and trouble and that the author is to be congratulated on the result.

The present time is a particularly suitable one for the preparation of such a record since it is extremely probable that the periodic submergence of large portions of Colombo and its suburbs by Kelani floods will soon become a thing of the past, and as such will only have a historical interest.

On page 2 of the paper the author very correctly classifies the proposals dealt with under three headings.

(i.) Improvements of the river mouth.
(ii.) Flood outlets.
(iii.) Flood banks.
The first two of these classes can be bracketed together under the general heading of *Kelani River Flood Prevention*, whilst the third may be called *Colombo Flood Protection*.

There is only one thing which is absolutely certain about a policy of Kelani River Flood Prevention, whether it is carried out by river mouth and channel improvement or by flood outlets, or by a combination of both river improvement and flood outlets, and that is that it would cost a very large sum of money indeed and would, if it was going to be fully effective have to include the control of the navigable canal by a lock or locks. It may also be stated that unless the river improvement effected a reduction of maximum flood level of at least six feet it would still be necessary to protect Colombo City by flood banks.

Under the circumstances, since the principal object of all the schemes is the protection of Colombo city and suburbs, it is fairly certain that if a really good and cheap scheme for Colombo Flood Protection was forthcoming it would be advisable to accept it in preference to sinking a very large amount of capital in improvements to the river mouth and channel, or in flood outlets.

Attention is now drawn to Diagram No. 10 accompanying the paper under discussion which shows the general appearance of Colombo City when a flood is in progress. Had this diagram been correctly extended three or four miles to the Eastward it would have contained the complete solution of the problem of Colombo Flood Protection as considered separately from Kelani River Flood Prevention.

Early in 1920 under the influence of the food crisis of that period and as a result of certain suggestions brought forward by the local food production committees, the Irrigation Department undertook the investigation of the whole of the low lying area in the neighbourhood
of Colombo, and also of the lands north of the Kelani, towards Negombo Lake and south of Colombo to Kalutara with a view to improving their drainage. It was my good fortune to be in charge of those investigations.

The preliminary investigations, as far as they concerned the Colombo area were completed in 1920 and the report on the survey was in the hands of Government early in 1921. The investigation covered the whole Hydrographic area which drains into the Kelani near the Victoria bridge by the main canal and the contour map of the survey shows the complete contour of a major Colombo flood together with the boundaries of the Hydrographic area in question.

Up to the present time the results of this investigation have been considered confidential, but in view of the fact that the final report on the Colombo South Flood Protection Scheme is at present being printed, permission has been granted by the Colonial Secretary to produce the contour map of the survey of the flooded area at this meeting.

The tracing on the board (see Diagram No. 13 reproduced) is taken from that map and the actual map is on the table for reference.

It will be seen from the tracing that the flooded area of Colombo South (which is shown in pale blue) is in reality a large reservoir basin and that Kelani floods only obtain access to this basin by two gaps, namely, the Kolonnawa gap marked A. on the tracing which is 1,670 feet wide and the Dematagoda gap marked B. on the tracing which is only 500 feet wide.

This reservoir basin is provided with two sea outlets, marked C. and D. on the map, at Wellawatte and Dehiwala. The extent subject to submergence is in round figures 8,000 acres of which 5,000 acres are more than three feet above mean sea level and are good building,
park and garden land, and the remaining 3,000 acres are grass and paddy land with a considerable central area of permanent swamp.

The tracing makes it clear that, owing to the excellent arrangement of natural features for the protection of Colombo South, that area must be dealt with as a separate unit and that the problem of protecting the very valuable land in Colombo North can be considered quite independently with the great advantage that it is possible to isolate this valuable North area from the extensive rainwater runoff from large south catchment. The extreme cheapness and simplicity of the works necessary to exclude Kelani floods from Colombo South is obvious from the tracing.

The tracing makes it clear, for the first time, what really happens in a Colombo flood, i.e., in the earlier stages of the flood, the water backs up the Kalutara canal and the Dematagoda Ela from Victoria bridge into the Colombo South reservoir. This earlier stage lasts till the water reaches six feet at Victoria bridge and during it the water in Colombo South reservoir will be from one to two feet below the water at Victoria bridge. As soon as the river reaches six feet at Victoria bridge the conditions change, the left bank of the river is topped and rapid flow begins to take place through the Kolonnawa gap from a point of the river where flood level is considerably higher than it is at Victoria bridge. During the higher stages of the flood, the water in Colombo South reservoir will be from one to two and a half feet higher than the water at Victoria bridge. During this stage northward flow occurs in the Dematagoda Ela causing a rise in flood level of the southwestern part of Colombo North.

A diagram is placed on the table for reference which shows the daily reading of the Victoria bridge gauge, plotted on the same base as the daily readings of the Harbour Works gauge at the Kolonnawa Oil Installation at Dematagoda, for the period 1918 up to
date, and this diagram shews clearly the exact transition from minor to major flood conditions which occurs when the six feet level at Victoria bridge is reached.

The sea outlets at Wellawatte and Dehiwela afford no relief during a major flood since the water comes in much faster through the Kolonnawa gap during the rising stage of a flood than it can escape through the sea outlets and the effect of the sea outlets is practically negligible until the river recedes within its banks. These outlets will however begin to give a return for the capital invested in them when the Colombo South Protection Scheme has been carried out.

Daily gaugings of the river level at Victoria bridge have been compiled covering the period from 1883 to date with a gap of eight years from 1896 to 1904 for which no records are obtainable. A diagram plotted from these gaugings is laid on the table for reference, and the Irrigation Department is deeply indebted to the Municipal Engineering Department, the Public Works Department, and the Harbour Engineer’s Department for the valuable gaugings and other information which they have placed at its disposal.

The labour involved in the complete investigation of the Colombo Hydrographic area was very greatly reduced by the very excellent maps of those areas which are available at the present time and which were not available at the periods when most of the previous investigations of the Colombo flood problem were made.

A careful analysis of the Kelani gaugings shews the average frequency and duration of various river levels at the Victoria bridge to be as follows:

<table>
<thead>
<tr>
<th>Height above M.S.L.</th>
<th>Age Frequency</th>
<th>Age Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 1'6&quot;</td>
<td>10 times a year</td>
<td>114 days per year</td>
</tr>
<tr>
<td>More than 2&quot;</td>
<td>8 times a year</td>
<td>82 days per year</td>
</tr>
<tr>
<td>More than 3&quot;</td>
<td>5 times a year</td>
<td>40 days per year</td>
</tr>
<tr>
<td>More than 4&quot;</td>
<td>3 times a year</td>
<td>29 days per year</td>
</tr>
<tr>
<td>More than 5&quot;</td>
<td>2 times a year</td>
<td>16 days per year</td>
</tr>
</tbody>
</table>
Since the low lying land in the neighbourhood of Colombo varies in level from a little below mean sea level to about three feet above mean sea level, a very considerable area being less than one foot above mean sea level, and since it all drains into the Kelani near Victoria bridge the foregoing analysis of gaugings makes it quite clear why there are long periods when it does not drain nicely.

On page 19 of the paper the author mentions the proposal to open a flood outlet from Ambatále where maximum flood level is 23 feet above mean sea level into the low lying area around Kotá and from that area into the sea by the Wellawatta sea outlet. The knowledge that this area is really a reservoir makes it certain that a connection with a flood level of 23 feet above mean sea level would have had disastrous results unless the proposed channel had been carried right across the low lying area (some 6 miles) in double banking in which case it would not only have been prohibitively costly but would have caused serious local drainage problems. There is no doubt that the former Director of Public Works, Mr. Macbride was quite right when he reported definitely and finally against this proposal.

On page 61 of the paper the author himself proposes a channel from the sixth mile post on the low level Avisawella road where maximum flood level is 15 feet above mean sea level to the Kalutara canal.

If this proposal was carried out it would considerably increase the level and duration of minor floods in Colombo South and would cause a minor flood to become a major one at a somewhat earlier period than it does at present.
On page 74 of the paper the author suggests the investigation of the possibility of connecting the Kelani between Kaduwela and Henpitiya with Bolgoda Lakes by a channel lying outside the Colombo catchment area. Such a channel is not impossible from an engineering point of view, but it would be very costly. The lowest place in the ridge dividing the Kelani and Bolgoda catchments being 70 feet above mean sea level. The suggestion, however, could not be seriously considered, even apart from the question of cost, since if a channel sufficiently large to relieve the Kelani floods was cut it would result in rendering subject to Kelani floods an area of land in the Bolgoda Catchment of very much greater extent than the area which would be relieved in the Colombo Catchment.

This low, lying Bolgoda area already suffers severely by being connected with the Kaluganga at a point at which its maximum flood level is 14 feet above mean sea level and to connect it with the Kelani at a point at which the flood level of that river is about 30 feet above mean sea level by a channel large enough to produce any mitigating effect on Kelani floods would be simply criminal, since the area is, like Colombo South, a reservoir and has only two sea outlets one at Panadura and one at Talpitiya.

On page 54 of the paper the author mentions his own proposal to utilize the new railway line from the graving dock to the Kolonnawa Oil Installation as a flood bank. This proposal is undoubtedly well worth reconsideration and it is almost a certainty that this railway bank (after it has had ample time for settlement) must ultimately become a flood bank. It is a very high class bank most excellently constructed of beautiful cobble gravel and with a minimum top width of 20 feet. It is built on a line which will protect from Kelani floods a large area of land which will become extremely valuable, and it will be a fairly simple matter to provide for very efficient rainwater drainage from the protected area.
after it has been isolated from the large catchment area of Colombo South. The forces in favour of using this bank as a flood bank must ultimately become too strong for the forces against so using it.

All the other proposals for flood banks which are mentioned in the paper are of course ruled entirely out of consideration by the additional knowledge obtained from the recent investigation as to what really happens in a Colombo flood.

This additional knowledge renders it possible to forecast the probable policy regarding Kelani floods as follows:

(i.) Since it is now certain that Colombo city and the greater part of its suburbs can be efficiently protected from Kelani floods very easily and at a very low cost, it is fairly certain that such protection will be carried out before long.

(ii.) All question of relieving the Kelani river by additional outlet channels from the river above the Victoria bridge may be finally dismissed from consideration on account of the large areas of low lying lands which would be adversely affected by such schemes.

(iii.) Since Colombo can be efficiently protected by cheap works it is rather doubtful if the large expenditure required for the improvement of the river mouth and channel will ever be justifiable, but if ever works are undertaken which will give the river a permanently open mouth it must be carefully borne in mind that this will result in the river becoming salt for some considerable distance from its mouth during very dry weather and will involve steps to prevent the salting of very extensive areas of low lying lands.

It is necessary to say a few words about diagram No. 12 which accompanies the paper under discussion since practically an exact
duplicate of this diagram accompanied my own report to Government on the Colombo South Flood Protection Scheme. The old Dutch map from which this diagram has been prepared was obtained by me from the Government Archivist some months ago, before the paper under consideration was written, and a reduction of it accompanies the final report on Colombo South Flood Protection Scheme as a diagram.

This report was completed and in the hands of Government several weeks before the proof copies of this paper were issued. When this report is published I trust that I shall be absolved from any suspicion of having obtained the idea or this diagram from Col. Jayewardene’s paper the appearance of which in both documents is a matter of pure coincidence.

Mr. S. W. Dassanayake: Mr. President and Gentlemen, I do not wish to detain you but merely wish to mention two points on which I think information is desirable. It has been stated by Major Day that the formation of the bar at the mouth of the Kelani Ganga appeared to him to be due to a strong current from the north, bearing sand down our coast, which current produced similar bars pointing southward all round the coast, at least from Colombo to the South. Now there is one case quite close to Colombo where conditions are different, 18 miles North of Negombo, where the bar is formed pointing north. It is a very considerable bar and it is really the only important bar that ever forms at the mouth of the Negombo Lagoon which is as you all know a river mouth. So here is one case where a bar points north about. If I remember rightly, if you follow the coast down South at Bentota, the bar distinctly points north about. This is another exception to the rule Major Day sought to establish. It appears to me that the only thing common to all these river mouths is that, what (in the case of the Kelani Ganga) we call the actual mouth of the
river (or the natural mouth) occurs in the protection of a cape whether to the north or south. If you observe you will see that in the case of the Kelani the actual mouth is just where the coast turns northwards. If you regard Colombo City as standing on a cape it is just at the root of this Cape that this natural mouth keeps open. It is the same at the mouths of the Kaluganga, Bentota River and Gin Ganga and several other rivers. I think therefore the position of the natural mouth of the Kelani Ganga is somewhat a unique one, produced by nature at the one spot where it can keep itself open and would support the proposal to cut a course from the bridge of boats up to this natural mouth so as both to shorten the river and eliminate the bend. Such a cut would also discharge directly at right angles to the coast through this natural mouth, thus tending all the more to keep it always open. That proposal has been rigorously decried by a number of very eminent Engineers. If I remember rightly, Mr. Skelton supported it very strongly and, indeed, I believe the paper read to-day says he did. He was a very good observer, his observation extended over a period, I believe, of something like 30 years, and he brought to bear on them a very original genius. I think, therefore, there is a very great deal to be said for that proposal. I would also point out from what I know of the waterways of the coast south of Colombo as far as Matara, that whether they be drains or large rivers, they are all closed by sand bars with one exception. There is a small canal near Galle Fort—the Pattiya Ella—where we do not see any sand bar at the mouth. This is the one exception. This canal enters the sea at the root of the peninsula on which the Galle Fort stands. No sand bar ever forms here from year's end to year's end and there is no suspicion of any accumulation of sand. This mouth is very similarly situated to that we call the natural mouth of the Kelani Ganga, viz., it occurs close under the shelter of a cape. I think a study of the reasons why that mouth always keeps open would throw a valuable
light upon the conditions at the Kelani River mouth. This Ela discharges, as the proposed cut in the Kelani River would, directly at right angles to the coast through a mouth closely sheltered and protected by the adjoining cape. I offer these very incomplete remarks for your criticism, and apologise for having taken up your time so long.

Mr. Nathaniel Sz: There is something in the paper I cannot reconcile with flood discharges—it may be my profound ignorance—why is the quantity of flood water discharged vide page 14 given as 9,377,784 cubic feet per minute? The full 8" rainfall is taken as the drainage co-efficient no allowance being made. It would therefore appear that all the water that fell came rushing down. Even Mr. Skelton's figures merely speak of a run off of 25,000 cubic feet per second.

Mullin's Irrigation Manual records the formula

\[ D = C \sqrt{5M^2} \]

where M represents the area of the catchment basin in square miles.

C is a co-efficient depending for its value upon rain fall, soil, slope of ground forming the basin, etc.

D is the resulting discharge which is usually taken in terms of cubic feet per second.

There must be some explanation. Perhaps the author of the paper may be able to state it. We must thank the author for having placed side by side these differences of opinion of eminent engineers on an important subject. The matter we are glad is now in the capable hands of Mr. Harward whose report we shall look forward to. If the Commission that sat in 1873 had laid down instructions regarding obtaining the necessary data required for such a scheme instead of offering general conclusions we should have gone forward more quickly. It does not want a Sir John Coode to say that the quantity of water must be considerably reduced in respect of absorption by the ground and evaporation. In schemes of
this sort further investigation often makes one absolutely alter his preliminary ideas. I quite agree with what Mr. Vine has said of his experience in opening the bar.

It is not so much the deepening of the bed by dredging that will help in a case like this. Observations show that the formation of sand banks is regulated by the velocity of flow at the mouth. The water that comes in, and goes out at high and low tides are both affected by the velocity of the stream due to the volume of the water coming down. When the velocity of the outgoing water falls to about one foot per second or so the sand bank begins to form. This conclusion is from personal observation.

My belief is that since the rain falls mostly in the higher regions with steep slopes, the desirable thing is to hold back the water in the higher reaches as far as possible and to provide flood banks in the flat and lower region. There need be no great fear about flood banks. They are easily controlled as might be noted in Holland. Instead of proposing to do away with the Poll Tax, depriving thereby in my estimation the poor of this country of their conscious co-partnership with their richer brethren in the full rights of citizenship, if a member of the Legislature would move that the present income thereby be earmarked for such a scheme as say of housing the poor on reclaimed lands instead of being credited to Revenue and spent on Rest Houses, etc., I make bold to say, that no one would grudge the tax. I must congratulate Col. Jayawardena on having succeeded in obtaining access to dusty tomes for the valuable information he has gathered in this paper which has deeply interested me.

The explanation I desired as to the drainage coefficient as regards Mr. Skelton's figure is self-evident. He puts the greatest flood discharge at one third the maximum days rainfall. At the time the paper was read I evidently skipped this or should not have made that reference.
Mr. Wimalasurendra: Mr. Chairman and Gentlemen, my excuse for speaking on this subject is that in connection with the Hydro-Electric Investigations in Ceylon, the main sources of the Kelani river have been under my investigation for several years. If you look at the map, you will notice that the river Kelani has three principal sources which supply the vast volume of water causing the floods. These are the Kehelgomo-oya, Maskeli-Oya and the Sitawaka river. The former two sources rise at an elevation of about 6,000 feet and flow in adjacent valleys draining an area of over 160 square miles and join together at Kalugala to form the Kelani river, while the latter rising in the 3,000 to 4,000 foot elevation belt joins this at Avisawella, at a level of about 100 feet. From Yatiyantota to Colombo the river bed has a very gradual fall; so much so that between about the 14th mile and the mouth the fall is only about 8 to 9 feet. If we consider for a moment what is taking place, we will see that after heavy rains in the catchments of the sources referred to, the rapid flow down the steep gradients in the upper reaches of the river meet the stagnant or slow moving waters at flat gradients lower down, causing over-flow of the river banks, in the form of floods. What happens when a stream flowing at about 16 feet per second meets one flowing at 4 or 5 feet per second it is quite easy to imagine. The waters meet in the fashion of a fast moving train running into a slow moving one; and the formation of a water mole or hill is the result. This is exactly what takes place at about the 10th to 14th mile at time of floods. The waters heap up and overflow the river banks causing the floods in the suburbs and Colombo. The problem hitherto considered has been to find out the most effective means of providing an easy out-let for these waters that get held up between about the 14th mile and the mouth of the river.

From especially about the 14th mile downwards the course of the river-bed consists of a series of sharp curves worn deep on the convex side and large accumulation of debris
deposited on the inner side. As the floods rise, the flow starts, under the impetus received, with a fairly good velocity of flow, but this soon wears out before long distance is covered; with the result that the debris carried in suspension is deposited in the river, thus gradually but effectively reducing the water way. The clearing of jungle in the catchment areas for the purpose of cultivation has, in my opinion, somewhat reduced the possible intensity of floods, while the "deltic" deposits in the river bed, year by year, has reduced the sectional area of the water-way and thus increased appreciably the intensity of floods.

All investigations so far made have been concentrated on finding the most effective outlet for discharging the accumulations of the water referred to and various projects, which appear to be very sound, have been put forward for the purpose. This sounds to me like letting a horse go and trying to stop it by tugging on to its tail (laughter). The sounder plan appears to me to be to devise means for regulating the flood-flow of the river. From observations made I find the upper reaches of the Kelani, the Kehelgomu-Oya and the Maskeli-Oya at times of flood contributing over 12,000 cusecs. This means that a volume of water of nearly 200 million cubic feet per day is added to the Kelani flood flow. If means could be devised for locking up this flow at times when floods are rising, it needs no stretch of imagination to realise that the intensity of such floods could be mitigated. I find in this paper the assumption of 8 inches of rain falling over 900 square miles adopted as the basis of calculation of the highest floods. I consider it incorrect to assume that 8 inches of rain would fall over the whole catchment simultaneously, for if it did, the whole island would be under floods. My opinion is that it is the synchronous flow at the 10th to 12th miles of the drainage from the three principal sources that cause the heavy floods and if the run-off from, for instance the Kehelgomu-Oya and Maskeli-Oya sources,
could be controlled as suggested the height of floods could no doubt be appreciably reduced.

In my opinion the best outlet channel is the existing river bed and it should be "trained" up to at least the 12th mile in addition to keeping the mouth opened by mechanical dredging. The storage proposed, would be not only effectual in controlling the floods but it could also be utilized for generating electricity, which transmitted to Colombo would supply the power required for dredging and thus save expense in fuel which is a heavy item in these operations.

The storage adumbrated under the final development of the proposed Aberdeen Laxapana Hydro Electric Scheme, would help to control the flow of the Kelani to a certain extent and at the same time supply electric power for dredging.

The proposed flood control of Colarado River by storage affords a striking example of the application of this system. Here it is proposed to deal with a river 1,700 miles long draining 25,000 square miles and having a total fall from source to mouth of more than 14,000 feet.

Lieut.-Col. Jayewardene: I am very much obliged for the discussion that has just taken place. I do not, however, think I have very much to meet. Taking the speakers in the order they spoke—there is nothing controversial in Mr. Prouse’s remarks. I quite agree with him that the cause of the formation of the sand bank and other obstructions at the mouth of the river requires thorough investigation extending many years. If he wants to know the particulars asked for by the late Sir John Coode, he will find them in Sessional paper No. 24 of 1880. As you all know, Mr. Prouse has taken a great deal of interest in the question of the Kelani mouth obstruction. The Diagram shewing the changes in the river mouth prepared by him has been reproduced by me as Diagram No. 3 in my paper.
As the late Major Day, acting Surveyor-General remarked in his memorandum that there was not available at the time any information regarding currents at the mouth of the river, I went to Mr. Prouse, the Harbour Engineer, to find out if any such information was now available. Mr. Prouse in his usual courteous manner produced the Diagram I have just mentioned, and said it was all he had. He said that it would take an officer's whole time for a long period to go into this question of currents thoroughly, and as he had no officer to spare for this work he could not have done any more than what he had done. In his usual jovial way he added that as an Engineer I wanted very valuable information, but as a member of the Retrenchment Commission I was out to suppress posts, which alone could supply such information (laughter). I have taken the hint, and will be most careful how I deal with Harbour Engineers when next I sit on a Retrenchment Commission (laughter).

I shall deal with Mr. Harwards remarks after I have dealt with the others. From Mr. Dassenaike's remarks I am glad to learn that there are in Ceylon rivers where mouths are not blocked by sand banks always starting from the North; that some start from the South, and that there are also rivers whose mouths are just where they ought to be, without being obstructed by any sand bank. This clearly shows that other considerations besides that of currents have a bearing on the position of the mouth of a river, and I would draw your attention to page 36 of my paper where reference is made to the action of salt water on colloidal organic matter, which is contained in some river waters, and the consequent formations of sand bars at river mouths. This is a matter worthy of thorough investigation, after what has fallen from Mr. Dassenaike. Regarding the small canal which falls into the near Galle Fort mentioned by him, so far as I can remember, the case is not quite similar to that of the Kelani Ganga. This canal discharges into the sea at a higher elevation than
the Kelani, and over rocks. Its mouth is much more sheltered, affording no opportunity for sand currents to have free play.

Mr. Wimalasurendra is as usual full of sound theories. I have no doubt he has a scheme of his own to deal with the floods of the Kelani, and it will, I am sure, not be long before he reads a paper on this subject before this Association showing the best way of stopping this running horse without hanging on to his tail (laughter).

To my friend Mr. Nathanielsz, who spoke last, I would only say that he could not very well expect me at this late hour to go into the calculations of discharge made by such eminent men who formed the Flood Commission of 1873. In disputing some of their calculations he is, I think, in very good company, for if he will refer to page 15 of my paper he will find that the late Sir John Coode also disputed the grounds on which some of their conclusions were based. Mr. Skelton the late Municipal Engineer, however, went fully into the whole question very thoroughly, and from reliable data published a memorandum which is here with me for my friend's information if he cares to see it.

I am glad to have an expression of opinion from so qualified an authority on this question as Mr. Harward. He has had much better opportunity of examining this question than anyone of us. He has taken contour levels over the whole flood area, whereas we who have put forward schemes have merely gone over the ground with a map. He is therefore in a much better position to point out where exactly a flood bank should be constructed than ourselves who, without having taken any levels could only point to the direction in which such a bank should lie. Mr. Harward's proposal, however, only deals with the protection of South East Colombo; whereas my proposals are for the protection of Colombo as a whole, North, East, South and Central. I think it very necessary that North and
Central Colombo should first be protected for it is the only direction in which commercial, and industrial Colombo could expand, being close to the harbour. South East Colombo can only be a residential quarter. The portion proposed to be protected from floods by Mr. Harward under his scheme is so low-lying that even to make it a purely residential quarter much money will have to be spent. This part of Colombo would only benefit the fairly well-to-do, and not the poor, for if you refer to pages 66 and 67 of my paper you will see what the Mayor of Colombo has to say on the housing problem in the city. So that to try to protect South East Colombo without first protecting the North and Central would, in my opinion, be a mistake. For the growth of the population of Colombo will be in direct proportion to the growth of its Commerce and industries, and to make provision for the former, without making adequate provision for the latter, would be making a start at the wrong end.

The idea of preventing flood waters entering the area depicted in Mr. Harward’s map by closing up the very channel mentioned by him is not a new one. It had been put forward by the late Mr. Elliott, Government Agent, Western Province, as far back as 1893, as you will see from page 76 of my paper. Evidently, because the scheme had been combined with his scheme for the protection of North and Central Colombo, and had been adversely reported on both by the Municipal Engineer, Mr. Skelton, and the Director of Public Works, Mr. Mac Bride, it did not receive consideration at the hands of Government.

Mr. Harward says that the flooded area of Colombo South is in reality a large reservoir basin of about 8,000 acres into which flood waters find their way by two gaps, namely, the Kolonnawa gap and the Demetagoda gap and that this reservoir basin is provided with two sea outlets at Wellawatte and Dehiwala, which afford no relief during a major flood since the water comes in much
faster than it can escape through these sea outlets. He is of the opinion that the best remedy is to close these gaps and prevent the flood waters entering this reservoir. I beg to differ from this. In my opinion the proper course would be to improve the sea outlets and let the flood waters escape as fast as they come in through the two gaps. The proposal to shut out flood waters from an area of 8,000 acres which is about twelve times the size of the Colombo harbour, without making any provision for the speedier discharge of flood waters either by the improvement of its present mouth, and channel, or by the construction of other flood outlets in place of those proposed to be blocked is, in my opinion, a very risky one; and not to be lightly undertaken on the face of professional opinion expressed by Messrs. Mac Bride and Cooper, two late Directors of Public Works, to the contrary. In January, 1895 on the late Mr. Elliott's Scheme which is practically Mr. Harward's scheme, the late Mr. Mac Bride, D.P.W. stated that the damage to property outside the protected area would be considerable, and heavy compensation would be the penalty, and his advice was to increase the flood outlet so as to mitigate the duration of floods and leave the Kelani as it is.

In 1907 a committee of which Mr. Cooper, the late D.P.W., was a member made these remarks in regard to Mr. Ward's scheme which is also practically the same as the late Mr. Elliott's and Mr. Harward's schemes.

'The immediate effect of protecting this area (10,000 acres) from floods will be to render it no longer available as a regulating reservoir, consequently the discharge of the water now stored over this area during floods will have to be provided for, or the flood level will be increased in the river and over the flooded lands adjacent thereto.

The extent to which the level will be increased by the construction of the proposed embankment is a matter requiring the most careful consideration.
In view of the probable increase in the height of the flood level that would be caused by the carrying out of Mr. Ward's scheme in the absence of an additional flood outlet we are not prepared with the information before us to recommend its adoption.

If, however, Government is forced to adopt a scheme which will interfere with the present flood outlets, and prevent them from being used as such, the least it should do, unless it is prepared to take the consequences, is to undertake works at the mouth of the river to keep the mouth permanently open and to deepen the existing channel to at least a distance of 10 miles by dredging, in order to improve the present discharging capacity of the river through its mouth. If, then, dredging has to be undertaken the question arises which is the scheme under which the dredged material could be utilised to the best advantage. There is no question that the scheme which has its embankment laid close to the river is the best one. For, the improvement of the channel and the construction of the embankment with the dredged material could then be performed in one operation. After the formation of the embankment the dredged material could also be utilised for filling in the adjacent low-lying lands, without going to the expense of bringing the harbour dredgings for that purpose, as suggested recently by a prominent member of the Chamber of Commerce.

I am very glad Mr. Harward had something to say in regard to the suggestion for a channel between Kaduwela and Henpitiya leading south to Bolgoda lake. I did not say that this should be carried out. I merely threw it out as an avenue that should be explored if Government is forced to close up the present flood outlets, and that is exactly what Mr. Harward has proposed should be done. I said that Government will do well to find out if such a channel was practicable; for it had been stated that the Dutch had led the waters of the Kelani into Bolgoda lake. Looking at
PLAN
SHewing
FLOODED AREA IN COLOMBO, SOUTH

Area within Catchment above Flood Level
Do.....do......below......do......

Scale, One Mile to an Inch

COLOMBO
HARBOUR
COLOMBO

SCALE

SEAL OUTLET

BOLGODA CATCHMENT
the map of this part of the country you will see how suited the area is to receive flood waters. The villagers in this part of the country would only be too pleased to have as much water as they could get. They are simply clamouring for it and say that if they could only get more water, why, they will not only have two crops of paddy, but even three a year!

Mr. Harward, however, says the scheme is impracticable and there is an end of the matter.

Mr. HARWARD: I do not say it is impracticable. I said it is perfectly practicable from an Engineering point of view.

Col. JAYEWARDENE: Yes, but you said it will be enormously costly, and criminal to undertake it.

The question of additional flood outlets being then out of the question it only remains for Government to carry out works at the mouth of the river and improve the river channel by dredging, if it is forced to construct embankments that will interfere with the present flood outlets.

The PRESIDENT: It remains for me to ask you to pass a very hearty vote of thanks to Lieut.-Col. Jayewardene for his interesting paper which is another valuable addition to the records of this Association. There is one other paper which must be taken as read as Mr. Marwood is away and time does not permit us to read and discuss it at this meeting.