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Last previous Paper.
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9242/12

MOMBASA WATER SUPPLY

Mr Morton agreed to inspect and report on the operations so far as the mainland portion is concerned for fee of £50. Sends copy of Report with comments of Director of P.W.

Sir G. Fiddes

This is satisfactory

Put by?

H S.R.
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Alone
P.A. 15/4/13

Put by
C.R.
27/6/13

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Keep as reference



Next subsequent Paper.
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1344



GOVERNMENT HOUSE,
NAIROBI,
BRITISH EAST AFRICA.

[redacted]

[redacted] No. 26

12th March 1913.



Sir,

With reference to your Confidential despatch of the 3rd of April 1912,* relative to the engagement of Mr H.J. Morton to undertake the investigations in connection with the proposed water supply to the Magadi Railway, I have the honour to inform you that the Acting Governor invited that gentleman to inspect and report on the Mombasa Water Supply operations so far as the mainland portion is concerned, and that he agreed to do so for a fee of £50.

2. I enclose herewith a copy of his Report together with the comments of the Director of Public Works thereon.

I have the honour to be,

Sir,

Your humble obedient servant,

Edward Beaufort.

GOVERNOR.

THE RIGHT HONOURABLE
[redacted], P.C., M.P.,
[redacted] OF STATE FOR THE COLONIES,
DOWNING STREET, LONDON, S.W.

* No. 9-42

Med & San.

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INCLOSURE No 1
to Despatch No dated 1912
Encl 1 in No

C.O.
11844

17 Blythswood Square,
Glasgow.
16th September 1912.

The Hon. the Chief Secretary,
The East African Protectorate,
The Secretariat,
Nairobi.

Sir,

**Mackinnon Bridge.**

I have the honour to state that in accordance with your instructions I made an inspection, in the beginning of July, of the works proceeding and projected upon the Mainland opposite Mombasa in connection with the supply of Water to that town, and I now beg to report on same for your information as follows:-

I received copies of the principal plans, drawings and documents relating to the scheme from the Director of Public Works, who accompanied me in my inspection, along with Dr Milne, Principal Medical Officer, and the Resident Engineer.

Dealing first with the scheme as a whole, I find that it has been so carefully and capably considered and laid down by your Engineers that there is no scope for criticism or amendment on general lines, and I am confident that when completed it will prove satisfactory.

There are a few points of detail to which I would respectfully direct the attention of your Engineers, and I shall now proceed to deal with these, following as far as possible the order of the Resident Engineer's Report of 2nd March 1912.

**Sources of Supplies Bills.**

The whole district has been explored by your Engineers

Engineers and the route selected by them for the pipe line has been very carefully considered and determined. The section is quite satisfactory, the gravitation main being under any [illegible] gradient for its whole length.

It is proposed to carry the pipes across the more important dongas or valleys on concrete pillars. At such places the pipe will be exposed to the sun and therefore subject to expansion, and, to allow for this an "expansion valve" is shown on the section. I do not know exactly what is meant by the term "expansion valve", but I would suggest that each of the joints in the open should be of the type known as the "[illegible] Patent Joint", which is specially designed for this purpose.

Sluices. - Valves, etc.

On the drawings there are no Sluice Valves shown on the Gravitation Main pipes. I would suggest that these valves should be fitted along the whole length from Mrori to Changamwe at suitable places, so as to divide the Main into sections of, say, 2 miles in open country and of about ½ miles along the Railway. In this way any section can be shut off when required for repairs, without emptying a long length of pipe. It is also an advantage to be able to shut off the pressure without delay, to prevent damage, should a burst occur. The positions of these valves should be arranged so that there is an Air Valve to provide for the ingress of Air and a Washout Valve to provide for the egress of water in each section.

Pipes.

I have carefully considered the thickness proposed for the 9 and 10 inches diameter pipes. In the Resident Engineer's report the whole length of 9-inch pipes and the greater

3

[redacted]





[redacted] part of the 12-inch pipe are shown as [redacted] inch thick, and the remainder of the 12-inch pipe as [redacted]-inch thick. In the draft Indent for the pipes these thicknesses are shown as [redacted]-inch and [redacted]-inch respectively. In my opinion the shells of the 8 and 10 inches diameter pipes can quite safely be made 3/16-inch thick. I find that the maximum static pressure to which the 12-inch diameter pipes will be subjected, according to the Resident Engineer's Report, is 224 lbs. per square inch, and a 12-inch diameter pipe 3/16-inch thick will withstand this pressure, allowing a factor of safety of about 6, which is ample to provide for shocks and also for probable loss by incrustation. As the reduction in thickness will effect a considerable saving in cost, and as I feared that the pipes might be ordered according to the Indent before this Report could be in your hands, I cabled on 19th September to the Director of Public Works stating my opinion on the subject.

I have no doubt but that the thicknesses in the Indent were adopted to provide for probable loss of metal by incrustation in the pipes, but even if very considerable incrustation should occur, the reduction in the effective thickness of metal would probably not exceed 1/16-inch, and the pipes should still be amply strong to stand the full working pressures.

I think that [redacted] gallons per 24 hours may safely be taken as the probable delivery of the main to the service reservoir when the pipes are clean and new.

I note the proposal to use hemp yarn for the pipe joints, but I would recommend instead that hemp wire should be adopted. The diameter of the wire should be such that it should fill the annular space between the spigot and the socket, 4

[illegible]



[illegible] gauge of an inch in the case of 9 and 10 inch diameter pipes. Each round of the wire should be caulked [illegible] the socket separately until a sufficient number of rounds have been caulked in to make up the required width of fillet. These joints should be quite satisfactory for the pressures in this case.

[illegible].

I approve of the proposal to lay the pipes under ground, with about 2 feet of cover. This should keep the water cool. I also approve of the proposed mole to carry the pipe across the mud flats at Port Keith, and at the River Kunche.

[illegible].

I agree with the proposal to construct a Break Pressure Tank at Mile 18, but I would suggest that the Inlet pipe to same should be controlled by a ball valve regulating the flow automatically to meet the demand. In my opinion the overflow of any surplus water should take place at the Intake Tanks at the rivers Kwari, Kabumbe and Mpatchara, and only sufficient water should be allowed into the mains to meet the demands in Zomba. If this suggestion is adopted the length of the lever on the ball valve should be at least 18 feet.

The depth of this Tank need only be sufficient to allow the free travel of the ball, but the horizontal area should be large enough to minimise danger of shock to the pipes through a too rapid rise of the water in the tank and consequent shutting of the ball valve.

I would further suggest that a bye-pass pipe, also 18-inches in diameter, should be laid round the Break Pressure Tank, provided with Sluice Valves, so that the supply can be maintained should the ball valve in the Tank get out of order. At such times the Ball Valves, which I advise hereinafter should be fitted to the Inlet pipes to the Service Reservoir, could

[illegible] also be cut out of action so that no excessive pressure will be created in the main pipes.

[illegible].

For the following reasons I am of opinion that the proposed suspension bridge is neither the most economical nor most satisfactory method of carrying the pipes over this Creek:-

(1) If the depth of mud is considerable it will be difficult and costly to secure good foundations for the loads concentrated on the towers and anchors.

(2) The unavoidable movement in the Suspension Bridge would be most likely to cause leakage from the pipe joints, and

(3) The cost would be excessive.

I am certain that a very considerable saving can be effected by the adoption of Concrete or Iron Screw piles sunk into the Creek bed in pairs at intervals of from 20 to 30 feet. The pipe would be carried between 2 Rolled Steel beams, spanning between the piles, and on top of these beams decking could be placed to form a footbridge, if desired.

In addition to the saving in cost, this Bridge would afford a rigid support for the pipes.

With either type of bridge "Brass joints" will be required for expansion, but if the suspension bridge is adhered to it will be necessary in addition to provide a special flexible connection at each end of the bridge, to prevent leakage where the moveable pipe on the Bridge joins the immoveable pipe on the land.

[illegible].

I believe that the Regulating Chamber is shown in the centre of the stream, and is covered with a flat concrete roof

road. I would suggest that it should be shifted to one side, clear of the stream, and that it should be enclosed in a house with a good space all round between the chamber and the walls. The roof should be high enough to allow a man to work inside. This house would, I think, be useful as a store and workshop, and for working the screens hereafter referred to.

It seems to me that the arrangement proposed for screening the water is inadequate, and I would suggest that double screens should be provided in each compartment of the chamber extending across the whole width. These screens would be formed of copper wire cloth secured to stout oak frames working in vertical channel guides, and should be provided with chain and winding gear for bringing them up to the floor level for cleaning purposes when required. I would suggest that under normal circumstances the water should flow through one compartment, that an overflow opening should be made in the division wall between the compartments on the up stream side of the screens, through which the water would flow automatically in the event of the screens in the one compartment becoming clogged up, and in the event of the screens in both compartments becoming clogged through want of attention that the water should flow over the top of the screens to preserve the supply.

As regards the mesh of the copper cloths, this would require to be ascertained by trial, and I would suggest that samples of cloth varying from 10 wires per lineal inch for the first screen to 20 wires per lineal inch for the 2nd screen should be procured and tried.

The inlet and outlet valves might be operated inside the house by means of handsticks and wheels.

The subsidiary chambers at one and two would, I expect be simple intake weirs. Fairly wide gratings should be fixed

in

road. I would suggest that it should be shifted to one side, clear of the stream, and that it should be enclosed in a house with a good space all round between the chamber and the walls. The roof should be high enough to allow a man to work inside. This house would, I think, be useful as a store and workshop, and for working the screens hereafter referred to.

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As regards the mesh of the copper cloths, this would require to be ascertained by trial, and I would suggest that samples of cloth varying from 10 wires per lineal inch for the first screen to 30 wires per lineal inch for the 2nd screen should be procured and tried.

The inlet and outlet valves might be operated inside the house by means of handsticks and chocks.

The subsidiary chambers at [illegible] and [illegible] would, I expect be simple intake weirs. Fairly wide gratings should be fixed

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in order to prevent the entrance of large floating material to the pipes.

The branch pipes from "B" and "D" to the Regulating Chamber are proposed to be each of 6 inches diameter. This is not sufficient to lead the water from component "D" and, in my opinion, this branch should be increased to 8-inches diameter.

**[redacted]**

At this stage I would state that from a practical point of view I think the sizes of those pipes should be increased from 8-inches, 6-inches and 3-inches diameter to 8-inches, 8-inches and 4-inches diameter.

The intakes at these two streams would also, I expect, be simple weirs, but it would be advisable to provide a small screening wall at each, on the same lines as at Mreri.

**[redacted]**

As to the quality of the water, and whether or not filtration is necessary to render it suitable for domestic use, you will be guided by the opinion of your Analyst. So far as I was able to judge by inspection I think that with efficient screening and subsequent settlement in the Service Reservoir it may be found that filtration is not required. This might, in any event, be tried in the first instance, and if it should subsequently be considered advisable, Mechanical Pressure Filters can easily be installed at any time, but it might be well to take steps now to ascertain whether this water can be adequately treated by Mechanical Pressure Filters.

**[redacted]**

I think a strong Motor Lorry could be obtained which would satisfactorily transport pipes and stores along the roads which have been constructed.

**[redacted]**

6.

**Service Reservoir.**

I inspected the site selected for the proposed Service Reservoir at Changapie, which seems very suitable for the purpose.

If it is found that Mechanical Pressure Filters are suitable for adoption should filtration prove necessary, there is no need to shift the site proposed for the Service Reservoir at the [illegible] foot level. The Pressure Filters can be installed on the [illegible] surface on the Kowri side of the Service Reservoir, which, in that case, will serve as the Clear Water Tank.

The division wall of the Service Reservoir is somewhat light, as shown on the drawing, to resist the pressure should the one compartment be full and the other empty. I would suggest that the thickness at the bottom should be increased by 6-inches.

I understand that good clay puddle is obtainable in the neighbourhood, and I advise that a layer, about 9-inches thick, should be put in behind the walls and under the floor of the Reservoir, to prevent leakage. If this is done and the inside surface of the Concrete work is rendered with good cement mortar, there is no need in my opinion, for the Asphalte shown on the drawing. If clay puddle is not to be obtained, Guilander's Bitumen Sheeting might be used to line both the walls and floor.

I fear that the proposed Corrugated Iron Roof will not protect the water in the Reservoir from the heat of the sun, and it seems a pity after bringing it underground the whole way from Kowri to allow it to become heated in the Service Reservoir just before it is sent down to Khuhasa for use. To prevent this I would suggest a reinforced concrete roof, which could be banked up with earth on top, if necessary. The Reservoir would, of course, require to be well ventilated in

any

[illegible]





any time.

In already mentioned, a ball valve should be fitted on the inlet pipe to each compartment of the Reservoir, and also sluice valve on each branch leading into same, so that the supply can be shut off from either compartment when desired.

The proposed floating arm Outlets from the Reservoir are sound in principle, but unless very carefully made and fitted are somewhat apt to give trouble by going out of order.

**Water available at Source.**

While every care has been taken by your Engineers to ascertain the probable minimum yield of the sources of supply it is needless to say that this can only be determined with any degree of certainty by a series of gaugings extending over a long period of years. For future guidance it would be well to fix gauges at each of the Intakes and keep a regular record of the quantities in the streams.

In a scheme of this kind where water is so valuable it is of the utmost importance to reduce leakage and waste to the absolute minimum. The first step towards this lies in the detection without delay of any leakage which occurs. I would therefore strongly advise that self-recording waste detecting meters should be installed on the Main Gravitation pipe at intervals of, say, 5 miles. A similar meter should also be placed on the primary distributing Main at the Service Reservoir to register the fluctuations of consumpt. I would further recommend that when the scheme of distribution comes to be considered a complete series of such meters should be provided on the branch distributing pipes throughout the District.

I quite agree with the Resident Engineer's theory that over and above the flow in the streams there is probably a a considerable flow underground. It might not serve any purpose

[illegible] to investigate this matter meantime, but if necessity should arise hereafter to augment the supply, your Engineers might keep before them the possibility of forcing this underground water to the surface by forming clay barriers in the valleys, under the beds of the streams.

I have carefully considered the point raised by the Director of Public Works in his letter to you of 11th June 1920, and I entirely agree with his conclusions as to the advisability of adhering to the 10-inches diameter pipe.

I have no information as to the population of Mombasa, or the probable consumpt per head, but presume that the figure of [illegible] gallons per day adopted by your Engineers includes reasonable provision for any probable increase in the demand.

**Distribution Mains.**

I do not quite follow the conclusion arrived at on page 14 of the Resident Engineer's Report, as to the pressures available in the town. In designing the scheme of distribution it will be necessary to keep in view the fact that at the busy hours of the day the consumpt will probably be equal to double the average, and to provide distributing pipes throughout the whole district which will [illegible] sufficient pressure for fire and other purposes even when the demand is at its daily maximum.

**General.**

In order to prevent pollution I would strongly advise that the whole areas draining to the Intakes on the Mreri, the Mzizibara and the Mkombe Rivers should be acquired, and that steps should be taken to ensure that no natives are allowed to settle, or, if possible, even to trespass within these areas. This in my opinion is a matter of great importance.

In conclusion I would express my appreciation of the very complete

complete nature of the Plans, Reports and other information regarding the proposed scheme, furnished for my use by the Director of Public Works.

I have etc.,

M. E.J. MERTON

M. Inst. C.E.

Encl 2 in No.

Public Works Department, 70

Nairobi.

INCLOSURE No 2
In Despatch No. 2 of 12-3 1913

No. 32/34

C.O
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December 19th 1912.
(Port Sudan)

MOMBASA WATER SUPPLY.

REPORT BY MR. H.J.MORTON.

Ref. Secretariat No.S.2671 of 12-10-12.

The following remarks appear to be called for with reference to the report by Mr.H.J.Morton upon the Mombasa Water Supply project.

I have already conveyed to Mr.Morton an expression of appreciation of the general reference contained in his third paragraph, as to the lines upon which the work has so far been prosecuted.

Succeeding remarks receiving comment in this memorandum are referred to by the page on which they appear in the type-written enclosure to your communication of October 12th, and by the number of the paragraph on the page.

Page 2. Paragraph 3.

The expansion joints have already been ordered from home, and I imagine that the ones to be supplied will not be found less satisfactory than the Dress patent joint referred to. They have been used on the recently installed nine inch main for Nairobi and were found to work satisfactorily there, a movement of upwards of half an inch being measured.

THE HON'BLE THE CHIEF SECRETARY,

N A I R O B I.

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- 2 -

Page 2. Last paragraph.

Six sluice valves were shown on the Resident Engineer's original drawings, but were subsequently omitted from the scheme. To avoid the delay and risk involved in the charging of a long length of main, if it should at any time become necessary to empty it, I am having eleven sluices ordered for the portion in the bush country and four for the portion along the Railway.

Page 3. Second paragraph.

Pipes have already been ordered.

Page 4. Last paragraph.

The lead wool that has already been ordered is made up by the firm supplying it in the form of a rope ready for insertion in the socket of the pipe on lines almost identical with the use of lead wire which Mr.Merton suggests using.

Page 5. Second paragraph.

The proposal as regards a ball valve on the break-pressure tank was made to myself and the Resident Engineer by Mr.Merton while here. It was adopted, and the necessary fittings are on order. As regards a capacity of tank which will obviate shock in the pipe due to a too rapid rise in the water level in it, a capacity of more than two minutes' discharge when the main is running full will probably eliminate all risks on this score. The tank as already designed is therefore adequate.

Page 5. Last paragraph.

An arrangement has been adopted in the design of the break-pressure tank whereby the pressure in the ten inch main will never exceed that due to the static head at the tank whether the bye-pass is in use or not.

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- 3 -

This will not be an excessive pressure to subject the pipes to, even in the lowest dip, at the Mwache crossing.

Page 6.

Continued examination of the shores of the Mwache crossing has led to the entire abandonment of the proposal for crossing by suspension bridge, attractive though such a project would be. It now appears pretty certain also that the screw pile jetty will also not be adopted. The considerable time required for the erection of such a structure is undesirable in view of the fact that the Mwache creek is the unhealthiest spot in the whole of this sufficiently bad region. It is probable that a pipe, in duplicate, will be laid under water, being first jointed up on shore and then floated out and sunk in position. The scour-cock which should be at the actual lowest point, which will be under water, will be located just above water on one bank, and it is not anticipated that any deposit, collected in the main, will fail to be ejected under the very considerable head prevailing at this creek-crossing.

Page 7.

The proposals as to the strainers and straining chambers will be generally adopted.

Page 8. Paragraph 2.

Varying meshes for the copper strainers will be tried as suggested.

Page 8. Paragraphs 4 & 5.

The subsidiary chambers A & B will now be abandoned as the Resident Engineer's proposal for a new intake lower down stream is adopted. The same remarks apply to the branches from the Makembe and Madabara Rivers.

/5

Page 8. Filtration.

The Medical authorities consider that it will be necessary in any case to filter the water to be supplied to international shipping at the port of Kilindini. Enquiries are being made as to the results obtained elsewhere with certain Mechanical Pressure filters. I may say that Mr.Morton has been good enough to offer to make enquiries with regard to the clarifying effect of various makes of Mechanical Pressure filter at home upon the waters of the Mreri and Makombe which are ordinarily slightly opalescent. Samples were forwarded to him in six sealed Winchester quart bottles. He entirely refuses to make any charge for this service, which is one of singular utility and assistance to me in guiding a choice as to the class of filter to be adopted. His report on this subject will form the subject of a separate communication from this office at a later date.

Page 9. Transport.

Tenders have been invited for transport of materials both by water and land. If the work has to be done Departmentally on account of no suitable tenders being received, it is probable that two or more lorries will have to be ordered.

Page 10. Negotiations for the acquisition of the land required for the Service Reservoir are in progress. The suggestion to substitute a tiled roof for a corrugated iron one will be adopted.

Page 11. The waste detecting meters suggested will be adopted.

I have the honour to be, etc
Sir,
Your most obedient servant,

Forwarded.

Sd./ W.H.Tanner.
Ag.Director of Public Works.
13-1-1918.

-Sd./ V.McGregor Ross.
Director of Public Works.

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