EGYPTIAN GOVERNMENT.

PRELIMINARY REPORT

OF THE

ANTI-MALARIAL COMMISSION.

CAIRO.
GOVERNMENT PRESS.
1919.

CONTENTS.

THE FINANCIAL ADVISER,
MINISTRY OF FINANCE,
CAIRO.

SIR,

The Anti-Malarial Commission have the honour to present herewith their preliminary report describing the steps taken to check the spread of the disease and recommending their continuance and extension.

The Commission wish to record their great obligation to your Ministry for its ready financial support and to the British Military Authorities and various Departments of the Egyptian Government for their general assistance.

We have the honour to be,
Sir,
Your obedient servants,

(*Signed*) P. M. TOTTENHAM (Chairman).
W. ANGUS, Lt.-Col., R.A.M.C.
A. GRANVILLE.
L. H. GOUGH.
J. FERGUSON LEES.
E. H. LLOYD.
R. E. MONTEITH SMITH.
C. P. THOMSON.

December 3, 1918.

EGYPTIAN GOVERNMENT.

PRELIMINARY REPORT

OF THE

ANTI-MALARIAL COMMISSION.

CAIRO.
GOVERNMENT PRESS.
1919.

INTRODUCTORY.

The Anti-Malarial Commission's Preliminary Report describes an examination made into the presence and extent of malaria in Egypt and the measures taken and proposed in order to prevent the spread of the disease and ultimately eradicate it if possible. The Report is divided into two parts, the first containing a general account of the Commission's work and views; the second describing works and proposals affecting various specified centres and localities where malaria is being attacked.

In general, the position is that malaria, long existent in the oases and in the neighbourhood of the Suez Canal, is now more generally present in Egypt proper. It is the Commission's opinion that it might in time permanently infect the whole country, and that a campaign against it is necessary; certain immediate measures of prevention have been carried out.

The report notes that the two factors contributing to spread malarial infection are the presence of anopheline mosquitoes and the presence of infected subjects, and that it is against the former that the campaign can best be conducted. There is a considerable water surface in the country on which mosquitoes breed, while closer relations with the East since the war and improving communications have multiplied and spread infection bearers. Some of the mosquito-breeding water is found in the yet unreclaimed marshes of the northern Delta; much of it results from defective agricultural drainage and canalization; much of it comes by infiltration from the Nile flood, though, owing to this annual phenomenon's extending into the cooler half of the year, the harm it does is fortunately less than it might otherwise be.

Great irrigation works, begun or in preparation, are ultimately to reclaim the marshes and will improve drainage and reduce infiltration water. These projects have partly relieved the Commission of the necessity for proposing any very large and costly programme, but their full effects cannot be felt for many years, and meanwhile other measures are of urgent importance.

Defective drains and canals may be improved, the proper design of new channels may be assured, legislation may restrict danger

from agricultural operations near cities, whilst in such areas or in spots where malaria already exists, local protection against infiltration water may be obtained by filling in or by various methods of draining off. Similar measures may be adopted in urban areas, and experiments are being made in Cairo. Concurrently with the execution of remedial measures, the Commission urge that the closest attention be paid to all works or undertakings likely to create new sources of infection, and that they be prohibited, or only allowed if they can be made to a safe design.

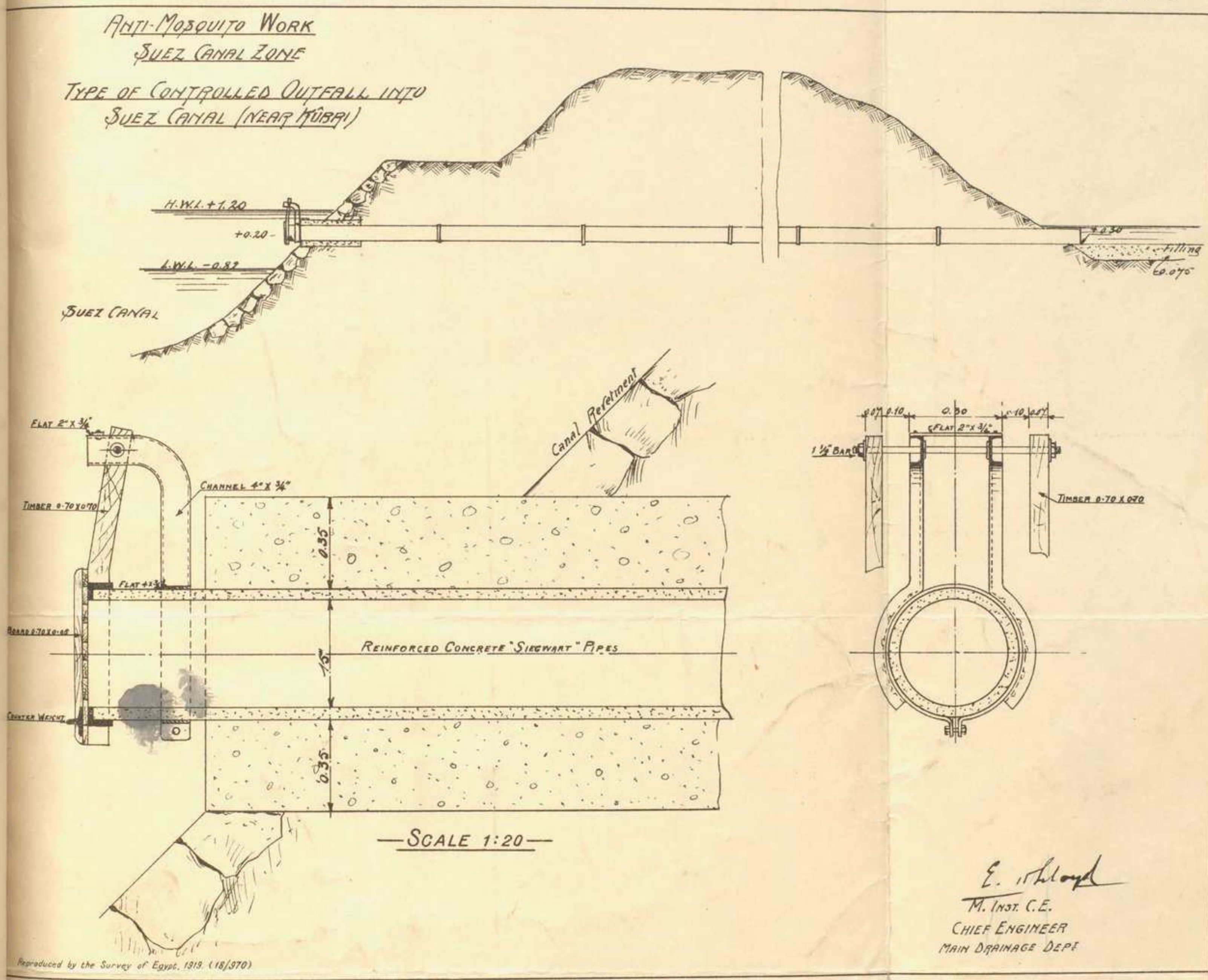
While the Commission consider the position is grave enough fully to justify these recommendations, they are hopeful of the future if all Government Departments collaborate in preventive measures.

They recommend that the Commission sit permanently to exercise general control over the campaign.

For reproduction if Director approves
JHt

5 3/4
+ 1/6 drop

APPENDIX Nº VI
PLAN Nº 2



Reduce to 4 1/6 inches along this edge

Sce D'At Nº 3200

QANṬARA
RECLAMATION PROJECT

Scale 1:100,000

Kilo 0 1 2 3 4 5 Kilos.

N

TO PORT-SAID
K.160

SUEZ CANAL

Gezîret el Ghuzlân

LAKE MANZALA

Qaṣṣâsîn el Sharq

Fumm el Ghuzlân

Gezîret Us el Gird

Gezîret Umm Khalaf

Baḥr el Asî

El Kabrita

Baḥr el Ghuzlân

Gezîret Baḥr el Ghuzlân

Scrub
Gezîret el Ghuzlân

Gezîret el Zarzâriya

Bahr el Bagar Dr.

Scrub
(R.L +1.00 to 300)
Gezîret Umm Alîṭa

Reeds

Kôm Dafana

LAKE EL SIBEITA

Gezîret Zahr el Gebel
(R.L. 300)

Undulating Scrub-Covered Sand
(R.L. + 100)

K.150

Dense Reeds

Reeds

6,100 FEDDANS

LAKE KASA

To El 'Arîsh

QANTARA
Axis of QANTARA St.
Kil. 146·200

To Qantara

Line of Banks

Undulating scrub-Covered Sand
(R.L. +2.00 to 3.00)

Reeds

LAKE
UMM EL RISH

Mourel Escape

MALLÂḤA

E.S.R. from Sâlhîya

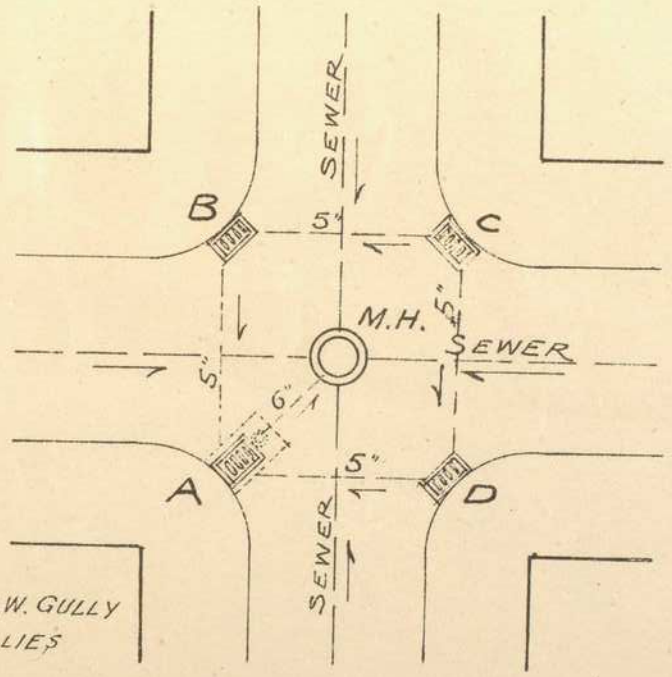
Sweet Water Canal
(El Abbâsîya Canal)

K.140

Printed by the Survey of Egypt 1919 (18/970)

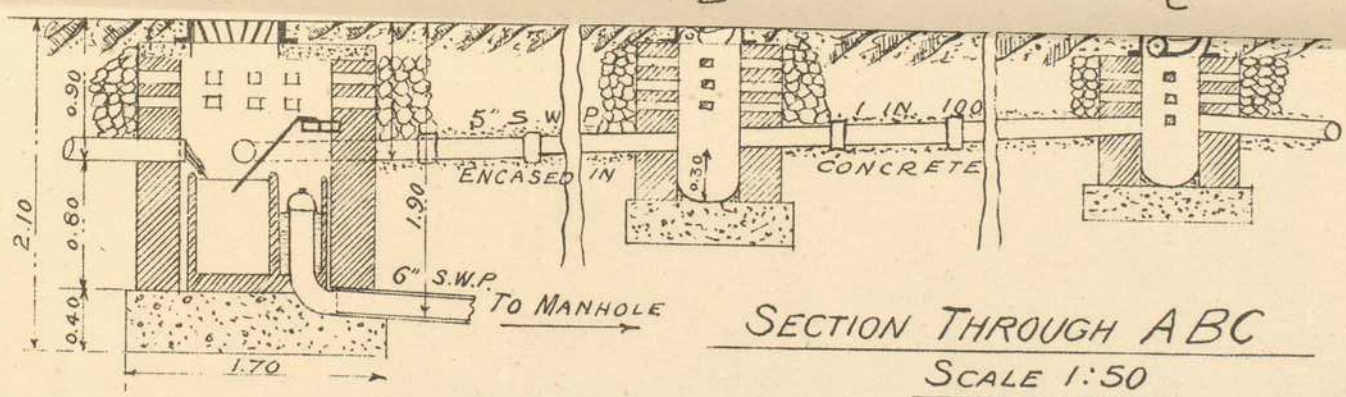
APPENDIX Nº VIII
PLAN Nº 4

ANTI-MOSQUITO WORK
SURFACE AND SUBSOIL WATER DRAINAGE
DEEP AND SHALLOW GULLIES

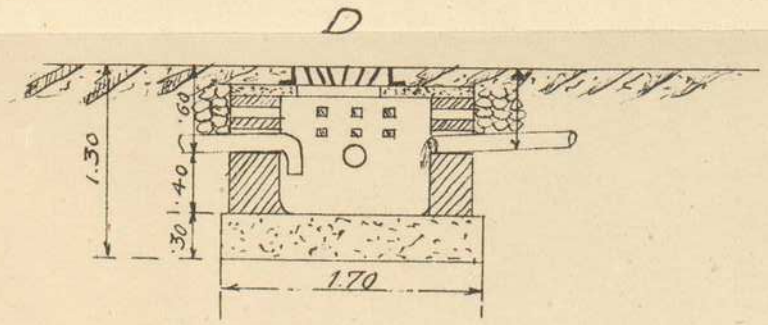


NOTE:
A, STANDARD M.D.D. S.W. GULLY
B, C, D, SHALLOW GULLIES

PLAN SHOWING GENERAL ARRANGEMENT SCALE 1:200



SECTION THROUGH ABC
SCALE 1:50



TYPE OF SHALLOW GULLY
SCALE 1:50

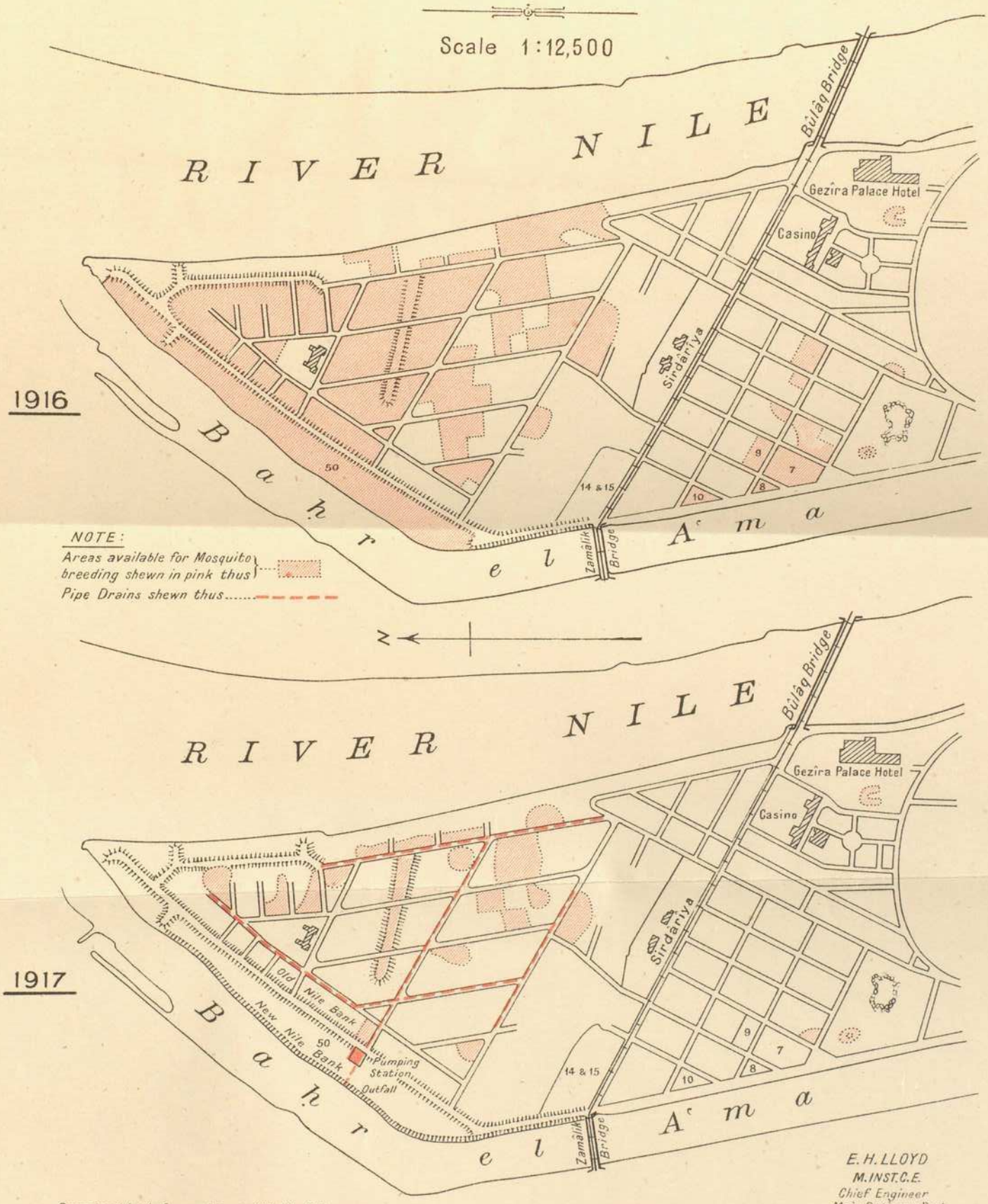
E.H. LLOYD
M.INST.C.E.
Chief Engineer
Main Drainage Dept.

Reproduced by the Survey of Egypt, 1919. (18/970)

APPENDIX Nº IX
PLAN Nº 5

ANTI-MOSQUITO WORK
PLAN SHOWING AREAS AVAILABLE FOR MOSQUITO BREEDING
1916 – 1917

Scale 1:12,500

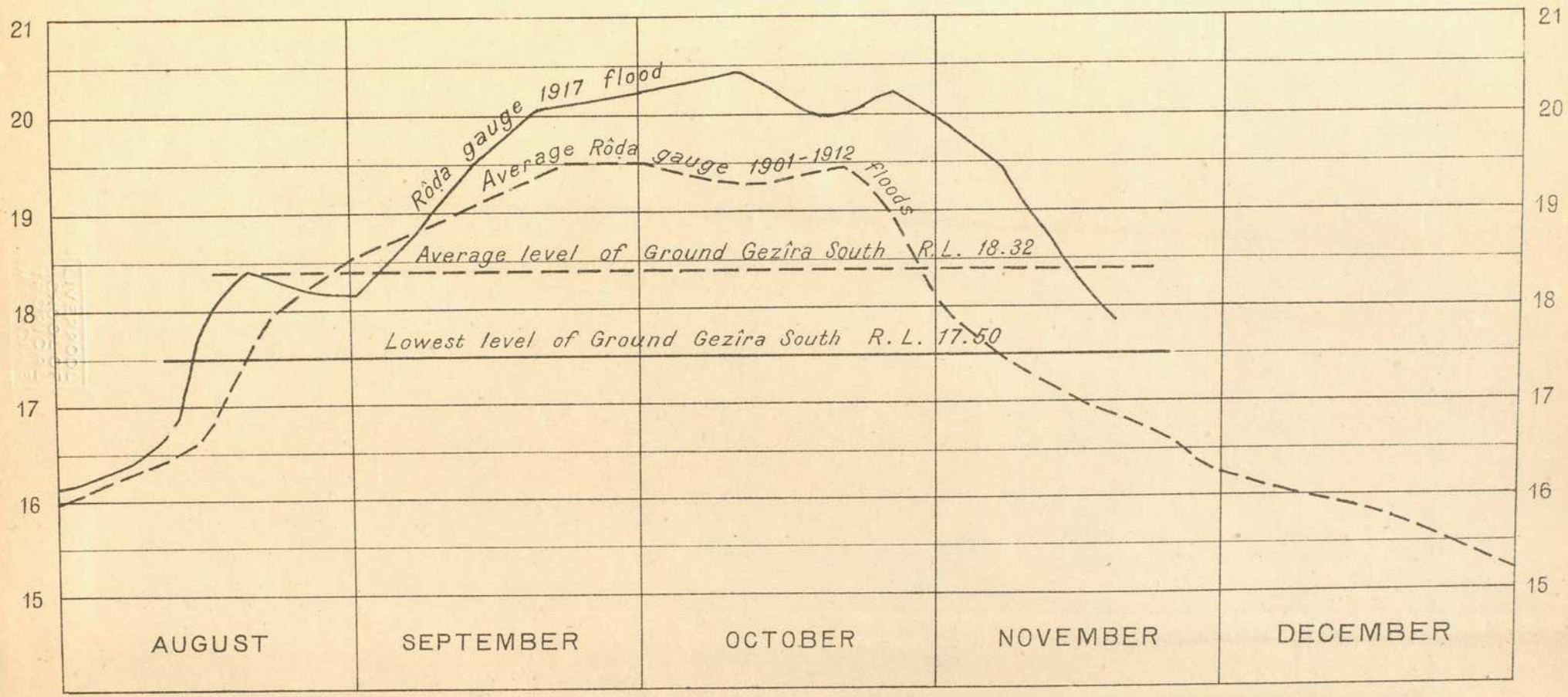


E. H. LLOYD
M. INST. C.E.
Chief Engineer
Main Drainage Dept.

Reproduced by the Survey of Egypt, 1919. (18,573)

ANTI-MOSQUITO WORK

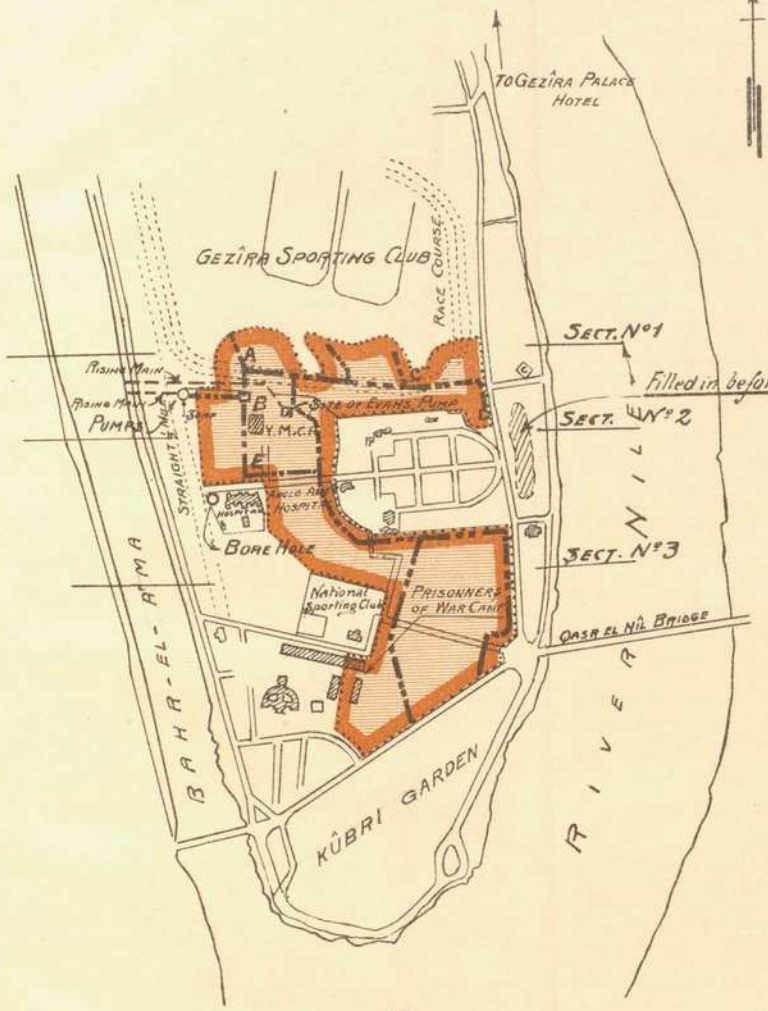
NILE FLOOD OF 1917 COMPARED WITH AVERAGE FLOOD



E.H. LLOYD
M.INST.C.E.
Chief Engineer
Main Drainage Dept.

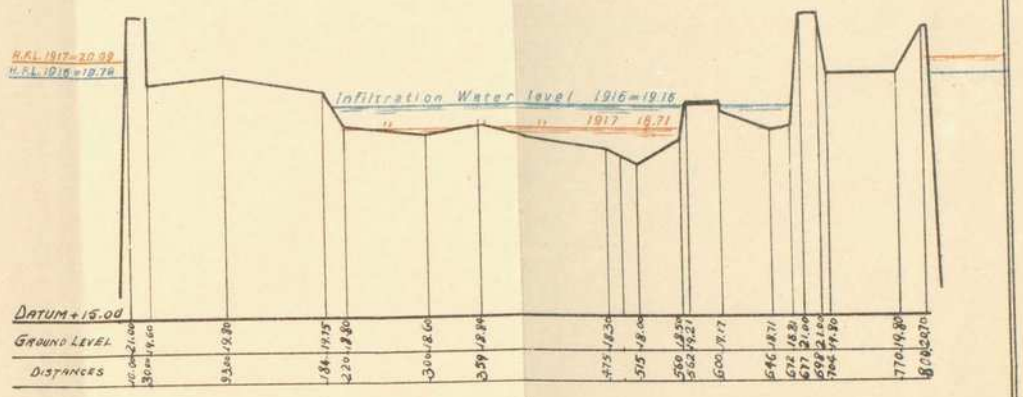
— ANTI-MOSQUITO WORK —
GEZIRA SOUTH

PLAN AND CROSS SECTIONS OF PART OF ISLAND DRAINED

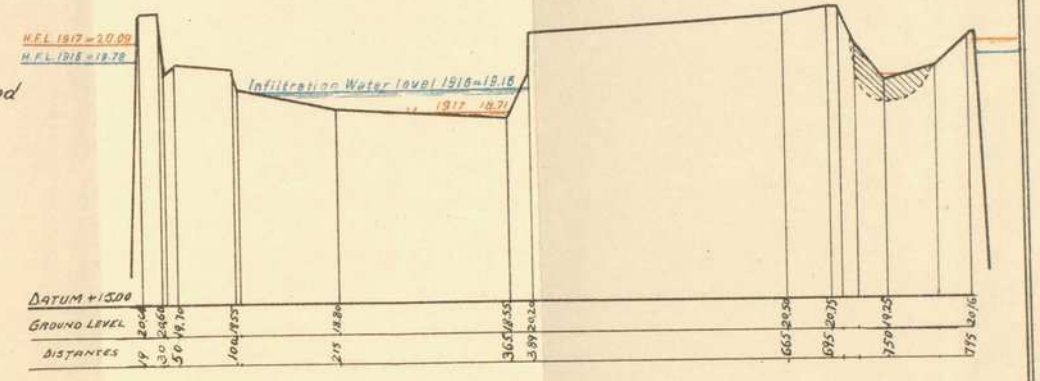


— PLAN —
SCALE 1:15000

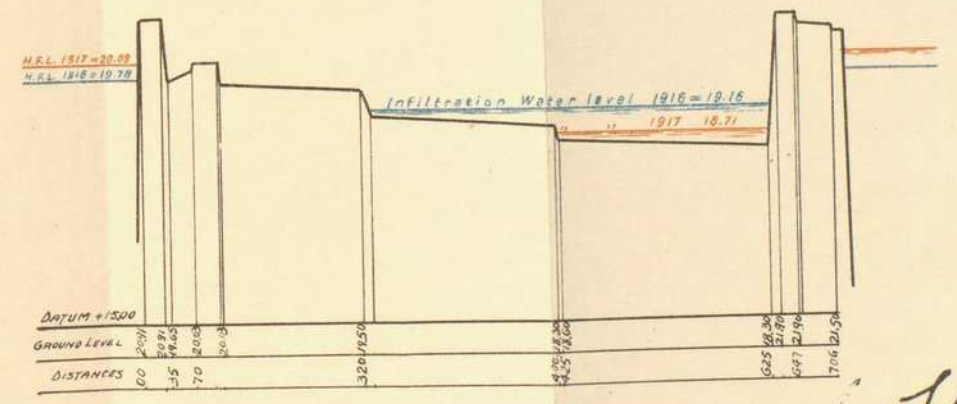
Note:
Boundary of Area Drained shown thus: ▬▬
Position of underground pottery drains " " ▬ · ▬ · ▬



Section Nº 1 through Gezira Sporting Club



Section Nº 2 through Y.M.C.A



Section Nº 3 through land South of Hospital Road

Scales: Horiz.... 1:7,500
Vertical... 1:1,500

L. H. Lloyd
M. INST. C.E.
CHIEF ENGINEER
MAIN DRAINAGE DEPT.

SCE D'AT Nº 3197/3

PRELIMINARY REPORT

OF THE

ANTI-MALARIAL COMMISSION.

PART I.—GENERAL.

Formation of the Commission.

Towards the end of 1916 the attention of the authorities was called to the possibility of Egypt's becoming seriously infected with malaria if a series of high floods, similar to that of 1916, coincided with the entry of large numbers of malaria-infected troops into Egypt.

On December 9, 1916, the following letter was addressed by H.E. the High Commissioner to the Financial Adviser :—

" The time seems to have come when we are called upon to take steps in the direction of an anti-malarial campaign against mosquitoes in Egypt.

" In the absence of malaria, the existence of the anopheles mosquito in Egypt was not of serious importance ; now, however, that we have had so many malaria-infected men brought into Egyptian hospitals from the Western Oases, Salonica, and Mesopotamia, there is a grave danger that malaria may permanently establish itself in Egypt through the medium of the mosquito.

" Much, I know, has already been done in the neighbourhood of the Suez Canal to deal with mosquito-breeding areas, and perpetuate the successful results of the anti-malaria measures taken some years ago in Ismailia. More, however, seems required to be done, even in the Canal area, but my remarks especially refer to important residential centres, such as Cairo and Alexandria, where little or nothing has been done to cope with the mosquito evil. The experience this autumn of the residents of Gezîra will suffice to show in what danger they, and others similarly situated, must always continue to be, unless adequate measures are taken against the mosquito.

" These measures, to have any chance of success, must be well thought out, thorough and systematic. They will, perhaps, involve some expenditure, but the object in view is worth it.

" It is very important that we should not lose any further time, but have these measures decided upon and put into effect before next autumn, when the danger of malarial infection will recommence.

" The assistance and co-operation of several Civil departments, Finance, Medical, Public Works, and other, will be necessary for success, and we may also have to invoke the aid of Military Authority to enforce the regulations that the campaign may require. The whole question, therefore, should be entrusted to a strong and competent committee, in which the departments concerned should be represented. General Sir Archibald Murray informs me that he is strongly in favour of a vigorous anti-mosquito campaign and will be glad to nominate military representatives on the committee.

" Will you kindly let me have your views as to the composition of the above committee."

In consequence of this letter a Commission was formed, representative of various Government Departments.

The Chairman was the Hon. R. L. LINDSAY, Under-Secretary of State, Ministry of Finance, but, on his taking up other duties, he was obliged to leave the Commission, which, for the greater part of the time it has met, has been composed as follows :—

Mr. TOTTENHAM, Ministry of Public Works, *Chairman.*
Colonel FOWLER, R.A.M.C.
Dr. GOODMAN, Department of Public Health.
Dr. GOUGH, Ministry of Agriculture (Entomological Section).
Dr. GRANVILLE, C.M.G., President Quarantine Board.
Dr. FERGUSON LEES, Department of Public Health.
Mr. LLOYD, Main Drainage Department, Ministry of Public Works.
Mr. MONTEITH SMITH, Ministry of Interior.

Colonel FOWLER was preceded by Captain BAHR and has been followed by Colonel ANGUS. Dr. GOODMAN retired from Government service in May 1918, not before completing his invaluable work on the Commission by helping largely in the preparation of this Report. His place has been filled by Major THOMSON, D.S.O., already introduced into the Commission at the end of 1917.

The terms of reference were as follows :—

To consider and report upon what effective steps can be taken (*a*) before the next Nile flood ; (*b*) subsequently, to destroy or reduce the numbers of fever-carrying mosquitoes in Egypt, more especially in highly populated centres.

It was clear from these instructions and from the composition of the Commission that a scientific investigation into malaria in Egypt was not contemplated at the moment, but rather a combined effort by the various Government Departments concerned to deal with the problem in the light of existing knowledge.

The task set of reporting on effective steps to be taken before the next Nile flood (1917) precluded any complete study of the question, and a number of sub-committees were therefore formed to report to the Commission, with the least possible delay, as to the most urgent measures necessary, and at the same time make suggestions as to further investigations and measures for the future.

The Sub-Committees reported on :—

(A) The measures necessary to deal with centres of malarial infection known to have existed in Egypt for a considerable time :—
  (i) The Suez Canal district.
  (ii) The various Oases.

(B) The measures necessary to abolish mosquito breeding places in highly populated centres :—
  (i) Cairo.
  (ii) Alexandria.
  (iii) The large towns of the Delta and El Faiyûm.

(C) The measures which might possibly be adopted in order to diminish the breeding of mosquitoes in agricultural areas.

(D) Anti-malarial legislation.

The work of the Commission has been principally confined to considering and dealing with the recommendations of these Sub-Committees and referring to the Ministry of Finance for the grants required to carry out such immediate proposals as were approved by the Commission. An account of the work done by these Sub-Committees and of the recommendations made forms Part II of this report.

Malaria in Egypt.

Malaria is not ordinarily an epidemic disease which breaks out from time to time, infecting large numbers of people with an acute illness of which they either die or recover in a short period, after which they are no further danger to the community. It is, on the contrary, when left to itself, a disease which is persistent or endemic in the district infected, and persistent or chronic in the individual attacked. It does not show itself directly in the death rate to any great extent, but gradually enlarges its scope and infects a greater percentage of the inhabitants in any area infected, and leads gradually to a general lowering of the vitality of the whole population and to a general increase in the death rate. The gradual nature of its onset and the inconspicuous effects of the disease, when only a small proportion of the population is infected, tend to mask its progress ; but, once it is established, it will persist and its evil effects will continue until effective measures of prevention have been taken.

Factors affecting the Spread of Malaria.

Modern research has shown that two factors are necessary to the spread of malaria in any country. When these two factors are co-existent, and when it has been shown that malaria has begun to spread, preventive measures are imperative if the spread is to be stopped. The extent to which they may be necessary requires careful consideration.

The two factors are :—

(i) The presence of mosquitoes of the anopheline group.

(ii) The presence of persons infected with malaria, whose blood contains the sexual form of the parasite.

Neither of these factors singly can spread the disease. The mosquito cannot originate infection, and anophelines may exist, as they did in England, without malaria. Cases of malaria do not give rise to infection in the absence of anophelines, as in the classical example of Mauritius.

It may therefore well happen that either factor may exist separately in different parts of the country and only give rise to infection when both are accidentally brought together.

The Human Factor.

The malaria carrier forms the less profitable study from the point of view of prevention. It is not practicable to prevent the free movement of malaria cases and, therefore, the importation of malaria carriers into a malaria-free country; further, once an endemic centre is established, it is quite impossible to discover each case of malaria and destroy the billions of parasites it fosters.

The Anopheline Factor.

The anopheline factor is the one therefore that has chiefly concerned the Commission. A complete mosquito survey of Egypt is undoubtedly necessary, and is being undertaken, but for the moment it is sufficient to state that anophelines breed in Egypt, as they do wherever the climatic conditions are favourable; in marshy districts malaria is found to be endemic.

Both factors essential to the spread of malaria occur in Egypt.

Malaria Statistics.

Endemic malaria is shown chiefly among children, adults acquiring a certain amount of immunity at the expense of lowered vitality. The amount of malaria in any given district is therefore not easy to determine.

The following methods of determination may be employed :—

Taking statistics of cases treated in hospitals or privately, or using death statistics.*

* This method is notoriously unsatisfactory; certain figures relating to civil and military cases are given in an Appendix as an indication of the presence of malaria in the country and do not claim to record the amount present in any given area or group of persons.

Taking spleen counts. This method is much more satisfactory and has been carried out in Egypt in certain districts, as shown in an Appendix.

Making blood examinations of a considerable number of children in the district under scrutiny. This method is probably the most exact of all, but requires a larger staff than has, up to the present, been available.

A completer estimate than we now possess of the amount of malaria in Egypt requires to be made, but for the present it will be sufficient to use the method of spleen counts * to gauge the success of local anti-malarial measures.

Possible Spread of Malaria.

A country in which anophelines breed freely and in which cases of malaria occur may undoubtedly long remain without any marked increase of malarial infection. There is nothing to show that Egypt has ever been generally infected with malaria; its dense population at various periods is evidence to the contrary, and yet it is probable that anophelines have bred and cases of malaria have occurred in Egypt for a considerable time. In all probability there is a point at which the increase of one factor or the other—human or anopheline—disturbs the equilibrium and leads to a generalized infection. The point at which this occurs probably depends upon climatic or other conditions special to each country, but, once reached, the disease tends to spread until the country becomes gradually depopulated. It spread in this way in ancient Greece and later in Italy, and, according to certain authorities, largely contributed to the decline of the Greek and Roman peoples. Too much stress need not be laid upon these historic parallels as likely to be repeated in Egypt, but the Commission calls attention to them as suggesting the necessity for gauging the increase of the two malarial factors with the greatest care.

If it could be proved that conditions were stationary, it might be possible for the Commission to confine its recommendations to such measures as were necessary to enable them to be accurately gauged—a malaria and an anopheline survey—and wait developments. There is, however, considerable evidence to show that the two factors are not stationary but are gradually increasing.

Tendency of Malaria to increase.

In the first place, agricultural drainage works have not kept pace with the irrigation improvements made in Egypt during the last two decades. There is a much larger supply of water, and though improved control has in the greater part of the country

* Spleen counts are made by palpating the spleens of children under the age of ten, for enlargement. The amount of malaria is indicated by the percentage of such children showing enlargement of the spleen and by the average degree of enlargement.

reduced the quantity used per feddân, larger areas are now cultivated, particularly with rice and other wet crops. These conditions, in conjunction with the difficulty of adequate drainage, undoubtedly allow the anopheline greater opportunities for breeding.

Drainage already occupies an important place in the programme of Egyptian Public Works, but for the present there is ample opportunity for the anopheline to increase. The danger from districts where rice is grown may be diminished, but not eliminated, by careful watering on the part of the cultivators; and the Commission can, at present, only confirm the conclusion of all previous investigators that the prevention of mosquito breeding in rice fields is impossible. In order to minimize the resulting danger, the Commission have proposed legislation by means of which the cultivation of rice within a given distance of large centres of population will be forbidden.

As regards the danger of infection, in newly irrigated areas of land in districts not previously malarial, owing to the possibility of badly planned irrigation or drainage systems, the Commission recommend that when such areas are originally the property of the Government, or when permission to draw on the water supply of the Nile is given, arrangements should be made whereby the whole planning and the working of the irrigation system should be made subject to the approval of the Irrigation Department, with the advice of the Department of Public Health.*

In the second place, improved means of communication have not only rendered Egypt more liable to infection from without, but have also made movement within the country from one possible malarial centre to another much easier and more frequent. Freer communication with the Oases, which are largely infected with malaria,† must tend to spread this form of infection throughout the country. Also, since the outbreak of war, there has been a large and continuous importation of malaria cases into the country from India, East Africa, Mesopotamia, Salonica, Sinai, and Palestine; a considerable proportion of these imported cases have been of the malignant variety. With the opening of railway communication with Palestine and the freer communication with all parts of the Turkish Empire and the East which is likely to result from post-war reconstruction, this importation is likely to continue.

The position is, then, that both the factors necessary to a spread of malaria exist together over a considerable part of Egypt, and whatever evidence exists points towards their increase rather than their diminution.

---

* Both these special recommendations regarding rice and new areas are more fully dealt with in the section on Agricultural Districts, page 36.

† Malignant Tertian Malaria is the most serious of the three forms of the disease. It shows little tendency to spontaneous cure, and, untreated, is frequently attended by grave complications, cerebro-spinal, gastric or cardiac.

Benign Tertian Malaria is due to a different parasite. As its name implies, it is a much less serious disease, and, left untreated, tends to a spontaneous cure, with of course frequent relapses in the acquisition of such cure.

The Factors of Temperature and the Nile Flood.

In connection with the probability of the spread of malaria in Egypt, the question of temperature is of considerable importance. The breeding of anophelines, as well as of other species of mosquitoes, is very largely regulated by temperature. Below a certain point, which probably differs for the various species and depends also upon other climatic conditions, breeding ceases—that is, the larvæ cease to develop. But a long quiescent period during winter does not in any way prevent the most active breeding during the summer months and the consequent severe infection of the country with malaria: Northern India and Salonica provide instances of this.

Now, the rise and fall of the Nile produces in Egypt a variant found in few other countries. During and for some time after the flood, the area of possible breeding-places is enormously increased. If, therefore, during the whole of this period the temperature conditions were favourable to mosquito breeding, a very great increase in the anopheline factor would result, which, granted the existence of cases of malaria, would naturally cause an annual spread of malarial infection.

A mean daily temperature of below 60° Fahrenheit may be taken roughly as the point below which mosquito breeding is probably reduced to *nil*, and remembering this and taking into account that the infiltration water remains for a considerable period after the Nile has fallen, it will be found that the increase in potential breeding places in Egypt due to the flood extends over the months of August, September, October, November, and December, whereas the temperature conditions favourable for breeding are practically confined to August, September, and October; that is, the potential breeding period of five months is reduced to an actual breeding period of three months.

If the Nile flood began in April instead of in August, it is extremely probable that Egypt would be a highly malarial country.

Breeding Places of Anophelines.

The places in Egypt where anophelines breed may be divided into five, of which the first is less important than the others. The four main sources of trouble are connected directly or indirectly with the Nile and its dependent irrigation system.* These various divisions are as follows:—

Desert water.

Permanent marshes or lakes into which most of the arterial drains of the Delta flow.

---

* As far as is known, the various species of anophelines that breed in running water, and which are found in India, South Africa and elsewhere, are not found in Egypt, but this point requires further investigation.

Badly aligned canals and drains, fostering vegetation; and dead-ends of canals.

Borrow-pits.

Outcrops of infiltration water.

The flooding of the land which occurs in basin irrigation is not included, because the water does not stand long enough to allow of the growth of vegetation, and further, it contains fish and water insects which prevent the breeding of the larvæ; wave action is also a deterrent factor.

Desert Water.

Rain water as a source of mosquito breeding in Egypt can, for practical purposes, be neglected, except for the rain water collected in the hills or in the higher ground in the desert in certain districts. This forms a little system of its own which requires notice.

When it rains, the water collects rapidly into the *wadis*, which become river-beds of considerable size. In passing through these *wadis* the water is partly lost in the faults in the rocks, and the remainder may be poured out upon the desert, often cutting deep temporary channels in the sand and finally either soaking into the sand or being lost by evaporation. The water which passes into the faults in the rocks and that which sinks through the sand forms a special variety of subsoil water, differing entirely in its origin, levels, and movements from the subsoil water of the alluvial plains of the Nile. Occasionally, as at Helwân, it bubbles up in the desert in the form of springs, which diminish in size or cease altogether during summer. In many places, traces of it may be found by digging in the desert sand. It is always many metres higher than the subsoil water in the valley of the Nile.

This desert water, standing in the lower-lying parts of the *wadis*, in footmarks in the bed of the *wadis*, in holes dug in their neighbourhood for drinking purposes, or in the marshes created by springs, forms excellent breeding grounds for anophelines.

As regards the four more important kinds of breeding places, these often occur together, but in most districts one or other of them is predominant. Particulars are as follows:—

Marshes and Lakes.

The bulk of the irrigation water drained off the land passes into channels which tail into the series of lakes along the northern coast of the Delta.

These lakes are plentifully stocked with fish, etc., but their borders, which are covered with vegetation, are most favourable to mosquito breeding, and in the great belt of land running across the Delta to the south of the lakes the country is very largely water-logged during the flood and winter months of the year. Over the whole of this belt and over the lakes themselves the problem of

mosquito prevention is soluble only as a part of the great programme of drainage and land reclamation which, it is understood, may be resumed in the near future. As a water-logged condition renders land unsuitable for cultivation, the population within this area is small, and from a malaria point of view, therefore, the necessity for undertaking preventive measures here is not pressing, so long as the country can afford to leave the land uncultivated.

Badly aligned Canals and Drains.

How to stop mosquito breeding in badly aligned canals and drains or in dead-ends of canals is a problem which is familiar in all countries in which anti-malarial measures have been undertaken. Its solution presents no special difficulties and it is understood that strong recommendations for rectification of such channels have been made by the Ministry of Public Works in view of the provision of irrigation by free-flow at all seasons of the year.

Borrow-Pits.

Borrow-pits, and especially railway borrow-pits, which are far the most numerous, by collecting waste water or allowing subsoil water to outcrop, provide innumerable breeding grounds for mosquitoes all over the Delta and, to a certain extent, Middle Egypt.

In order to complete their measures for the abolition of mosquito breeding places in populous centres, and to prevent them from being rendered ineffective, the Commission therefore propose :—

That in no future railway construction should the formation of borrow-pits be allowed.

That, as also explained later in the Report, in the neighbourhood of the nine Mudîrîya towns included in the Commission's programme steps be taken to fill in the railway borrow-pits.

That in any future extension of the programme to other populous centres, sums for dealing with railway borrow-pits be included in the funds provided.

The Commission do not, in the meantime, propose any measures for dealing with the nuisance in rural districts, not because such measures would not be desirable from an anti-malarial point of view, but in pursuance of their policy of asking only for such credits as will show a maximum result.

Outcrops of Infiltration Water.

Infiltration water, which partly accounts for the formation of the marshes, lakes, and borrow-pit pools described in preceding paragraphs, is in its formation of *birkas* and its general influence on the condition of the country of such importance as to warrant separate consideration.

Infiltration Water.

How to prevent the spread of malaria due to infiltration water is the most difficult problem to be settled in the campaign against the disease in Egypt. The section of the Nile Valley at any point north of Asyût shows the cultivated land to be as a whole appreciably below the levels of the river in high flood. The question of reducing the dangers from the obviously great degree of infiltration there must be under these circumstances is closely allied to and in fact is part of the problem of subsoil water, which is of the greatest importance to Egypt in connection with agriculture, irrigation, and public health. The movement of subsoil water deserves closer study than it has received as yet, and it is hoped that, as soon as the war is over, a comprehensive investigation into it will be made.*

Briefly, subsoil water begins to rise shortly after the commencement of the Nile flood and attains its maximum level somewhat later than the river itself. Its rise is gradual and is conditioned by its distance at any point from the Nile, by the nature of the subsoil, and by the period over which the high level of the Nile is maintained. In low-lying places it frequently emerges above the surface of the ground; existing *birkas* are increased in size, marshes become lakes, and land previously dry becomes marshy. The Nile flood, after maintaining its maximum for a short time, begins to fall rapidly. The subsidence of the infiltration water is very much more gradual,† so much so that large collections of it may remain for months several metres higher in level than the Nile in their immediate neighbourhood.

If the immediate checking of malarial infection, in so far as regards infiltration water, required general measures for the reduction or control of exceptionally high Niles, the position would be far more serious than it is. Fortunately, lesser measures should be sufficiently effective, for the flooding described is of immediate danger only in districts in which anophelines normally breed and which are already infected or likely to be infected with malaria. Ultimately, as infection spreads, all collections of infiltration water would be sources of danger, but for present purposes the danger of subsoil water is that its rise temporarily enlarges or increases existing breeding places, and this danger is increased by a succession of high floods; in a district already infected a considerable extension of

---

* *See* Appendix No. 1.

† The reason for the slow natural return of infiltration water after the river has fallen has never been demonstrated by experiment and requires further investigation It probably depends on the fact that the subsoil water rises comparatively easily through a sandy soil until it reaches the surface under the pressure of the height of the Nile, but its return is impeded by the layer of mud on the surface, consolidated by the presence of the water above, so that it remains as a collection of surface water for some time after the level of the subsoil water has fallen. The impermeability of this mud is shown in practice by the smaller irrigation channels used by the cultivators, which, though they are carried at a higher level than the surrounding land, lose little of their contents by seepage.

infection may be expected to follow repeated outcrop of the subsoil water, varying in seriousness and permanency according to the degree in which the district is populated.

The very large works which would control high Niles are, with other projects for draining and reclaiming large areas in the Delta, actually in process of preparation and execution in the interests of agriculture. Such works are the White Nile Dam in the Sudan and various undertakings on the Blue Nile; these will enable the maximum levels of the Nile and the length of their duration to be reduced. Comprehensive works to improve the drainage of Lower Egypt, already far advanced in two large areas and only interrupted by the war, will, it is understood, throughout seven-eighths of the Delta lower the general level of the subsoil water and tap and lead it away when it tends to collect in low-lying areas.*

The first of the Sudan works cannot, however, be completed for several years; the drainage works, though they will from the moment of commencement beneficially affect the areas in which they are executed, can only be undertaken progressively, and it may be a number of years before certain areas are benefited.

With regard to the problem of how to deal with subsoil water, having in view the facts stated above limiting its immediate importance from a malaria point of view, the Commission have come to the three following conclusions :—

(i) That any general attempt on their part to deal with temporary infiltration water due to Nile floods is quite out of the question, general prevention being only gradually attainable by large undertakings; reference has been made to these.

(ii) That the endeavours of the Commission to deal with it should be confined mainly to those local centres where endemic malaria is known to exist and where high floods aggravate the danger.

(iii) That, in addition, attention should be paid to certain areas, of which the Gezîra and Gîza districts of Cairo are good examples, where anophelines normally breed and which, although a few cases of local infection occur, cannot at present be considered as local endemic centres. Owing to the importance of these areas as centres of population and as places at which cases of malaria acquired elsewhere are liable to congregate, it is desirable that they should be dealt with separately.†

* In low patches of land which adjoin the Nile, and for which drainage for agricultural purposes is not pressing, filling-in is probably the best cure.

† This point of view will be found more fully developed in the section of the Report dealing with Cairo (Gezîra), page 26.

Having considered the limits within which it is immediately possible to deal with temporary infiltration water, the next point is to decide the best method of dealing with it when the necessity arises.

Filling-in is the simplest and best solution. It is, however, obviously so expensive that it is only suitable for small sites.

Where filling-in cannot be undertaken, recourse must be had to drainage. Two general methods have been tried.

In the first, an attempt is made so to lower the general table of the subsoil water that it will not outcrop at any part of the area dealt with.

In the second, the subsoil water is allowed to attain its own level and is then run off from the places in which it appears into a system of drainage pipes.

The areas treated fall into two classes: cultivated land and building sites.

On cultivated land subsoil water can often be disposed of by employing the first method of drainage and connecting the area liable to be flooded with the existing drainage system discharging into the lakes or the sea; to do this it may be necessary to construct a network of small open branch drains, through whose side slopes and beds the water penetrates and is thus drawn off before it has time to rise to the surface. The depth and number of these channels depend upon the nature of the soil and the volume of water to be dealt with, and can only be determined by experiment. Where the fall between the area to be drained and the outlet is insufficient to allow the infiltration water to gravitate away at levels which are lower than the land surface at all points of the area to be drained, an artificial slope must be created by means of a pump discharging it into a public drain or canal, or into the Nile. An experiment on these lines is being tried in Cairo at South Gezîra, with every prospect of success.

Where the less radical and less expensive principle is observed of allowing the subsoil water to rise and then draining it off from the places in which it has appeared, this may be done either after the Nile has fallen below the level of the surrounding water or else as fast as the water collects on the land. Shallow surface drains are made, leading the water, as it appears, to a collecting sump, from which it is passed into a system of closed pipes and is afterwards discharged by a pump.

In experiments undertaken on North Gezîra, this method successfully reduced the amount and period of flooding; it does not, however, prevent the formation of small pockets of water in which mosquitoes can breed. By increasing the number of points in the pipe system at which the flood water is drawn off, the efficiency of the method may perhaps be increased.

For the drainage of building sites, the principle of lowering the general level of the subsoil water can alone be used. A method

must be adopted which will not permanently occupy much surface space; that is to say, the water must be drawn off by underground drains. In two districts of Cairo, the Main Drainage Department have very successfully tapped the soil by surrounding the lower portion of a network of underground gullies with loose stones and removing a certain number of bricks from the barrels of the gullies. The water, after filtering through the loose stones, enters the gullies at these points, passes down the sewers and is pumped away with the ordinary sewage. This method can be suitably employed wherever there is a municipal drainage system.

At the south end of Gezîra a less expensive method has been tried, in which open-jointed agricultural pipes were used. The method does not appear suitable for very light and porous soils, but might do in a denser stratum. Further experiments are being made with stone drains laid in a gravel filter one metre below the surface of the ground. The Gezîra drains lead to special pumps, not to a sewage system, but this does not affect the experiment so far as regards the kind of pipes or gullies to be used.

On the whole, the most satisfactory remedy for infiltration water on building sites may often be simply to fill in low-lying spots. This has been described as an expensive solution, only suitable for small areas. Within this category, however, building sites commonly fall. Underground drains, leading to a town drainage system or special pump, work satisfactorily in their more expensive form; until experiments at Gezîra are completed, it cannot be said whether a less expensive variety can be found to give equal satisfaction.

Present Measures and Future Developments.

The Commission find that any attempt to abolish forthwith all possible breeding places of anophelines is impracticable. Nothing would be easier than to propose a large and far-reaching scheme of this sort, involving a heavy financial burden on the country, but the task has never been attempted in any country and would be foredoomed to failure. The Commission recognize that in this as in other questions of public health it is necessary to preserve a due sense of proportion, and at each stage balance the cost of the measures proposed against the results likely to be obtained and the dangers likely to be avoided.

Their programme is therefore much more modest and tentative. It is to take certain measures of precaution now, whilst the problem is of manageable proportions, and to watch the results carefully, leaving the nature and extent of future measures to be decided by circumstances.

The immediate measures of precaution, in regard to which, as Part II of this Report shows, a great deal has already been done, are intended to deal with the best defined local centres; and, secondly,

to protect, as far as possible, the chief centres of population. Ross states : " We can scarcely ever attempt to deal with anophelines in large areas ; on the other hand, we may reasonably hope to reduce them, if not to exterminate them, in the principal centres of population and civilization." The same principle is applicable to the case of water-borne diseases : the provision of a pure supply of drinking water to cities is one of the first tasks of any civilized state, the gradual improvement of rural water supplies being left to future generations. The Commission freely recognize that the realization of even a limited and modest programme can only be brought about in stages, and that, for example, the total disappearance of anophelines in any municipal area can only be attained gradually and step by step with other forms of sanitary progress.

The chief endemic centres are the Suez Canal Zone and the Oases. The measures already taken or projected in these areas are expected to produce a gradual diminution of local infection and, in consequence, of the human factor which is at present spreading infection to other parts of Egypt.

Chief centres of population which have received attention are Cairo and eight large towns in the Delta. The principle adopted has been that it is for the Government first to deal with the breeding of anophelines on its own property : in Government *birkas*, expecially railway borrow-pits and in dead-ends of canals. At the same time, private owners are being called on to fill in *birkas* upon their own lands, and representations are being made to the proper quarter to prevent the further formation of railway borrow-pits in any future construction, both in the large centres of population under consideration and in rural regions as well. In this way, the largest breeding areas will be gradually abolished. The smaller breeding areas can only be dealt with by a rigorous application of such an anti-mosquito law as is outlined in the Appendix on Legislation. When all these measures have been carried out or are in force, it should be possible, with a reasonable annual expenditure, to keep these larger towns completely mosquito-free, except during the Nile flood. If this end is attained, the continued presence of cases of imported malaria—the human factor—will not lead to a spread of infection. The same measures, if found successful, should be gradually extended to other provincial towns and produce the same beneficial results.

At the end of some years, during which the continuance of the Commission's policy is recommended, the possibility of a general spread of malaria throughout the country should have been avoided at a comparatively small cost to the Government, a gradual diminution of each of the factors necessary to its spread having been obtained at the points where each of them is most dangerous.

As regards rural districts, conditions have been described, when discussing the tendency of malaria to increase and in the paragraphs

on infiltration water. The Commission's immediate programme leaves them comparatively untouched; partly because, with the possible exception of the defectively-drained and sparsely-populated belt of land running across the Delta south of the seaboard lakes, these rural districts are not subject to bulk infection by imported cases of malaria; partly because the chief dangers to rural districts —lack of drainage combined with increased irrigation supplies and flood infiltration—require large preventive measures, which can only gradually be executed and which, in any case, are already in hand primarily for agricultural purposes independent of malaria prevention.

Finally, the Commission remark that, whatever measures may be undertaken in all parts of the country, if immunity against malaria, once acquired, is to be maintained, constant watch will need to be kept against the formation of new breeding places.

Any excavation or any excess of water, without the compensation of adequate drainage, may produce a breeding place. Even after all precautions are taken, almost every commercial and agricultural development within a populous area will have to be most carefully watched. Railway development may leave borrow-pits; new canals may produce seepage areas; re-alignment of channels leaves marshes, brick-making causes *birkas*, land reclamation may leave low-lying places requiring lift drainage; new Nile reservoirs necessitate new drainage works; market gardens give rise to breeding in small irrigation watercourses, and even a town water supply without town drainage may cause trouble. Each of these forms of development requires most careful watching so that the appropriate remedy may be applied at the moment the danger is created, or, better still, that the danger may be safeguarded against in the planning of the original scheme, on the principle that prevention is better than cure.

The Commission wish to lay down as a principle that no private individual, Company, or Government Department should be permitted to create anopheline breeding grounds, particularly within a certain distance of any populous area. It asks that the Government should give sanction and authority to this principle and, in order that careful watch may be kept by a body with sufficient knowledge and authority, it recommends that the Malaria Commission should be placed upon a permanent basis, meeting from time to time and reporting on any matter which, in its opinion, has or is likely to have an important bearing on the question of the disease.

PART II.—ANTI-MALARIAL MEASURES IN SPECIFIED CENTRES AND LOCALITIES.

I.—The Suez Canal District.

The Suez Canal district* comprises the towns of Port Said, Ismailia, and Suez, with the intervening stretches of lake,† marsh and dry land which adjoin the Maritime Canal. Separated from the Delta by desert or the brackish waters of Lake Menzala, the district is supplied with fresh water by the Ismailia Canal, which bifurcates near Ismailia, one branch going to Port Said and the other to Suez. These branches run approximately parallel to the Maritime Canal but at a higher level, and the greater part of the land they serve lies much below them. Added to this, that they skirt or traverse the desert and are largely dug in sandy soil, and the result is that they leak and seep heavily and raise the level of the subsoil water, which emerges in the low-lying areas and creates swamps. Further, their outlets are not under sufficient control; a greater supply is drawn off than is wanted and the swamps receive and are extended by the excess of water. These swamps,‡ which are without adequate means of drainage, and the borders of Lake Menzala are the great breeding places for mosquitoes.

The district has been a centre of malarial infection ever since the Maritime Canal and its attendant fresh-water canals were made, and even before that it is possible that the swamps the canal now traverses were breeding places for anophelines. The sickness and death rate amongst the workmen during its construction and the condition of Ismailia for years afterwards are matters of common knowledge. Subsequent measures carried out by the Canal Company rendered the town comparatively free of malaria. Along the canal, however, there was little or no change for the better,§ except in the garden district north of Suez, where measures, taken during the last ten years, have to a certain extent kept the disease under control.

That the canal district constituted a slow but constant source of infection for the rest of Egypt has been frequently pointed out by the Department of Public Health; also that measures taken in one part of the district would be comparatively ineffectual until the whole area was treated. During the war, and especially during 1915–1916,

---

* *See* general plan (Plan No. 1) of Suez Canal District in Appendices.

† Lakes Menzala, Ballah, Timsah and the Great and Little Bitter Lakes.

‡ The most important swamps are those bordering Lake Menzala, especially Qantara, and those at Ferdân, Abu Gamus and Abu Ballah near Ismailia, Serapeum, Faied, Genefa, Shallûfa, Kubri North, Kubri and Suez.

§ Since 1915 conditions had become worse in so far as malaria of a malignant type had been ntroduced, chiefly by Indian troops camped in the district.

the district has been occupied by large bodies of troops and important measures of protection against malaria have been carried out by the Army. Renewed and more pressing attention was drawn to the condition of a district which had become the temporary home of a large population and whose future population promised to be much increased, and early in 1917 the present Commission sat to decide how best the civil authority might supplement the work of the Army, and what comprehensive measures might be undertaken to clear the whole Canal district of malaria.

After careful study, a note was submitted to the Ministry of Finance, the essential portion of which is given below :—

" The Canal Zone must be considered as a single area with three considerable towns—Port Said, Ismailia, and Suez—situated along its length. Between these towns there is constant traffic by rail, boat, and foot. Further, Qantara is likely, in the immediate future, to undergo considerable development as the main junction of the Egyptian-Palestine Railway, and it will almost certainly be a station for troops for some time to come.

" The marshy nature of the land along the greater part of the western bank, and the consequent chronic infection with malaria, has led to a very sparse population in the intervening stretches between the above towns, but this marshy land, when dealt with by drainage and reclaimed, would admit of profitable cultivation and, in the absence of malaria, could support a considerable population.

" A number of factors combine to show that after the war the importance of the Canal Zone to Egypt will be increased to such a point as to render its freedom from malaria imperative :—

" (1) The development of the Eastern trade through Suez, consequent upon the changed conditions in the ports of the Red Sea and the Persian Gulf.

" (2) The development of a railway route across the land between Egypt and Palestine by means of El Arish Railway.

" (3) The probable increase in population of the Sinai Peninsula and the consequently greater communication with the Canal Zone by caravan routes.

" (4) The probable maintenance of a permanent garrison either at Qantara or at some other port upon the Canal.

" On these grounds the Commission holds it to be a matter of urgent necessity—

(A) " To put in hand at once measures for dealing with malarial marshes in the neighbourhood of Kubri, Shallûfa, Faied, and Genefa, and for filling borrow-pits in the immediate neighbourhood of Qantara at a cost of L.E. 9,000.

(B) " To commence at once the study of a scheme for rendering Qantara and its neighbourhood free of malaria—the importance of this place has been pointed out above. For this purpose it will be necessary to provide a sum of L.E. 1,000. This scheme would consist in land reclamation from the lake, which would provide land absolutely necessary for the development of Qantara, and which might in all probability result in a return equivalent to the capital expense.

C.—" To provide power, by legislation, for the regulation of garden irrigation so as to prevent land, now or in the future under cultivation, from breeding mosquitoes.

" This question is being dealt with separately by the Commission under general legislative proposals.

" The remaining mosquito breeding areas along the canal could be dealt with gradually as the Canal Zone develops in importance.

" In putting forward this anti-malarial scheme and in asking this grant of L.E. 10,000, the Commission is convinced that it is providing a moderate and reasonable solution to a question which must inevitably be dealt with sooner or later, and which, if postponed, will not only lead to considerably increased expense but which will seriously impede the development of Egyptian interests in the Canal Zone, and may react to the detriment of the whole of Egypt by spreading inland."

The sum asked for was placed at the disposal of the Commission in due course. In the meantime, surveys of the swampy areas between Suez and Genefa had been put in hand by the offices of Lieut.-Colonel Lloyd, who was combining the functions of Deputy-Director of Works in the Canal Zone, and Chief Engineer Cairo Main Drainage Department. Among a number of points at which troops were stationed, Kubri, near Suez, and Kantara were considered by the Commission to be the most important. At the former, up to that time held to be the gravest danger-spot on the Canal, a very large number of men * had been attacked by malaria and several severe outbreaks of the malignant type had occurred, and as the Army Medical Service were taking temporary measures at Qantara, it was at Kubri that a commencement was made by the Commission. Works of prevention were also carried out at Qantara, Ismailia, and Suez. Port Said is practically on an island, is naturally less affected, and has benefited by the preventive measures of the Canal Company and the installation of a drainage system.

---

* During the construction of a road in this neighbourhood, over 50 per cent of the labourers were struck down with malaria and a considerable number died from the acute cerebral form of the disease.

Kubri.

The area requiring drainage at Kubri consisted of some 650 feddâns of swampy land lying between the Maritime Canal and the Suez Fresh Water Canal, fed by escapage of excess water from the latter, which here stands high above the land it serves, and also by inflow from the Maritime Canal at high tide. The first step taken was the construction of pipe outlets * placed under the bank of the Maritime Canal at such a level as would allow the swamp water to run off at low tide. The pipes were provided with flaps which closed automatically when the tide rose. At the same time open drains were cut through the swamps to lead the water to the pipes, and the water supply in the Suez Branch Canal and from its outlets was brought under stricter control.

The result of these measures, which were carried out at a cost of about L.E. 2 per feddân, has been that the water-level throughout the 650 feddâns of swamps has been very considerably lowered, improving the drainage of adjoining land and enabling cultivation to be extended over land previously water-logged. Countless numbers of small fish have found their way into the drains and, on inspection in April, 1917, Colonel Heron, Public Health Inspector for the Port Said District, was unable to find any anopheline mosquitoes or larvæ, though a few patches of water were found in which culex larvæ were breeding. These patches have since been drained and the general clearance of drains is carried out by a small maintenance gang at negligible cost.

Qantara.

As regards Qantara, this spot was also notoriously malarial before the war. The village lies on the edge of Lake Menzala, not far from where the Port Said Branch Canal has its escape. The fresh water thus passed into the lake had created an extensive area of reedy swamp alongside the railway station, and here mosquitoes bred freely.

When a large camp was formed at Qantara on the outbreak of war, the Army Medical Service † undertook such immediate anti-malarial measures as were possible, and were spending some L.E. 4,000 per annum when the Commission took the matter up. As the result of the latter's studies it was decided to cut off by a bank and dry that portion of the lake which lies between the escape channel and the Salhia–Qantara–Port Said railway line, so as to leave the lake three kilometres distant from the railway for a length of four kilometres north of Qantara Station. A credit of L.E. 5,000 was granted for this purpose by the Ministry of Finance; the construction of the bank, which will enclose an area of some 6,000

---

* *See* Plan No. 2 in Appendices.

† Under the able direction of Captain Ingles, R.A.M.C.

feddâns,* was put in hand in May, 1918, and was expected to be completed during the autumn.† With the drying-off and subsequent drainage and reclamation of the enclosure, original malaria in the neighbourhood of Qantara should be entirely prevented. Pending reclamation on a large scale, the Commission recommend the application, where required, of similar methods to other breeding places along the borders of the lake between Qantara and Port Said. Another measure taken at Qantara was to fill in a large number of borrow-pits adjoining the Sweet Water Canal and Salhia Railway. This was done by the State Railways Administration in May and June 1917.

Ismailia and Suez.

At Ismailia about seven feddâns of the Abu Gamus swamp were filled in at the instance of the Commission. This completed certain filling and drainage operations that had already been undertaken by the Government in 1915; about fifty feddâns have been brought under cultivation.

At Suez, immediately to the north of the town, eight feddâns of marsh, that had been a constant and dangerous source of infection, were filled in early in 1918.

Proposals for draining the marshes at Faied, and between Shallûfa and Genefa, were studied by the Commission early in 1918, but as the troops stationed at these points had either been reduced in number or moved elsewhere, and as, on the other hand, there was a great shortage of labour, the work was postponed.

Summarized, the methods of prevention adopted, or to be adopted, in the Canal district are as follows:—

Filling in or draining low-lying sites near towns; this has been done at Ismailia and Suez.

Reclaiming land by enclosure as is being done at Qantara. This work could be continued towards Port Said.

Remodelling outlets from the fresh water canals and controlling supply more strictly, thus reducing waste and escapage.

Draining swamps by channels discharging into the Maritime Canal through automatically-controlled outlets, as is done at Kubri.

Lowering the water-level in the Ismailia Canal and branches, particularly the Suez branch. Flow would then be more rapid, the growth of weeds and reeds would be reduced. There would be less seepage and also the level of subsoil water would fall. If necessary, drains might be made parallel with the Suez branch to catch subsoil and seepage water and divert it at intervals into the Maritime Canal.

Carefully maintaining all canals and drains and keeping them clear of aquatic plants.

---

* *See* plan (Plan No. 3) of reclamation project in Appendices.

† Three hundred feddâns had been completely isolated early in August.

Filling-in is a local measure to be used when and where necessary. Enclosing the borders of Lake Menzala is a semi-permanent work, since it will be long before the lake is reclaimed, and part of it probably will always remain as a fishery. Draining swamps is the principal measure and the final preventive in the whole district. It must be supplemented by control of the high-lying fresh water canals which help to feed the swamps. The Kubri experiment in drainage has shown that good results can be obtained at a reasonable cost. When it is further considered that the land filled in or drained can be rapidly put under cultivation, it is evident that the country is not likely to be at much final expense over the works proposed. On the other hand, the three canal towns are being increased to four by the rise of Qantara, the Port of Suez is being greatly enlarged, while all along the canal the impetus of railway communication with Palestine will be felt; conjointly with this rise of the district to greater importance the Commission see no reason why it may not be completely freed of its previous disrepute as a home of malaria.

NOTE.—Plans showing mosquito-breeding areas and the Qantara works and a drawing of a typical controlled drainage outfall are among the Appendices to this Report.

II.—The Oases of the Western Desert.

Khârga Oasis is connected with the Nile Valley by a light railway line; Dâkhla is a western extension of Khârga; caravan tracks cross the hundred and fifty miles from the Oases of Baharîya and El Farâfra, and the much greater distance from Siwa. The oases are large depressions in the desert—Kharga is as large as an average county—within which a much smaller total area is watered in patches by springs and by wells, of which there are nearly three hundred in use in Khârga alone. Nearly all the wells are of ancient construction and, with plentiful ruins of temples and forts, are evidence of former importance and prosperity. Siwa has also played a part in the events of to-day, but of the oases in general a different impression is received. In 1911 the Financial Adviser,* sending the inhabitants of an oasis some boring machinery as an item of return for their taxes, speaks of the miserable condition of these poor people. A report† describes them as living in a backwater of civilization. Another,‡ written some twenty years ago, both describes and explains their condition. "In our condemnation of the indolence of the inhabitants of the oasis," says the writer, "we must not forget the conditions under which they live. The summer and autumn of each year bring fevers, which carry off many victims and leave the remainder weak, and the effects of the climate are only too evident in the low general physique of the dwellers in the oasis."

---

* Sir PAUL HARVEY, K.C.M.G.

† By R. S. PATTERSON, May 6, 1907.

‡ Geological Survey Report, 1899, Kharga Oasis, by JOHN BALL, Appendix A.

In 1907 measures were considered for combating these fevers or malaria, spread by mosquitoes from the well-water, which is thus both the life and ruin of the oases. A note writen at this time on a village in Khârga ran as follows: "As rice is the staple summer crop here, the village is surrounded by fields of stagnant water, near which it is impossible to venture in the evenings. The mosquitoes must be seen to be believed; they rise at sunset in a thick cloud."* In 1917 a note † from the Baharîya Oasis describes a particular patch of cultivation as so infected with mosquitoes that the natives of the oasis cannot live there. At the same time an army doctor ‡ finds, in the place he is reporting on at Dâkhla, that practically every person is infected with malaria. The present enquiries into the origin and prevention of malaria in Egypt could not neglect so certain—if somewhat infrequent—a source of infection as reports of this kind showed the oases to be, while a more active control over these frontier districts induced by the war may well involve improvement in the interests of their own inhabitants.

The wells, the source of the trouble, are commonly fed from deep borings, many going as deep as 450 feet; they are filled with sand, through which the water rises under natural pressure to or near the surface of the soil. The well-heads are fissures in the rock in Baharîya; in Siwa they are large open heads built in with stone; in Khârga and Dâkhla the water rises through wooden shafts. Where the water does not quite reach the surface it may be lifted by mechanical means or the well is left unused; otherwise § the water flows out uncontrolled as from a natural spring, and it is wells discharging in this way that are the chief breeders of mosquitoes in the pools or *birkas* that their overflow creates in their neighbourhood. From the wells the water proceeds to the fields, where, on a poor soil, the staple crop cultivated || is rice, with its regular accompaniment of fever. Finally, the waste drains off into the nearest hollow and creates marshes, pools, or lakes, most favourable to mosquitoes, often too shallow and too hot for fish, often of temporary duration, drying up during the year, sometimes of temporary situation, drying up when cultivation has shifted to another spot or the land is left fallow. At times of the year when cultivation may be idle the continual discharge from the wells runs all to waste in the pools and swamps. To these three principal breeding places of the insect—overflow pools, rice fields, and drainage pools—may be added the water standing in disused wells, in and near feebly-flowing wells or in open, irregular, or badly-kept channels,¶ and there are plentiful

* R. S. Patterson, May 6, 1907.

† By the Frontier Districts Administration.

‡ Captain Bahr, R.A.M.C.

§ Except for a few wells in Kharga sunk in recent years by the Corporation of Western Egypt.

|| Rice is the staple crop throughout the oases, except Siwa, where it is not cultivated.

¶ Mr. Patterson describes pools left in roads used to carry water in place of proper channels.

opportunities for breeding in gardens and in small water-filled hollows of all kinds.

The oasis most infected, and to a very severe degree, is Dâkhla, followed by Baharîya, Khârga, Siwa, and El Farâfra in the order given. The results of a spleen count are attached to this Report.* The prevailing type of malaria is malignant tertian—why, it is not known—and study of the question is recommended; benign tertian is common; quartan is observed occasionally. Various types of malaria-carrying anophelines have been identified.†

Throughout the oases all cases of malaria are given free medical treatment; prophylactic quinine is administered to all Government servants and troops. In Siwa there are two definite systems of drainage designed to receive the large access of water coming from a periodical cleaning out of the wells; these systems discharge into salt lakes; the oasis has the further advantage that its wells, pools, and drains contain large numbers of larvæ-eating fish. Here the drains are being kept clear of silt and weeds in accordance with an old established custom by a general call on the inhabitants at stated intervals. Marshes are being connected to the systems. Owners have been called on to fill in *birkas* on their property within a certain delay, to keep their drains free from obstruction, to connect blind drains to the system or fill them in, and to clean feebly-flowing wells, or fill them in if disused. Prisoners are filling in *birkas* on Government property. In Kharga a lake near the town has been largely drained and some filling has been done. In Baharîya all the male population of two villages were recently reported cutting a long drain.‡ Larvæ-eating fish are being introduced into Dâkhla and Khârga, and a member of the present Commission§ has made an experimental visit to the oases with fish from the Nile.

In continuation of these measures the Commission recommend that steps be taken to exercise public control over the water supply in the oases from the well-head till it is finally disposed of. Drainage works should be carried out; unused wells should be filled in, and *birkas* and water-holes whenever necessary. Draining and filling may be expensive, but it is believed it would be the duty of the population to assist with their labour, work so directly benefiting their health.

Rice of a variety which, it is understood, has been cultivated in the Sudan without fostering mosquitoes is to be tried in the oases. If unsuccessful, and the cultivation of other rice cannot be carried on without malaria, it should be considered whether, near the villages, other crops might not be grown instead; it is noted that with so limited a cultivable area it would not be fair simply to prohibit rice.

---

* Appendix No. IV.

† In Siwa: *Anopheles Turkhudi*, *Culifaciens* and *Palistenensis*. In Dakhla: the same first two varieties and *Celia Pharoensis*.

‡ Under the direction of the Frontier Districts Administration.

§ Dr. Gough.

With the proposals that experiments in the introduction of fish should be continued, and the degree of malaria present in the oases should be tested from time to time for evidence of improvement, the items of the Commission's recommendations end. Their first item, however—control of water from the well-head—brings them into contact with a very intricate question which, after discussion, they have left with the Frontier Districts Administration, now controlling the oases, with only a general expression of their views.

In the oases, ownership is vested in water, not in land. The wells are private property and Government only requires its consent to be obtained before a new well is sunk or an old well reopened. A well may have as many as two hundred owners, among whom the right to use its outflow is distributed by minutes, hours, and days;* the large partners do not draw all their supply at once; small owners pool their shares in the water and cultivate collectively. This interesting system must make it difficult to take over control of the supply at its source, and yet it is most important that this should be done. The taxes are levied on water, not land, according to a rough and ready system, whose inequality would be felt if the taxes were not so low, and the shares of the cultivators in the wells are officially recorded. With these records to go upon, it might be possible to convert water tenure into land tenure, as the area cultivated is proportionate to the amount of outflow the particular owner is entitled to, but there are various considerations which would complicate the plan. There are some cultivators who do own land but do not own water and who take their supply by arrangement from the others; surplus water may be sold to other wells and the profit divided; the land is often parcelled out into exceedingly small plots; a class of craftsmen, the well-borers, carpenters, and others may hold shares in the well but no corresponding land; complimentary water-shares may be held by men with influence; the men who bear the chief capital expense of sinking a new well have preferential rights to water in case of shortage.

The consideration of how to meet claims which it is evident simple conversion of the medium of tenure would not satisfy has been left to the more intimate local knowledge of the Frontier Districts Administration. The Commission recommend that this authority should take over control of water in the oases, with technical assistance from the Irrigation Department. They consider that difficulties, whether administrative, legal, or technical, in the way of assuming control are not insurmountable. They hope that the assumption may lead in future to the substitution of land for water as the basis of property.

---

* The description here given of the system of water tenure applies mainly to Kharga, and the facts are borrowed from Mr. PATTERSON's Report in 1907.

III.—Cairo.

The Cairo Drainage System, which began to work in 1915 and is now discharging the sewage of a large part of the capital, is not, in its principal operation, directly concerned with malaria. Cesspits, which it is its principal object to abolish and which are rapidly going out of use and being filled in as sewer reticulation and house connection spreads, do not breed the species of mosquito that carries malaria. The powerful effect of the drainage works on the general health of the city lies outside the strict concerns of the Anti-Malarial Commission.

The system has, however, been of great direct importance in reducing the extent to which anopheles mosquitoes can breed in the city during the Nile flood. The part of Cairo east of the old Khalig—the suppression of which waterway was itself one of the most important sanitary measures of the last twenty years—and the suburbs bordering the eastern desert lie too high to be affected by the flood. Elsewhere and especially near the river, in Bûlâq, Shubra, and Sakakini, even ordinary floods cause sewage to rise in cesspits and overflow, while infiltration water also saturates the soil and, in a high flood like that of 1916, may inundate many of the streets.

The trouble with the cesspits ends with their abolition. Surface flooding by infiltration water is being prevented by tapping it with the street gullies as it rises to the subsoil, and carrying it away to the ejectors and thence into the mains.

The method * proved very satisfactory in Sakakîni and Shubra in 1917, and there was no flooding, although the river-level was higher than in 1916. Tried also in Bûlâq and Shubra, its effect was partly spoiled by six ejectors having to be stopped to economize fuel; the water rose and flooded certain areas and mosquitoes were plentiful. Still there was approximately only one-third of the flooding that there was in 1916, and it lasted thirty-six days instead of sixty-nine.

There remain a number of excavations or low-lying areas of limited extent which form standing or temporary pools and *birkas*; these, in the opinion of the Commission, can be best disposed of by filling-in. A list of them has been passed to the Tanzîm Department and the Principal Medical Officer of Health for Cairo, and they will be gradually filled with building rubbish. Meanwhile they are tapped by the drainage system.

Schemes for prevention of conditions favourable to malaria are being studied for Gîza, Imbâba, Rôd el Farag, Bahtîm, and Ma'adi, as rapidly as shortage of staff permits.

---

* The method adopted is as described on page 13 of Part I of the Report. *See* also plan (No. 4) in Appendices.

IV.—Cairo (Gezîra).

Anti-malarial measures carried out on the island of Gezîra are distinct from those carried out elsewhere in Cairo and already described. The island is mostly open land, with its sporting clubs, public gardens, plots of cultivation, and large proportion of still unoccupied building sites, while, besides these characteristics, distinguishing it from an urban area, there was the further particularity that in 1917 it was not yet connected to the city drainage system.

It was important that the island should be treated, because cases of malaria had occurred among residents on it and, besides being one of the best quarters of the town, it is a popular resort from which infection would be very widely diffused.

The works carried out have, besides their local effect, had a considerable experimental value.

Every year, during high Nile, large areas of the island were flooded and bred anopheles mosquitoes. It was out of the question to connect them with the Nile so as to allow the entry of fish—though this suggestion was made—and repeated attempts to prevent mosquito breeding by using petroleum had proved unsuccessful. Besides the large flooded areas there were many isolated patches, especially on the north of the island.

Two alternative methods of dealing with the problem lay open to the Commission, filling or draining. The shortness of time before the arrival of the 1917 flood, shortage of labour and the heavy cost involved in raising all low land to suitable levels compelled the adoption of a drainage system as the cheaper and quicker method, in spite of the fact that it was not a permanent cure and would involve maintenance charges. It was, however, combined with a limited amount of filling.

The experimental nature of the work undertaken lay in the fact that drainage was to be applied to large quantities of water in a sandy soil in close proximity to two branches of the river. The work was to be done cheaply and there was to be as little filling-in as possible, but it was not known whether the lower places on the island could be successfully treated by pumping nor to what extent pumping would anywhere prove a satisfactory alternative. It was known that neither pumping nor filling could give the island an entirely dry surface in an exceptionally high Nile.

The programme was to balance the two methods and note, for application elsewhere, below what levels pumping needed to be replaced by filling, and above what levels neither filling nor pumping were worth the expense.

The experimental results of the work are not yet complete. When they are, it is hoped they will indicate the lines on which infiltration water may be cheaply and quickly disposed of in places where the cost of filling would be prohibitive.

Particulars of the operations on the island are as follows :—

Works at Gezîra North :—

After complete survey had been made of the areas flooded in 1916 and all the evidence that could be brought to bear upon the case had been collected, the expenditure of L.E. 11,000 was recommended by the Commission. This sum was promptly granted by the Ministry of Finance and the following measures * were taken, a portion of the filling being carried out by the Tanzîm Department and the remainder of the work by the Cairo Main Drainage Department.

(1) The Nile bank, from the Zamâlek Bridge northwards, protecting the north-west corner of the island was removed and placed nearer the Bahr el 'Ama, thus reducing the area liable to be flooded during high Nile. This was combined with the filling-in to a suitable level (R.L. 19.50) of the low area of Government land adjoining (Plot No. 50 on the map) and which had in the past been a swamp during high flood. In addition, a large number of low and isolated areas were filled in (Plots Nos. 7, 8, 9, 10, 14, and 15 on the map). The total filling was 85,000 cubic metres and twenty-six and a half feddâns were raised.

(2) The remainder of the work consisted in the draining of low-lying agricultural land and depressions liable to be flooded. To deal with these a pump was erected on the Bahr el 'Ama 650 metres north of the Zamâlek Bridge and to it was led a system of closed pipes, fed from small open ditches and laid under the principal roads of the northern portion of the island. These were intended to tap and carry away the major portion of the surface water liable to lie in pools and stagnate. The water drained was to run by gravitation down the closed collecting pipes to the pump and be lifted into the Bahr el 'Ama when the river was too high for it to discharge by natural flow.

The 1917 flood was abnormal, its maximum close on a metre † above the mean, its arrival five days in advance, the duration of high levels fifteen days longer than the average. The river stood above the level of the land to be drained for a hundred and two days. Under this severe test the filling done proved satisfactory, and the twenty-six and a half feddâns, which in previous years of high flood have always been under water, remained dry throughout.

The drainage works proved equal to the duty imposed on them until, when the flood was at its maximum, one of the pipes of the main leading to the pump settled and broke, and on October 10, 1917, pumping had to be discontinued for about half the total area. The water then rose throughout the area affected, a result which, however

* *See* Plan No. 5 in Appendices.

† 0·97 metre. *See* Plan No. 6 in Appendices.

unfortunate, served to demonstrate the previous value of the drainage. Until the effect of the pump ceased, the large areas of water which formerly provided breeding places for mosquitoes were non-existent.

Judged by the season's work, the system adopted promises to be quite satisfactory for prevention of actual floodings of low-lying areas ; it undoubtedly effected a great reduction in the area of breeding places, the flooded area being reduced from eighty to twelve and a half feddâns. No actual record of mosquito diminution is available, but the general testimony is that the reduction in the number of the insects was very considerable. It was, however, clear that the system required extension, for it failed to tap certain areas of land to the extent necessary to prevent their surfaces from becoming sodden. In these areas the infiltration water either rose to the surface or very close to it and formed puddles in holes and footmarks ; in these and in the damp vegetation and grass, whose growth it encouraged, mosquitoes bred profusely and, if the system is to be thoroughly satisfactory, the surface of the land must be kept entirely free of water. In consequence, it was recommended either that the system of underground piped drains be further experimented upon or that stone percolation drains should be tried. Either kind, if successful, would advantageously replace the open catch drains or ditches which, unless very carefully maintained, are liable themselves to foster mosquitoes. It was also recommended that the existing system should be somewhat extended.

In general, the Commission is of opinion that in one way or another of those tried, or by a combination of them, the north end of Gezîra can be kept almost entirely free of breeding areas ; it remains a fact of importance that mosquitoes may cross from flooded lands on the west of the Bahr el ʿAma, unless or until these are also treated.

For 1918 it was recommended that a sum of L.E. 2,000 be granted for completion of the original work, for extension of the drainage system, for trial of a new method of drainage and for maintenance of the whole system.

Works at Gezîra South :—

The following works * were undertaken at Gezîra South :—

(1) The lowest portion of the ornamental garden lying to the east of the avenue leading from Qasr el Nîl Bridge to Gezîra Palace Hotel was filled in to a suitable level. It was hoped to do this with spoil dredged from the river-bed adjoining, but it was found to be too sandy and the spoil was therefore carted from the berms of the Bahr el ʿAma.

In addition, a small portion of the lowest-lying areas of the Gezîra Sporting Club were filled in.

---

* *See* Plan No. 7 in Appendices.

(2) To deal with the low-lying areas of agricultural and open land surrounding the Anglo-American Hospital and the Willcocks recreation ground, a pump was erected near the bank of the Bahr el 'Ama half-way along the "straight half-mile." To it was led a system of locally manufactured earthenware agricultural drain pipes, laid about two metres below natural ground level. These pipes had open joints to admit the infiltration water.

The filling-in of the riverside garden was sufficient to prevent the creation of pools of stagnant water but not to prevent the surface becoming damp, and its level will have to be raised by twenty centimetres in the lowest parts. The drainage system did not come up to expectations, though it very considerably reduced the size and number of pools in which mosquitoes had bred in other floods and kept the water level everywhere one metre below what it was in 1916.

Defects were these :—

The make-shift pumping plant borrowed from the Tanzîm was of inadequate power to cope with the unexpectedly large volumes of water it had to remove, reaching 172 cubic metres per feddân daily, or three and a half times what was anticipated. On North Gezîra the maximum rate was fifty cubic metres.

The pipes were the rough *baladi* type, no others being available in the country : they broke easily and blocked the drainage lines ; they were not large enough for the volumes to be dealt with, failed to carry away the water sufficiently fast, and filled with silt from their sandy surroundings.

Had the pipes been larger, had the drains been closer to one another, and had the pumping power been adequate, it is believed that the system might have sufficed to keep the infiltration water well below the surface, but, owing to the sandy nature of the soil, it is doubtful if the open-jointed pipe method of drainage would ever prove entirely satisfactory.

It happens that the floods of 1917 and 1916 were very similar, and by comparison of the two years it can conveniently be shown that, despite the difficulties described, results were good. In the agricultural land south of the road to the Anglo-American Hospital, an area of twenty-six feddâns was inundated in 1916 by September 1, up to R.L. 19·16, and did not dry until the end of December ; the mosquito-breeding period lasted seventeen weeks and the tenants were unable to sow crops until the end of December. In 1917 the flooding started on September 15, and ten and a half feddâns were flooded by October 2. This area increased to twenty-three feddâns on October 30, with the water level standing at R.L. 18·89. The whole surface was drained by November 17. The mosquito-breeding period extended over nine weeks, and most of the tenants had sown by November 15. Had pumping not been continued, the "Prisoners of War" Camp would certainly have been flooded out and been forced to move elsewhere.

In the Y.M.C.A. Club the whole area of six feddâns was flooded in 1916, the club house was surrounded by a sheet of water and access to it was impossible from September 9 to November 18, whereas in 1917 only half a feddân was flooded, the club house and tennis courts were continuously in use, and the low-lying hollows in the cricket ground were flooded in patches to a depth not exceeding two centimetres.

At the Anglo-American Hospital in 1916, patches of water appeared in the paths and near the kitchen garden; in 1917, the whole place was dry and the maximum level did not exceed R.L. 19·31, sixty centimetres below natural ground level.

The four feddans of agricultural land to the north of the Hospital and the west of the Y.M.C.A. Club were flooded by September 1 in 1916 and were not dry until December 1, so that mosquito breeding extended over a period of thirteen weeks, whereas in 1917 only a small part of this land was flooded on October 2 to a depth from four to five centimetres. This flooding eventually extended over half the area, but there was very little mosquito breeding, as the water was constantly running off at several points. The land was dry by November 2 and crops were then planted.

In the Gezîra Sporting Club twenty feddâns of land were under water in 1916. The water commenced to show in August and the place was not dry until the middle of December. The maximum level which the water reached was R.L. 19·16. Mosquito breeding lasted nineteen weeks. The first race meeting was held on December 23. In 1917, water first appeared in low bunkers on September 13, four feddâns of land were under water at R.L. 18·44 by October 12. On that date the discharge of water into the pipes was shut down in order to economize coal and the flooded area increased to ten feddâns; the maximum level to which the water rose was R.L. 18·71. The land was drained by November 8. Mosquito breeding lasted eight weeks. The first race meeting was held on November 24, or a month earlier than in 1916.

Complete and permanent results in the southern portion of the island can only be obtained by raising all low-lying land to such a level as will preclude water rising above the soil in high flood. In normal times the cost of this work is estimated at L.E. 22,500, of which L.E. 9,600 would be recovered by sale of land overlaid by the banks of the Ismailia Canal and which it is proposed to use for filling. The net cost would therefore be L.E. 12,900.

Meanwhile it was recommended that, for 1918, funds should be granted for replacing the underground pipes by a system of open drains as being the next best measure to filling and the cheapest; the purchase of an electrically operated pump was also recommended, and finally a grant of L.E. 2,315 for filling in the very lowest places as an instalment of complete filling later. All these proposals were sanctioned, the total grant for Gezîra South being L.E. 6,105.

V.—Alexandria.

As only nineteen cases of malaria were reported among the civil population of Alexandria in 1917, it is reasonable to believe that the disease is being attacked in time; to this it may be added that the city and its suburbs* are so situated as to make measures of prevention comparatively easy. Built on sandy soil which readily absorbs the winter rainfall, Alexandria is isolated by the sea on the north and Lakes Mariût and Hadra on the south;† to the west is desert, on the east are sand-hills or, where there is cultivation, it is the well-drained Abu Qir Estate. Forty miles away lies the Rosetta branch of the Nile, not too far for the influence of the flood to be felt, but the neighbourhood of Alexandria, while situated at a sufficient level above its surroundings, is further protected by the fact that Lake Mariût is artificially kept three metres below sea-level and serves as a great drain to intercept infiltration water in the subsoil. To this favourable environment the reedy borders of the two lakes are an exception. There are also the possible breeding places common to all towns, garden pools, ornamental water and watercourses in cultivated plots and market gardens.

Since the war began Alexandria has been an important base for the Army and a convalescent camp and holiday resort for troops, numbers of whom have been infected with malaria in Thessaly, Italy, or the East. The Army had made a general survey of mosquito breeding places in the district, had oiled such as were in the neighbourhood of camps and taken local measures of precaution for the troops themselves. The seriousness of the infection thus imported might, however, be sufficient to overcome the conditions described above as inimical to the spread of the disease, and at the beginning of 1917 the Anti-Malarial Commission proceeded to consider the artificial protection of the city. The following steps were taken :—

Accurate observation was made of all malaria cases in the civil hospital for purposes of diagnosis and research of origin.

A spleen count was made in the immediate neighbourhood of places known to harbour the anopheles. ‡

A map was made of the town and district showing all sites likely to breed anopheles and specimens of mosquitoes captured in the district were collected for identification and registration.

The oiling measures already begun by the Municipality were continued.

---

* This comprises the Municipal area and extends from Mex on the west to Abu Qir on the east.

† Mosquitoes do not breed in the salt water of the Mediterranean and Lake Mariût is plentifully stocked with fish.

‡ In this connection, use was made of a valuable survey of the breeding places in the Alexandria District, with special reference to anophelines, carried out by Col. C. M. Wenyon and Capt. F. W. O'Connor, both of the R.A.M.C., in July, 1916.

The reduction of the western area of Lake Hadra by deposit of city rubbish was continued and the Government were urged to accelerate the complete drying-off and drainage of that lake. The depression near the Deaconess Hospital was filled in.

In December 1917, the Military Sanitary Officer for Alexandria District * reported that, though culecines—chiefly *Culex fatigans*—were breeding freely, there was little evidence of anophelines breeding; only in the neighbourhood of the Mahmudîya Canal and on the banks of Lake Mariût † could larvæ of the latter be found. Regarding the prevalence of malaria he wrote :—

" Very few cases have occurred that could be termed 'caught in Alexandria.' For example, in this year's list of cases treated at the Greek Hospital not a single one, this year, is attributed to Alexandria. The military cases on investigation are said to be attributed to Alexandria at the rate of about five to six a week or so. But on closer investigation I feel sure that this number is excessive. For example, when I was acting Military Sanitary Officer I had returns from medical officers under the heading " Source of Infection " returned as " Mosquito bite " ; and this number five or six a week includes all those whose histories are not definitely proved to be outside Alexandria ; many of these would, I feel sure, be proved to have antecedent malaria infection (*e.g.* the Italian camps). Such clear evidence as we have seems to point to an infection late in the year (September and October) ; and this would suggest that the anophelines are not active carriers in Alexandria."

To continue and complete preventive measures, the Commission recommend that all pools where mosquitoes breed be filled in and that market gardens and other minor breeding places be carefully treated under the legislative and administrative authority proposed elsewhere.‡ Lake Hadra should be dried § and Lake Mariût too, beginning with the border of it next the city. To dry Mariût is a very large undertaking. Before the war it was, however, on the point of being done as part of the Government projects for improved drainage and reclamation throughout the northern half of the Delta, and the work will be resumed at the first opportunity.

VI.—Provincial Towns.

The first step taken by the Commission towards the treatment of provincial towns was to ascertain the degree of urban infection in Lower and Middle Egypt. South of Minya, in Upper Egypt, it was known there was comparatively little malaria. On the other

* Captain Sibley, R.A.M.C.

† Wherever fish (*Bulti*) had access no breeding could be found.

‡ *See* Appendix No. II.

§ The lowest portion of its bed lies 2·25 metres above the water surface of Lake Mariût and Lake Hadra could thus be drained stone-dry, if the connection—by siphon under the Mahmudîya Canal—was made between the two lakes.

hand, it was known that the field selected needed urgent attention and would require an expenditure exceeding the funds likely to be available. A spleen count made in the Mudirîya towns * from Minya northwards and in the Delta shows a considerable degree of malaria in Benha, Damietta and Mansûra, and a certain amount in Faiyûm, Tanta, Damanhûr, Shibîn el Kôm, Zagazig, and Beni Suef. Minya may be regarded as practically free from the disease.

Types of mosquito breeding grounds were investigated in the towns and in 500-metre belts round them. Apart from the well-known garden breeding places, the following were marked down as the most important: railway borrow-pits, *birkas* and marshy land, low-lying land flooded at high Nile, rice fields, badly-maintained drains, and drains with insufficient fall, collections of water due to seepage through canal banks, dead-ends of canals, and systems of watercourses receiving supply from more than one source.

With regard to borrow-pits, *birkas*, marshes, and low-lying land flooded at high Nile, the Director of Municipalities kindly had these surveyed and maps made showing them. Distinctive colours were used for railway borrow-pits, and for *birkas* and low-lying places, according as they belonged to the State Domains, Waqfs, or private owners. With an eye to the recommendations the Commission intended to make, an estimate was prepared of the amount and cost of earthwork † required to fill in the State Domains property; at the same time estimates were made by the Irrigation Department of the cost of abolishing dead-ends of canals and piping inter-communicating irrigation channels within the limits of various towns. ‡

	Percentage of Enlarged Spleen.		Percentage of Enlarged Spleen.
* Benha	16·5	Damanhûr	7
Zagazig	8·9	Damietta	14
Mansûra	13·5	Faiyûm	8
Tanta	10	Beni Suef	7·5
Shibîn el Kôm	9·09	Minya	5

NOTE.—Giza has not yet been dealt with.

	Cubic Metres.		Cubic Metres.
† Zagazig	3,000	Damietta { Town	1,661
Benha	27,000	Damietta { Across River	20,050
Mansûrah	4,800	Faiyûm	68,000
Damanhûr	13,600	Tanta ... { Government *birkas* now	
		Shibîn el Kôm { filled in.	

	L. E.
‡ *El Faiyûm* / *Beni Suef* { Piping inter-communicating water channels within the municipal boundaries	650 / 180
Zagazig: Altering course of canal receiving water from both ends	1,000
El Mansûra: Connecting three dead-end channels to drains	1,150
Damanhûr / *Damietta* { Suppressing water channels feeding *saqias*, by placing *saqias* on canals	100 / 250

The following note outlining the views of the Commission and putting forward their proposals was then submitted to the Ministry of Finance :—

" The problem of dealing with malaria in the Provincial towns of Egypt can only be solved by doing away with the following sources of mosquito breeding :—

" (1) The larger breeding grounds such as marshes, borrow-pits, and *birkas*, which can only be dealt with by filling them in.

" (2) Those innumerable minor sources which can only be dealt with by some such Anti-Mosquito Law as is now being drafted by this Commission.

" The larger breeding grounds in private hands can be dealt with under the *Birka* Law, but it would be useless and inequitable to call on private owners to incur expense in dealing with their property, if the Government did not at the same time set the example with its own breeding grounds. Similarly, to apply a mosquito law to the minor sources of mosquito breeding while leaving the larger untouched would be equally useless and inequitable.

" For these reasons the first steps in any programme for dealing with the problem must be to do away with all Government breeding grounds. They consist of *birkas* belonging to the State Domains Department, and in certain cases to the Ministry of Waqfs, of borrow-pits belonging to the State Railways, and canals and drains belonging to the Irrigation Department.

" The following programme—to be carried out by a systematic and combined effort of all parties concerned—for dealing with the problem, within an area of three kilometres beyond municipal boundaries, is therefore recommended :—

" 1. The State Lands Department should fill in its *birkas*.

" 2. The Ministry of Wakfs should do the same.

" 3. The State Railways should fill in its borrow-pits.

" 4. The Irrigation Service should deal with such of its canals and drains within this area as are a source of mosquito breeding.

" 5. The *Birka* Law should be applied to all privately owned *birkas* within this area, and finally,

" 6. The Anti-Mosquito Law, now under preparation, should be applied to each one of these areas so as to deal with the smaller breeding areas. It is hoped that the cost of inspection under this law when applied can be borne by the Municipalities which will benefit by its application.

" In pursuance of this policy it is proposed to commence with the filling in of *birkas* owned by the State Lands Department, situated within the nine municipal areas which are the most important and the most infected, *viz.* : Tanta, Faiyûm, Damanhûr, Shibîn el Kôm, Beni Suef, Benha, Zagazig, El Mansûra, and Damietta.

" The cost of this filling has been estimated at L.E. 10,000. Once it has been done, the increase in value of the land so reclaimed is estimated by the Domains Administration to amount to nearly L.E. 9,000. The net cost of the work is therefore only L.E. 1,000.

" In addition to the filling-in of these *birkas* it would be necessary to provide for the piping and filling-in of the dead-ends of certain canals which provide irrigation water within these Municipal areas, as it is not considered that this is a fair charge on the Irrigation Service. The estimated cost of this is L.E. 3,500.

" The Commission therefore recommends the opening of the following credits :—

	L.E.
For dealing with the dead-ends of canals	3,500
For the filling-in of Government *birkas*	10,000
TOTAL ... L.E.	13,500

" It is suggested that the L.E. 10,000 should be placed to the credit of the Domains Administration, which might most suitably arrange with the Municipalities Section to carry out the work from time to time as labour conditions and supply of carts, animals, etc., allowed ; and the L.E. 3,500 be placed at the disposal of the Irrigation Department.

" Once these credits have been granted and the work put in hand, the next step in the programme would be taken ; *i.e.* the Ministry of Waqfs, State Railways Administration, and the Irrigation Department would be requested to undertake within these areas the work outlined in items 2, 3, and 4 of the above programme, and the *Birka* Law (item 5) will be applied to *birkas* in private ownership. It is understood that the execution of the programme depends upon co-operation and the enlistment of the sympathies of all parties concerned.

" If the Government is unwilling or unable to bear its share of the cost involved, the whole attempt to free these provincial towns of malaria must be postponed. On the other hand, if it is willing to provide the small sum asked for, then the whole programme can be undertaken with a fair prospect of its object being attained within a few years, while the towns concerned will not only be rid of malaria but also have their general health improved."

It may here be remarked that the modesty of the preliminary financial recommendations made by the Commission for anti-malarial works in provincial towns is partly explained as agreeing with their general policy of keeping to a strictly practical programme, partly it must be remembered how closely packed these Egyptian towns are, and, except for a few quite new quarters, how abruptly they

end and the open country begins; the area not actually occupied by house or street is relatively small; there are few open spaces and no extensive outskirts with plots of waste or semi-cultivated land to be looked after. It follows that for a few thousand pounds an effective start can be given to the abolition of their larger breeding places of mosquitoes. Town drainage is a separate question and gardens cannot be well controlled until special regulations, now under consideration, have been introduced. Here prevention will encounter the innumerable minor breeding places mentioned in the Note to the Ministry of Finance, but, though it may be difficult to render and keep them innocuous, the need, throughout this branch of the anti-malarial campaign, will be rather for authority than for expenditure, and the Commission's proposals are not so much for the obtaining of money as of power, by the application of present laws and the introduction of new measures.

As a result of the Note quoted above, the Government provided L.E. 5,000 in the 1918-1919 Budget for filling State Domains *birkas*. This was half what had been asked for, but labour was nearly all taken up by the Army. Arrangements are, however, being made with the State Domains and Municipalities Section of the Ministry of Interior to carry out part of the Commission's programme forthwith and fill in *birkas* at Benha, Damietta, El Mansûra, Damanhûr, and Zagazig. In the last four places, also Beni Suef and Faiyûm, Inspectors of Irrigation Circles have been given their share of the small credit of L.E. 3,500 proposed and granted for dealing with certain dead-ends of canals and inter-communicating channels. The undertaking of these Government works is to be followed by application of the *Birka* Law to private owners.

It is, however, to be noted for separate consideration that the law does not extend to low-lying land not of *birka* formation and flooded only during high Niles. Nor will the suppression of the larger *birka* and irrigation breeding areas now proceeding obviate danger from rice cultivation. If any difficulty is anticipated in securing the early passage of the proposed Mosquito Law, the administrative powers of the Irrigation Department should be invoked to prevent rice being grown within three kilometres of Mudirîya towns in the Delta and El Faiyûm.

VII.—Agricultural Districts.

South of Minya the only districts known to harbour malaria to any degree are Kôm Ombo and Nag' Hammâdi. Both here and north of the Minya the type of fever is mostly benign tertian; a few cases of quartan have been observed. Malignant malaria occurs in the northern Delta near the lakes, in the Faiyûm, and between Tel el Kebîr and Ismailia. Further facts are still wanted regarding the distribution of this type of the disease and instances of it are

being specially noted. An investigation into malaria in Egypt had been set on foot before the war and a spleen count had been taken in Beheira, Minûfîya, and the Tel el Kebir-Ismailia district; Kôm Ombo has now been examined too. The results of these enquiries confirm the view that serious preventive measures are necessary.*

Mosquito breeding places in rural districts fall into four main classes :—

Outcrops of subsoil or infiltration water.

Lakes and marshes fed by waste water from drains and canals, and by infiltration water.

Rice fields.

Defective canals and drains.

The nature of subsoil or infiltration water has been described in the first part of this Report. A common cause of mosquito production in Middle Egypt, it creates in the Delta their chief breeding grounds. Apart from assisting to make the Delta lakes and marshes, it fills borrow-pits dug for railways, canals, or roads, excavations made for building or agricultural purposes, and hollows and holes of every kind. The village ponds or *birkas* originally formed by excavation are a common feature of the Delta landscape and particularly towards the north. During flood their size and number are increased. Their danger has this restriction that, to breed mosquitoes readily, they need to be fed by surface drainage water or to be freshened during high Nile.

Rice, it is understood, cannot be grown under conditions that will not produce mosquitoes. It is, however, a crop which is generally grown on land unsuitable for other cultivation, and in Egypt, when the rice districts have been properly drained, it will to a great extent yield automatically to more valuable crops such as cotton.

Defects in canal and drainage systems, breeding mosquitoes, are:—

Bad alignment and inadequate fall.

Dead-ends to canals supplied from more than one source, and drains without outlets.

Abandoned channels not filled in.

Seepage through canal banks or overflow may also collect water breeding mosquitoes. These defects are a relatively unimportant source of trouble. To them, however, may be added the cultivation of sugar in large and unlevel fields, involving the use of an excessive quantity of water. It is believed that it is in this way that malaria is produced at Kôm Ombo, where in some villages spleen counts show a twenty-five per cent infection or as high a ratio as at Siwa. At Nagʿ Hammâdi an equally high rate is found, though the disease is not so widespread. In Armant, malaria is present in a less degree. More information is still needed regarding the frequency of the disease in Egypt where sugar-cane is grown.

---

* *See* Appendix No. IV.

Control of the Nile flood and adequate drainage of the Delta are the measures by which malaria may be eradicated; they are measures that will change natural conditions in a whole country, but, however rapidly they may be pushed forward, it will be many years before they are complete, and they need to be supplemented and anticipated by local preventive works wherever possible. Their effect will be to cause a general and effectual lowering of the subsoil water, to reclaim the Delta Lakes, to replace rice by cotton or other safe crops, and to encourage the filling in of *birkas* by increasing the value of land. Meanwhile, in and about the more severely infected villages, minor defects in the irrigation system may be remedied, local drainage may be effected, *birkas* and borrow-pits be filled in with spoil from adjacent canals, or neighbouring landowners be induced by the offer of low rentals to fill them in themselves. Rice cultivation, as is noted in the chapter on Provincial Towns, should be prohibited by law within three kilometres of them, or temporarily stopped by administrative measures. As regards sugar-cane cultivation, the Ministry of Agriculture might institute a comparison between the methods of irrigation after the third month, in districts where sugar-cane is grown without malaria and in those where the disease and the crop appear to be closely associated, as at Kôm Ombo.

To prevent formation of new breeding-grounds the attention and co-operation of State Departments should be engaged.

Facilities should be refused for extension of irrigation in areas where there is not sufficient drainage to prevent breeding.

The extent of flooded and marshy areas adjoining the lakes might be reduced by leading escaped water between continuous banks into the sea.

Contracts for canal, drain, or road construction should include the filling-in of borrow-pits, and, when canals are re-aligned, the disused channels should be filled in at the same time.

Irrigation concessions should require the concessionaires' system to be so designed, graded, and maintained, and the water supply so regulated as to prevent mosquito breeding; and in general the conditions should be drafted with a special eye to malaria prevention, with guarantees for inspection of the works and enforcement of the terms laid down.

In the same way as for roads and watercourses, so, for railways: new constructions should include the obliteration of borrow-pits.

APPENDIX I.

Note on the Present State of Knowledge with regard to Subsoil Water in Egypt.

General.

The general mathematical principles of the flow of subsoil water have been worked out in France and elsewhere and are well known in so far as they concern movement of water in saturated ground. This is the more important form of movement, though agriculturists are interested in flow under capillary action. The general laws of this are also known.

The flow in saturated ground takes place in the direction of the slope of the water surface in the ground, and the velocity of the flow depends on the slope and the permeability of the soil. Flow may be fairly rapid in sand or gravel, but is very slow in the thick clay subsoil underlying a large part of the Delta.

Previous Work in Egypt.

This consists of :—

1. Laboratory and field experiments on soil physics, mainly in the way of determination of moisture content of soils, under different conditions, mechanical analysis of soils to determine the size of their particles, and some general field observations. Almost all of this was done in connection with agriculture and deals only with the upper ground layers and does not concern directly the waters drawn upon for supply of drinking water in towns.

2. A soil survey started just before the war and some progress was made. This related to the surface soil and was purely for agricultural purposes.

3. Many tube-well observations have been made in different parts of Egypt, but nearly all these were stopped at the beginning of the war in order to economize staff.

4. Drainage experiments have been made in the Delta, and the effect of drainage in the Northern Delta is marked. Deepened drains have enabled the State Domains to close down some drainage pumps.

5. Samples from borings have been collected by the Geological Survey, which has accumulated a good deal of knowledge about the nature of the subsoil.

Results.

Tube-well observations are liable to be erroneous, but a good deal of information has been collected which requires working up. The main result of these observations is to establish that the level of water in tube wells depends mainly on the strata in which they are sunk. Deep wells going down to sands and gravels will usually depend for their level on the nearest branch of the Nile or deep canal. Those which do not pass through the impervious clays depend indirectly on the Nile, but mainly on surface waterings and local conditions. The wells dependent on the Nile show that when it rises this rise is transmitted through the soil to the wells, diminishing in effect as the distance from the river increases. There is therefore an outflow when the river rises and a return flow to the river when it falls again. This has been proved directly by dye experiments, and it is also known indirectly from river discharge measurements. The principal motion of subsoil water is therefore transverse to the

river. There will also be longitudinal motion, but since the head of water causing it is much smaller than that producing the transverse, it will in most cases be masked by the latter. One result which has been often noted is the great variation of subsoil water conditions often in the same field, due to the occurrence of pockets of sand and clay which break up the homogeneity of the soil.

Future Work.

1. An examination of all accumulated observations of tube wells should be made in order to summarize the results and see whether this work should be recommenced.

It would probably be possible to find out what is the effect of canals and drains in different parts of the country. A single experiment in Central Gharbîya, where the soil happened to be unusually sandy, showed that the effect of infiltration from and defiltration into a water channel was directly measurable up to distances of 200 metres. At Talbîya, on the Pyramids Road, this effect was traced up to a distance of 400 metres.

2. The extension of discharge measurements will give indirect evidence about subsoil water by determining seepage gains and losses from water channels.

3. Further work should be done on the physical properties of soil, as is done by the American Department of Agriculture, which has a special branch for this work.

4. The above work will give a lot of general information which would ultimately probably enable answers to be given directly to questions about subsoil water. The only course open at present, if a question arises relative to conditions at a particular place, is to investigate on the spot.

CONCLUSION.

The study of subsoil water concerns irrigation, agriculture, and public health, and as in Lower Egypt its level is always within three metres of the ground surface, and often less than this, it is impossible to ignore its importance. In years of high flood its effects are especially prominent.

It may not be possible in a limited time to minimize the ill-effects of high subsoil water levels, but any solution of the problem will depend upon accurate data, which should be collected systematically over a number of years. In this way the best results will be arrived at with the minimum of expense.

May 5, 1918.

(Signed) H. E. Hurst,
Acting-Director, Physical Department.

APPENDIX II.

Anti-Malaria Legislation.

No actual anti-malaria law has been drafted, as the Commission were legally advised that the time was not opportune. The lines on which such a law should be drafted have, however, been fully considered by the Commission and are shortly as follows :—

1. Every occupier or, in default, every proprietor of a house, garden, or land, cultivated or otherwise, within the areas to be defined under this law shall take all necessary precautions in accordance with these regulations to prevent the breeding of moquitoes.

2. This law or any part of it to be made applicable by Ministerial *Arrêté* to the whole or part of any municipal area or to any place within three kilometres of the municipal boundaries. Within the areas so defined the whole or part of the regulations laid down in the following articles shall be enforced.

3. All wells or *saqias* shall be kept properly covered so as to be mosquito-proof and shall be provided with pumps. No new wells or *saqias* shall be installed in the area to which this law is made applicable except with the consent of the Public Health Authorities, which may lay down conditions necessary to prevent the breeding of mosquitoes.

4. All cisterns or tanks shall be provided with proper mosquito-proof covers, which shall be kept closed and in good repair, to the satisfaction of the Public Health Authority.

All *zîrs*, barrels, or other movable water receptacles shall be similarly covered and placed on stands.

5. All fountains or artificial ponds shall be either—

(*a*) If so constructed as to be completely emptied by the removal of plug, they shall be emptied weekly or at such a time as the Public Health Authority shall direct.

(*b*) If not so constructed, they shall (i) be kept stocked with larvæ-devouring fish to the satisfaction of the Public Health Authority, or (ii) suppressed.

All irrigation chambers shall be so constructed as not to retain water.

6. Hose plugs for water pipes shall be so constructed as not to retain water.

7. All casual collections of water in gardens, courtyards, or in general on any property, shall be so dealt with as to prevent the breeding of mosquitoes.

8. All ventilation shafts or inlet vents shall be covered with wire in such a way as to prevent the exit or ingress of mosquitoes. All cesspits shall be provided with mosquito-proof covers and kept in repair to the satisfaction of the Public Health Authority.

9. In the case of irrigated lands or gardens, the owner or tenant to take the steps necessary to prevent his drains, private canals, or irrigation channels providing mosquito breeding-grounds.

Owner or tenant to keep private canals or irrigation channels clean and free from obstruction, and to repair the banks thereof to prevent leakage of water.

Owners to clean and keep free of obstruction existing drains or such drains as may be subsequently made.

The consent of the Public Works Department shall be necessary before making any new drains.

Owners or tenants shall close blind drains which cannot be made to discharge into any existing drain.

Owners or occupiers shall make drains in marsh lands, provided that they can obtain access to existing drains.

10. All disused cesspits, drains, or gullies shall be filled in or removed.

11. All pits, holes, or excavations containing water, whether at flood time or otherwise, shall be filled in. In the case of excavations for the foundations of buildings actually in course of construction, the contractor or, in default, the proprietor shall be held responsible, but he may, in lieu of filling in, take such steps to prevent the breeding of mosquitoes (petroleum, cyllin, etc.) as will satisfy the Public Health Authority.

12. In the case of any collection of water within the above areas which cannot be dealt with under the above regulations, and which can be shown to be a source of mosquito breeding, the Minister of the Interior shall have the power to issue an *Arrêté* compelling the proprietor or occupier to carry out such conditions as may be necessary to prevent this.

13. Rice growing shall be prohibited within three kilometres of any municipal town boundary, whether the remainder of this law is made applicable to that area or not.

14. In the case of cellars or basements which are flooded at any time, the occupier or proprietor shall be held to raise the floor of the basement or to treat the water in such a way as to prevent the breeding of mosquitoes.

15. All the penalties against the breeding of mosquitoes applicable to houses or gardens shall be held applicable to any steamer, *dahabîya*, or boat moored within the area to which the law is applicable.

16. Right of entry to properly-accredited inspectors shall be granted into any of the places coming under these regulations, between the hours of 8 a.m. and 5 p.m., provided that, in the case of houses or of gardens attached thereto, twenty-four hours notice be given of each visit of inspection.

17. If, as the result of inspection, any condition is found requiring to be remedied by the occupier or proprietor, written notices of result of inspection shall be served either at the time or after the inspection.

18. Every occupier leaving his house temporarily unoccupied shall be held to take all precautions to prevent the breeding of mosquitoes within the house and gardens during his absence.

In case of such houses temporarily uninhabited, notice served upon the caretaker will be considered sufficient. In such cases, or where there is no caretaker, the garden or courtyard attached to the house may be entered and such measures taken as may be necessary to prevent the breeding of mosquitoes.

In case of untenanted houses the responsibility will rest on the proprietor.

19. In case of contravention of any of these regulations, besides the penalties laid down in Article 20, the Department of Public Health shall have the power, after due notice served upon the person responsible, to carry out the necessary measures and to recover the amount under the Law of 1880.

20. Penalties—P.T. 100 or imprisonment for one week. In case of contravention of Article 9, the judge may order the stoppage of the water-supply.

APPENDIX III.

Malaria Cases reported in the Country in 1917.

Markaz.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Port Said	—	—	1	1	3	1	13	10	15	13	6	11
Cairo	—	—	2	—	1	4	5	5	10	18	11	8
Suez	4	8	2	1	—	—	1	27	22	15	—	3
Damietta	—	—	—	—	—	—	—	1	6	—	—	2
Quweisna	—	—	—	—	—	—	—	—	—	3	1	2
Minûf	1	—	—	1	—	—	—	1	1	2	2	—
Shibîn el Kôm	—	—	—	—	—	—	—	—	—	1	—	—
Ashmûn	—	—	—	—	—	—	1	1	—	1	—	—
Tala	—	—	1	—	—	—	—	3	—	—	—	—
El Mansûra	—	—	—	—	1	—	—	—	—	1	—	—
Minyet el Qamh	4	—	2	—	1	3	—	4	2	9	3	—
Hihya	—	—	—	—	—	—	1	—	1	—	—	—
Fâqûs	—	—	—	—	—	—	1	1	—	6	13	1
Damanhûr	—	—	—	—	—	1	—	—	—	—	—	—
Disûq	—	—	—	—	—	1	—	2	—	1	—	—
El Santa	—	—	—	—	—	—	—	—	—	1	—	—
El Mehalla el Kubra ...	—	—	3	—	—	—	—	—	—	1	—	—
Tanta	—	—	—	1	—	2	1	8	5	3	3	—
Qalyûb	—	—	—	—	—	2	—	2	—	3	2	2
Benha	—	—	—	—	—	—	—	2	—	1	3	—
Shibîn el Qanâtir	—	—	—	—	—	—	1	—	—	—	—	—
Tûkh	—	—	—	—	1	1	—	—	—	—	—	—
El Saff	—	—	—	—	—	—	—	—	—	—	2	—
El Gîza	—	—	—	—	—	2	—	—	—	—	—	1
Imbâba	1	1	—	1	—	—	—	3	—	—	—	—
Barrage	—	—	—	—	—	1	—	—	—	—	—	—
Beni Suef	2	—	—	—	1	1	—	—	1	6	10	3
Biba	—	—	—	—	—	—	—	—	—	6	1	—
El Faiyûm	—	—	—	—	—	—	—	—	—	12	13	—
Itsa	—	—	—	—	—	—	—	1	—	2	—	1
Sinnûris	—	—	—	—	—	—	—	—	1	4	1	—
Fashn	—	—	—	—	—	—	1	2	4	—	4	—
El Minya	—	—	—	—	—	—	1	—	—	1	3	—
Maghâgha	—	—	—	—	—	—	—	—	—	—	4	—
Asyût	4	4	—	—	—	—	1	—	—	—	1	3
Manfalût	—	—	—	—	—	—	—	—	—	—	—	2
Abnûb	—	—	—	—	—	—	—	—	—	—	1	—
Mallawi	—	—	—	—	—	—	—	—	—	—	—	1
Tahta	—	—	—	6	2	—	—	—	—	—	—	—
El Balyana	—	—	—	—	—	—	—	—	—	2	—	—
Kôm Ombo	747	141	7	22	31	30	96	169	266	255	200	115
Edfu	—	—	—	—	—	—	1	—	—	—	—	—
Total	763	154	18	33	41	49	124	242	334	367	284	155

P.S.—Figures in black are imported cases.

Total cases for the year 1917: 2,564.

APPENDIX III (*continued*).

Malaria Cases reported in the Country in 1916.

Markaz.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Suez	10	6	—	—	—	—	1	12	35	19	22	14
Cairo	3	2	—	—	—	9	9	8	12	9	11	8
Port Said	1	1	3	—	—	—	—	2	—	—	—	—
Damietta	—	—	—	—	—	—	—	—	—	—	1	—
Benha	—	—	—	—	—	2	—	—	—	1	—	—
Qalyûb	—	—	—	—	—	2	5	2	1	2	8	—
Tûkh	—	—	—	—	1	2	—	—	—	—	2	—
Shibîn el Qanâtir	—	—	—	—	2	2	—	—	—	—	—	—
Barrage	—	—	—	1	—	—	—	—	—	—	—	—
Zagazig	—	—	5	—	—	—	—	—	1	2	5	1
Minyet el Qamh	—	—	5	2	2	16	1	9	2	3	12	6
Hihya	—	—	—	—	—	—	—	—	3	1	1	—
Fâqûs	—	—	—	—	—	—	—	—	—	2	—	—
Bilbeis	—	—	—	—	—	2	—	1	—	1	—	—
Kafr Saqr	—	—	—	—	—	—	—	—	—	—	2	—
El Mansûra	—	—	—	—	—	—	—	—	—	—	2	2
Minûf	—	—	—	—	—	11	3	—	2	1	2	—
Shibîn el Kôm	—	—	—	—	1	2	3	4	3	3	4	2
Tala	—	—	—	—	—	—	2	—	1	—	—	—
Ashmûn	—	—	—	—	—	1	1	1	1	2	2	—
Quweisna	2	—	—	—	—	1	2	2	—	3	1	3
Tanta	—	—	—	—	—	—	3	6	1	—	—	1
El Mehalla el Kubra ...	—	—	—	—	—	2	—	—	—	—	1	—
Damanhûr	—	—	—	1	1	—	—	1	5	—	—	1
El Dilingât	—	—	—	—	—	—	—	—	1	—	—	—
Kafr el Dauwâr	—	—	—	—	—	—	—	—	1	—	—	—
Imbâba	—	2	—	1	—	—	4	4	1	4	22	2
Ayat	—	—	—	—	—	—	—	—	—	—	4	—
El Faiyûm	—	—	—	—	1	—	—	—	4	—	—	—
Itsa	—	—	—	—	—	1	—	—	—	—	—	—
Beni Suef	—	—	1	3	—	1	2	—	2	—	6	—
Biba	—	—	—	—	—	—	—	—	—	—	—	2
El Wâsta	—	—	1	2	—	—	—	—	—	—	—	—
El Minya	—	—	—	—	—	2	—	1	1	2	—	1
Fashn	—	—	—	—	—	—	—	—	1	—	—	—
Abu Korkas	—	—	—	—	—	—	—	—	—	1	1	—
Deirut	—	—	—	—	1	—	—	—	—	—	—	—
Sohâg	—	1	—	—	—	—	—	—	—	—	—	—
Tima	—	1	—	—	—	—	—	—	—	—	—	—
Qena	—	—	—	—	—	—	—	—	—	—	—	5
Total	16	13	15	10	9	56	36	53	78	56	109	48

Total cases for the year 1916 : 499.

APPENDIX III (*continued*).

Malaria Cases reported in the Country in 1915.

Markaz.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Suez	—	1	2	1	3	4	9	14	27	—	56	18
Cairo	—	—	—	—	—	—	—	4	5	6	3	1
Port Said	—	—	—	—	—	—	—	—	—	1	—	1
Damietta	—	—	—	—	—	—	—	—	—	—	—	2
Benha	—	—	—	—	—	2	4	3	7	—	—	—
Qalyûb	—	—	—	1	—	2	7	5	7	2	4	4
Tûkh	—	—	—	—	—	2	3	1	3	3	1	—
Shibîn el Qanâtir	—	—	—	—	—	—	1	—	1	—	1	—
Zagazig	—	—	—	—	—	2	3	2	9	9	—	1
Minyet el Qamh	—	—	1	—	1	—	1	—	1	12	3	7
Fâqûs	—	—	—	—	—	—	—	2	—	—	—	—
Minûf	—	—	—	—	—	—	1	1	3	2	2	—
Shibîn el Kôm	—	—	—	—	—	—	8	4	1	7	8	—
Tala	—	—	—	—	—	—	1	2	5	5	1	—
Ashmûn	—	—	—	—	—	1	—	3	2	3	—	—
Quweisna	—	—	—	—	—	—	1	2	4	5	5	—
Tanta	—	—	—	—	—	2	5	—	3	2	1	—
Zifta	—	—	—	—	—	—	—	1	—	—	—	—
Damanhûr	—	—	—	—	—	—	—	—	—	—	—	1
Teh el Bûrûd	—	—	—	—	—	—	—	—	—	14	—	—
Imbâba	—	—	—	—	—	—	—	—	2	5	1	8
El Faiyûm	—	—	—	—	—	—	—	—	2	—	—	—
Beni Suef	—	—	—	—	2	2	—	—	3	—	1	—
El Minya	—	—	1	1	—	—	—	—	—	1	—	—
Beni Mazâr	—	—	—	—	—	—	—	—	1	—	—	—
Asyût	—	1	—	—	—	—	—	—	—	—	—	—
Luxor	—	—	—	—	—	—	—	2	—	—	—	—
Aswân	—	—	—	—	—	—	—	—	—	—	5	—
Idfu	—	—	—	—	—	1	—	—	—	—	—	—
Total	—	2	4	3	6	18	44	46	86	77	92	43

P.S.—Figures in black are imported cases.

Total cases for the year 1915 : 421.

APPENDIX III (*continued*).

Malaria Cases reported in the Country in 1914.

Markaz.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Suez	—	—	—	—	—	—	—	14	6	17	15	—
Benha	—	—	—	—	—	—	—	—	4	2	4	—
Qalyûb	—	—	—	—	—	—	—	—	1	5	—	—
Tûkh	—	—	—	—	—	—	2	—	—	2	1	—
Shibîn el Qanâtir	—	—	—	—	—	—	—	—	1	2	1	—
Zagazig	—	—	—	—	—	—	—	—	—	1	2	—
Minyet el Qamh	—	—	—	—	—	—	—	—	—	1	—	—
Hihya	—	—	—	—	—	—	—	—	—	4	—	—
Fâqûs	—	—	—	—	—	1	—	—	—	1	—	—
El Mansûra	—	—	—	—	—	—	—	—	1	1	8	—
Minûf	—	—	—	—	—	—	—	—	1	3	3	2
Shibîn el Kôm	—	—	—	—	—	—	2	3	2	7	7	—
Tala	—	—	—	—	—	1	1	—	2	3	—	3
Ashmûn	—	—	—	—	1	1	—	—	—	8	—	—
Quweisna	—	—	—	—	—	—	—	—	—	—	—	1
Tanta	—	—	—	—	—	—	1	—	1	—	—	—
El Santa	—	—	—	—	—	1	1	—	—	3	—	—
Zifta	—	—	—	—	—1	—	1	—	1	—	—	—
Kafr el Sheikh	—	—	—	—	—	—	1	—	1	—	1	—
Talkha	—	—	—	—	—	—	—	—	—	—	10	4
Damanhûr	—	—	—	—	—	—	—	1	1	1	—	1
Teh el Bûrûd	—	—	—	—	—	—	—	1	—	—	—	—
El Dilingât	—	—	—	—	—	—	—	—	—	—	3	—
El Faiyûm	—	—	—	—	—	—	—	—	—	3	—	—
Itsa	—	—	—	—	—	—	—	—	1	—	—	—
El Minya	—	1	—	—	—	—	1	—	—	—	1	—
Beni Mazâr	—	—	—	—	—	1	—	1	1	—	—	—
Abu Qurqâs	—	—	—	—	—	1	—	—	—	—	1	—
Asyût	—	—	—	—	—	—	—	—	—	1	—	—
Dairût	—	—	—	—	—	—	1	—	—	—	—	1
Mallawi	—	—	—	—	—	—	—	—	—	—	4	—
El Balyana	—	—	—	—	—	—	—	—	—	1	—	—
Nag^{e} Hammâdi	—	—	—	—	—	—	—	—	—	1	—	—
Qûs	—	—	—	—	—	—	1	—	—	147	From Sudan	
Luxor	—	—	—	—	—	—	—	—	3	4	24	—
Aswân	—	—	—	—	—	—	—	—	—	—	—	—
Idfu	—	—	—	—	—	—	—	—	—	5	—	—
Total	—	1	—	—	2	6	12	20	27	223	85	12

P.S.—Figures in black are imported cases.
Total cases for the year 1914 : 388.

APPENDIX III (*continued*).

Malaria Cases reported in the Country in 1913.

MARKAZ.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Suez	—	—	—	—	—	—	—	7	49	48	—	—
Damietta	—	—	—	—	—	—	1	—	—	—	—	—
Benha	—	—	—	—	—	—	—	—	1	3	1	—
Qalyûb	—	—	1	—	—	—	—	—	—	1	1	—
Tûkh	—	—	—	—	—	—	—	—	—	—	2	—
Zagazig	—	—	—	—	—	—	—	—	—	—	3	—
Minyet el Qamh	—	—	—	—	—	—	—	—	—	—	1	—
El Mansûra	—	—	—	—	—	—	—	—	—	—	1	1
Dikirnis	—	—	—	—	—	—	—	—	1	—	3	—
Minûf	—	—	—	—	—	2	—	—	—	4	1	—
Shibîn el Kôm	—	—	—	—	—	1	1	—	—	9	7	—
Tala	—	—	—	—	—	—	—	2	—	6	3	—
Ashmûn	—	—	—	—	—	—	—	—	—	1	3	—
Quweisna	—	—	—	—	—	1	2	—	—	5	6	—
Tanta	—	—	—	—	1	—	—	1	—	1	8	—
El Santa	—	—	—	—	—	—	—	—	—	—	1	—
El Mehalla el Kubra ...	—	—	—	—	—	—	—	—	—	2	2	—
Zifta	—	—	—	—	—	—	—	—	—	2	—	—
Samanûd	—	—	—	—	—	—	—	—	—	—	1	—
Kafr el Zaîyât	—	—	—	—	—	—	—	—	—	1	1	—
Damanhûr	—	—	—	—	—	—	—	1	—	—	—	—
Imbâba	—	—	—	—	1	—	—	—	—	—	—	—
El Faiyûm	—	—	—	—	—	1	—	—	—	2	—	—
Asyût	—	—	—	—	—	—	—	1	—	**2**	—	—
Dairût	—	—	—	—	—	—	—	—	—	—	—	1
Girga	—	—	**1**	—	—	—	—	—	—	1	—	—
Aswân	—	—	—	—	—	—	—	—	—	—	1	—
Sohâg	—	—	—	—	—	—	—	—	—	—	**4**	—
TOTAL	—	—	2	—	2	5	4	12	51	89	50	2

P.S.—Figures in black are imported cases.

Total cases for the year 1913 : 217.

APPENDIX IV.

Table showing Percentage of Enlarged Spleen in the Country.

Town.	Per Cent
Suez Canal District.	
Suez	5
Ismailia	3·1
Provincial Mudîrîya Towns.	
Benha	16·5
Zagazig	8·9
El Mansûra	13·5
Tanta	10
Shibîn el Kôm	9·09
Damanhûr	7
Damietta	14
El Faiyûm	8
Beni Suef	7·5
El Minya	5
Rural Districts.	
Suez Gardens	52
Nifîsha	4
El Mahsamah	21
Qassâsîn	5·3
Tell el Kebir	10
El Minûfîya Province.	
Shibîn el Kôm District :—	
Shibîn el Kôm	9·09
Kafr Duqmâq	1
Mît el Môz	22
Milîg	6
Mit Khâqân	15
Shintina el Hagar	21
El Museilha	20
Minûf District :—	
El Bâgûr	12
Kafr Fîsha el Kubra	15
Ghimrîn	12
El Wât	17
Kôm el Dabʿ	12
Ashmûn District :—	
Ashmûn	16
Samâdûn	18
Migîrya	17

Town.	Per Cent.
El Minûfîya Province (*cont.*).	
Tala District :—	
Tala	9
Kafr ʿIlwân	1
Barawi	22
Kafr Mît Abu el Kôm	14·5
Kafr el Shurafa el Sharqi	22
Tablûha	6
Quweisna District :—	
Quweisna	25
Ibnahs	6
Kafr ʿAbdu	8
Baqsa	16
Mît Abu Sheikha	23
Tambisha	21
Bata	15
El Beheira Province.	
Damanhûr District :—	
Damanhûr	7
Zarqûn	16
Disûnis	11
Tarabamba	8
Abʿâdîyet Damanhûr	18
Ramleh District :—	
ʿEzbet el Mahrûsa, Danna, Baghûs el Wastânîya	17
Abu Qîr (El ʿAmrîya)	2
Rosetta District :—	
El Meʿadîya	0
El Burg	4
Rosetta	1
Kafr el Dauwâr District :—	
El Nashw el Bahari	6
El ʿAkrîsha	19
El Karyûn	11
Maʿmal el Qezâz	10
Abu Hummus District :—	
El Garâdât	14
Qâfla	7
Deir Ams	20
Disûnis	10

APPENDIX IV (*continued*).

Town.	Per Cent
El Beheira Province (*cont.*)	
Ityâi el Barûd District :—	
Maʿniya	10
Gabâris	6
Shandid	18
Nikla el ʿInab	6
Shubra Khît District :—	
Shubra Khît	12
Farnawa	13
Kafr Kishk	19
Kunaîyiset Urein	
El Dilingât District :—	
El Dilingât	12
El Misîn	15
El Hagar el Mahrûq	20
Ruzzâfa	17·3
Kôm Hamâda District :—	
El Tôd	4
Bibân	9
El Negîla	9
Kafr Bûlîn...	10
Qena Province.	
Armant District :—	
Armant el Wabûrât...	12
Nagʿ el Malakan	12
„ Abu Dawûd	3
„ Mirasa	
„ Abu Halîma	4
„ Hasan el Naggâr	2
Nagʿ Hammâdi District :—	
Gamana	8·3
Hiw	12
Bahgûra	3·8
Nagʿ ʿIsa	0
„ Emâmsa	
„ ʿAit	
Bahsîya	
Barûra	
Salîm	
Abu Kabûb	
ʿEz. Dongol	
Ngâhya	
Nagʿ Hammâdi	6·7
El Gharbi Bahgûra	12·5
ʿEz. Hammâd	0
Nagʿ Shalaila	12·5

Town.	Per Cent
Qena Province (*continued*).	
Nagʿ Hammâdi District (cont.) :—	
Zeliten	7·2
Nagʿ Rokab	25
„ Kilh	0
ʿEz. Ginaidi	17·6
„ Salmân	8·6
Awlâd Nigm Bahgûra District :—	
Nagʿ Shotbîya	0
„ Sâhil	6·6
„ Awlâd ʿAly	0
„ Shanna	25
„ ʿIsa	0
ʿEz. Hasan...	
Nagʿ ʿArab	
„ Mosleh	
„ Sit	
„ el Naggâr...	
„ Kombol	16·6
„ Khodarât	16·6
„ Shagarât	20
El Deeb	3·7
Kôm Ombo District :—	
Kôm Ombo	8
Kôm Ombo Qibli	13·75
Baîyâra	5·3
ʿEz. el Fabrika	6
„ el Tarâkwa	22·5
„ No 6	21
„ el Fârsîya	18·6
El Raghama Sharq	25
El ʿAbbâsîya	19
El Tawfîqîya	18·3
Ismailia	8
El Khôr Qibli	19
El Sebîl No. 2	21·2
Matana Sebîl	21·6
El Sebîl Bahari	16·6
ʿAtmûr Mustagid	24
„ Bahari...	10·6
„ Qibli	10
El Raghama Gharb	25·3
No. 7 Qibli	17
El Bisalîya	14·2
El ʿIleiqât	18·6
El Khôr Bahari	10·7
No. 7 Bahari	22
El Higâziya	18
Shotb	8

APPENDIX IV (*continued*).

Table showing Percentage of Enlarged Spleen in the Country.

Locality.	Per Cent.
El Khârga Oasis.	
El Khârga Oasis :—	
Children	25·5
Genâh :—	
Children	25
Bûlâq :—	
Children	11
Barees :—	
Children	48·7
Markaz el Shirka :—	
Children	36
ʿEz. el Maharîq :—	
Children	16·6
Siwa Oasis.	
Siwa Oasis :—	
Children	23·1
El Baharîya Oasis.	
Elʿ Agûz :—	
Children 34	32
Zabu :—	
Children 120	61
Mindaisha :—	
Chilrden 138	63
El Hana :—	
Children 31	60
El Bâwîti and Qasr :—	
Children 673	60·3
El Farâfra Oasis.	
El Farâfra Oasis :—	
Children 183	18

Locality.	Per Cent.
El Dâkhla Oasis.	
Mût :—	
Children	25·5
El Râshda :—	
Children	65
Handâw :—	
Children	72·8
Asmant :—	
Children	68·8
Badkhulu :—	
Children	62·5
El Qalamûn :—	
Children	72·5
El Gedîda :—	
Children	53·3
El Qasr :—	
Children	71·4
El Mûshîya :—	
Children	56
Balât :—	
Children	58
El Maʿsara :—	
Children	72
Tineida :—	
Children	64

Breeding grounds are : 1. Rice. 2. *Birkas.* 3. Old wells.

INDEX.

S

T

U

V

W

Y

Z