DETAILED REPORTS

ON

SANITARY CONDITIONS

RELATING TO

PROPOSED CANTONMENTS AND ENCAMPMENTS FOR THE TROOPS

IN

SOUTH AFRICA.

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REPORT ON NEWCASTLE, NATAL, AS A SITE FOR A PERMANENT GARRISON.

Having arrived at Newcastle in accordance with instructions from the Principal Medical Officer, South Africa, on the 26th September, 1902, I proceeded to examine various points bearing on the sanitary aspects of the locality. 269 Cape 50

This involved examination of the physical characters of the surrounding district; sources, quantity and quality of water supplies; cleanliness or otherwise of surface soil; sanitary administration and general sanitary arrangements of the township; and vital statistics and meteorological records of the locality.

Some notes on these various points will help to explain the conclusions arrived at and the recommendations submitted.

Physical Characters.

The town of Newcastle is stated to be 3,900 feet above the sea level. The official altitude of the railway station is 3,893 feet.

It is on the south bank of the N'Kandu River, which rises in the Drakensberg about 20 miles above the town, and which flows into the Buffalo River, after a winding course eastwards, 12 to 15 miles lower down. The characters of this river are noted in the section dealing with water supplies.

The country to the north of the town is formed of slopes rising from the river to a ridge or kopje about 3 miles distant on the north and running almost west to east. It inclines towards the south-east at its eastern extremity and is about ¾ mile long.

The western extremity of this ridge is known as Signal Hill and is the highest point in the ridge. It is noted on military maps as being about 400 feet above the town level. The eastern extremity is known as Windsor Castle.

The country to the south of the town is of similar formation, namely, a slope rising to a ridge or kopje, known as Rooi Pynt, also about 3 miles distant. This ridge has also a west to east direction, and is about 4 miles in length from its most western to its eastern point. The latter, owing to a bend in the ridge, faces north-east. Its altitude is about 320 feet above the town.

These slopes north and south of the town open out towards the east into a series of undulating slopes intersected by the N'Kandu and leading to the Buffalo River. Immediately to the west of the town the ground is broken by a series of hills and plateaux forming the foot hills of the Drakensberg range.

The town lands of Newcastle, portions of which have been offered as sites for a garrison, are the slopes described above as rising to the Signal Hill and Rooi Pynt ridges and the open undulating slopes to the east.

The extent of unalienated land on these slopes is estimated at 16,842 acres, the total acreage being 17,386 acres.* The northern slopes are more cut up by dongas and spruits than the southern or eastern slopes, the eastern being apparently most free from these.

The geological formations immediately underlying the surface are the sandstones and shales of the coal measures, and coal is being worked by collieries within 50 or 80 feet of the surface in the immediate neighbourhood. Overlaying the sandstone is a formation spoken of locally as "ironstone." It is a red, lava-like formation, that appears to be spread evenly over the surface of the sandstone to a depth of 3 or 4 feet. It disintegrates and forms with the alluvial deposits a red surface soil, which is very characteristic of the locality.

When the "ironstone" is not so disintegrated, it occurs in the form of irregular nodular masses forming a surface conglomerate, containing numerous granules of quartz embedded in it.

Where the "ironstone," or red earth, does not appear on the surface of

* Statistical Year Book for Colony of Natal, 1901.

the slopes and hollows, the soil is usually a rich dark loam or alluvial deposit, containing a considerable amount of clay. This soil is spoken of locally as "black soil." Another surface formation seen in some areas on the town lands is a light sandy loam. This is found most on the eastern slopes and fields near the river.

But the chief characteristic, geologically, of the locality is the intrusion of igneous rocks in the form of dykes in numerous places. The Signal Hill and Rooi Pynt ridges are covered with boulders showing the position of these dykes, and at various points on the slopes the intrusion of igneous rocks is apparent; in fact, wherever there are kopjes, dykes of intrusive rock occur in the geological formation.

There are no marshes in the neighbourhood, but in heavy rains it is stated that one of the fields by the river to the north of the town becomes a swamp, and water appears near the surface on the cemetery site on the south-east corner of the town.

Bogs form around the numerous springs and along the beds of some of the dongas, wherever there is much argillaceous soil.

On the lower parts of the slopes near the river banks, the surface soil is apparently a typical rain-wash loam or brick earth and is used for making bricks.

The "red soil" is studded all over the surface with antheaps, the "black soil" seldom, or at any rate, very sparsely.

The local explanation of this is that the ants prefer a dry soil, and where antheaps abound the site is considered a dry one, and is preferred on that account for building. The antheaps themselves are considered valuable as manure for gardens, or for forming mud floors. They contain a considerable amount of vegetable and animal organic matter, and have "binding" properties. These physical characteristics have been entered into as fully as information and time available permit. They have an essential bearing upon the hygienic aspects of the sites, and on the sources and quality of the water supplies.

Water Supplies.

Three sources of water are available—

(1.) River water.
(2.) Spring water.
(3.) Wells.

1. *River Water.*

There is an abundant and continuous supply from the N'Kandu River. A rough gauging was made of the quantity at a reach about 10 miles above the town, and about ½ mile above the waterfall, and it was estimated that there is a flow of at least 10,000,000 gallons in the 24 hours. This gauging was made on the 29th September, at the end of the dry season, and before the volume of water could be influenced by the rains.

As regards quality, it may be generally assumed that the stream is polluted, or liable to pollution all along its course; but the degree of pollution is infinitely less from the immediate neighbourhood of the Drakensberg, where it rises, to within a short distance of the waterfall, than is the degree of pollution between the waterfall and the town.

From the town downwards the stream in its present state is little better than a sewer, the water being polluted by the town refuse deposited on its banks, by the filth accumulating in and washed down from the spruits (especially those of the northern slopes, which have been much occupied by troops), and by carcases buried along the banks. The banks and bed of the river are generally muddy and much suspended matter is carried into the stream. At points, however, the water is clear and flows over a rocky bed, with rocky banks. I should divide the river, therefore, into four sections as regards its suitability for providing water for domestic purposes—

(1.) The section flowing down the precipitous sides of the Drakensberg.

(2.) The section winding through the plateau between the Drakensberg and the waterfall.

(3.) The section from the waterfall to the town.

(4.) The section from the town onwards.

Water drawn from the first section is likely to be pure and safe, water from the second is comparatively safe till within a mile or so of the waterfall. The reach just above the waterfall is liable to pollution from drifts and spruits, and, in fact, the banks immediately above the waterfall have been much polluted lately by Yeomanry camps. For some distance along one of the banks there was an accumulation of recent latrine paper and refuse, smelling foully, and attributable to a neighbouring latrine and refuse heaps belonging to a camp above.

The third section contains water of doubtful or suspicious character and is unsafe, unless carefully and scientifically filtered.

The fourth section is fit neither for drinking nor for bathing purposes; and at one point, known as "Stink Drift," about ½ mile below the town, the river smells like sewage. The water here is unfit for any domestic purpose whatever.

Although no proper equipment was available for biological and chemical analysis, Major Eckersley, R.A.M.C., prepared some material, and was able to make plate cultures of samples collected immediately below the waterfall, and at a point about ½ mile above. The biological characters of the former showed unmistakeable increase of growth as compared with the latter. A Thresh's Field Service Cabinet was obtained, but the chemical tests did not show any marked impurity nor any great distinction between the samples.

These tests are very imperfect; but with a properly equipped laboratory much valuable information could be obtained, by applying these methods of analysis to the water at various points on the river above and below the waterfall, and above and below the town.

2. *Spring Water.*

Numerous small springs occur half way up the slope of the Signal Hill and Rooi Pynt ridges. I examined and gauged all of these, wherever it was possible to do so. They appear to ooze out from the rock at the point of contact between the intrusive rock and the sandstone formations. In most cases the water oozes into the alluvial loam of the surrounding slope and forms a bog; in a few instances it trickles out over rock and forms a bog lower down, or runs off in a spruit.

The present town supply is derived from water collected from several small springs on the southern slope of the Signal Hill ridge. I made gaugings of these springs on the Signal Hill side of the town on the 27th September, before the rains, and again of some of them on the 4th October, 3 days after some heavy rain.

On the 28th September and 3rd October I gauged springs on the Rooi Pynt Ridge. The result of the gaugings is shown in Table I., appended. Approximately the quantity of water likely to be obtained from the springs of the Signal Hill side of the town amounts to some 100,000 gallons daily. The springs of the Rooi Pynt side do not seem likely to yield more than half that amount, and most of them are, moreover, used by or are on the property of farmers whose homes are situated near them.

There is no information to show whether these springs are perennial or not, but the impression in the mind of the borough engineer is that they are "dying." This is, however, open to question; and as the springs are no doubt fed by the rain falling on the plateaux above and percolating through the rock, they are likely to continue so long as the meteorological characters of the district continue.

The quality of the spring water is, at its source, pure and safe. It is clear, palatable and sparkling, but it is liable to obtain considerable organic matter and surface pollution after leaving the rock; indeed, the water there is of much the same character as surface well water.

At present the spring water is being used not only for the town but for the various camps. The sanitary points connected with the collection, conveyance, storage and distribution of the water are noted in the section dealing with sanitary administration and general sanitary arrangements.

Samples of the water were collected from the rock, and from a pipe leading into the surface soil through which the spring water percolated.

The biological contrast was most marked. In the former no growths were obtained on gelatine with $\frac{1}{4}$ cc. and $\frac{1}{2}$ cc. dilutions, and non-liquefying colonies grew slowly with 1 cc. dilutions, amounting to 32 after 24 hours, and about 500 after 72 hours. Shake cultures of 1 cc. in gelatine showed no growth beyond a slight growth on surface after 72 hours. The same water collected through the pipe leading into the surface soil surrounding the spring showed no growths with $\frac{1}{4}$ cc. in gelatine, but $\frac{1}{2}$ cc. and 1 cc. cultures rapidly liquefied, and 1 cc. shake cultures gave marked gas formation.

Further detailed examination of the colonies is being made, but the test is sufficient to indicate the marked difference between the quality of the spring water collected direct from under the rock, and the same water collected after it has come in contact with surface soil.

(3.) *Well Waters.*

These are not generally used, but in the lower slopes at the town level abundant supplies of water are obtained from surface wells. The water however in these wells can scarcely be described as subsoil water, as it seems invariably to be derived from shale or sandstone strata, and in some cases, in sinking wells, the water on being found has rapidly risen and overflowed, indicating the tapping of springs in a stratum held down by an impervious stratum above.

This fact is also evident from an examination of the level of the water in wells. Thus a well in the enclosure of No. 14 General Hospital has its water level 11½ feet from the surface. It remains, in wet weather and dry, practically at the same level, while in a well some 5 feet lower down the slope and only about 50 yards distant (*i.e.*, at the ice factory), the water level is about 20 feet from the surface.

Were the water in these wells ordinary subsoil water, the level of the well lower down the slope would be higher than that of the well above in proportion to the difference in surface levels, instead of lower. The sandstone and shale strata from which the water of these wells is derived are shown in the bed of a nullah which cuts the ground between the wells.

The water in these wells is clear, and contains a hardness of 8 to 10 degrees Clark's scale, none of which is removable by boiling. It is suited for some domestic purposes, but the risk of pollution from surrounding habitations renders it unsafe for drinking.

Biological and chemical analyses of all these supplies are being conducted as rapidly as circumstances and the lack of equipment and material permit. Major Eckersley is personally interesting himself in carrying out the details of these analyses.

Condition of Surface Soil.

The condition of the surface soil may be described very briefly. The northern slopes of the town lands, with the exception of a small area between the railway and the Utrecht Road above the site of the present camp of the Brigade Division of Artillery, have been camped over during the last 2 years by large bodies of troops. The ground surrounding Fort Amiel and Kitchener's Kop has in addition been occupied by a large number of remount, sick depôt, and other animals. There is evidence everywhere of latrine and refuse trenches; refuse has also been dumped down in heaps irregularly all over the surface of the slopes. It is difficult without actually opening up the trenches, one by one, to say what is refuse, what is latrine soil, and what is ordinary defence works; but the general result is that, indubitably, the northern slopes contain the largest area of what may be described as polluted surface soil.

Further, these northern slopes are, as already noted, intersected by several dongas, all of which have collected a certain amount of camp refuse and dead animals. Fortunately, with the exception of Spring (8) in Table I, all this polluted surface is *below* the level of the springs.

The southern slopes have been less generally polluted by encampments, the upper half of the slopes leading to the Rooi Pynt ridge being comparatively free from signs of previous occupation.

The eastern slopes are the cleanest, and have apparently received very little camp pollution. They surround, however, the most polluted portion of the river.

The ground to the west of the township does not form part of the town lands, but it, too, has been camped over to a considerable extent.

Some sites on the top of Rooi Pynt have also been used as encampments, and latrines have been dug immediately above some of the springs, *e.g.*, Springs (11) and (12) of Table I. The amount of occupation in proportion to area is, however, less than on the northern and lower parts of the southern slopes of the town lands.

Sanitary administration and Sanitary arrangements of the Township.

These have an important influence on the health of any garrison situated in the vicinity, and I have examined them in detail.

At present the sanitary administration is vested in the Borough Corporation, who make their own bye-laws; but they again are under the control of the Public Health Act of the Colony, which was issued on the 26th August, 1901, and which remains in force till 31st December, 1902.

This Act is of the highest importance, as it indicates the standard of sanitation which the Government of the Colony seeks to establish.

It provides for the following essential principles in dealing with the public health :—

(1.) A supreme sanitary authority, and division of the Colony into sanitary districts, each under a medical officer of health, with a staff of sanitary inspectors.

(2.) Regulations for the abatement and prevention of nuisances, such as prevention of overcrowding, ventilation and cleanliness of habitations, drainage and removal of foul water and refuse, inspection of habitations, stables, &c.

(3.) Inspection and supervision of meat, milk, fruit and other supplies.

(4.) Prevention of pollution of "streams, rivers, wells and other water, and of watercourses," and compulsory "disposal of noisome or foul discharges, dirt or refuse, so as not to enter or be drained into any such water or watercourse."

(5.) Sanitary control of noxious trades and factories.

(6.) Notification of infectious diseases.

(7.) Disinfection or destruction of infectious articles, and purification of buildings, &c.

(8.) Provision for special action being taken during epidemics.

A series of general sanitary regulations have been made by the Governor in Council under Section 8 of the Public Health Act. These regulations give in detail the requirements of the Act under the above headings, and define the duties of townships, villages, and local authorities. Both the Act and regulations are admirable, and cover in a thorough manner the requirements of sanitation as applied to communities in modern times.

It has, however, two weak points, which are almost bound to lead to the Act becoming a "dead letter."

The first of these weak points is that the Act is in force only till the end of this year. What is to happen then? So far as Newcastle is concerned nothing has apparently been done as yet to fulfil the clauses of the Act, and no Public Health Act will ever be of practical use in influencing the public health if it depends for its existence on annual renewals at the will of a representative legislative assembly.

All sanitary measures, when they are initiated, cause flutters and discontent in communities that are accustomed to their own ways of dealing with sanitation. On this account the Public Health Act might, at any moment, be thrown out by representatives of the people in a parliament selected by popular vote, and the danger of this is far greater in the early years of the operation of such an Act than after its beneficial influence has commenced to be appreciated.

The second weak point is in the appointments of health officers of local authorities.

In Newcastle there are two health officers appointed under the Act, one the health officer of the township (Dr. Nolan) and the other the health officer of the magisterial division (Dr. Ormonde). Dr. Nolan has just come to the town, on appointment as health officer, and is paid 100*l*. a-year, 75*l*. of which are recoverable from the town; but he has to depend on private practice as his main source of income, and zeal and determination to carry out sanitary reforms are not always compatible with obtaining an income from this source. Hence the very important powers vested in the health officers under the Act run a certain amount of risk of not being fully utilized. Further, the health officers are not required to possess any special qualification in state medicine or public health.*

For these two reasons, so far as any real improvement under this otherwise admirable Act is concerned, the Act need never have been promulgated. The only object that can be seen in its promulgation is that it will no doubt pave the way towards enactments placing it on a more permanent and sounder basis. When this has been done great and rapid improvement of the health of communities in Natal may be expected, and garrisons stationed there will reap the benefit.

As regards the sanitary administration and sanitary arrangements of the township of Newcastle itself, regulations under the Public Health Act, 1901, may be regarded as an unconsidered quantity. Beyond the fact that a health officer has been appointed there is no evidence that the other sections of the Act are being enforced, and the sanitary regulations, on which the sanitary arrangements are based, are contained in the bye-laws of the borough, which took effect from the 18th January, 1896. These bye-laws contain 50 sections and 388 paragraphs.

The sections relating to sanitation, directly or indirectly, are—

Section XV.—Sanitary, dealing with nuisances.
" XVI.—Removal of nightsoil.
" XVII.—Inspection of food and drink.
" XVIII.—Slaughterhouses.
" XIX.—Dairies.
" XXII.—Buildings.
" XXXIV.—Waterworks regulations.
" XXXV.—Watercourse regulations.
" XLV.—Cemetery regulations.

It will be convenient to note the actual state of the town as regards these various points.

With regard to nuisances, the town may be described as fairly clean. It is divided into erf plots,† on which one or more buildings are erected. The better class occupiers keep their plots tidy and have them laid out, as a rule, in gardens; but many plots, notably in the business centre of the town, are untidy and covered with old tins and refuse of all kinds, although the refuse is, generally speaking, of an inoffensive character.

* I do not intend these remarks to be in any way personal They merely enunciate a well-known principle in state medicine or public health. Dr. Nolan is as much imbued with a desire to see sanitary reforms carried out as I am; but he naturally feels the limitations which are associated with a position more or less dependent on the goodwill of the town itself.

† A Newcastle erf appears to be 150 feet frontage with 190 feet depth.

The arrangements for removal of waste products are as follows :—

There is no system of public drains, the only drains being surface channels, bricked or earth ditches, at the sides of the streets, for the removal of storm water. Channels from private houses may lead into these, but for the removal of rain water only. There are no public or private channels or drains for the removal of slop or foul water. This has to be disposed of by the inhabitants on their own plots of ground and the intention of the administration is that it should be used for watering gardens; if not so used, it soaks into the ground. Rain water is generally collected in tanks and used for domestic purposes; otherwise it, also, soaks into the ground and into the foundations of the house, unless the owner has run a rain-water channel into the street surface drain.

The only foul matter removed by the municipality, therefore, is the night-soil and the dry refuse. For the night soil each owner of a house is obliged to erect a privy, not nearer than 15 feet from any dwelling house or public thoroughfare, and so constructed as to contain one of the municipality's night-soil pails. There must be one such pail for every seven inhabitants.

During the night these pails are collected and the contents emptied into a galvanized-iron tank wagon of 350 gallons capacity; or into a tip-cart of of about 150 gallons capacity. The municipality have one cart of each description only for the removal of nightsoil from the town. The pails are emptied, in consequence, only three times weekly. The pails, after being emptied into the tank, are carried away on the wagon, clean pails being left in the privy in their place.

The carts convey the soil to trenches in a field near the river and about $\frac{3}{4}$ mile below the town. The pails are also cleaned and disinfected there, and return on the carts to replace those removed during the night. *See* photograph, Appendix, General Report.

Until recently the nightsoil was "tipped" into large pits by the side of the river and about $\frac{1}{2}$ mile below the town, the pails being washed in the river. The spot has become known as "Stink Drift," and old nightsoil pails can still be seen accumulated on the bank and lying in the river there. *See* photograph, Appendix, General Report.

At present the soil is placed in trenches measuring 5 feet wide by 2 feet deep and 155 feet long. Three or four such trenches have been dug at distances of about 60 feet between each and parallel to one another; it takes several tank loads to fill trenches of these dimensions. Thus, to fill one of these trenches to within 1 foot of the surface would take over 9 days at 500 gallons daily, the amount which the equipment of the municipality is able to deal with at present.

If only 6 inches of soil are deposited in these trenches it would still take nearly 5 days before they are ready to be filled in. They remain uncovered, therefore, for several days, and the stench from them is most offensive and unbearable; fortunately the stench is not perceptible within the limits of habitations even in high winds. No dry earth is used in the pails and the trench area is not cultivated.

The work of removal of soil, depositing in trenches, and cleansing and disinfecting pails, is carried out by native labour, under the supervision of the superintendent of police, who is chief sanitary inspector. There are also two European and six native constables acting as sanitary inspectors, and the number of labourers employed in sanitary work by the municipality is 24 Kaffirs.

Refuse is removed in an open ox-wagon, the municipality possessing two such wagons for the purpose. Refuse is stored in boxes, barrels, or other receptacles, pending removal. The bye-laws do not compel the use of any kind of "sanitary bin," although the Regulations of the Public Health Act do. The carts convey the refuse to an area of some acres fenced in with barbed wire on the banks of the river just above "Stink Drift," where it is deposited on the surface in heaps, all combustible matter being burnt. Pigs are allowed to live in this enclosure, and the slaughterhouse is in the vicinity. *See* photograph, Appendix, General Report.

Stable refuse has to be removed by owners, otherwise the municipality removes it at a charge of 5*s.* per load. Food and drink may be inspected at any time by the inspector of nuisances (*i.e.*, the superintendent of police), who may have any articles, which he thinks unfit for food, destroyed by order of the Mayor. At present, the only butcher meat being sold locally is refrigerated meat obtained from Durban, and the slaughterhouses are not in use.

The articles of drink which specially require sanitary supervision are the aerated waters. There are three factories in the town producing these. In all the town water supply is used. In one, the water is filtered through a 3-candle Berkefeld pressure filter, and the bougies replaced and cleansed every third or fourth day; in another, there is no sterilizing filter, but a filter of blotting paper is used; in the third, a 3-candle Berkefeld filter is connected with the bottling apparatus, but the present manager stated that he did not know what was inside it; he had never opened it. In all three factories the bottles are rinsed and washed in tubs or troughs with town water; but in the first factory only had the water any appearance of cleanliness. The washing is done by natives, and by hand.

Bakeries are above ground, but the kneading of the dough is done in the oven room by natives and by hand. The natives whom I saw employed in this work wore dirty clothing, and worked in dirty, or at any rate, untidy surroundings.

There are two slaughterhouses, at present unused, but no slaughtering is permitted except at these. They are not slaughterhouses in any special sense of the term, but merely gallows fixed in the open fields near the town, with a galvanized-iron enclosure or pound adjoining. The bye-laws of the municipality provide for more elaborate slaughterhouses than these.

Dairies, cowsheds, and milk shops have to be licensed. At present there are no milk shops, and only one place which can be called a dairy or cowshed; this is a farm in the portion of the town known as Paradise, on the banks of the river, where the town commences. The farm contains 30 cows, which graze on the town lands during the day. No milk is stored on the premises, as the milk is at once filled into imperial pint bottles and sent direct to customers, 6*d*. being charged for each bottle full. The bottles are corked with ordinary corks, are of all kinds and descriptions, and are washed by hand by a native servant in the open farmyard. The process of washing consists of filling the bottles with pebbles and water and rinsing out; the rinsings being passed from one bottle to the other, until the water is so foul as to require renewal. Town water is used but there is a surface well on the premises, and the river is close at hand. There were two cases of enteric fever in the family of the owner recently.

The bye-laws regarding buildings provide for surface drainage, open space, superficial area and height of rooms, and rendering of inside walls, so as to enable them to be limewashed, as well as for the prevention of building over fouled soil. The houses generally seem to be well and substantially built of brick, well raised above the ground on good solid foundation and with corrugated-iron roofs.

The waterworks regulations provide for occupiers of houses having water laid on, for control of fittings, pipes, &c., and for the protection of water areas, reservoirs and channels. At present, the municipality water is collected from a few springs issuing along a line of sandstone outcrop about 100 feet below the top of the Signal Hill and Windsor Castle Ridge. The water from these springs is clear and good, but the yield of each spring is small, the total yield, as noted in Table I., from the pipe into which the pipes from the various springs converge, being only 21,000 gallons daily, or less than 10 gallons per head of population, irrespective of troops.

The diagrammatic sketch, appended, indicates two methods by which the town water supply is collected at its source. The old method (Fig. 1), allows a considerable amount of surface water to percolate into the collecting pits and, after rain, the water collected in this way is muddy; the filtration through broken stones is insufficient to prevent this. The second method is much more satisfactory, but in order to obtain any considerable yield of water each individual spring must be carefully traced to its course in the rock, enclosed as shown in Fig. 2, and collected into a subsidiary reservoir common to them all. Some attempt at this is being done, but these subsidiary reservoirs or catchpits have loose stone covers, and the fact that they are being used by natives or others was indicated by the stone covers being invariably found removed, and I saw chunks of bread and other foodstuffs in one of the catchpits.

The reservoirs into which the yield of these springs eventually discharge are situated on the slope of the Signal Hill Ridge at a level about 200 feet above the town. There are three reservoirs, but one only is used. They are built above ground, or rather in an excavation, and are of ordinary masonry work, not rendered with cement or other smooth material. There was only about 2 feet of water in the reservoir, and the surface was covered with frog spawn. The reservoirs are uncovered, but wire netting with wide mesh is stretched over the top.

Catchpits connected with these reservoirs were very foul, as if dead animals were putrefying in them. They did not seem, however, to be used for storing or receiving water, either before entering or after leaving the reservoir.

The water is conveyed to the reservoir from the springs in galvanized-iron pipes with screw joints. The pipes are carried on to the surface or slightly under the surface, but in crossing dongas they are carried above ground from bank to bank. The joints are not altogether reliable; at any rate, one of the joints where the pipes crossed a donga was leaking. The mains are 5-inch cast-iron pipes with yarn and lead joints; they are carried under ground. The supply is intermittent, and is liable to be cut off for long periods during the 24 hours.

During the rains, most occupiers of houses collect the roof water for domestic purposes, and the demand on the town supply is less than at present, when the supply is at its lowest.

A new water scheme is in course of construction, and, it is stated, will be ready in 5 or 6 months. The scheme consists of pumping water from the river at an intake about 3 miles above the town to a reservoir, from which it will be led into the existing mains. This intake is at the middle of the third section of the river which I have already described, and the water is not only a much more polluted water than the existing spring water, but is also turbid. To obviate these defects the municipality are constructing filter beds in connection with the reservoirs. The pipes to be used in connection with the scheme are 5-inch cast-iron pipes with yarn and lead joints.

I can see no advantage in this scheme beyond the increase in the quantity of the town water supply.

As regards quality the supply will be distinctly inferior to the present supply. The filtration process will require careful watching, and the water from the filter beds should be analysed chemically and biologically at frequent and regular intervals. If a river water supply were contemplated, the intake should have been well above the waterfall, where a clear and comparatively safe water can be obtained by gravitation. This, too, is the recommendation of Mr. Humby, the civil engineer, who was asked to report on a water supply from the river.

Mr. Humby, however, selects an intake, which, in my opinion, is not far enough above the falls. It is at the spot where the banks have been polluted by the latrines and refuse of adjoining camps. The corporation are willing to extend their intake to the point I have suggested if there were a permanent garrison here.

The bye-laws relating to the watercourses refer no doubt to the prevention of fouling of watercourses leading to the town water supply. As open watercourses do not exist in this connection, these bye-laws appear to be in abeyance. There is no evidence of their being made applicable to streams, dongas, or river.

The cemetery regulations, so far as sanitation goes, refer only to the dimensions and sites of graves and to exhumations. No mortuary is provided, and the cemetery itself is partially on marshy ground, which has to be drained.

There are no public laundries, and the washermen use the river, more especially at the point where it passes the dumping ground for the town refuse, about 100 yards above "Stink Drift." The clothes are dried in the sun on the bank opposite the refuse ground.

See photograph, Appendix, General Report.

The rates levied on rateable property for general purposes is 3½*d.* in the £, and the water-rate ½*d.* in the £ of assessed freehold value. The total rates levied amount therefore to 4*d.* in the £.*

This assessment produced an income for general and sanitary purposes

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* The assessed freehold value includes the value of the land + the value of any building on it. Thus one property is valued at 200*l.* land + 1,050*l.* house, and the rate levied is 4*d.* in the £ of a freehold assessed value of 1,250*l.*, or 20*l.* 16*s.* annually. This rate is equivalent to the rates levied on assessed rental of houses in English towns, and may be considered comparatively high.

and water supply of 2,278*l*. in 1901, for an estimated population of 2,500, the total income of the municipality from all sources being 5,506*l*.

The rate is higher than the rates levied in any other township in Natal.

Some of the figures illustrative of this are shown in Table IV., which has been compiled from data in the Statistical Year Book of the Colony for 1901.

Two other localities require consideration in connection with the civil surroundings of a garrison at Newcastle. Marching with the western limit of the town, there is a locality known as Lennoxtown. It is practically a suburb of the town, contains a colliery, and a tweed factory, the latter being at present out of use; but as those form the two industries of Newcastle, numerous houses are being built in incipient streets over the area. These houses are under no sanitary jurisdiction beyond that of the district health officer.

They have no water supply or drainage or sewage disposal systems; yet it is here that the prostitute class, who are not allowed to ply their trade within the town jurisdiction, are congregating, and it is here, therefore, that the garrison is likely to acquire disease.

The other locality is the railway station. The sewage disposal of the station staff and waiting rooms is carried out by the municipality, by the pail system, and the general condition of latrines, &c., is fairly satisfactory, or can be easily made satisfactory.

The water supply is town water, but there is a water tank for feeding engines, about 300 yards from the station, adjoining the military supply depôt and fed from what I have described as the fourth section of the river. There is a tap below the tank supplying a railway laundry, and any soldiers working in the supply depôt or on the hospital trains, which usually lie up on a siding in the neighbourhood, would find this tap the most accessible for their water supply. Town water is laid on to the station itself.

Native kraals are not numerous in the neighbourhood, and consist, with one or two exceptions, of a few huts only. Their water supply is from unprotected springs near at hand; indeed, these natives do not appear to form their kraals near the river or to use river water.

Natives living in the town are under the same sanitary restrictions as other inhabitants, but at certain places on the outskirts of the town there are screened trench latrines for the use of natives.

These notes describe many faults in connection with the sanitary arrangements of the township and the locality which will be apparent to anyone conversant with sanitary administration, but the corporation itself and their officers, at any rate all with whom I have come in contact, have shown the keenest interest in being made acquainted with local defects, and are anxious, if they could only be assured of the permanency of a garrison here, to carry out improvements, such as an alteration in their methods of collecting and disposing of sewage, erection of a dust destructor, and extension of water supply intake to well above the waterfall.

Vital Statistics.

The population of Newcastle is estimated at 1,400 Europeans, 700 natives, and 400 Indians, a total of 2,500, living in 355 houses.

The age and sex distribution cannot be estimated from published documents, except for the whole division, neither can the deaths of the township be disintegrated from those of the division; but both these elements in vital statistics indicate to some extent the main features of the health of the locality.

With regard to age there is a preponderance of individuals living at the ages of low mortality, as compared with England and Wales. The estimated distribution per 1,000 is shown in Table V. Males are in excess of females, 544 per 1,000 as compared with 456 per 1,000.

Deaths are registered under a law of 1867, amended, with the object of facilitating registration, by Acts in 1894 and 1899. The death register has been examined from 1870 to 1898, a period of 29 years. The deaths recorded are almost all those of Europeans, and until the last year or two deaths amongst natives and Indians have apparently not been recorded in the registry.

The number of deaths recorded for these 29 years is 482, which is equivalent approximately to an annual death rate of 12 per 1,000 in a constant population of 1,400 Europeans. This is no doubt a high estimate of mean population for the period, and a 12 per 1,000 death rate must be regarded as below instead of above the actual mortality.

The age distribution would have a marked influence in lowering mortality in Newcastle, while the sex distribution would tend to raise it; but there are no data to enable a standard death rate and factor for correction for the locality to be worked out.

It is unfortunate that the Natal age groups do not correspond with those of the Registrar-General's age groups. If they did it would have been easy to work out the standard and factor for correction.

As regards the causes of death, 100 out of the 482 deaths are recorded as due to dysentery (24), "fevers" and enteric fever (46), croup and diphtheria (30); that is to say, over 20 per cent. of the deaths were due to these causes. Pneumonia is also a commonly recorded cause of death, 41 cases of deaths from this cause being recorded. 22 deaths are entered without any definite cause being assigned.

The distribution of deaths from the principal zymotic diseases in quinquennial periods is shown in Table VI. The total number, 139, gives a zymotic death rate of 3·5 per 1,000, which compares unfavourably with the standard for sanitary towns in England and Wales.

Local practitioners say that up till 1891 deaths from fevers were frequent, but that since 1891 the town has been very healthy. This is borne out by the statistics of 1892-93, but not by those of later years. In 1891 the water supply and pail system were introduced in place of wells and cesspits.

The health statistics of the military population during periods of occupation during the first and recent Boer war, and during the Zulu campaign, dealt with abnormal conditions. Table II. shows the incidence of dysentery and enteric fever in encampments during 1901–02, but these encampments were formed largely of troops coming in from the field to refit, and their statistics give no true indication of the incidence of locally contracted disease. They only indicate the relative amount of infection of soil that must have been going on in the encampments shown on the table. It may be mentioned that the camps in 1881 were in or near Fort Amiel, where the ground is Government ground.

Meteorological Observations.

These have been recorded in the Government Gazette since July, 1894. Any local records before then have been lost along with subsequent records during the Boer occupation of the town in 1899–1900. The observations recorded are only the maximum and minimum shade temperature and the rainfall. There are no wind or humidity records.

With regard to temperature, the mean of the maxima for the coldest month, July, varies between 63 and 72 degrees Fah.; the mean of the minima for the same month varying between 32 and 41 degrees Fah. The means for May and June differ, however, but slightly from those of July.

For the 6 months, October to March, the mean of the maxima exceeded 80 degrees Fah., the highest being 91·9 degrees Fah. for December, 1898. The mean of the minima for these months has varied from 48·3 degrees in October, 1895, to 66·0 in October, 1897; the average being about 60 degrees Fah.

As regards absolute maximum and minimum, the highest recorded shade temperature is 103 degrees in November, 1897, and the lowest 25 degrees in July, 1898.

The total rainfall has varied from 28·63 inches, for the season 1st July, 1896, to 1st July, 1897, to 41·59 inches for the season 1st July, 1894, to 1st July, 1895. Little or no rain falls in June, July, and August. In April, May, and September the fall is usually under 1 inch, although in May, 1898, 3·43 inches were recorded, and in April, 1896, 3·67.

The heaviest rainfall is in December, January, and February, the maximum recorded in these months being 9·32 inches in February, 1896. Six to 8 inches appear to be a normal record for those months, but there is considerable irregularity in the time and amount of fall. Thus, March, which is not one of the wettest months, has a record in 1895 of 9·11 inches.

The number of days on which rain fell was 19 as a maximum for January, 1898, and February and December, 1899. The heaviest shower was 3·78 inches in March, 1895.

These somewhat scanty meteorological records are sufficient to indicate some of the characters of the climate, namely, dry winters, with considerable warmth, if not heat, during the day, and cold nights; and summers with a moderate rainfall, hot days and cool nights.

During the summer sudden variations of temperature are common, hot days being succeeded by cold after heavy rain, and there is at all times great diurnal variation.

Dryness of atmosphere is a marked feature, though actual records of humidity are wanting, and, from a hygienic point of view, the climate may be described as bracing and stimulating during the greater part of the year.

Conclusions.

(1.) The physical and climatic characters of the district surrounding Newcastle and the general configuration of the locality are well suited, from a hygienic point of view, for barracks.

(2.) The best sites on town lands are the upper portion of the slopes rising to the south of the town, and there is sufficient area on comparatively clean ground for two battalions of Infantry, a brigade division of Artillery, a regiment of Cavalry, hospital and other accessories, if the ground to east and west of the Dundee road is utilized.

(3.) The slopes around Fort Amiel and Kitchener's Kop specially, and the northern slopes generally, have been largely occupied by troops, and good sanitary sites on these slopes are not obtainable, or are obtainable only in patches. No portion of these slopes can be recommended as sites for permanent garrison, with the exception of the areas that lie above the existing Artillery camp between the Utrecht road and the railway. This area is large enough for a regiment of Cavalry or brigade division of Artillery, but not for the whole garrison.

(4.) The eastern slopes are extensive, clean and ample for a large garrison, but their proximity to the more fouled portions of the river is objectionable.

(5.) Outside the limits of the town lands there are excellent sites on elevated plateaux, especially the plateau on the top of the Rooi Pynt Ridge above Osborne's and Grant's farms.*

(6.) The best water supply for the first and second of these sites, as regards quality, is from the springs along the Signal Hill or Rooi Pynt slopes, but the method of collection requires improvement and the water needs protection from the moment it leaves the rock. For the high plateau site river water taken from near the Drakensberg would be best, unless sufficient spring water from a higher level is obtainable.

(7.) As regards quantity, the amount of spring water that can be collected is estimated at over 100,000 gallons daily, and this would be ample for 3,000 troops.

(8.) The town scheme of a river water supply is not to be recommended, if the intake remains as proposed at present, but, both as regards quantity and quality, it would form a good supply if the intake is placed some distance above the waterfall.

(9.) The river water below the town is unsafe for any domestic purpose.

(10.) Water in local wells is suitable for bathing, but, without special measures of protection, it is unsafe for drinking. It is somewhat hard for laundry purposes.

* With reference to selection of sites on elevated plateaux, it is essential that water supplies should be obtained from a higher level, or, at any rate, not from spings immediately below, as the water in these is apt in time to receive the drainage, or a portion of the drainage, from the habitations above. This is well exemplified in the case of some of the Indian hill stations.

(11.) The sanitary administration of the town is ample for a good sanitary system, but the regulations of the Public Health Act are not being enforced.

(12.) The sanitary arrangements require considerable improvement and modification; the method of removing and disposing of sewage and refuse is insanitary; the protection of water supplies is insufficient; the bakeries, dairies and cowsheds, and aerated water factories require sanitary improvement; and proper slaughterhouses and laundries do not exist.

(13.) The principal diseases causing death indicate soil and water pollution, and insufficient or improper removal and disposal of filth and other waste products.

(14.) The suburb, Lennoxtown, is likely to become a menace to the health of any garrison, unless it is brought under sound sanitary control and administration.

(15.) Enteric fever will continue to be the prevalent disease unless the arrangements for prevention of soil and water pollution are perfected

Recommendations.

(a.) *For establishment of cantonments.*

(1.) Whatever site is selected should be mapped out and kept free from refuse dumping ground, latrines or encampments. Any existing refuse should be burnt and removed and the ground underneath covered with dried straw or grass and burnt. No ground on which there have been latrine trenches should be included in the site, nor should such trenches be within a short distance of the site.

(2.) The drainage and water supply systems should be completed before the huts or barracks are occupied.

(3.) The best method of sewage removal is the water-carriage system, and this could be readily applied by utilizing the town river water supply for flushing purposes. I would strongly recommend the introduction of such a system into any new garrison here. This would involve the provision of water latrines and w.c.'s to barracks and quarters, and a drainage system, constructed as laid down in the drainage manual. No one would think of introducing any other system in home garrisons where the water supply is sufficient, and in a country where enteric fever is endemic, a water-carriage system is imperative, wherever conditions of water supply and ground admit of it.

(4.) The final disposal of the sewage from the drains of a water-carriage system should be by land irrigation with or without septic tanks and filter beds, the configuration and surface soil of the slopes near the river are well adapted for broad irrigation and cultivation at a safe distance from barracks. The area required for proper land treatment by broad irrigation is 1 acre to every 300 persons, without bacterial treatment, or 1 acre for every 1,000 persons with bacterial treatment. Generally speaking, land treatment gives a safer effluent than bacterial treatment, and when sufficient ground is available it should be used. Bacterial treatment without subsequent land treatment is not recommended.

(5.) Should there be insuperable difficulties to the adoption of a water-carriage system (and, considering its advantages over any other system, expense should not be one of them, nor with an ample water supply from the river should want of water be another), the next best system is the American trough system. To carry this out properly the latrines should be provided with troughs and urinals (as described in the details already sent out from the War Office to South Africa), along with pneumatic vacuum carts for collecting and removing the contents.* The disposal of the contents of the carts should be by land treatment, as in the water-carriage system.

(6.) The pail system, with removal of nightsoil by carts which have to be filled by hand, is not a satisfactory system in any locality where enteric fever is endemic. Latrine flies are apt to abound, infected pails are carried about and brought to buildings and barracks previously free from enteric, and there is considerable risk of soil pollution from spilling of the contents while the carts are being filled. Wherever a pail system is employed the use of chloride of lime or other powerful disinfectant in the pails is imperative, and the expense, in the long run, is likely to equal that of a water-carriage system.

(7.) Huts should be raised on brick or stone plinths at least 2 feet high, and the soil immediately underneath covered with a layer of concrete or other smooth impervious material. The soil on the sites mentioned as suitable for barracks on the Newcastle town lands is dry and a thin layer, $1\frac{1}{2}$ to 2 inches, would be sufficient to maintain cleanliness of surface, and prevent the scourings from the floors soaking into the soil beneath the hut.

(8.) I understand that it is desirable to place Cavalry and Artillery barracks near the river, because of the facilities afforded for watering horses. I would strongly deprecate such a course, and would recommend that the watering of horses should be carried out by river water from the town supply, carried by gravitation or pumping to properly constructed watering troughs near the stables.

(9.) If the site recommended on the southern slopes near Rooi Pynt is to be occupied by barracks, the spruit running to the east of the slope should be cleaned, and the bottom of the channel bricked or otherwise made self-cleansing. This is essential in order to get rid of the numerous stagnant pools along its course. These form receptacles for all kinds of filth, and they are used for bathing purposes.

(10.) In order to prevent men bathing at undesirable places along the river, a swimming bath should be constructed in connection with the barracks, and be supplied with river water from the town supply.

(11.) The water for all purposes except for flushing, and bathing and watering horses, such as could safely be provided from the town river supply, should be collected from springs, as shown in Fig. 2 of the sketch, and all catchpits and reservoirs should be covered with close-fitting locked coverings, so as to avoid any contamination by surface dust, by natives or others. Such a supply, collected from various springs, would probably have to be pumped up to the level of the barracks from a collecting reservoir; but this is better than the river supply, unless the latter supply can be obtained from a point at a considerable distance above the waterfall.

(12.) I strongly recommend that in any new garrison a garrison aerated water factory should be established under sanitary control.

(13.) Finally, I would recommend that trees should be planted along the roads and approaches to any cantonment, in order to afford shade and break the dust storms, and that, as far as possible, the maintenance of grass plots and gardens should be attended to.

(b.) *Civil surroundings.*

(1.) It is understood that, when the new river water scheme is completed, the existing water supply and reserviors will be available for the use of a garrison. In any case, a thorough overhauling and examination of the collecting areas, catchpits, pipes and reservoirs are essential, and the catchpits and reservoirs should be cleansed and covered in such a way as to prevent any possibility of access to them by anyone except the official concerned with the waterworks.

* In the event of a water-carriage system being impracticable, I have been asked whether the slop water should be removed by surface drains or by closed drains. In my opinion the latter are preferable, as they are more self-cleansing. Surface drains, as can readily be seen in this country, become the receptacle of all kinds of filth; they get broken, and they cease to be self-cleansing.

(2.) Cleansing of river banks is essential. The habit of burying carcases and dumping refuse down along the river bank should cease, and properly mapped out and enclosed areas should be selected for this purpose at a distance from watercourses. Preferably such refuse should be disposed of in a destructor, and the heat generated by the destruction of refuse utilized for other economic purposes. For example, the destruction of refuse in the Borough of Fulham gives sufficient heat to supply electric lighting for the whole borough as well as for supplying the requirements of a large disinfecting establishment.

(3.) The removal and disposal of nightsoil by the pail system might well be replaced by a water-carriage system, when the river-water scheme is completed. This would necessarily involve a large capital expenditure ; but it would make a vast difference in the health of the locality.

In the meantime I should strongly recommend the purchase of two more filth carts of the same capacity as at present. The amount of nightsoil from a mixed community of 2,500 inhabitants is about 1,000 gallons fluid, and 500 lb. solids daily.

These together amount approximately to 200 cubic feet, and I should strongly recommend that the system of disposal of that quantity daily should be in a single furrow, which could be covered in immediately after the contents of the carts have been emptied into it

A furrow 1 foot wide and 1½ feet deep would require to be 400 feet long, if 6 inches depth of nightsoil is placed in it. These are the dimensions I should recommend for each furrow, allowing 1 foot of earth to be covered in over the nightsoil. The use of a suitable hose would enable the labourers to fill the trench from the carts rapidly and without fouling the edges of the furrow. Successive trenches should run parallel to one another at a distance of 1 foot apart.

For the disposal of the estimated amount of nightsoil (viz., 200 cubic feet daily), a plot of ground 730 feet by 400 feet would be required in one year ; and I would recommend that such a plot be mapped out and enclosed on suitable ground (*e.g.*, the ground near the present trenches), and the system of trench and furrow indicated above carried out, instead of the present system ; that is to say, a furrow 400 feet long should be dug and covered in daily. Such a plot at the end of the year should be cultivated and a fresh plot commenced for the next year. The system could be so arranged that each plot would be used alternately for cultivation and trenching, and intelligent management and supervision rather than expenditure of more money and labour are all that is required.

(4.) I would recommend a rigid application of the Public Health Act regulations to all places connected with milk supplies, and drastic reform in the method of washing aerated water bottles. Four successive washings are recommended, the last two in filtered water pinked with permanganate of potash ; and preferably spray washers should be used.

(5.) I would also recommend the construction of proper slaughterhouses as laid down in the regulations of the Public Health Act and the Town bye-laws.

(6.) The suburb of Lennoxtown should be brought under sanitary administration, and be provided with proper water supply and sewage systems, if there is to be a garrison in the neighbourhood.

I have gone somewhat fully into these details, although much more will require to be added if it is definitely fixed to have a garrison at Newcastle ; but if this is abandoned, much of what I have written will be found applicable to other localities, and the notes may not, therefore, be altogether useless.

The work of making definite scientific investigations of soil and water at a number of selected spots along the sites has been abandoned because of the delay involved in carrying the investigations out to a sufficiently complete extent to satisfy modern standards of research, but I would strongly urge that the laboratory equipment here be completed to enable Major Eckersley to continue the biological investigations which have been initiated in connection with my examination of the soil and water of the localities.

I have been unable to obtain any suitable plan of the locality to attach to this report, but the map accompanying it will serve to indicate many of the local features to which it refers. A few photographs are submitted which will also serve to illustrate some of the sanitary points noted.

In conclusion, acknowledgment must be made of the readiness with which all the borough officials placed their records and other sources of information at my disposal, and the keen interest which they took in any sanitary investigation I wished to make. There is an evident desire to improve the sanitary arrangements, so far as the resources of the town permit, and, should a garrison be placed here, there is little doubt that very great sanitary improvements would be made in the townships, and that it could be made a perfectly healthy locality.

W. G. MACPHERSON, *Major,*
R.A.M.C.

NEWCASTLE, NATAL,
16th October, 1902.

APPENDICES.

TABLE I.—SPRINGS in the neighbourhood of Newcastle, Natal, suitable for a Garrison Water Supply.

Locality of spring.	Approximate altitude above town.	Date of gauging.	Yield in gallons per 24 hours.	Remarks.
		1902.		
1. Spring below Signal Hill, used for filling watercarts.	250 feet at watering point, 375 feet at source.	27th Sept. . 4th Oct. ..	34,560 34,560	The yield was gauged at the pipes leading to the lower pond, and include the yield of two pipes filling the pond. The water was traced to a rocky stratum.
2. Spring on north slope of Windsor Hill.	..	27th Sept. .	43,200	The yield was gauged from two pipes entering pond.
3. Town reservoir ..	200 feet ..	27th Sept. . 4th Oct. ..	21,600 21,600	The yield was gauged from pipes entering the reservoir.
4. Small springs collected into town reservoir supply near Signal Hill.	350 feet ..	4th Oct. ..	480	Gauged from ¾-inch pipe leading from spring to catchpit.
5. Ditto	350 feet ..	4th Oct. ..	384	Gauged from ¾-inch pipe leading from spring to catchpit. These two springs are close together, and the water from each is led from the catchpits into a larger catchpit, which feeds the reservoir pipe.
6. Springs collecting into old waterworks catchpit.	280 feet ..	4th Oct. ..	7,200	An adjoining catchpit, giving a large yield, could not be gauged, as the pipe was inaccessible.
7. Spring near railway at east end of Windsor Castle Ridge.	..	27th Sept. .	8,320	The water is collected in a bog and pumped from tanks sunk in the bog.
8. Spring above Utrecht Road, about ¼ mile from town bridge.	..	27th Sept. .	528	A small spring low down on northern slope to river, below camping ground.
9. Artillery spring near Osborne's Farm.	195 feet ..	3rd Oct. ..	1,920	The spring is traced to rock and is collected into pond. Yield gauged from pipe leading to pond.
10. Osborne's Farm ..	205 feet ..	3rd Oct. ..	5,400	Spring issues in bog, is collected into duck-pond, and is led by pipe into ornamental pond. Yield gauged at pipe flowing into latter.
11. Rooi Pynt southern slope, near railway culvert.	250 feet ..	29th Sept. . 3rd Oct.	5,760	Issues from rock. Yield gauged from corrugated-iron channel. The yield only represents probably about half total yield, as there is considerable flow of water not entering the channel.
12. Rooi Pynt Spring, similar to and adjoining (11).	250 feet ..	3rd Oct. ..	(6,000?)	This spring has not been used, and there is no pipe or channel for gauging, but the yield appears similar to that of 11, and an approximate estimate is entered in brackets.

TABLE I.—*continued.*

Locality of spring.	Approximate altitude above towns.	Date of gauging.	Yield in gallons per 24 hours.	Remarks.
		1902.		
13. Rooi Pynt Spring at north-east end of ridge, known as the Coal Pit Spring.	200 feet ..	3rd Oct. ..	?	No proper means of gauging. The yield is, however, large, and probably equal to that of 1 or 2.
14. Spring near (13) ..	200 feet ..	3rd Oct. ..	?	This is also an ungauged spring, with a considerable flow down a sandstone channel.
15. Springs on hillside between Grant's Farm and Dundee Road (Rooi Pynt).	300 feet ..	3rd Oct. ..	?	These are springs oozing out into bogs, which, if cleared, would probably give a considerable yield.
16. Springs of farm east of Dundee Road (Rooi Pynt).	300 feet ..	3rd Oct. ..	?	A large yield of water near farm-house, supplying ornamental lake and duck-pond.
17. Springs about ½ mile to west of Osborne's Farm, under Rooi Pynt, west end of ridge.	200 feet ..	7th Oct. ..	?	These are springs oozing out into bogs, giving a considerable yield.

N.B.—Apparently, only 3, 4, 5, 6, 7, 8 are on town lands; the remainder are on private property, and 10 and 16 are used by farmhouses, 13 and 14 by native kraals; 4, 5, and 6 feed 3, and their yield would be included in the yield of 3.

TABLE II. (A).—DISTRIBUTION of Enteric Fever and Dysentery in localities occupied by Troops around Newcastle. 1901.

Locality.	Average annual strength.	Admissions, enteric.	Admissions, dysentery.	Total admissions, enteric and dysentery.	Percentage admissions to average annual strength.		
					Enteric.	Dysentery.	Total enteric and dysentery.
Fort Macready	4	4	..	4	100·0	..	100·0
Umbana	89	22	14	36	24·7	18·1	42·8
Fort Hay	15	5	..	..	40·0	..	40·0
Dannhauser	16	5	1	6	31·2	6·2	37·4
Fort Biddulph	25	5	2	7	20·0	8·0	28·0
Donga Spruit	12	2	1	3	16·6	8·3	24·9
Fort Metcalf	35	6	2	8	17·1	5·7	22·8
Allcocks Ridge	14	2	1	3	14·3	7·2	21·5
Kitchener's Kop	115	20	5	25	17·4	4·3	20·7
Konigsberg	160	27	6	33	16·8	3·7	20·5
Fort Amiel	67	7	5	12	10·4	7·4	17·8
Ingagane	72	9	3	12	12·5	4·1	16·6
Utrecht	495	64	17	81	12·9	3·4	16·2
Windsor Castle	31	5	..	5	16·1	..	16·1
Rooi Pynt	80	10	2	12	12·5	2·5	15·0
West End Fort	49	4	2	6	8·1	4·1	12·2
Signal Hill	53	2	3	5	3·8	5·6	9·4
Fort Cowan	22	2	..	2	9·1	..	9·1
Fort Maxim	18	1	..	1	1·5	..	5·5

Calculated from lists in office of Principal Medical Officer, No. 14 General Hospital. The returns commence for week ending 28th February, 1902, but the strengths are reduced to an annual average.

The strengths for the camps in the town itself are not obtainable but more than 200 cases occurred in them in 1901.

TABLE II. (B).—1902 (January to September).

Locality.	Average annual strength.	Admissions, enteric.	Admissions, dysentery.	Total admissions, enteric and dysentery.	Percentage admissions to average strength. Enteric.	Dysentery.	Total enteric and dysentery.
West End Fort	3	3	..	3	100·0	..	100·0
Supply Depôt	10	3	..	3	30·0	..	30·0
Transport Depôt	15	1	2	3	6·6	13·2	19·8
Fort Metcalf	17	1	2	3	5·9	11·8	17·7
Fort Biddulph	25	4	..	4	16·0	..	16·0
Fort Amiel	112	7	10	17	6·2	9·0	15·2
Defence Camp of Newcastle	600	51	36	87	6·5	6·0	14·5
R.A.M.C. Camp and General Hospital ..	130	12	4	16	9·2	3·1	12·3
Rooi Pynt	40	3	1	4	7·5	2·5	10·0
Royal Engineer Camp	41	2	2	4	4·9	4·8	9·7
Signal Hill..	23	1	1	2	4·3	4·4	8·7
Utrecht	335	19	5	24	5 6	1·5	7·1
Ordnance Camp	25	1	1	2	4·0	4·0	8·0
Fort Hay	328	7	18	25	2·1	5·5	7·6
Ingagane	27	1	1	2	3·7	3·7	7·4
Konigsberg	189	11	2	13	5·8	1·1	6·9
Kitchener's Kop	648	25	28	53	3·8	4·3	8·1
Umbana	46	2	1	3	4·3	2·2	6·5
Windsor Castle	352	2	2	4	0·5	0·5	1·0
Sick Horse Depôt..	6	..	..	..	..	..	..
Remount Depôt	100	..	..	..	..	..	..
Rust Port	6	..	..	..	..	..	..
Fort Maxim	75	1	..	1	1·3	..	1·3
Donga Spruit	6	..	..	..	..	..	..

Calculated from lists obtained from Head-quarters Office, Newcastle, reduced to an annual average. The admissions are to date (end September). A few cases of enteric fever and dysentery shown in the return are omitted as not being traceable to the strengths shown.

TABLE III.—Monthly Distribution of Admissions for Enteric Fever and Dysentery from Camps in and around Newcastle (including Utrecht).

Months.	Enteric.	Dysentery.	Total Enteric and Dysentery.
1901.			
January	67	1	68
February	92	14	106
March	73	13	86
April	53	5	58
May	57	14	71
June	19	3	22
July	10	1	11
August	6	1	7
September	4	7	11
October	15	24	39
November	15	21	36
December	32	20	52
Total	443	124	567

TABLE III.—*continued.*

Months.	Enteric.	Dysentery.	Total Enteric and Dysentery.
1902.			
January	49	23	72
February	21	13	34
March	26	12	38
April	9	7	16
May	23	28	51
June	17	21	38
July	5	5	10
August	4	6	10
September	10	6	16
October	..	..	..
November	..	..	..
December	..	..	..
Total	164	121	285

TABLE IV. (A).—RATES levied on each £ of Assessed Freehold Value of Property.

1901.

Township.	General purposes rate.	Water rate.	Total.
	d.	d.	d.
Pietermaritzburg	$2\frac{1}{2}$	$\frac{1}{4}$	$2\frac{3}{4}$
Durban	2	$\frac{1}{2}$	$2\frac{1}{2}$
Ladysmith	2	$1\frac{1}{2}$	$3\frac{1}{2}$
Dundee	3	$\frac{1}{2}$	$3\frac{1}{2}$
Greytown	2	Nil	2
Verulam	$1\frac{1}{4}$	Nil	$1\frac{1}{4}$
Newcastle	$3\frac{1}{2}$	$\frac{1}{2}$	4

TABLE IV. (B).—COMPARATIVE Table of Municipal Expenditure for Sanitary purposes.

1901.

Township.	European population.	Total population.	Expenditure per head of population. Sanitary purposes. European population.	Sanitary purposes. Total population.	Water supply. European population.	Water supply. Total population.	Total municipal expenditure per head. European population.	Total municipal expenditure per head. Total population.
			s. d.	s. d.	s. d.	s. d.	£ s. d.	£ s. d.
Pietermaritzburg	18,500	30,000	7 6	4 7	10 0	6 2	4 4 0	2 12 0
Durban	28,000	57,000	14 6	7 3	6 8	3 6	7 14 0	3 16 0
Ladysmith ..	2,509	4,959	4 8	2 5	5 1	2 6	4 0 0	1 12 0
Dundee	1,150	2,280	16 3	8 1	15 5	7 8	4 8 0	2 4 0
Greytown ..	800	1,300	7 0	4 3	Nil	Nil	2 2 0	1 6 0
Verulam ..	237	673	Nil	Nil	Nil	Nil	2 8 0	0 16 0
Newcastle ..	1,400	2,500	15 2	8 6	1 6	0 $9\frac{1}{2}$	4 2 0	2 6 0

TABLE V.—AGE and Sex Distribution of European Population in the Newcastle Division.

1898.

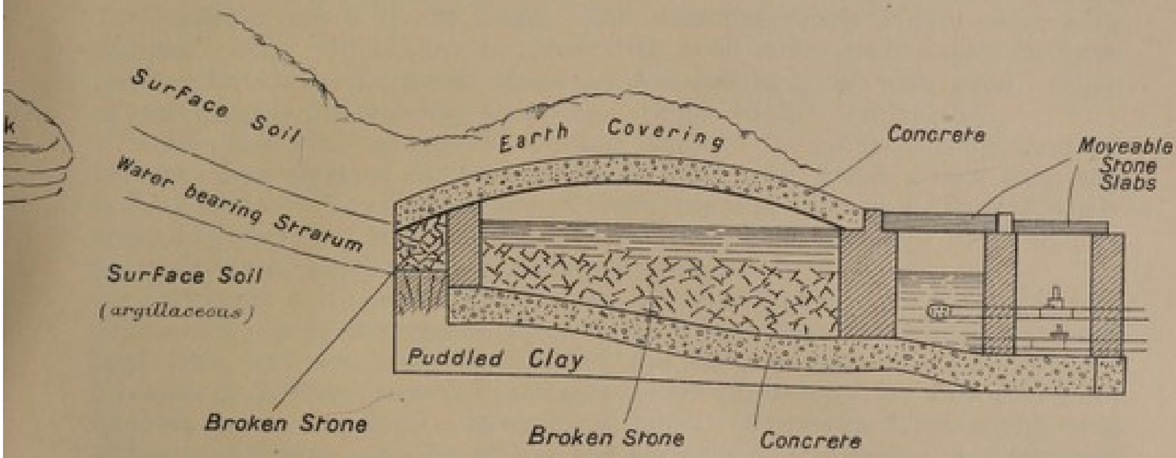
Age group.	Males.	Females.
	per 1,000.	per 1,000.
Under 5	78	84
5 to 10	64	74
10 „ 15	62	50
15 „ 20	52	56
20 „ 30	112	91
30 „ 40	87	40
40 „ 50	49	36
50 „ 60	29	19
60 „ 70	8	3
70 „ 80	2	2
80 „ 90	1	1
Over 90	..	..
All ages	544	456

TABLE VI.—DEATHS from principal Zymotic Diseases amongst the European Population, Newcastle Division.

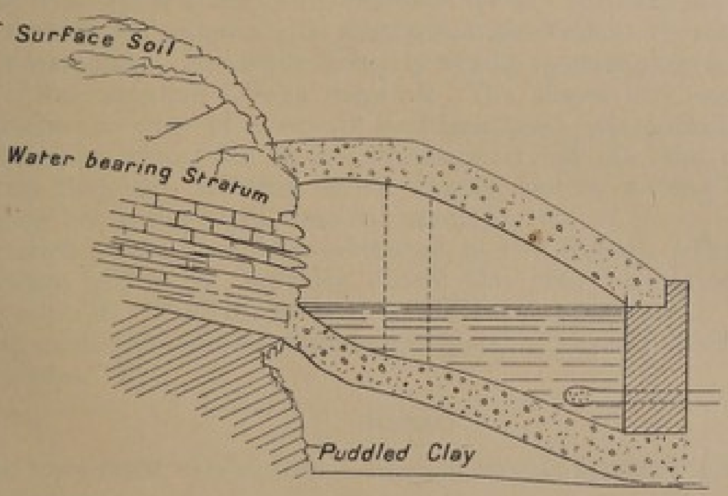
	1870–74.	1875–79.	1880–84.	1885–89.	1890–94.	1895–98.
Small-pox	Nil	Nil	Nil	Nil	Nil	Nil.
Measles	..	..	..	2	5	1
Scarlet fever	..	..	..	..	..	..
Diphtheria	4	4	2	7	6	8
Whooping cough ..	..	2	2	3	..	1
Fever { Typhus, Enteric, Continued } ..	2	10	13	6	13	2
Dysentery	3	2	4	7	4	4
Diarrhœal diseases ..	..	4	4	2	5	7

DIAGRAMMATIC SKETCH OF METHODS OF COLLECTING WATER FROM SPRINGS: NEWCASTLE, NATAL.

(1)



(2)



(1) Old method of collecting water from springs for town reservoir supply.

(2) Improved method.

W.E.M.

(1903. 1180) 232-18 w.o.

SUMMARY OF NOTES ON MOOI RIVER, HOWICK, AND PIETERMARITZBURG AS SITES FOR THE PERMANENT GARRISON OF NATAL.

Mooi River.

The remount depôt site is not recommended. It is too extensively covered with horse lines, and there is no adequate water supply from a pure source.

The existing supply for drinking and domestic purposes yields about 1,500 gallons only in the 24 hours. The remaining supply is river water at a polluted source. Ideal sites, *i.e.*, sites with good and gentle slopes, facilities for sound methods of disposal of sewage and drainage, and with good quality of water supply conveniently accessible, are not readily obtainable.

The best site, as regards soil and facilities for proper arrangement of barracks is an elevated site west of the Estcourt road, about 1 mile from the railway station. The site is however much exposed to cold south-east winds and mists, prevalent at present, and there are dolerite outcrops and ridge in proximity to it, which are said to attract lightning.

The next best site is the upper part of the slope rising from the old racecourse and east of the road to Greenfield Farm. Both these sites are town land sites, and are large enough for the Cavalry regiment and Brigade Division of Artillery, provided the barracks are constructed (as they should be) of brick and on the plans of barracks at home. Otherwise there might be a difficulty in finding room for stables and barracks on the second site for both mounted branches. The first site would however be large enough. There will be difficulty in obtaining a good clear spring water for either site, but there are certain springs about ½ mile from the first site and higher up, which, if conserved according to the method recommended in the Report on Newcastle, would give a good drinking water supply (by gravitation) for either site.

The river water is ample in quantity for all purposes, but would require a proper waterwork scheme with permanent supervision to render it safe for domestic purposes. The chief difficulty will be in arranging a sound sanitary system of drainage and sewage disposal. The slopes are too steep and too near the river to allow of adequate land treatment before discharging into the river, and there is no other line of drainage except into the river at a point higher up than the remount depôt supply, unless a long line of drains discharging below the depôt were constructed.

Detailed proposals will be submitted in the Report. The civil sanitary surroundings will be a difficulty unless the civil habitations come under sanitary control. They are at present without any sanitation. The climate is a bracing mountain climate suitable for retaining physical fitness and vigour in British troops.

Howick.

The town lands extend over a small area only between the bridge and the railway station.

They are suitable, however, for a garrison of either two battalions of Infantry or a Cavalry regiment and Brigade Division of Artillery if barracks and stables are constructed as at home.

The soil is much heavier clay loam than the soil of Mooi River, Newcastle or Maritzburg, and the site will require more careful subsoil drainage.

The village has a spring water supply laid on by gravitation. It is capable of much improvement and increase, and could be laid on by gravitation to the town lands site. This supply would not be adequate for both town and garrison, if the town increased greatly in size, as is probable.

The river water is open to the same objection as that of Mooi River, but is ample in quantity for all purposes. Drainage of slops and surface water at a safe point into the river would be easy from the town lands site. There is an adequate area for land treatment (after biological treatment) of sewage on the town lands near the waterfall. With an ample river water supply a water carriage system of disposal is therefore strongly recommended for a garrison on this site. Water can be raised by hydraulic ram to the site.

Brick barracks constructed on home plans are recommended. The climate is very suitable for British troops.

PIETERMARITZBURG.

The climate is more enervating than either Howick or Mooi River, but this enervating effect is not felt during the greater portion of the year.

The sites at present occupied by the garrison (Fort Napier) are not satisfactory on account of—

(1.) General overcrowding of site by horse lines and barracks.

(2.) General pollution of ground.

(3.) Inadequacy of drainage.

(4.) Unsatisfactory systems of disposal of nightsoil, urine, stable drainage and refuse.

(5.) Unsatisfactory construction of many of the barracks and quarters.

The sites on other portions of the War Department lands are equally unsatisfactory for extension of garrison. One of the slopes has already been largely polluted by Burgher camps, and the only clean ground is a somewhat steep slope, at the entance to the Zwartkop Valley, and not a suitable site from a climatic point of view for the garrison.

The best site, almost the only site, on town lands, is undoubtedly the slopes leading toward the town from the Fox Hill. It is a good site.

There is sufficient ground on these slopes for the whole garrison, if barracks are constructed as at home.

Water supply, sewage disposal and drainage would be simple when the town water scheme and contemplated water carriage system are completed.

As regards the town itself, there has been very marked strides in sanitary matters since the Report of Major Simpson (Appendix VI., of Army Medical Department Report for 1898), and if the present undoubtedly progressive and enlightened sanitary administration is going to be continued, there is every prospect of Pietermaritzburg being free from Enteric Fever, as an endemic disease, in the near future.

Reasons for this opinion are—

(1.) The completion of the surface drainage.

(2.) The macadamizing of roads.

(3.) The pavement of foot paths.

(4.) Total abolition of cesspits.

(5.) The probable abandonment of the present water supply in 18 months or 2 years.

(6.) The introduction of a water supply from a collecting area under sanitary control, and the construction of proper waterworks.

(7.) The contemplated introduction of a water carriage system of sewage disposal.

Generally speaking, as regards the future prospects of the health of a permanent garrison in Natal, much stress cannot be laid on want of sanitation in Pietermaritzburg. Sanitation is in fact considerably better there than elsewhere, and the chief works required are the water carriage system of sewage disposal and a new water supply to make its sanitation equal to that of most English towns. When these are introduced into the locality, and if proper barracks are built for the troops, there should be no question of its not being a healthy locality, and equal to that of a home garrison.

As regards the influence of town slums on the health of the garrison, it is feared that the temptation of women and drink will be found to crop up around whatever locality is selected as a permanent garrison, and in time Mooi River and Howick will in that respect be no better than Pietermaritzburg.

W. G. MACPHERSON, *Major,*
R.A.M.C.

10th November, 1902.

REPORT ON PIETERMARITZBURG, HOWICK, MOOI RIVER, AND NOTTINGHAM TOWN LANDS, AS SITES FOR A PERMANENT GARRISON IN NATAL.

The report has been made at the request of the General Officer Commanding the Natal District, and in accordance with the instructions issued in War Office letter 55677/70, A.M.D., of 20th August last.

Attention was specially directed to the sanitary condition of Fort Napier and town of Pietermaritzburg, in consequence of questions having arisen as to the advisability of stationing the whole of the Natal garrison in Pietermaritzburg, and also in consequence of a report by a Board of Officers held last month, condemning a large number of the barracks in Fort Napier.

Enquiries at Mooi river, Howick, and Nottingham town lands were made, in order to determine what were the best sites for a portion of the garrison, should it be decided that the whole garrison is not to be stationed at Maritzburg. The conclusions and recommendations are based on personal examination of the localities in question, and of records bearing on the local health. Some of the facts, which it is convenient to record on this latter point, are given in tables and charts as an Appendix.

The difficulty of obtaining suitable contour maps has the effect of making a report on the enquiry entrusted to me far from complete, as regards details of new sites and the extent of the areas available for barracks and accessories. These are, therefore, stated approximately only.

Biological enquiries are also very imperfect, because a much longer period is required for these enquiries than can be devoted to them, unless the investigations at other stations are to be indefinitely postponed. Such enquiries have, therefore, been limited to a rough estimate of the comparative degree of soil pollution in certain localities in Pietermaritzburg.

The report has been drafted on the same lines as the report on Newcastle, the sanitary details being noted in order to indicate the grounds upon which the conclusions and recommendations are based.

PIETERMARITZBURG.

Physical Characters.

The height of the railway station, situated between Fort Napier and the town, is 2,218 feet above sea level, at lat. 29° 3′ S.

The town and fort are on a spur, sloping in a north-eastern direction, from Signal Hill to the junction of the Umsindusi river with a small stream, the Dorp Spruit, the former flowing along the southern and the latter along the northern base of the spur and taking the drainage of its slopes. The spur, in fact, resembles closely a tongue, arched at the base and becoming gradually flattened out towards the apex. The garrison is on the higher arching of the tongue, and the city on the lower portion of the tongue down to the apex.

The country to the north-west is formed of three enclosed valleys, the the Zwaartkop, Town Bush, and Chase valleys, extending to a line of plateau, about 1,500 feet higher than the Maritzburg slope, and about 5 miles distant.

On the south-east the country is more open, and is formed of the valley of the Umsindusi with slopes rising gently to higher ground, none of which in the immediate neighbourhood is much more elevated than the upper portion of the Maritzburg spur.

The extent of the lands belonging to the borough is 45 square miles and includes the valleys mentioned above, the slopes on the south-east and the banks of the Umsindusi for about 2 miles below its junction with the Dorp Spruit. The city boundary itself, as distinct from the borough land boundary, encloses an area of 1,000 acres.

The War Department land includes the upper part of the town slope to

Signal Hill, and two minor slopes from Signal Hill running into the Zwaartkop valley parallel to the town slope. It covers an area of 1,689 acres.

Barracks and stables occupy 127½ acres of the slope immediately above the town, Ordnance stores, cemetery, and Mounted Infantry stables occupy 46½ acres above this, while the remainder of the slope to Signal Hill is steep and unoccupied.

The relative heights of these occupied garrison areas above the Town Hall, which is halfway down the portion of the slope on which the town is built, are 100 feet for the lowest point in the lower occupied area, and 200 feet for the highest point in the upper area.

With the exception of the upper portion of the more northerly of the two, the minor slopes on the War Department land have been occupied as camping grounds and by burgher hutments, the intervening valley being used as a rifle range.

The southern slope of the main spur below the Ordnance stores has also been used as a camping ground, and is known as Edendale Camp.

The town lands are occupied by scattered farms, groups of Kaffir and Indian shanties, nursery gardens, grazing grounds, brickfields, &c., but it is impossible to estimate the relative proportion of occupied to unoccupied area. There are, however, only two slopes of any considerable size that have not been broken up, and are otherwise suitable for garrison purposes, namely, the Fox Hill slopes on the south, and a portion of the slopes known as Mountain Rise on the north of the town.

The geological formation of the whole of the lower slopes of the district is the ecca shales, the yellow shales of the series being close to the surface everywhere, and the black shales at a varying depth underneath. Intrusive rock is also characteristic of the locality, as it is of other parts of Natal, but it does not appear so much on the surface, as for example at Newcastle and Mooi river.

The more elevated parts of the town lands, *e.g.*, Signal Hill and the higher parts of the valleys on the north-west, are the sandstones of the coal measures, and they overlie and are conformable with the ecca shales.

The surface soil, as a rule, is thin, and is composed of a stiff clay loam with a considerable amount of iron, washed out from the intrusive basalt. This reddish clay loam is very characteristic of the surface soil both at Maritzburg and elsewhere.

In some places the soil is more sandy, especially along the beds of the river below the town. In other places there are pockets of stiff clay and brick earth, notably at the debouchment of the valleys on the north-west.

The "ironstone" conglomerate, described in the Report on Newcastle, is also found as a recent or surface deposit, and its disintegration is the cause of the red colouring of most of the surface soil.

Generally speaking, the valleys on the north-west have deeper and richer surface soil than the slopes on the south-east. There is more moisture in the soil there; while the southern slopes are brown and dry, the slopes of the northern valleys are green and covered with vegetation.

A few scattered ant-heaps are seen on the dry southern slopes, but they are not a feature of the locality.

Water Supply.

Existing water supplies.

The town and the fort are supplied with water laid on in pipes from two sources.

The first is derived from the various springs arising from the sandstone of the upper areas of the Zwaartkop valley, and the second from similar springs in the Town Bush and Chase valleys.

The Zwaartkop springs form the Dorp Spruit already referred to, and a smaller stream known as the "Clear Stream." The yield of these streams is conserved at Town Waterworks at the lower end of the valley. The minimum daily gauging in October last was 1,000,000, and the maximum 1,670,000 gallons.

The waterworks consist of two settling reservoirs of 783,000 gallons capacity each, and one service reservoir of 536,000 gallons. These reservoirs are uncovered. The water is distributed from the storage reservoir in cast-iron mains with lead and yarn socket jointing. There is a pumping station where the main enters the town for supplying Fort Napier and the higher slopes of the town. The house connections are lead pipes. Formerly they were galvanized-iron pipes, but these are being abandoned on account of numerous bursts.

The Town Bush and Chase valley springs collect in two streams, one flowing down the Town Bush valley and the other down the Chase valley. These streams yield on an average 800,000 and 200,000 gallons respectively. The October gaugings show a minimum of 549,000 gallons for the Town Bush stream, and of 169,000 gallons for the Chase valley stream, with a maximum of 1,554,000 and 262,000 gallons respectively. They run into one another at the debouchment of the valleys, and are there conserved in waterworks consisting of (1) a small tank where the water is mixed with alumino ferric, (2) a settling tank of 160,000 gallons capacity, (3) two sand filter reservoirs of 100,000 gallons capacity each, and (4) a small service reservoir of 800 gallons. The last is the only covered reservoir. This water is distributed to the lower part of the town.

These two waterworks, yielding a minimum of about 1,500,000 gallons daily with a storage capacity of 2,122,000 gallons, supply the only water used at present by the town and garrison. The storage of water for the garrison is in Fort Napier, in two tanks of 10,000 and 5,000 gallons respectively on water towers, and one tank of 19,500 gallons underground, or a total of 44,500 gallons, in addition to subsidiary cisterns of 400 gallons each for buildings or groups of buildings. It is laid on to barracks in cast-iron mains and galvanized-iron house connections.

The water of these two supplies is pure at the source, but gathers contamination of all kinds as it becomes collected into streams and flows down the valleys to the waterworks. The slopes of the valleys are used as grazing grounds, as cultivated gardens, as sites for residences, schools, poultry farms, pigstyes, cowsheds, &c., and, at one place a few hundred yards above the lower waterworks, there is the Government bacteriological establishment, where numerous horses and cattle are kept for experimental purposes in paddocks through which the stream flows. The streams in question are in fact the drains of these slopes. At one house, the house refuse was seen on the bed of a rivulet feeding the stream, and the domestic washing was going on in this rivulet. At another house just above the Zwaartkop valley intake the drainage of poultry yards and cowsheds was passing almost directly into the stream, and the amount of domestic pollution is practically incalculable. The sewage disposal of habitations on these areas is in pits in the gardens.

With the exception of the settling tanks at the Zwaartkop valley works and the alumino-ferric treatment and sand filtration at the lower works there is no purification of these supplies.

In Fort Napier there is a Maiche sterilizer fed by a 400-gallon tank and working day and night automatically in a locked chamber in one of the water-towers. The sterilized water is led by a ½-inch galvanized iron pipe to a 400-gallon tank placed in the open, and anyone who likes can draw off water from this tank for drinking purposes. This is the only purification of the water after it comes under military control.

Other Sources of Water Supply.

Two schemes for improving the Maritzburg water supply have been considered :—

(1.) River water from the Umgeni river, collected at a point about 2 miles above the waterfall at Howick, and close to the railway line, about 3 miles beyond Howick Station.

The intake is about 1,300 feet above the highest part of Maritzburg, and it was proposed to lead the water to the town by a short route, tunnelling the rock on to the ridge between the Zwaartkop and Town Bush valley, or by a long circuitous route following the contours of the river valley. The shorter route would be 15¼ miles to the proposed reservoir and 17 to the town. Impounding the river at the intake is estimated to give storage of 1,000 million gallons.

The advantage of this scheme is the unlimited supply of water. The disadvantages are the great cost and the fact that the water at the intake is full of suspended matter and would require slow filtration. The scheme has been rejected by the Corporation.

(2.) River water from the Umsindusi river, collected about 2 miles above the point where the river falls into the Edendale valley.

The proposed intake is 1,000 feet above the lower part of the town, and the scheme consists of a dam impounding the valley at the point of intake, just below the junction of the Umsindusi proper with the Umsindusan, a somewhat smaller but clearer stream rising in an adjoining valley.

The Umsindusi and Umsindusan drain the area known as the Zwaartkop location, an area of 60,406 acres, with a kraal population estimated at 6,270 persons in 1,525 huts.* The kraals are scattered all over the area, and are usually high up on the slopes, away from the streams. The surface generally is used as grazing ground; cultivation and forests are not a feature of the location. The only European habitations are the Mounted Police Barracks at the old Gordon Mission on a slope about 300 feet above the Umsindusan near the intake. The population is small, only six Europeans.

The area which it is proposed to form into an impounding reservoir will have a bottom of 25 acres, and a capacity of 500 million gallons. The bottom is at present a mealie field, and there is much cowdung on it. The soil is a light sandy loam. The river bed at this point is formed of basalt rock. The kraals in the immediate neighbourhood have been removed, and the Corporation hope to obtain complete control over the location.

Conveyance of water from this reservoir will be by open conduits, steel pipes syphoning over valleys, and tunnels through two intervening ridges.

The water will be treated by alumino ferric in continuous settling ponds delivering 20,000,000 gallons daily, just below the reservoir, and by three filter beds each delivering 1,000,000 gallons daily, with a storage capacity of 2,100,000 gallons. The filter beds will be at a level of 670 feet above the Town Hall, on a small plateau below Signal Hill, the distance from the intake being 6 miles.

Distribution from the filter beds will be by pipe—

(1.) To a distribution reservoir of 3,000,000 gallons for Fort Napier and the higher levels of the town.

(2.) To the Zwaartkop reservoirs of 2,122,000 gallons capacity.

(3.) To the Chase valley reservoirs of 360,000 gallons, and

(4.) To a reservoir of 500,000 gallons on the Fox Hills.

The total storage will therefore be 3,322,000 gallons.

In addition to the water of the Umsindusi and Umsindusan streams it is proposed to lead into the conduits the water of the Inquilini stream, a stream draining a valley on the Zwaartkop location to the east of the Zwaartkop Mountain, and draining a portion of the location. The minimum yield of these streams obtained by daily gaugings during the last 2 years is 2,000,000 gallons daily for both the Umsindusi and Umsindusan and 1,000,000 gallons for the Inquilini.

The above scheme has been adopted by the Borough Corporation and works have already been commenced. In 12 months it is estimated that the Inquilini stream supply will be available, and in 18 months the supply from the Umsindusan, both being led direct into conduits before the construction of the impounding reservoir is commenced. It is estimated that the latter work will not be ready for another 3 years. 100,000*l*. have been already taken up as a loan for these works, but no money has yet been taken up for the construction of the dam.

In the immediate future, therefore, the minimum water supply from the new waterworks will be 3,000,000 gallons daily.

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* The huts are distributed in 490 kraals, *i.e.*, a population of one person in 2 acres, or 320 in the square mile.

Well Waters.

Well water is not used for domestic purposes, but wells were seen in two aerated water factories, the water of which had been used and was intended for use in the manufacture of aerated water.

The water was about 14 feet from the surface and apparently derived from a thin sandstone stratum in the ecca shales.

In the lower part of the town there are several surface wells used by Indians for irrigating vegetable gardens.

These appear to be the only wells in the locality.

Condition of Surface Soil.

A number of the streets have concrete block pavement for foot passengers and macadamized roadways. They are well guttered and all surface water is at once removed by concrete or brick channels to the river.

The streets, that have not yet been macadamized, are covered with the red ironstone conglomerate, and this works into a stiff mud during rain.

On War Department land there are practically no macadamized roadways or pavements, and in rains the red earth and ironstone conglomerate, of which the roads are made, work into a stiff mud.

The drainage of the surface in Fort Napier is somewhat irregular. There are concrete or brick surface drains round many of the buildings, but no systematic plan has been adopted for removing storm water or other surface water. The drains, in fact, appear to have been made at different periods and in different sections without reference to any comprehensive or detailed plan. The result is that much of the surface has not the appearance of being properly drained as is evident from the rankness of the vegetation at many places on the slopes of Fort Napier.

These surface drains, both in the town and in Fort Napier, receive not only the storm water and surface washings but also the slops from kitchen sinks, ablution and bathrooms, and the washings from urinals, latrines and stables. They receive, in fact, all the foul water, with the exception of any that finds its way into the latrine or urine pails. A sample of silt from one of these surface drains tested biologically showed a very high amount of micro-organic growths, quantitatively equal to that of crude sewage.

Defects in the drainage system are, therefore, apt to cause considerable pollution of the surface soil, and this was clearly shown by the close approximation between the amount of micro-organic growths from the surface of the Edendale camping ground, which has no drainage beyond earth drains, and the amount in the silt of the concrete drains.

Samples of soil were collected from various portions of the occupied area in Fort Napier, and a rough estimate made at the Government laboratory of this comparative pollution. The soil from the camping ground gave evidence of being markedly more polluted than the soil taken from other spots in the fort.

Samples of soil from the burgher camps and of soil from the Fox Hills were also submitted to rough biological tests. Details of these tests are given in the Appendix. They are confessedly very imperfect, but they indicate roughly the degree of pollution in different soils.

The samples were collected by myself in sterilized glass stoppered bottles with usual precautions to prevent errors, and were plated out and cultures made by the Director of the Government Laboratory, Mr. Pitchford, and his assistant, Mr. Potter. The examination of the cultures and estimation of the results were made in conjunction with Mr. Pitchford.

Disposal of Refuse Matter in Maritzburg.

Sewage disposal.—The pail system is universally used in the town for the European, Asiatic and native population, and also in the garrison and camps. There are no cesspits, sewers, or trenches in the town or fort, but outside the town, the inhabitants of houses on town lands and in the valleys, forming the water-collecting areas, dig the excreta into the gardens or use privy pits, many of them in juxtaposition to the water supply streams.

The town system is in the hands of the Corporation and under the control of the Chief Sanitary Inspector, who has a staff of Europeans and natives under him for the purpose of removing the nightsoil and urine.

The system adopted is as follows:—Each house is obliged to have a privy not nearer than 6 feet from the house itself, and the privy must be able to hold two pails for every five inhabitants. The Corporation provide these pails free. They are pails of 4-gallon capacity, constructed of galvanized-iron, without handles. The pails are removed once in three or four nights (twice weekly), and clean pails are put in their place. The number of pails dealt with is estimated at 6,500. They are conveyed to a nightsoil depôt, which is situated 2 miles below the lowest part of the town, and on the banks of a stream running into the Umsindusi. At the depôt there are poudrette works where the nightsoil is converted into manure by being mixed with burnt ashes and ground into powder. No attempt is made to fix the ammonia or other gases in the process, and the smell is very foul. The manure is sold at 4*l.* per ton.

The method of conveying the pails to the depôt is peculiar. The contents of the pails are not emptied into a tank or tumbril cart, but the pails, each with its contents, are nested one inside another and placed in large wooden carts, with sides 4 feet high, each capable of carrying 500 pails, nested as stated. In order to prevent the bottom of one pail resting on the contents of the pail into which it nests, there are brackets inside each pail about halfway between the bottom and the rim; and it is the custom to empty the contents of one pail into another if it is too full. The carts are well and solidly constructed. They are kept tarred inside and out, and no signs of leakage from the pails were evident.

The pails are cleansed at the depôt in a series of concrete tanks. Five tanks are used, and after cleansing the pails are dipped into a smaller tank containing sheepdip in solution as a disinfectant. The tanks are supplied from the stream and discharge into it lower down, where the stream is, in consequence, extremely foul and markedly putrescent. The pails are tarred at the depôt once a month.

The whole of the work is carried out by one European night inspector, one foreman, and 60 natives or coolies, who live at the poudrette works. The transport used is six carts of the kind noted above, and 80 oxen.

Until 15 months ago the work had been entrusted to a contractor. Since the Corporation undertook it themselves there is said to be a marked improvement, greater cleanliness being attended to in the methods of removing and replacing pails, and scarcely any complaints are said to be made by the householders.

Urine is removed by a different staff, and in a different manner. Each householder has to provide himself with a urine bucket, which the Corporation sells to him for 6*s.* 8*d.*, and replaces when worn out. The bucket is practically an 8-gallon oil drum.

The contents are emptied into galvanized-iron tank carts, of which the Corporation have three, two discharging by valves, and the third a Crowley cart.

There are 650 urine pails in the town, and the carts are capable of removing their contents only twice weekly.

The urine is disposed of by emptying into a concrete basin on the river bank at the lower end of the town, from which there is a pipe discharging into the river. A staff of 10 is employed in this work.

Slop water, stable drainage, &c.—As already stated, all slops, &c., not thrown into the urine pails, discharge into the surface drains and are conveyed to the river and Dorp Spruit at several points of discharge. The silt from the silt pits of the gulley traps which are inserted in the line of drain, wherever the surface drain becomes a closed drain, is cleaned out and carted away in steel-lined carts, of which the Corporation have two. A staff of 30 scavengers are employed in keeping gutters and gulleys clean.

Dry refuse.—Householders are not obliged to have any special sanitary bin for refuse, but must place their refuse in some receptacle or other near the street entrance to the house every morning. The Corporation carts, (20 open carts), go round daily between 6.30 a.m. and 11 a.m., collect the refuse and remove it to pits formed by the quarrying of brick clay at the brickfields just outside the town at the entrance to the Town Bush and Chase valleys. Street refuse is removed by the same carts in the afternoon, and street gulleys are disinfected twice weekly. A staff of 55 is employed in removing refuse.

Provision for natives.—Indians and natives who are householders are under the same rules as Europeans, and must provide themselves with properly constructed pail privies.

For those who are servants latrines are provided, as at Newcastle, at various spots on the outskirts of the town. These latrines are all of the same pattern, namely, corrugated-iron screens surrounding a concrete base, adapted for holding 12 pails in line. No seats are provided. There are 15 such latrines.

Provision for the garrison.—For the troops in garrison, arrangements are made by the military authorities. The Municipality does not interfere, and sewage, urine and refuse disposal is in the hands of a contractor. The pail system is used, but the pails are of Ordnance bucket pattern with handles and high backs. The pails are not removed, cleansed and replaced as in the town system, but the contractor uses three four-wheeled tumbril carts of 260 gallons each. The forepart of the cart carries an open barrel filled with sheep-dip disinfectant, and as each pail is emptied into the cart a native labourer dips it into the barrel of disinfectant, scrubs it round with a brush, and replaces it in the latrine. The pails are tarred once monthly at the military prison.

The contents are removed by the contractor and deposited in trenches or pits at farms belonging to him, one on the road to Camperdown, near the Star and Garter Inn, east of the Fox Hills, and the other about 2 miles on the side of the Umsindusi, furthest from Fort Napier.

Refuse and urine are deposited on the War Department land at Fort Napier, just beyond and close to the Ordnance Store Depôt. About 3 years ago arrangements were made with the contractor to remove the urine to the place where the town urine is discharged at an extra cost of 30*s.* to 50*s.* daily, but at the beginning of the present year the old contracts have been renewed, and refuse and urine continue, as from time immemorial, to be deposited on the Fort Napier site, and on the highest portion of the site.

Slops, stable drainage, &c., as already stated, pass into the surface drains, of which there are several types—concrete, brick, cobble-stones and earth. In the burgher camps and Edendale Camp there are one or two improvised surface drains made out of strips of corrugated-iron sheeting bent into a U, but the general drainage of the camp is into the soil.

Milk Supplies.

There are no dairies, and milk is supplied direct to customers in pint bottles from the cowsheds.

The cowsheds have to be licensed, and licenses are withheld unless there is sufficient cubic space, good ventilation, and paved and drained flooring.

The bottles are washed on the premises by natives, and at one shed I observed a native using the mud from a surface drain, in place of clean pebbles, for cleansing the bottles.

It is the rule to find poultry and other animals in the yards. The premises are under the supervision of the Sanitary Inspectors' branch.

Aerated Waters.

There are seven aerated water factories in the town; they were all carefully inspected.

All used town water, but in two there were wells, which are used when occasion demands, as, for instance, when the town water is turbid or when the supply is low. The yield from these wells is about 500 gallons daily.

The water is purified in Berkefeld filters in five out of the seven factories. Charcoal filters are used in the other two, the type being that known as the syphon-filter cistern.

The Berkefeld filter installations vary from one candle (one factory) to three candles (two factories), seven candles (one factory), and 14 candles (one factory).

In all but one factory, where gas cylinders are used, the gas is generated from carbonate of soda.

In all, the bottles are washed in tubs of town water by hand and brush. In two a final rinsing is given by spray washers. In none is there any cleansing with a pure or sterilized water.

The cleanliness, flooring, drainage, &c., of the premises varied from a remarkably high standard of cleanliness and construction, in one only, through different degrees of tidiness and cleanliness to a state of dilapidation in another. Ice is manufactured in one factory only.

Slaughterhouses.

There is only one public slaughterhouse, and no private slaughterhouses are allowed. It is placed at the extreme end of the tongue of land on which the town is built, at the junction of the Dorp Spruit and the Umsindusi. It belongs to the Corporation, and each butcher may rent a compartment in it. There are nine compartments.

Slaughtering and dressing of the meat are carried on in the same compartment, the drainage from which is carried to the Dorp Spruit in a concrete drain, discharging into an earth drain on the banks of the stream. There is an enclosed yard and pens for cattle, and water is laid on, but the general conditions are not particularly clean or free from foulness. The Drop Spruit is much fouled by the blood and offal from the slaughterhouse, and the ground surrounding the building is unpaved, untidy and foul.

The butchers' shops are well constructed, and have, as a rule, tiled walls and floors. Refrigerated meat is extensively used.

Disposal of Carcases.

Dead animals are buried at a depth of not less than 6 feet on the slopes of the Zwaartkop, Town Bush, and Chase valleys, below the point of intake of the waterworks.

The offal, &c., from the slaughterhouse are also buried by the Corporation sanitary staff.

There is no disposal of carcases along the banks of the river and streams, as at Newcastle.

Public Laundries.

There are none. Washing is done in houses, gardens, or in the river.

Cemeteries.

The cemetery is well and tidily kept and has a mortuary. The garrison has a separate cemetery at Fort Napier.

House Construction in the Town.

No corrugated-iron huts or thatched roofs are allowed and most of the houses are of a good class and well constructed of the local kiln-burnt brick or of freestone. Details of construction are well attended to. In the majority of the houses the ground floor is raised 2 or 3 feet above the surface on brick or concrete foundations, with the air space underneath ventilated.

All plans of new houses have to be submitted to the Corporation for approval, and no repairs are allowed in old houses not constructed according to modern requirements.

The houses are arranged in wide regular streets and many have well kept, trim gardens and hedges.

There is no portion of the town which can be fitly described as a slum.

Construction of Buildings in Fort Napier.

The buildings in Fort Napier are of a heterogeneous character.

They may be classified as follows :—

1. Wooden huts of weather-boarding, similar to the old Crimean hut.
2. Corrugated-iron huts.
3. Shale stone buildings.
4. Green brick buildings.
5. Kiln-burnt brick buildings.

In addition to these five groups, the variety is increased by the nature of the foundations, the nature of the cement, plaster, or inside lining, the amount of window area and ventilation, the type of verandah, guttering, and so on.

They are of various ages, from the time the fort was handed over in 1854 to some married quarters constructed in 1899-1901 of good brick and in accordance with the Inspector-General of Fortifications' plans.

A number of the older buildings has been condemned recently by a Board of Officers.

The main defects of these buildings are as follows :—

(1.) *Bad material.*—Many partition walls are of green brick, as well as some external walls. The cement in many cases is local mud and not proper cement, and where these mud brick walls and mud cement are found vermin abound. Some of the wooden huts are also said to be full of vermin, and in the older married quarters (A, B, and C Blocks) dampness has risen into the walls.

(2.) *Insufficient ventilation.*—The majority of the huts are poorly ventilated, by eaves' gratings only. Very few have adequate ridge or extraction shaft ventilation. This is notably the case in the corrugated-iron barrack huts used by all branches.

(3.) *Insufficient guttering and paving around huts.*—Defects in guttering are not now a very marked feature, but there is a distinct want of adequate paving round the huts, the ground around them and many of the verandahs being muddy up to the thresholds of the doors.

(4.) *Insufficient lighting.*—In the majority of the hutments the window area is only equal to $\frac{1}{14}$th of floor space, and the pitch of the verandahs frequently interferes with the full lighting capacity of the windows.

(5.) *Bad construction of stables.*—The stables are of an extremely poor type and insufficiently paved and drained. They are close to the huts and add greatly to the soil pollution in the immediate neighbourhood.

(6.) *Overcrowding of site.*—Huts, buildings and accessories have been placed on the site in such a manner as to give the impression of considerable overcrowding.

The lower barrack hutments are in some cases barely 30 feet apart, and the proximity of horse lines to huts adds also to the appearance of overcrowding.

It is difficult to select any specific instance in which huts block out light and air from one another, but the irregular manner in which the buildings, accessories and stables have been placed relatively to one another and the fact that all the buildings are one-storey buildings have had the effect of leaving no well-defined and extended open spaces between buildings or groups of buildings.

The variety of construction also adds to this general effect, and it may be said that the new married quarters and the hospital buildings are the only occupied buildings which have the semblance of good sanitary construction.

It is fair to say that, on examining the flooring of the huts, the construction was found to be admirable, the space underneath being a 6-inch dry, clean and well-ventilated air space between good, clean concrete base and a double flooring of diagonal ⅞-inch boards underneath with ⅞-inch horizontal groove and tongue boards placed on a bitumen bed above. Dust, however, taken from the jointings showed a considerable growth of putrefactive organisms, but none of the bac. coli group.

The plots ot ground around the Fort buildings are either bare shale or mud plots, or ragged untidy plots covered with weed and rank vegetation. The hospital grounds are laid out to some extent in tidily kept gardens, but it is the rule and not the exception to find the general surface of Fort Napier covered with weed.

Local Sanitary Administration.

The sanitation of Maritzburg comes under the Public Health Act of 1901, the Regulations issued under that Act and the Borough bye-laws. Details of the Public Health Act and Regulations were given in my report on Newcastle, and need not be repeated.

So far as Maritzburg is concerned the Act is a dead letter, with exception of the clauses affecting notification of disease. It is only in its infancy, and apparently no attempt has yet been made to apply it rigorously. It expires at the end of next year, having been renewed during the last Parliamentary Session.

The present Borough bye-laws were proclaimed in 1895. Amendments and additions were made in March, 1901, and further amendments and additions have just been passed. A copy of these last is appended.

The bye-laws contain 615 clauses in 54 sections, and those referring to sanitation cover the whole ground of water supply, drainage, sewage and refuse disposal, milk, food, and aerated water supplies, slaughterhouses, cowsheds, stables, overcrowding, house construction, cemeteries, &c., in a thorough and comprehensive manner. They are defective in the matters relating to infectious and contagious diseases. In fact, only one short clause is devoted to this, namely, that no one shall carry and expose in the street any one suffering from infectious or contagious disease, unless under the direction of a properly qualified medical man. No provision is made in the bye-laws for notification, disinfection, or isolation ; but an isolation hospital has recently been provided, and notification has been made compulsory during the last 9 months, under the Public Health Act.

The administration of the bye-laws is in the hands of the various departments of the Corporation. The Borough Engineer, who has a large and skilled staff, controls the waterworks, drainage, roadways, lighting (electric lighting), and house construction. The Sanitary Inspector, with a staff of six European Inspectors and the native staff already mentioned, controls the sewage, urine, and refuse disposal works, the slaughterhouses, cowsheds, and dairies, aerated water factories, market supplies, sanitation of premises and nuisances generally. The Medical Officer of Health has charge of no department, and only deals with questions referred to him by the Corporation or other departments. He is paid 150*l.* annually, and engages in private practice. The present Medical Officer has not held office for more than 18 months. Wide or comprehensive management of the health aspects of the locality are not indicated in the reports of his predecessor. The present health officer is, however, taking keener and more efficient action, and the following information, courteously given by the Town Clerk, indicates progress in the larger questions of hygiene, as affecting sewage disposal, water supply, and surface drainage :—

Sewage Disposal.

Until 1877, sewage was disposed of in cesspits. From 1877 to 1883, boxes were used in place of cesspits, and the soil removed by a contractor. In

1883 the pail system was introduced. In 1901 the Corporation took over the management of the pail system from the contractor.

Cesspits existed at various places during the introduction of the box and pail system, and until 1895, when, under the new bye-laws, they were prohibited within the city boundary.

A scheme for a water-carriage system of sewage is being prepared now.

Water Supply.

From the establishment of the city until 1880 the water supply was from open sluits.

The Zwaartkop Waterworks were opened in 1880, and the Town Bush and Chase Valley supplies, with filter beds, added in 1891.

Wells were abolished about that time.

A new water supply scheme is now being introduced.

Surface Drainage.

Macadamizing with ironstone was commenced in 1873, and with whinstone in 1883.

Paving of footpaths commenced in 1882. In 1899 the footpaths of the larger portion of the city, including the whole of the principal streets, were paved with Victoria stone, imported from England. At present all but a small section of street has proper surface drains.

A Sanitary Inspector was first appointed in 1870, and a Medical Officer of Health in 1876.

In the present year marked and enlightened action has been taken and is expected to continue in connection with sanitation. The credit for this is due to the new Borough Engineer, Mr. Jameson, and his predecessor, Mr. Laffan, aided by some progressive members of the Town Council, of which Mr. Laffan is now a member. The new waterworks scheme, which has been commenced, promises well, and the borough engineer is now engaged in working out a scheme for the introduction of a water-carriage system of sewage disposal. His plan is to drain into two intercepting sewers running one along the contour of the Umsindusi, the other along the contour of the Dorp Spruit, and leading the sewage to septic tank and double contact filter bed installations on the bank of the Umsindusi about 2 miles below the town, the flattest gradient being 1 in 500. He proposes to discharge the effluent direct into the stream, but if necessary there is a plot of sandy loam below the bacteria beds, where there is 27 acres of broken land available for irrigation.

The rates levied are $2\frac{3}{4}d.$ in the £ of assessed freehold value. This is equivalent to about $2s.\ 6d.$ in the £ of assessed rental in England, and is a low rate for general sanitary purposes. The rate for the water is $\frac{1}{4}d.$ in the £.

Health Statistics.

Town Population.

No accurate or useful records have been kept of the health of the town, the Health Officer's reports being of a vague character.

To clear this point up, however, I examined all the entries in the death register from 1868 onwards, extracted the number of deaths for the principal zymotic diseases, and eliminated any deaths amongst natives or troops. The numbers are all shown in Table X. appended, and they indicate as nearly as possible the actual deaths and causes of death recorded amongst the European population. The population returns in the table are taken from the official blue books. The population for 1889 is however inaccurate, in all probability, as it does not correspond with the preceding or succeeding years. The ratios, therefore, for that year should be ignored.

Taking the results of the ratios in the table as indicating the health conditions of the locality, and taking into consideration the fact that death registration in the earlier years was imperfect, it will be found that the death rate up till 1883, when the cesspits and box systems were replaced by the pail system, was excessive, and that the rate decreased then and approached that of a healthy community in subsequent years, but without any marked or steady decline year by year. The death rate may be regarded just now as fluctuating around 20 per 1,000 for a European population, (exclusive of troops and refugees), of nearly 12,000.

The zymotic death rate has not, however, shown any marked decline, although there is a progressive decrease in the higher points of the curve, *e.g.*, from 1879 to 1882, and from 1882 to 1886. From 1886 to 1889 there is a slight rise, but again, from 1889 to 1893, and 1893 onwards, the decrease is more definite.

Compared with healthy communities in England, the zymotic death rate is very high, and the percentage of deaths from zymotic disease to deaths from all causes is also very high. For example, this percentage during the 5 years 1895–99 is as high as 25·6 per cent. The percentage may be high from two causes, namely, a deficiency in deaths from ordinary causes, or an excess of deaths from zymotic disease. The inference to be drawn from this high percentage depends, therefore, on which of these two causes is the true cause. From the otherwise high zymotic death rate, the probability is that an excess of zymotic disease is the cause of this excessive proportion of zymotic mortality to mortality from all causes, rather than a deficiency of deaths from ordinary causes.*

With regard to enteric fever, the curve has shown a somewhat marked decline, commencing in 1891, but the death rate from this cause, even during the period of this decline is excessive, and four or five times as great as it should be in a healthy locality.

The group of diseases which have shown any marked decline since 1883 is the diarrhœal diseases group (including dysentery), but this too is excessive as compared with healthy communities.

Stated generally, enteric fever, diarrhœal diseases and diphtheria account for practically all the zymotic death rate in most years, smallpox, measles and scarlet fever accounting for very few, and whooping cough for a considerable amount in some years only. (*See* Table X.).

Compared with the statistics of the troops, these town statistics present a somewhat lower mortality from enteric fever than the garrison. This may be accounted for by the difference in age groups.

Military Population.

The principal statistics of the garrison are shown in the tables and charts appended.

The charts disclose one very marked feature, namely, the progressive rise in recent years in the admission rates for enteric, dysentery, diarrhœa, throat affections and respiratory diseases, and the marked decline in the venereal group of diseases.

In fact, as regards the former class of diseases, the garrison occupies a far from enviable position, and must be regarded from these indications as markedly insanitary, while venereal diseases have recently been less prevalent in Maritzburg than in almost any other part of the world. As there is no sanitary control over prostitution, this is remarkable.

Meteorology.

The mean of the maxima for each year varies between 78·8 and 81·6 degrees Fah. during the last 6 years, the mean of the minima between 52 and 54·4 degrees.

The absolute maximum was 108 degrees in 1897, and 103 degrees Fah. in 1896; the absolute minimum 31 degrees in 1899, and 35 degrees in 1897.

The total rainfall varied from 25·18 inches in 1900 to 43·64 inches in 1898. The number of days on which rain fell was 112 in 1901, and 165 in 1896. The rainfall is seasonal, and occurs in the hot months.

* The population returns have not been grouped in age-groups corresponding with the Registrar-General's age-groups, so that the effect of age cannot well be noted for comparative purposes.

Climatic conditions are favourable to health, but the relative humidity is said to be somewhat greater than in the higher lands, and the climate consequently more enervating. No comparative records, however, of relative humidity are available.

It may be convenient here to mention that as compared with Howick and Newcastle, Maritzburg gives a higher mean of maximum and minimum temperatures of about 3 degrees Fah. While the rainfall is similar to that of Howick and Newcastle in amount, Maritzburg shows, as regards the number of days of rainfall, fewer rainy days than Howick, but markedly more than Newcastle.

There are no records of temperature at Mooi river available for reference here.

HOWICK AND MOOI RIVER.

As regards sanitation these two places may be grouped together. They are under no sanitary system.

Howick consists of a scattered village of 90 houses, about a mile in length, running up a slope on the north bank of the Umgeni River just above the falls.

Mooi River consists of 20 or more houses, erected irregularly near the railway station, and one or two houses, an hotel and church at Weston, 2 miles distant.

Both places are situated at high elevations, Howick Railway Station being 3,439 feet and Mooi River 4,556 feet above sea level.

Howick.

The physical features of Howick are those of a fairly well wooded agricultural district in England, with considerable slopes and upland valleys. The soil is a rich alluvial loam overlying ecca shales and sandstones of the coal measures, intrusive basalt dykes showing here as elsewhere.

There is a large amount of clay in the loam. The land around Howick slopes to the Umgeni River, which, just below the village, drops over a basalt dyke a distance of 360 feet to a narrow valley below.

The town lands cover a small area of ground, about 1,000 acres, between the waterfall and the railway station, on the opposite bank from the village. The lands are not built over, and have no appearance of having been used as camping grounds. The surface is covered with coarse grass, and is a heavy soil of disintegrated ironstone and alluvial loam.

About 80 to 100 acres of this land is suitable as a site for barracks, and this area would be sufficient for two battalions of Infantry with accessories, or for two mounted units.*

There is an area of about 40 acres at a lower level forming a gentle slope to the river, between the road and the waterfall, which is well adapted for land irrigation of sewage, and where sewage could be treated primarily by bacterial filter beds.†

The water supply of Howick is from springs in the mountains to the north. It is stored in a well-constructed concrete covered reservoir of 77,000 gallons. The reservoir is locked, and is surrounded by a locked barbed-wire enclosure, which is very well kept. The water is apt to be turbid in rainy weather, and is collected from an open stream leading from the springs.

The height of this reservoir is about 200 feet above the bridge across the river, and about 50 feet above the highest point of the town land area, referred to above. The yield of the springs is said to be double the storage capacity of the reservoir.

On slopes of the river opposite the village there have been a large burgher camp and a general hospital. They are on private ground, but similar, in regard to soil and geological formation, to the town lands.

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* It has been impossible to find anything but clay soils, derived from the shales, in these localities.

† There may be a sentimental objection to an installation of this kind near the falls. As this has to be reckoned with, an alternative drainage system into the valley below is possible.

They have been supplied with water from the Umgeni River at an intake about 1 mile higher up. The water is led in an open mill lead on the other side of the river to a point below the camp, where it is conveyed in cast-iron pipes across the river and pumped up to the camp by two turbines. It has been purified by filtration through two 15-candle Berkefeld filters, but no primary clarification process is in use. The river at this point is muddy, and flows through cultivated lands.

Mooi River.

The physical characters of Mooi River differ from those of Howick considerably. It is much more mountainous. The slopes are steep, and the valleys either narrow valleys or wide flat meadows through which the river takes a winding course. The surface soil is thin, and there is very little arable or forest land. Shales and sandstones of the coal measures are the underlying geological formations, and basalt dykes are numerous and extensive, the outcrop being a coarse grained dolerite in some places.

The town lands are extensive, about 6,000 acres, and a considerable portion has been occupied as encampments, a large area by Remount Establishment (about 4,000 to 6,000 horses) and paddocks, and a lesser area by Artillery or Cavalry encampments, and a general hospital.

There has consequently been some difficulty in finding suitable clean ground for the establishment of a permanent garrison on town lands.

Two sites are, however, suitable so far as surface soil, slope and area are concerned.

(1.) An elevated plateau on the west of the Estcourt Road, about 1 mile from the railway station. There are really two plateaux here, one about 50 feet lower than the other and nearer the village. The upper plateau has a clean, sandy soil, with sandstone formation underneath. The lower has a more alluvial surface and, at its junction with the upper plateau, there is a tendency to spring formation, no doubt from the sandstone formation above.

The upper plateau is much exposed to weather, the lower is somewhat sheltered by a ridge of dolerite.

(2.) The second site is the spur rising from the site of the general hospital and sloping gently upwards from the racecourse. The boundary fence of the Greenfield Farm runs along the highest line of the hog's back formed by the spur, the northern slope being on town lands. It is a clean site and suitable for the construction of barracks. The spur is sheltered by higher spurs on all sides.

As regards water supply at Mooi River considerable difficulties present themselves. The river water is unlimited in quantity but it is turbid, and comes through a series of farm lands. Springs of clear water from the sandstones are fairly numerous but their yield is small. No suitable works have been undertaken to conserve this yield for troops except at a spring close to the road leading from Mooi River Station to the Remount Depôt at Weston. The yield of this spring is not more than 1,500 gallons daily.

Other springs at levels which would enable water to be brought by gravitation to either of the sites mentioned above are on private property.

Three such springs were noted on Mr. Stevenson's farm, two with a probable yield of 2,000 gallons daily and the third with considerably more.

A Boer hospital encampment was placed close to one of these springs, and pits for burying dead animals have been dug in the slopes leading to another. The Boer camp was formed, it is stated, in 1899, and occupied for 6 days only.

The drainage and disposal of sewage from either of the sites mentioned also present difficulties if serious pollution of the river above the Remount Depôt is to be avoided. There are no good slopes with gentle gradients such as is required for treatment by land irrigation.

As regards climate and health of inhabitants of both Mooi River and Howick districts little can be said beyond the fact that the air in both places is bracing and invigorating, and that no health records were available.

Mooi River is liable to have great alternations between hot broiling days and cold, chilly mists during the summer rains. The winter months are clear, sunny, dry and frosty.

Enteric fever has occurred amongst some of the families living in Howick and Mooi River, but it is stated that it was unknown amongst them until the war. At one farm, 2 or 3 miles from Mooi River, a child was attacked who had never been away from the farm, according to the father's statement. The farm had been occupied by the Boers during their 6 days stay in the district. The statistics of the general hospitals at both places have been sent to England, but it is stated that there were practically no locally contracted cases of enteric during the war.

Thunderstorms are severe, especially in the Mooi River district, and deaths from lightning have occurred in camps there.

It is understood that a valuable statistical and meteorological report on Mooi River has been prepared and taken to England by Lieut.-Colonel H. H. Johnston, R.A.M.C., who was attached to the general hospital. It may be available for reference at the War Office.

CONCLUSIONS.

(1.) The best site for barracks at Pietermaritzburg is the upper portion of the Fox Hill slopes.

(2.) The area there suitable for barracks is at least 600 acres. This is large enough for a full garrison of all branches of the Service.

(3.) The present garrison at Fort Napier shows a progressive increase in incidence of those diseases which are usually attributed to insanitary conditions.

(4.) The conclusion to be derived from this indication is that the site has become more and more polluted and overcrowded and that the measures for avoiding pollution have been inadequate.

(5.) The chief sanitary defects in Fort Napier, apart from details of barrack construction, are in the surface drainage, in the proximity of horse lines to barracks, in defective arrangements for preventing pollution of soil around stables and habitations, and in insanitary systems of sewage, urine and refuse disposal without adequate means of minimizing the dangers of these systems.

(6.) The great sanitary defect of both town and garrison of Maritzburg is, however, the water supply.

(7.) The defect is not a defect of quantity as there is a minimum yield and storage sufficient for at least 50 gallons per head of the present population. The defect is in the quality.

(8.) As regards quality the water supply is liable to dangerous pollution, and no adequate method of purification is adopted.

(9.) The milk supply and ærated water supply of Maritzburg admit of much sanitary improvement.

(10.) The arrangements for removal of urine and nightsoil are insanitary as they necessitate the retention of these waste products near houses for 3 days before removal.

(11.) The arrangements made for prevention of pollution of soil and overcrowding of sites in the town of Maritzburg are progressing on sound lines.

(12.) The prospective works for improving the water supply and introducing a water-carriage system of sewage disposal are of a nature likely to reduce the high zymotic death rate of the town to the standard of healthy cities.

(13.) The climate of Maritzburg, Howick and Mooi River is suitable for British troops, that of Mooi River being the most invigorating, of Howick next, and of Maritzburg the least.

(14.) The best site for a garrison at Howick is the unoccupied and higher plateau on the town lands between the railway station and the town.

(15.) This site is suitable for two regimental units with accessories, 100 acres being available.

(16.) It is also suitable for a good system of sewage disposal, and a good spring water supply is probably available by gravitation.

(17.) The surface soil at Howick requires careful drainage and subsoil drainage may be necessary where the depth of soil admits of this.

(18.) The best site on town lands at Mooi River is the two elevated plateaux west of the Estcourt Road above the railway station.

(19.) This site is large enough for two regimental units with accessories.

(20.) Possible objections to this site are the danger of lightning and the exposure to cold winds and mists.

(21.) An alternative sheltered site is the slope above the hospital encampment. The objection is that it is in an enclosed valley and it is not so wide and extensive as the other site.

(22.) This alternative site is large enough for two units with accessories, only if the lower part of the slope down to the hospital is utilized.

(23.) There are likely to be greater difficulties at Mooi River than at Howick with regard to water supplies from any other source than the river, and also with regard to disposal of drainage and sewage.

RECOMMENDATIONS.

(1.) The Board condemning many of the barracks in Fort Napier arrived at a sound conclusion, and, if a suitable opportunity offers, it is recommended that the whole of this polluted area be given up, a good clean area taken over on the Fox Hills, and barracks, drainage, and water-carriage sewage disposal works planned and completed before the area is occupied.

(2.) In the meantime, the existing systems of sewage and refuse disposal would be better dealt with by the Corporation methods than by those of the contractor; and it is recommended that the Corporation be asked to take over the working, provided they can arrange to remove the urine and nightsoil daily.

(3.) A complete and comprehensive plan of drainage, of macadamizing roadways, clearing and tidying waste ground, concreting or paving around barracks and stables, removal of old insanitary stables, and construction of proper stables is hygienically necessary if the garrison remains in Fort Napier and mounted branches of the Service are retained there.

(4.) With regard to town sanitation, it is recommended that pressure should be brought to bear in order to improve the conditions connected with milk and aerated water supplies, so far as the cleansing of bottles and milk vessels are concerned. Provision of running water in tanks, or sprays of sterilized or boiled water is necessary, in place of the existing systems.

(5.) It is also recommended that the Corporation should remove the nightsoil and urine daily, but this is a matter upon which the military authorities cannot well bring pressure to bear.

(6.) As regards the existing town water supply, there is urgent need, so long as it is in use, for the universal employment in barracks and town of sterilizing filters, or other means of sterilizing water. The Maiche apparatus is good in itself, but it is not worked so as to meet the requirements of the whole garrison. The water from it should be distributed regularly to vessels in all barracks and workshops; and, if the yield is insufficient, additional sterilizers should be provided.

(7.) With regard to Howick, it is recommended that a complete system of surface drainage and water-carrriage system of sewage disposal be carried out, in connection with barracks on the town lands site; that the water for drinking be obtained from the same source as the village supply, by enlarging the reservoir and conserving the springs as much as possible in the manner suggested in my report on Newcastle; and that the water for a water-carriage system of sewage disposal be obtained from the river by turbines or hydraulic ram, or other means of pumping.

The outfall of such a system should be at a septic tank and filter bed installation, on the slope leading to the river just above the falls, and the effluent should be passed over the land before entering the river.

(8.) With regard to Mooi River, a water-carriage system of sewage disposal with adequate land treatment before entering the river, does not seem possible on account of the difficulty of obtaining a suitable slope of land in connection with the sites selected; but, if the elevated site were adopted, then a short tunnel through the dolerite ridge would convey the drainage in a short line of drains to meadow lands below the Remount Depôt; and this is what I would recommend if the garrison is to be permanent in the locality. In such a case a water-carriage system would be feasible, and is strongly recommended. Otherwise, the American trough system with removal to suitable land in vacuum carts, or the system indicated by Majors Firth and Horrocks in the British Medical Journal of 27th December last (*see* Appendix C), is urged, instead of the pail system. Failing these, as stated in my report on Newcastle, the universal use of chloride of lime solutions in all pail or bucket systems is imperative.

(9.) As regards the water supply of a garrison at Mooi River it is recommended that the springs on the mountain above the old Weston College, about ½ mile from the elevated sites selected, be conserved in the manner noted in my report on Newcastle, and their yield used for drinking and kitchen purposes. For other purposes river water would be required, as it is extremely doubtful whether the yield of these springs would suffice for more than the drinking and kitchen requirements.

Plans are submitted showing as nearly as possible the position of these sites.

I have made no mention of site planning of barracks. This should be considered when it is determined where and in what numbers troops are to be stationed.

I have also made no recommendations about barrack construction, because it is understood that huts of I.G.F. South African type are being sent out, but it is strongly recommended in the interests of sanitation, and to give facilities for economical construction of good systems of drainage and sewage disposal, that the I.G.F. verandah type of barracks constructed out of the local bricks, which appear to be of excellent quality, should be adopted in the more permanent stations instead of the wood and corrugated-iron huts.

With regard to the latter, instead of wood lining a lining of expanded metal and plaster is advocated as a means of preventing vermin, and it is further recommended that the walls should be raised to at least 10 feet instead of 8½ feet, in order to avoid the interference with light, inevitable from the pitch of the verandah roofs.

W. G. MACPHERSON, *Major*,
R.A.M.C.

PIETERMARITZBURG,
12*th November*, 1902.

REPORT ON NOTTINGHAM ROAD TOWN LANDS AS A SITE FOR BARRACKS.

The nearest limit of these town lands from the railway station is about 9 miles west. The area is a large irregular polygon covering about 24 square miles, or 15,360 acres. Its population consists of five European families in the village at Fort Nottingham, and two 50-acre farms rented to Europeans on the southern slopes of Mooi River. The native population consists entirely of labourers connected with these farms.

The physical features are a high mountain of sandstone with precipitous slopes running south-west to north-east, the southern slope falling to a small triangular corner on which the village of Fort Nottingham is placed, and the northern slopes falling to the Mooi River, which takes a serpentine course diagonally across the northern half of the lands. The north side of the river is a precipitous rise to sandstone cliffs and to a plateau, which, however, is beyond the boundary.

A rough section across the town lands from north to south might be diagrammatically represented by the attached drawing (*see* Appendix). It will be seen that to get from the village to the river one has to go right over the sandstone mountain. The 50-acre plots are on the slopes leading from the northern cliff of this mountain to the river.

The eastern boundary of the river valley is open country; the western narrows considerably, and is broken up by foothills of comparatively low elevation. Springs form on the upper portion of the cliffs as indicated; they are of comparatively small volume, but they are fairly numerous, and form a mountain burn on the south, which passes below the village and is its water supply. On the cliffs north and south of the river valley they form streams of a smaller volume.

The river has a large volume of water, and flows over a bed of basalt rock. It is a clear rippling stream in most parts of its course through town lands. The plateau and slopes are covered with grass, the cliffs with a considerable amount of bush. There is a wide unpassable bog between two of the slopes from the main mountain to the southern bank of the river.

Sites for Garrison.

Three possible sites suggest themselves—

(1.) The high plateau. It is wide and extensive, about 2 or 3 miles long by 1 mile wide, at an elevation of some 5,600 feet.

(2.) The low plateaux, north and south of the river. They are limited in area, and about 5,300 feet elevation.

(3.) The slopes leading to the south bank of the river. They are long hog's back slopes, of low gradient and fairly extensive as regards length, but somewhat limited as regards width.

Recommendations as to Sites.

(1.) The high plateau, although affording a fine mountain climate is difficult of access, and water supply would be an expensive matter dependent on pumping from a distance. A garrison on this plateau would be liable to pollute the springs feeding the habitations below.

(2.) The lower plateau, especially that on the north bank, is the most suitable site; but it is not large enough for a large garrison, and its drainage would be almost direct into the river. The two lower plateaux, one on the north, the other on the south bank (above Stanley's holding), might accommodate two units. The latter is a considerable distance (2 or 3 miles) from the river. The former is not very accessible.

(3.) The long hog's back slopes would accommodate one unit each but no more. There are two or three such slopes, but the best of them drain into the bog intervening between two slopes.

WATER SUPPLY.

For the first site no suitable water supply is available except from river or springs at a distance. Pumping would have to be resorted to.

For the second site springs at a higher level might be conserved and led to the sites by gravitation. Their supply would probably be insufficient for the horses.

For the third sites spring water might also be conserved and led to sites by gravitation. The supply would also be insufficient for horses.

The second and third sites could be supplied readily with unlimited water from the river by pumping or watercart. Such a supply would require sterilization, but probably little or no clarification if collected at a suitable spot.

If the third sites were occupied the bog should be drained. This might not be difficult as it is close to the river.

Generally speaking, the lower plateau on the north of the river presents the best hygienic features, but there would be difficulty in accommodating a large number there except in good brick barracks and stables.

The cattle of the district, sheep and oxen, are frequently carried away by epidemics. So, too, are fowls, and crops are said to be destroyed completely by hailstorms. Mange has been among the horses, but otherwise it is said to be a good country for horses.

The cost of erecting good sanitary barracks on any portion of town lands with easy access would be very great, but there is abundance of freestone on the spot for building.

W. G. MACPHERSON, *Major,*
R.A.M.C.

NEWCASTLE,
15th November, 1902.

APPENDIX A.

BIOLOGICAL EXAMINATION OF SOIL, MARITZBURG.

A.—First Series. Rough Examination of Soils in Fort Napier.

Sample 1.—Loam over shalestone on upper slope of fort, near swimming bath, 1½ inches from surface.

Sample 2.—Surface soil above shale, 10 feet from occupied bell tent and on slope above cavalry stable 2½ inches from surface.

Sample 3.—Red argillaceous earth on slope below No. 2A hut, upper barracks, and just above No. 2B hut, 2½ inches from surface.

Sample 4.—Dust from jointing of boards in No. 1 room, No. 2 hut, Royal Artillery barracks. Taken from centre of room, 10 a.m., 26th October, 1902.

Sample 5.—Stiff loam from centre of Edendale Camp, 1¾ inches from surface of ground recently covered by bell tent.

Sample 6.—From mound of garden loam round roots of syringa and mulberry trees in garden immediately below No. 2, married quarter. Latrine 8 feet distant, and tents 30 feet distant, 4 inches from surface.

Sample 7.—Silt from surface drain, draining from hospital and Fort Barracks.

Sample 8.—Stiff soil, similar to sample 3, from slope leading to road drain below terrace of No. 4 hut, lower barracks.

All samples were collected in sterilized bottles and with a sterilized spoon. One measured teaspoonful each. Subsequent weighing and drying were omitted at the laboratory. The test was of a rough preliminary nature. Date of collection, forenoon of 26th October, 1902.

100 c.c. sterilized water added to each sample and shaken up, and cultures in boullion made as follows from each.:—

(*a*.) 1 c.c. of soil water added to test tube of boullion.

(*b*.) 3 m. Parietti's solution and 3 m. of soil water added to boullion.

(*c*.) 5 m. Parietti's solution and 5 m. of soil water added to boullion.

(*d*.) 7 m. Parietti's solution and 5 m. of soil water added to boullion.

Test tubes were incubated at 37° C. and finally compared as to degree of turbidity on 2nd November, 1902.

Results.

Samples 7 and 5 showed slight turbidity with 7 m. Parietti's solution, and marked turbidity in other dilutions.

Samples 6, 1, 3, showed no turbidity with 7 m., and slight turbidity with 5 m., more marked with other solutions.

Samples 4, 2, showed no turbidity with 7 m. or 5 m. dilutions, slight to marked turbidity with other dilutions.

Sample 8 was free from turbidity in all the Parietti dilutions.

Only one sample, sample 6, gave indol reaction.

Roughly estimated, sample 8 gave the best results, samples 7 and 5 the worst. In other words there was little to choose between the drain silt and the ground camped over at Edendale Camp.

B.—Second Series.

Sample 1.—Dry soil over shale from Fox Hill slopes about 200 yards on the city side of Red Farm, 50 yards west of Camperdown Road. Soil covered with dry grass and grazed over.

Sample 2.—Similar soil from Fox Hill slopes about 300 yards on Fox Hill side of Red Farm.

Sample 3.—Soil from base of ant heap about 10 yards from site of sample 2.

Sample 4.—Soil from Edendale Camp, from same spot as sample 5 of first series.

Sample 5.—Soil from trench, round ground on which marquee had been pitched, above burgher hutments, War Department ground.

Sample 6.—Soil from mound of earth about 12 feet down slope from spot where sample 5 was collected.

Sample 7.—Soil from ground, previously covered by bell tent, above burgher hutments.

All samples were collected with usual precautions, and about $1\frac{1}{2}$ inches from the surface.

Samples 1 to 4 were collected on afternoon of 2nd November, 1902; samples 5 to 7, forenoon of 3rd November, 1902.

Of each sample 5 grms. were taken, and shaken up with 100 c.c. sterilized water.

Each sample was tested for (*a*) aerobic and (*b*) anaerobic growths.

A.—Aerobic Tests.

Dilutions were made in accordance with the method described by Houston in Report of Parliamentary Commission on Sewage Disposal, *i.e.*, 1 c.c. of the original water was added to 9 c.c. of sterilized water, 1 c.c. of this dilution added to 9 c.c. of sterilized water, and so on till dilutions equal to ·1, ·01, ·001, ·0001, ·00001, ·000001, and ·00000001 of the original 1 c.c. were obtained.

1 c.c. of original water and 1 c.c. of each of the dilutions were added to gelatine agar plates (5 per cent. agar, 5 per cent. gelatine and boullion q.s.); and 1 c.c. of the original water was added also to gelatine agar plates containing ·02 per cent. pure phenol.

The gelatine agar plates were incubated at 37° C. on 6th November, 1902, the phenolated plates on 8th November, 1902. The plates were examined 9th November, 1902.

Results.

All samples showed growths both in the phenolated plates and in the ·00000001 dilutions.

In the phenolated plates the colonies were discrete except in samples 4 and 6.

Sample 5 gave the smallest number of colonies in this series, next in order being 2, 3, 7, 1, 4 and 6.

In the non-phenolated plates the degree of growths in the higher dilutions, *i.e.*, ·00000001 to ·00001 indicated that sample 5 had the smallest number of colonies, followed by 2, 3, 1, 6, 7 and 4.

In the lower dilutions the plates were all so opaque with growths that it was impossible to distinguish which was worst and which best.

B.—Anaerobic Tests.

1 c.c. of original water was added to glucose agar tubes and incubated *in vacuo* in a Buchner's tube at 37° C. on 7th November, 1902. Examined, 9th November, 1902.

Results.

Sample 4 was completely broken up with gas formation. Sample 2 showed considerable gas formation, sample 1 slight gas formation, sample 7 commencing gas formation, and samples 5, 6 and 3 no gas formation.

This second series of tests again makes the soil of Edendale Camp stand out in a marked manner as the most polluted sample obtained.

The gas formation in sample 2 is probably due to pollution of soil from droppings of cattle, as the Fox Hills are used for grazing and cow dung was seen generally over the surface.

The comparative position of sample 5 (soil from trench of the site of a marquee) is unexpected, but the condition of soils from the other portions of the camped-over ground above the burgher hutments approach that of the Edendale Camp, although there is a distinct line of demarcation between the latter and all other soils examined.

W. G. MACPHERSON, *Major*,
R.A.M.C.

APPENDIX B.

(From *Natal Witness*, 8th November, 1902.)

OUR WATER SUPPLY.

Reasonable Precautions.

Newly Amended Bye-laws.

At its monthly meeting yesterday the City Council unanimously passed the following amendments to the Waterworks bye-laws, as drafted by the City Solicitor :—

(358.) "It shall be the duty of the person for the time being in charge of any premises to see that the ordinary supply of water thereto is not used to an unreasonable extent or in a wasteful manner, or for any of the purposes mentioned in Section 375 hereof, and any person using or permitting or suffering such supply to be used to an unreasonable extent or in a wasteful manner, or for any of the purposes mentioned in Section 375 hereof, shall be guilty of an offence.

(360.) "The use of hose pipes, revolving sprays or similar contrivances for watering gardens connected with private dwelling houses, and not used for the purpose of trade or profit, shall be regarded as being included in the ordinary domestic supply. Provided, however, that for every hose pipe, revolving spray, or similar contrivance for the purpose of watering gardens connected with private dwelling houses aforesaid, there shall be payable in advance on 1st August in each year a sum of ten shillings sterling: Provided that the hose, spray, or other contrivance, as aforesaid, shall not be used for more than two hours each day.

(361.) "No person shall use, or cause to be used, for the purpose of watering any garden, or for any other purpose whatever, any hose or other similar contrivance, that shall be fastened to any tap or pipe connected directly or indirectly with the ordinary supply from the waterworks, unless during the whole time of such use, such hose or contrivance shall be held by hand and directed by, and under the immediate personal care of some competent person present on the spot.

(363a.) "Every applicant for water supply must have the pipes and fittings ready fixed before any connection will be made by the Council with their mains.

(379.) "The Town Council may make special arrangements with large consumers of water at such special rates as it may from time to time determine, and may make special contracts for the supply of water for any of the aforementioned purposes, with or without having a meter fixed.

(380.) "The following provisions shall apply to water supplied by meter: —(*a.*) Meters will be read on or about the first day in each month, when the account for water will be rendered for the preceding month's consumption. (*b.*) Fifteen days' delay in settling such account will render the service liable to be cut off. (*c.*) If any delay arises in fixing the meter, after the service is laid on, the average consumption for the first month after the meter is attached shall be taken as the basis for charging for consumption for the time during which the meter was not attached. (*d.*) Should the meter be out of repair, or cease to register, or register inaccurately, the Borough Engineer shall estimate the consumption, and charge shall be made accordingly.

(385.) "Water shall be supplied to properties outside the borough through a meter only, at such a rate or charge, and for such times, and on such terms and conditions as the Council may from time to time determine, and the Council may at any time, on giving three months' notice in writing of such its intention, discontinue any supply of water outside the borough, without being liable for any compensation for such discontinuance, or for any loss thereby sustained. The provisions of Section 381 (power to cut off extraordinary supply) and Section 381 (extraordinary consumers to sign an agreement) shall also apply to the case of water supplied outside the borough.

(385a.) "Water may be supplied to any person living more than 220 yards from the water mains upon such terms and conditions as the Council may from time to time determine.

(386.) "No person shall bathe in any stream, reservoir, or aqueduct connected with the waterworks belonging to the Corporation, or wash, throw, or cause to enter therein any dog or other animal.

(387.) "No owner or occupier of any land within the drainage area of any reservoir or aqueduct or waterworks of the Corporation shall do or permit to be done on his land, any act, or permit to remain thereon any matter or thing which, in the opinion of the Council, is likely to injure the water supply, after notice to discontinue or remove the same shall have been given to him in writing by the Council. No person shall cause the water of any sink, sewer, or drain, or other filthy water belonging to him, or under his control, to run or be brought into any stream, aqueduct, or other waterworks as aforesaid, nor shall do any other act whereby the water supply of the Corporation shall be fouled.

(391.) "No person shall connect any service pipe with the Corporation mains or any pipe communicating therewith, without the consent of the Borough Engineer, nor until such service pipe shall have been inspected and approved of by the Borough Engineer or his authorised deputy. No person shall tamper with or alter any pipe, meter, stopcock, or other water fitting on the property of the Corporation.

(393.) "Should any waste or leak occur in private or Government premises, due to defective taps, pipes, or fittings, it shall be the duty of the consumer to have such waste prevented by having the same repaired at his own cost."

APPENDIX C.

(*British Medical Journal*, 27th September, 1902. Extract from a Paper by Majors Firth and Horrocks, R.A.M.C.)

"We have no experience of South Africa, but we have of India, and the conditions of both, we understand, are not dissimilar. Any general introduction of a water-carriage system of sewage disposal, as we know it in this country, is out of the question either in India or South Africa. Two great stumbling blocks stand in the way of its introduction; one is the deficiency of water, the other is the cost attending the laying and maintaining any complete system of drains and sewers. A limited and modified system of water carriage with water-closets is, we think, not impracticable, particularly in lines occupied by British troops, and after all it is among them that the evil effects of dry closets and conservancy methods chiefly manifest themselves. We therefore seriously suggest the abandonment of dry earth latrines, and the substitution of trough water-closets or water latrines. We are fully aware of their defects and the reasons why they have been discarded, where possible, in England; but we think that, notwithstanding their drawbacks, they offer a better safeguard to health than dry latrines. The great difficulty in respect of their introduction will be a sufficiency of water. A 3-gallon flush per head per diem we think will be adequate, and this is a volume of water which few Indian cantonments would fail to supply.

Of course, this will mean the provision of suitable tanks at the head of each latrine, the connecting of these tanks with the local water supply, means for filling them, and, finally, pipes or drains to carry off the sewage. None of these are unsurmountable difficulties, though they certainly involve a complete remodelling of existing arrangements.

In place of having a large system of drains connecting all these trough latrines together, and finally delivering a common effluent, we suggest that each water latrine or group of, say, two or more adjacent latrines should discharge its effluent by a short drain into a collecting tank or chamber. The contents of this chamber should be sterilized or rendered specifically innocuous by either the addition of chemical disinfectants or by the application of heat sufficient to raise the temperature of the contents to at least 80° C. for 1 hour. Where heat is employed the discharge valves from these tanks or chambers should be of such a nature that they will not open until the desired temperature of 80° C. has been attained. Once their contents are rendered innocuous, the tanks might, in fact should, be emptied and their contents removed by carts and disposed on land. The great object in any scheme of this kind is to secure a prompt moist removal of the excreta from the place when it leaves the human body to a point where it can be sterilized. Once that is secured, the risks of dissemination of infective material by either flies or in the form of dust are small.

We see no practical difficulties in arranging one or more of these water latrines with sterilizing effluent chambers for every corps unit in a cantonment including both regimental and sudder bazaars. Certain engineering difficulties may arise in some stations, owing to gradients and perhaps as to enough water, but none are insurmountable. The question of cost is likely to be more serious, but we believe the sum required to test the feasibility and efficiency of this system of sewage removal in a selected cantonment would be money well spent if we consider the lives at stake."

TABLE I.—ADMISSIONS, Deaths, and Constantly Sick in Garrison of Fort Napier, Maritzburg.

Year.	Average strength.	Admissions.	Died.	Constantly sick.	Percentage to strength.		
					Admissions.	Deaths.	Constantly sick.
1883 ..	1,042	674	6	49·24	64·5	·57	4·7
1884 ..	801	633	2	43·66	79·0	·25	5·4
1885 ..	1,467	1,257	12	76·38	85·7	·81	5·2
1886 ..	1,547	1,273	7	81·55	82·3	·45	5·2
1887 ..	1,414	1,138	12	84·85	80·4	·84	6·0
1888 ..	827	730	8	54·94	88·2	·96	6·6
1889 ..	912	967	4	68·05	106·0	·43	7 4
1890 ..	982	1,080	9	69·17	109·9	·91	7·0
1891 ..	1,030	1,026	18	79·45	99·6	1·74	7·7
1892 ..	1,264	1,554	7	86·67	122·9	·55	7·0
1893 ..	1,393	1,400	10	78·22	100·5	·71	5·6
1894 ..	1,329	1,056	8	64·54	79·4	·60	4·8
1895 ..	1,416	1,329	10	76·35	93·8	·70	5·3
1896 ..	1,594	1,444	13	88·39	93·7	·81	5·5
1897 ..	2,307	2,472	19	172·75	107.1	·82	7·4
1898 ..	2,459	2,275	33	116·89	92·6	1·34	4·1

Summary in Quinquennial Periods.

1881–88 ..	6,056	5,031	41	341·38	83·07	·67	5·6
1889–93 ..	5,581	6,027	48	381·56	108·00	·86	6·8
1893–98 ..	9,100	8,576	83	518·92	94·25	·91	5·9

TABLE II.—ADMISSIONS and Deaths from Enteric Fever amongst Troops in Maritzburg.

Year.	Admissions.	Deaths.	Percentage.*		Number of admissions for enteric fever, by months.											
			Admissions to average strength.	Deaths to average strength.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1883 ..	5	1	·4	·09	1	..	1	..	..	1	1	..	1	..	..	..
1884 ..	5	..	·6	..	2	1	1	..	..	..	..	..	..	..	..	1
1885 ..	11	5	·6	·30	9	1	..	..	..	..	..	..	..	..	1	..
1886 ..	7	5	·4	·30	1	2	1	1	1	..	1	..	..	..	..	..
1887 ..	3	1	·2	·07	..	..	1	1	..	..	..	..	..	..	1	..
1888 ..	1	..	·1	..	..	..	..	..	..	..	..	..	..	..	..	1
1889 ..	4	2	·4	·2	..	..	..	..	..	1	..	..	..	..	2	1
1890 ..	43	3	4·3	·3	4	1	3	3	1	..	1	..	1	..	1	28
1891 .	59	16	5·7	1·5	21	14	14	6	1	1	1	..	1	2	1	2
1892 ..	25	2	1·9	·1	7	4	2	3	1	..	..	1	..	1	2	4
1893 ..	17	2	1·3	·1	3	..	1	1	..	..	1	..	3	2	1	5
1894 ..	30	5	2·2	·4	7	11	1	1	1	2	2	..	2	..	2	1
1895 ..	24	1	1·6	·07	2	3	1	1	3	..	..	..	..	..	4	10
1896 ..	23	6	1·4	·7	6	3	1	2	..	..	1	..	2	1	5	2
1897 ..	116	6	5·0	·2	6	5	5	5	11	..	1	1	12	31	20	17
1898 ..	114	18	4·64	·7	24	10	17	11	9	4	3	.1	..	3	10	22
Totals	..	..	..	..	93	55	49	35	28	9	12	3	22	40	50	96

Summary in Quinquennial Periods.

1884–88	27	11	·44	·18
1889–93	148	25	2·65	·44
1894–98	307	36	3·37	·39

* For average strengths, *see* Table I.

TABLE III.—ADMISSIONS for Simple Continued Fever and Febricula amongst Troops in Maritzburg.

(N.B.—No deaths are recorded under this heading.)

Year.	Number of admissions.	Percentage to average strength.*
1883..	52	4·9
1884..	30	3·7
1885..	127	8·6
1886..	116	7·4
1887..	20	1·4
1888..	14	1·8
1889..	68	7·4
1890..	83	8·4
1891..	83	8·0
1892..	106	8·3
1893..	97	6·9
1894..	100	7·5
1895..	77	5·4
1896..	81	5·2
1897..	169	7·3
1898..	188	7·66

Summary in Quinquennial periods

1884–88	307	5·07
1889–93	437	7·83
1894–98	615	6·75

* For average strength, *see* Table I.

TABLE IV.—ADMISSIONS for Dysentery and Diarrhœa amongst Troops in Maritzburg.

Year.	Dysentery.		Diarrhœa.		Percentage admissions to average strength.	
	Admissions.	Deaths.	Admissions.	Deaths.	Dysentery.	Diarrhœa.
1883	12	..	20	..	1·15	1·91
1884	3	..	13	..	·37	1·60
1885	6	..	17	..	·40	1·15
1886	7	..	5	..	·45	·32
1887	7	1	8	..	·49	·56
1888	6	..	4	..	·75	·50
1889	5	..	30	..	·57	3·29
1890	14	..	50	..	1·42	5·09
1891	3	..	30	..	·29	2·91
1892	5	..	51	..	·39	4·03
1893	13	..	27	..	·93	1·93
1894	3	..	25	..	·22	1·88
1895	28	..	45	..	1·97	3·17
1896	51	1	72	..	3·19	4·51
1897	118	1	75	..	5·11	3·10
1898	90	3	84	..	3·66	3·42

Summary in Quinquennial periods.

1883–88 ..	29	1	47	..	·47	·76
1889–93 ..	40	..	188	..	·71	3·36
1893–98 ..	290	5	301	..	3·18	3·30

TABLE V.—Admissions for Diphtheria, Sore Throat, Tonsilitis, and Quinsy amongst the Troops in Maritzburg.

Year.	Number of admissions.	Percentage to average strength.*
1883	10	·95
1884	22	2·74
1885	39	2·65
1886	62	4·00
1887	45	3·18
1888	24	3·03
1889	27	2·96
1890	40	4·07
1891	56	5·43
1892	106	8·38
1893	77	5·52
1894	66	4·96
1895	129	9·11
1896	110	6·90
1897	107	4·63
1898	122	4·97

Summary in Quinquennial Periods.

1884–88	192	3·17
1889–93	306	5·48
1894–98	534	5·86

* For average strengths, *see* Table I.

TABLE VI.—Admissions for Bronchitis, Pneumonia, Pleurisy, and Bronchial Catarrh amongst Troops in Maritzburg.

Year.	Admitted.	Died.	Percentage of admissions to average strength.*
1883	54	1	5·18
1884	36	..	4·49
1885	43	1	2·93
1886	13	..	·84
1887	6	..	·42
1888	17	2	2·15
1889	40	..	4·38
1890	47	..	4·78
1891	36	..	3·49
1892	76	1	6·01
1893	65	1	4·66
1894	46	1	3·46
1895	42	1	2·96
1896	42	..	2·63
1897	77	..	3·33
1898	160	2	6·52

Summary in Quinquennial Periods.

1884–88	115	3	1·89
1889–93	264	2	4·73
1894–98	367	4	4·03

* For average strengths, *see* Table I.

TABLE VII.—ADMISSIONS amongst Troops in Maritzburg for Primary Venereal Sores and Gonorrhœa.

Year.	Primary venereal sores.	Gonorrhœa.	Percentage to average strength.*	
			Primary venereal sores.	Gonorrhœa.
1883	78	61	7·48	5·85†
1884	42	71	5·23	8·86
1885	180	125	12·27	8·52
1886	254	172	16·41	11·11‡
1887	279	140	19·73	9·90
1888	59	57	7·47	7·21
1889	127	102	14·58	11·71
1890	72	59	7·33	6·00
1891	50	35	4·85	3·39
1892	64	75	5·06	5·93
1893	107	88	7·68	6·31
1894	47	89	3·53	6·69
1895	74	100	5·22	7·06
1896	62	125	3·89	7·84
1897	108	175	4·68	7·58§
1898	67	63	2·68	2·56

Summary in Quinquennial Periods.

1884–88	814	665	13·44	10·98
1889–93	420	359	7·52	6·43
1894–98	358	552	3·93	6·06

* For average strengths, *see* Table I.
† Primary venereal sores include all venereal sores.
‡ New nomenclature introduced, and ulcer of penis comes under primary venereal sores.
§ Soft chancre takes the place of ulcer of penis in nomenclature.

TABLE VIII.—MONTHLY percentage Constantly Sick to strength for Maritzburg Garrison for the 16 years 1883 to 1898.

January	6·71
February	6·57*
March	6·47*
April	6·21*
May	5·97
June	5·20
July	5·53
August	6·14
September	6·00
October	5·54
November	6·10
December	6·23

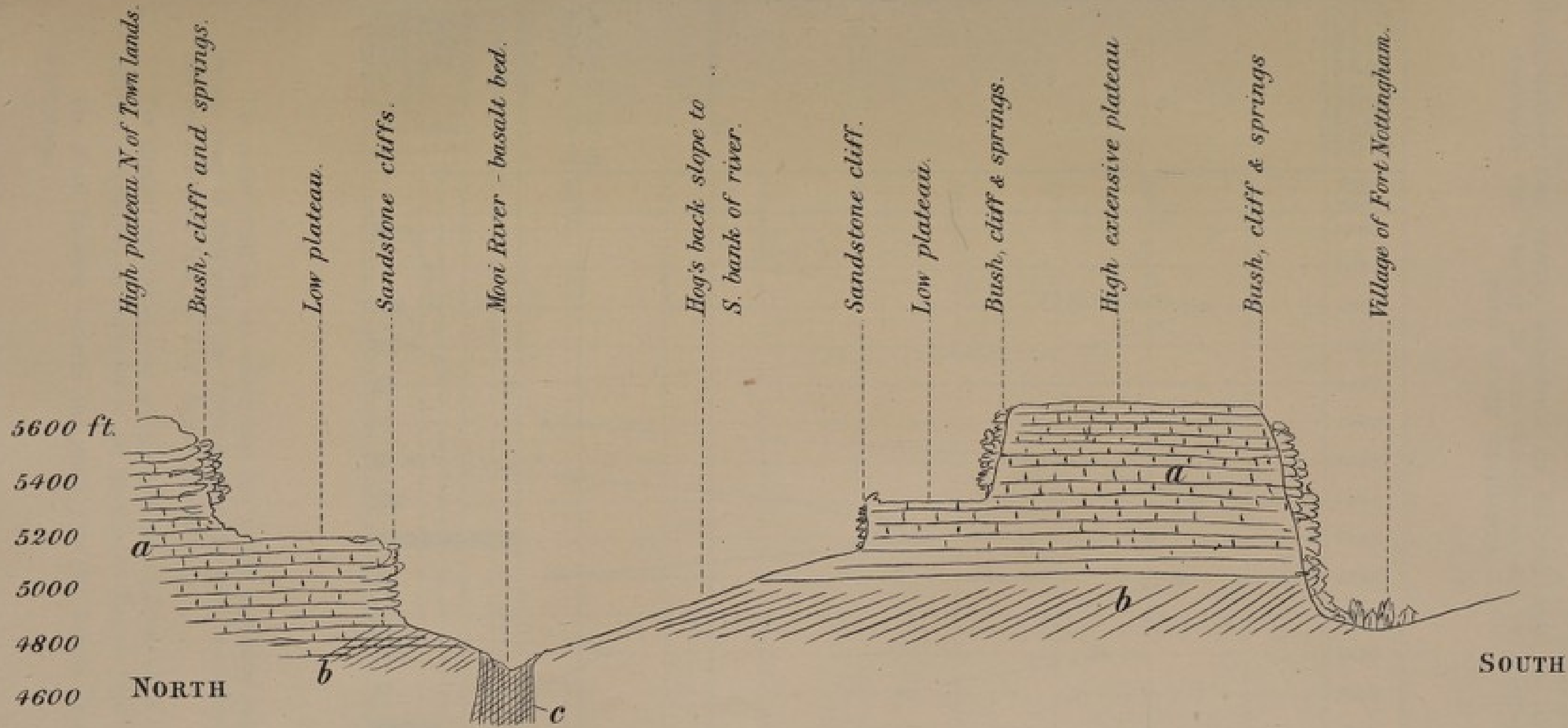
* 1891 excluded, as during these months a large proportion of the garrison was removed, while the sick remained.

TABLE X.—Death Rates for City of Pietermaritzburg (1868–1899).

(N.B.—The number of deaths has been taken direct from the Death Registers, the deaths of natives and soldiers being eliminated. The populations are taken from the official Blue Books, and are based on Census Returns in 1880, 1884, 1887, 1891 and 1898.)

Year.	Estimated deaths.		Principal zymotic diseases.								Ratio per 1,000 of population.			
	European population.	Recorded European population.	Small-pox.	Measles.	Scarlet fever.	Diphtheria.	Whooping cough.	Enteric and continued fevers.	Diarrhœal diseases.	Total zymotic diseases.	Total deaths.	Enteric and continued fevers.	Diarrhœal diseases.	Total zymotic.
1868	3,032	44	..	..	..	1	..	4	8	13	14·5	1·30	2·6	4·2
1869	3,632	108	..	..	..	6	..	6	11	23	29·7	1·64	3·0	6·3
1870	3,632	197	..	6	..	5	..	12	6	29	54·2	3·30	1·6	7·9
1871	3,632	86	..	4	..	1	..	7	8	20	23·6	1·92	2·2	5·5
1872	3,259	77	..	..	..	15	..	5	7	27	23·6	1·53	2·14	8·2
1873	3,259	95	..	..	..	16	12	2	9	39	29·1	·64	2·76	11·9
1874	3,259	119	..	1	..	7	..	2	19	29	36·5	·64	5·82	8·8
1875	4,290	105	..	..	..	7	..	2	21	30	24·4	·46	4·89	6·9
1876	4,290	112	..	..	..	4	3	5	16	28	26·1	1·11	3·72	6·5
1877	4,290	101	..	..	..	1	2	2	11	16	24·6	·46	2·56	3·9
1878	4,724	182	..	..	..	9	3	10	37	59	38·5	2·21	7·83	12·4
1879	4,724	162	..	..	..	8	..	12	32	52	35·8	2·54	7·08	11·0
1880	6,085	194	..	2	..	..	2	9	39	52	31·8	1·47	6·40	8·9
1881	6,085	187	..	..	.	3	..	11	27	41	30·7	1·80	4·43	6·7
1882	6,085	181	..	..	1	10	6	7	38	62	29·7	1·84	6·24	10·1
1883	6,105	211	..	..	..	7	.	6	43	56	34·5	1·39	7·04	9·1
1884	8,474	165	..	..	..	7	..	12	21	40	19·4	1·41	2·59	4·7
1885	8,474	188	..	..	..	12	2	17	29	60	22·1	2·00	3·58	7·0
1886	8,474	188	..	..	..	9	10	22	24	65	22·1	2·59	2·64	8·0
1887	9,251	133	..	..	..	7	2	15	11	35	15·0	1·62	1·24	3·7
1888	9,251	163	..	3	..	8	1	11	31	54	20·6	1·24	3·93	5·8
1889	5,266	196	..	..	..	17	8	8	18	51	38·9	1·51	3·41	9·6
1890	9,986	217	..	..	..	11	8	30	22	71	21·7	3·00	2·20	7·1
1891	9,986	183	..	3	..	10	..	17	22	52	18·3	1·78	2·30	5·4
1892	9,986	191	..	3	..	20	1	15	37	76	19·1	1·50	3·70	7·6
1893	9,986	145	..	1	..	21	11	7	14	54	14·5	·70	1·40	5·4
1894	9,986	170	..	..	..	10	4	6	19	39	17·0	·60	1·90	3·9
1895	9,986	183	..	..	3	6	1	10	17	37	18·3	1·00	1·7	3·7
1896	9,986	208	..	2	..	5	2	5	21	35	20·8	·50	2·1	3·5
1897	11,309	191	..	1	..	3	..	15	37	56	16·7	1·25	3·24	4·9
1898	11,836	245	4	..	..	1	7	13	51	72	20·7	1·09	4·30	6·0
1899	11,836	296	..	4	..	3	5	19	57	88	25·0	·42	1·60	7·4

DIAGRAMMATIC SECTION N. TO S. OF NOTTINGHAM ROAD TOWN LANDS.

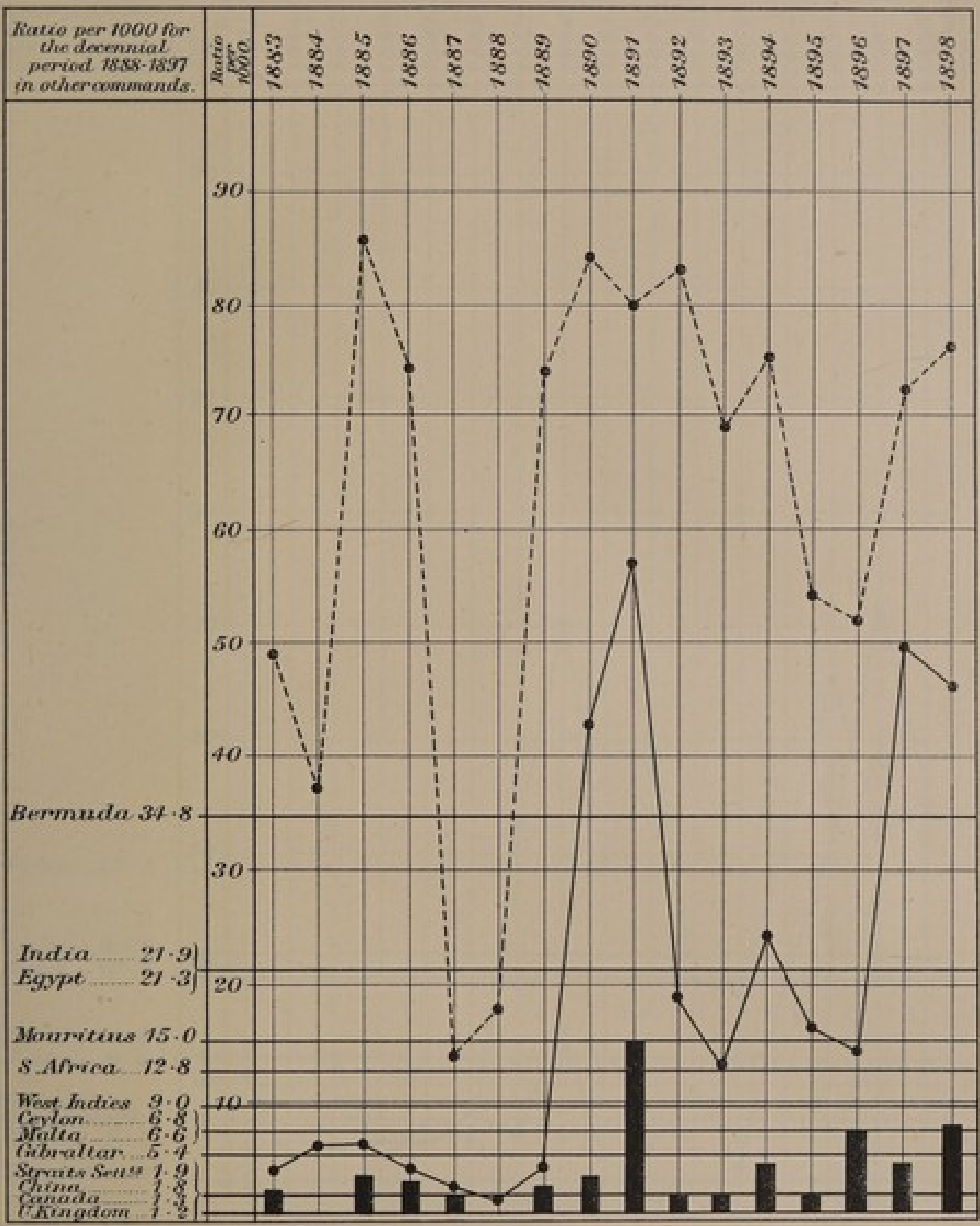


a = Sandstone } Basalt dykes run through these but are not shown.
b = Shales }
c = Basalt

(209.12/03. 1341) 232 - 20 a. w. c.

CHART I.

ILLUSTRATING THE YEARLY INCIDENCE OF ENTERIC AND S. C. FEVERS AMONGST THE TROOPS IN MARITZBURG—NATAL; IN COMPARISON WITH OTHER COMMANDS.



The curve made by the continuous line is the admission rate for Enteric Fever in Maritzburg per 1,000, average strength; the interrupted line the admission rate for S. C. Fever and Febricula.

The straight horizontal lines are the average admission rates of the different commands, as indicated in the margin, for Enteric Fever only.

The Black Columns indicate the death rate for Enteric Fever in Maritzburg.

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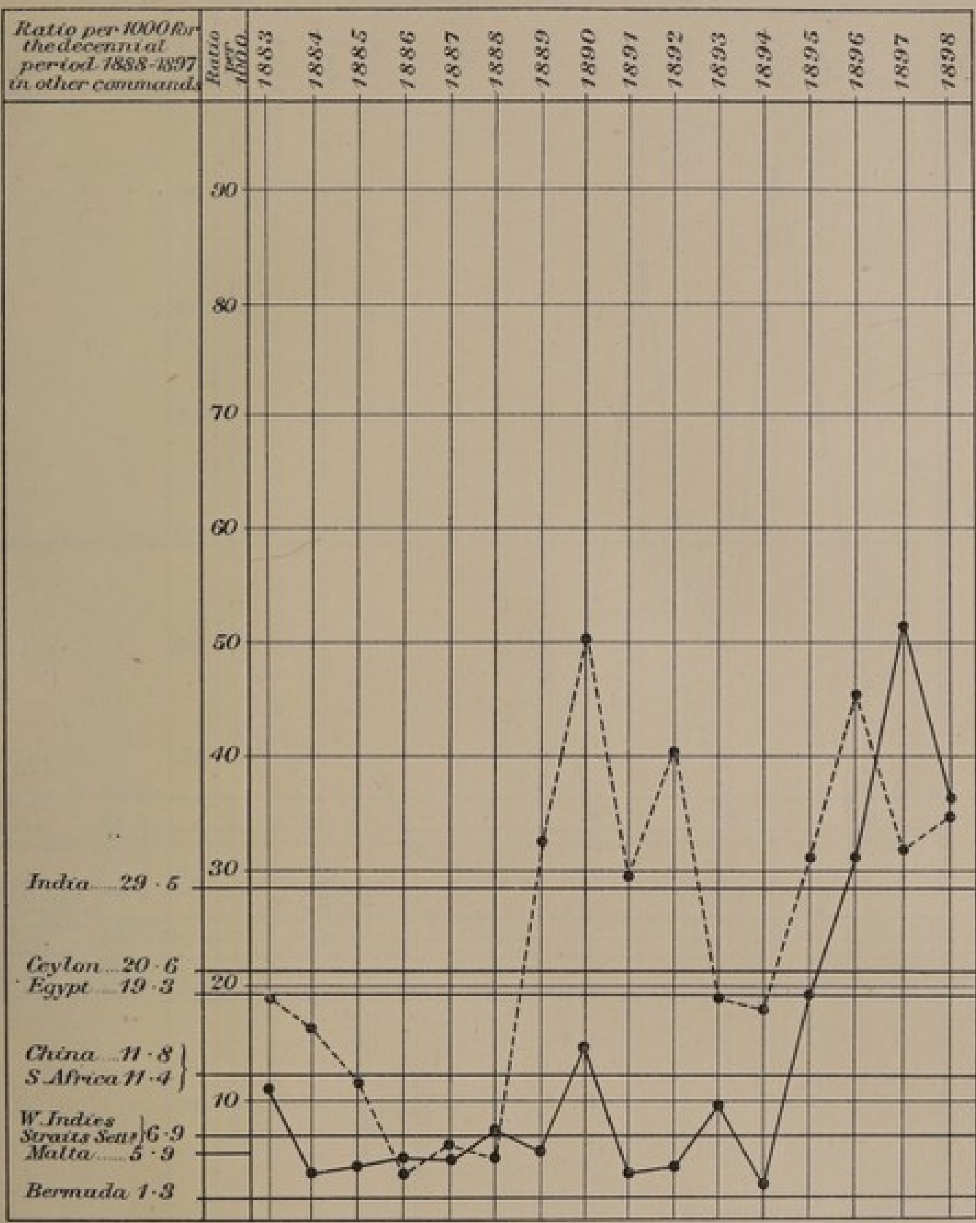
CHART II.

ILLUSTRATING THE YEARLY INCIDENCE OF DYSENTERY AND DIARRHŒA AMONGST THE TROOPS IN MARITZBURG—NATAL; IN COMPARISON WITH OTHER COMMANDS.



The curve made by the continuous line is the admission rate for dysentery in Maritzburg per 1,000, average strength; the interrupted line the admission rate for Diarrhœa.

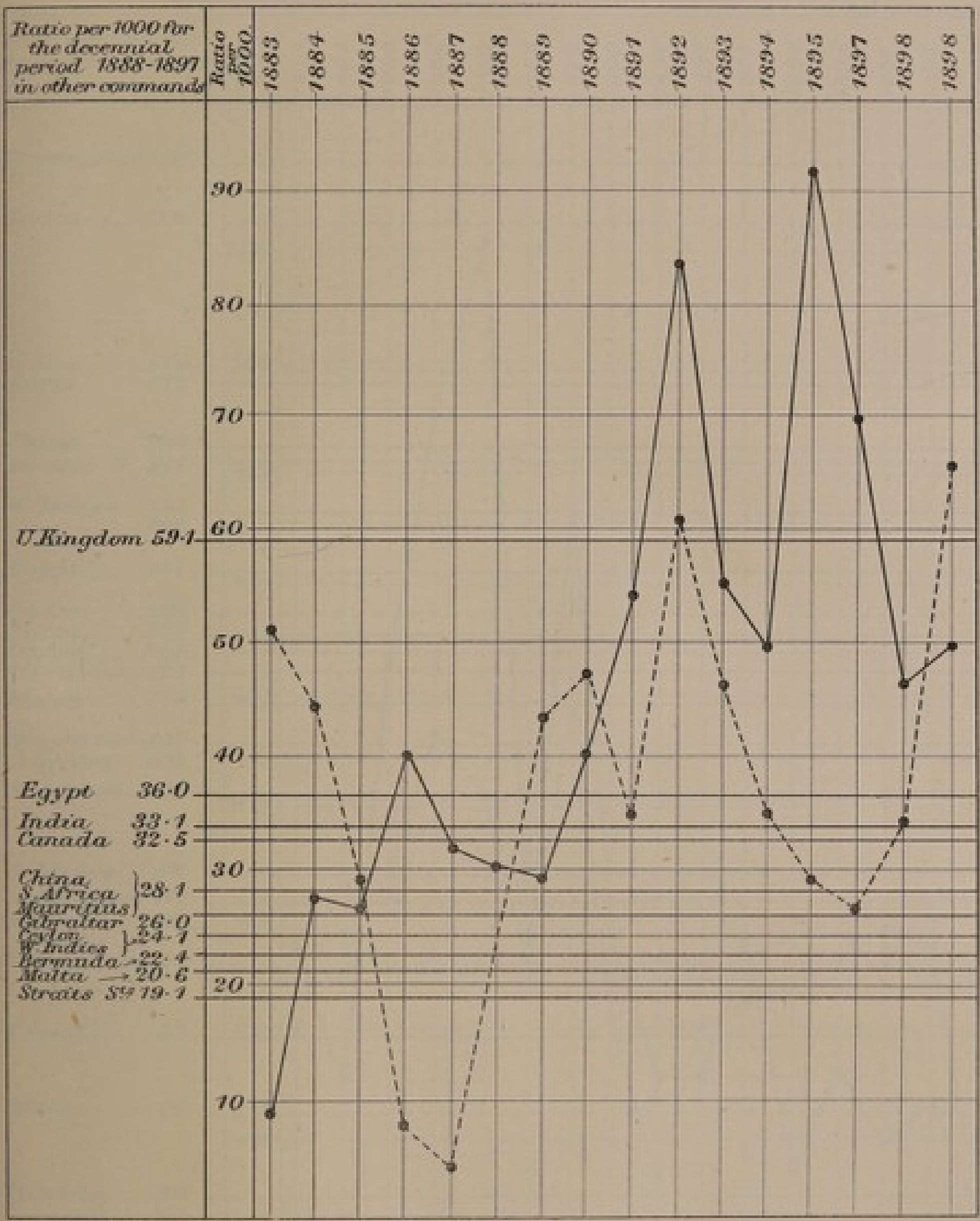
The straight horizontal lines are the average admission rates for Dysentery alone in the different commands, as indicated in the margin. The rates for the United Kingdom, Malta, Canada, and Mauritius are not indicated, as they are less than 1 per 1,000.

W E

(2/1903.1341) 232 200 W.O.

CHART III.

ILLUSTRATING THE YEARLY INCIDENCE OF THROAT AFFECTIONS AND RESPIRATORY DISEASES AMONGST THE TROOPS IN MARITZBURG—NATAL; IN COMPARISON WITH OTHER COMMANDS.



The curve made by the continuous line is the admission rate for Throat Affections (Diphtheria, Tonsilitis, Quinsy, and Sore Throat) in Maritzburg per 1.000, average strength; the interrupted line the admission rate for Respiratory Affections (Pneumonia, Bronchitis, Bronchial Catarrh, and Pleurisy).

The straight horizontal lines are the average admission rate in the different commands, as indicated in the margin, for Respiratory Diseases only.

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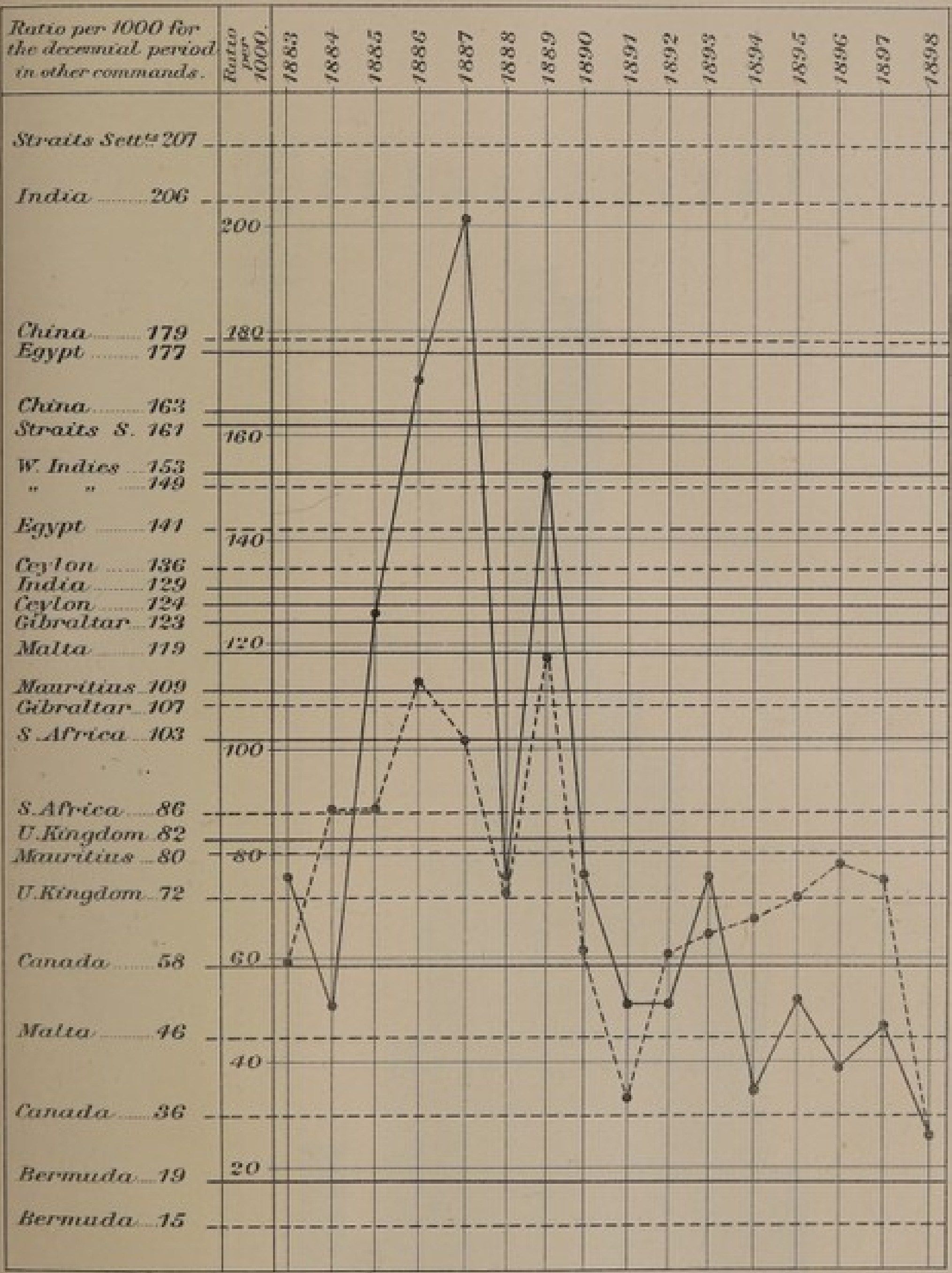
CHART IV.

ILLUSTRATING THE YEARLY INCIDENCE OF PRIMARY VENEREAL SORES AND GONORRHŒA AMONGST THE TROOPS IN MARITZBURG—NATAL; IN COMPARISON WITH OTHER COMMANDS.



The curve made by the continuous line is the admission rate for Primary Venereal Sores in Maritzburg per 1,000, average strength; the interrupted line the admission rate for Gonorrhœa.

The straight horizontal lines are the average admission rates in the different commands, as indicated in the margin; the continuous line being Gonorrhœa and the interrupted line Primary Venereal Sores.

W. E.

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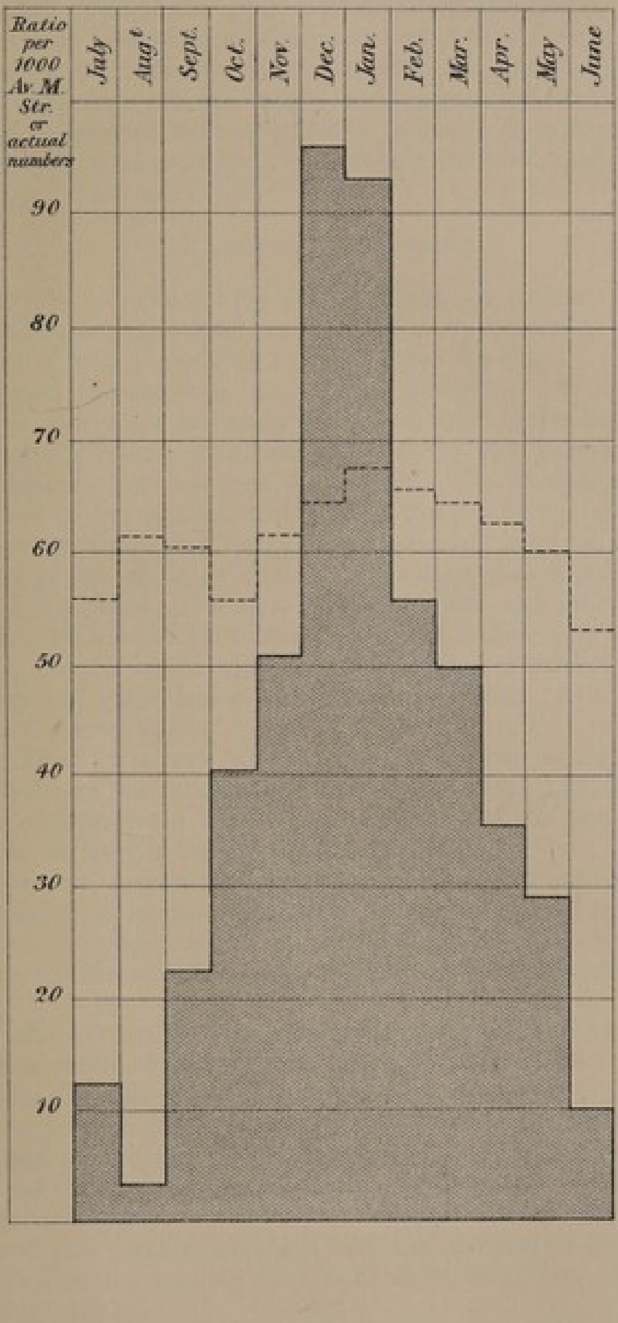
CHART V.

ILLUSTRATING THE MONTHLY VARIATION IN THE RATIO OF CONSTANTLY SICK AND IN THE ACTUAL NUMBER OF ADMISSIONS FOR ENTERIC FEVER AMONGST TROOPS IN MARITZBURG FOR SIXTEEN YEARS, 1883—1898.



The shaded columns represent the actual number of admissions for Enteric Fever for each month from 1883 to 1898.

The dotted line represents the ratios of constantly sick to average monthly strengths for the same period.

P. M. B. Natal
6 · 11 · 02

W. L. Macpherson
Major R.A.M.C.

(2/1903. 1341) 232 - 20f mo.

REPORT ON THE NEW CANTONMENT FOR BRITISH TROOPS IN STANDERTON.

In carrying out the instructions of War Office letter, No. 5567/70 (Army Medical Department) of 20th August last, I have had to modify my enquiries in Standerton by the fact that sites have already been selected, that barracks have been planned and their erection well advanced towards completion, and that until the town came under the British Government in 1901 there was no system of sanitation or death registration amongst the civil inhabitants. This report is, however, arranged on lines similar to the reports already submitted on proposed garrisons in Natal, with a view to estimating the influence of existing and prospective sanitary conditions on the health of troops, and the conclusions and recommendations which these have determined. In accordance with instructions received from the Principal Medical Officer, South Africa, the question of water supply has been specially considered.

Physical Characters.

The country is an open rolling veldt. There are several kopjes or knobs of intrusive rock in the neighbourhood, and the veldt is formed of undulating slopes, the highest point of which is 100 to 150 feet above the river.

The geological formation is shale and sandstone. Without more precise information it is impossible definitely to assign their geological position.

A section of a bore-hole is appended. It shows the general character of the shale and sandstone for 110 feet from the surface. The predominance of the shale over the sandstone is very marked, and there is also a good example of the intrusive rock in the measures, although it forms an exceptionally thin stratum here.

The surface of the soil is, as a rule, a fairly deep alluvial soil, derived from the disintegration of the basalt and shales. The red earth and disintegrated ironstone, which form such a well-marked feature of the Natal surface soil, are not evident, nor are ant-heaps a feature of the locality. The surface is covered with a much finer and more springy turf grass than the surface soil in Natal. In wet weather this soil works up into a slippery mud.

The Vaal River flows from north-east to south-west in various bends through the district, and drains the undulating slopes of the veldt on either bank.

The town of Standerton lies on the west bank of the river at an elevation of 5,190 feet above sea level at the railway station.

It has a normal population estimated at 1,500 Europeans, 200 natives and 56 Indians, exclusive of garrison, camp population and refugee camps.

The ground actually covered by houses is about 40 acres, but, if the few scattered houses on the outskirts are included, the acreage is about double that amount.

The site selected for the barracks is an open, clean, grassy plateau, 2½ miles north-west of the centre of the town, at an elevation of 70 feet above the railway station, and about 150 feet above the river.

The veldt slopes from this plateau to the north-east and south-west; the northern slope draining into a basin and donga leading to the Vaal just above the town; and the southern slope into a similar basin leading to a donga that skirts the western boundary of the town, passes through the lower part, and enters the river just below it.

There is a Kaffir location of about 100 mud houses on the western bank of the river below the town extending for a mile down the river. Many of these are now empty and dilapitated.

The townlands are occupied at present by temporary camps. The Burgher, repatriation, artillery and cavalry camps are placed on the slopes of the veldt on the east bank of the river facing the town, the infantry and transport lines on the slopes on the west and north of the town, and the transport, ordnance, supply and hospital camps in groups in the neighbourhood of the railway station, which bounds the town on the west, the railway line crossing the river just below the town, skirting its southern boundary and bending at right angles along its western boundary where the railway station is placed.

There is a location of well-built houses opposite the station on the west side of the line for the railway employés.

Although the town has been mapped out in plots, the houses are somewhat irregularly built. As a rule they are built of whinstone or sandstone, and raised above the ground on good solid foundations. The roofs are almost entirely of corrugated iron. There are also numerous corrugated iron shanties, especially on the outskirts. The railway location contains the best and most solidly constructed houses, the streets and compounds being well planted with trees and the plots laid out in gardens. There are a few trees in the gardens of many of the town houses, but otherwise the country is destitute of trees. Avenues of trees have been planted along the approaches to and streets of the new barracks, but they have scarcely taken root yet. A large extent of roadway has, however, been lined with trees in this way, as many as 3,000 trees having been planted by the Commanding Royal Engineer.

Water Supply.

The sources of water supply in the locality are river water, surface wells, deep wells, and rainwater.

(1.) *River Water.*

The Vaal, which skirts the town, is a muddy river, although at numerous places it flows over a rocky bed. Water from it is laid on to the town and camps from three intakes:—

(*a.*) An intake above the town supplying a reservoir on the plateau, on which the new barracks are being erected. This is the town intake.

(*b.*) A Burgher camp intake on the east bank of the river about 100 yards higher up stream than (*a*).

(*c.*) An intake below the town supplying the railway station location. It may be described as the railway intake.

The town intake is from near the bottom of the river, just above the point where the donga draining the northern slope of the barrack site enters the river. There is some backwash here, and the intake cannot be described as altogether beyond the sphere of this drainage area. The pumping station is on the bank of the river south of the donga, although the intake is carried north of the donga. The pump delivers at present about 4,000 gallons per hour, and the reservoir, which is an octagonal-shaped uncovered reservoir of freestone, has a storage capacity of 100,000 gallons. The bottom is saucer shaped, the depth being 5 feet 6 inches at the centre and about 5 feet 2 inches at the side. The sides are octagonal with a diameter of 60 feet.

The water is distriuted from the reservoir to the town and camps in wrought-iron, screw joint mains, and is drawn by the users from standpipes in the streets.

There is no filtration or other treatment of the water at any point.

The reservoir was constructed by the late Government before the outbreak of war. After the occupation of the town by the British the works were completed by the Royal Engineers who laid down mains and fixed standpipes. The pumping station and waterworks are now in their hands.

The Burgher camp intake is a temporary work. The pumping station is on the bank and delivers water to tanks in the burgher and military camps on the slope above.

The railway intake is at a point where two dongas enter the river. The first is the large donga draining the southern slopes of the barrack site, and passing through and draining the town, the second is a smaller donga taking the drainage of the remount camp, military hospital, cemetery and railway location. The water is laid on to each house in the location, and to a tap on the railway platform, which passengers and others can drink from. A placard, with "Not for drinking" is placed over it, but it is almost illegible; a tap, labelled "For drinking," from the town main is alongside it, at a distance of 6 feet, against the same wall and over the same concrete channel.

A diagrammatic sketch of the river bank is appended to show the sanitary aspects of these intakes.

Lower down stream than the intakes there is the Kaffir location with its trench latrines on the banks of the river. Further down stream, and close to the banks, there are the night soil pits, carcase pits and refuse dumping grounds. Many acres of ground are strewn with carcases along the banks of a donga leading to the river below the night soil pits. Just below these, sand is being taken from the bed of the river for use in connection with the buildings at the new barracks.

A considerable amount of washing is done on the section of the river beside the Kaffir location. Above the railway intake, and along the section of the river skirting the town, the stream is also much used for washing purposes. The eastern bank opposite the town and below the Burgher camp has been used for trenching the refuse, slops and night soil from the Burgher camp. Between this point and the town intake there is some washing done on the Burgher camp side, while on the town side soldiers are in the habit of bathing.

Above the town intake the banks are clean and drain sparsely populated farm lands, the nearest habitation from the intake being a farmhouse $1\frac{1}{4}$ mile up stream and about $\frac{1}{4}$ mile from the river. The banks skirting the town are intersected by short dongas draining portions of the town.

Generally speaking the river accumulates all kinds of pollution from the town intake to the railway intake and down through the Kaffir location, while above the town intake the pollution from habitations is probably not constant but is more or less intermittent, and small in proportion to river volume. The most serious pollution affecting intakes is from the trenching of Burgher camp nightsoil on the bank, the washing of clothes, and the drainage of town and hospital into the river above the railway intake. The water is at all places very muddy.

(2.) *Surface Wells.*

The principal water supply of the houses in the town was from surface wells until the British occupation. These wells still exist, and are used by the inhabitants in preference to the river water from the standpipes. The wells are sunk in the shale, usually in the gardens. One of these was examined; it was in a garden on the bank of the river about 30 feet above the stream, and about 100 yards distant from it. The water was at a level of 16 feet from the surface; it was an open well, the upper portion was steyned with masonry (stone and cement). There was no cover, and the water was drawn by rope and bucket. The water was clear, and was in constant use as drinking water, without purification. There was a privy on the top of an old open cesspit at a distance of 64 feet from the well, slightly lower down and nearer the river. The house was on a slope above the well and drained towards it. The well in question was the well of one of the better class houses, and is a fair sample of the town wells.

(3.) *Rainwater.*

Rainwater also formed the domestic supply before river water was laid on, and most of the houses still use rainwater for drinking purposes. For example, the district surgeon, Dr. Symonds, has six 400-gallon tanks which he states are filled after 2 or 3 days of rain, from the rain collected from the roof of his house. Rain in April usually fills the tanks and leaves him with sufficient for drinking and domestic purposes until next rainy season, *i.e.*, he starts with 2,400 gallons, which gives him 10 gallons a-day for 240 days.

(4.) *Deep Wells.*

Deep borings have not been successful in giving a sufficient supply for the troops. Trial borings were made and two failed on intrusive rock being struck without reaching the water-bearing stratum. The third and fourth borings are close to one another, the former being a small trial bore, and the latter the full bore, now being used as a source of water supply for the troops. The section of the bore is appended. The yield is 2,000 gallons daily. There are three adits driven horizontally into the sandstone. The depth of the bore is 110 feet, and the adits are one to south of $7\frac{1}{2}$ feet, one to east of 30 feet, and one to west of 43 feet. The west adit alone is said to yield water.

(5.) *Springs.*

There are no springs of any importance in the immediate neighbourhood, and those that do exist are on the slopes below the barrack plateau, where they form a series of small upland swamps or surface pools. They are associated, as usual, with sandstone outcrops. Farmers are in the habit of forming dams below the surface springs; such dams are noticed in the neighbourhood of the farmhouses.

Condition of Surface Soil.

During the war the slopes for an area extending for a considerable distance round the town have been occupied by military camps, animals, and Boer and native refugee camps; refuse and carcases have also been deposited everywhere.

The greater portion of the slopes has now been cleared of dead animals, and, with the exception of an extensive area below the Kaffir location where the bank of the river is strewn with skeletons of animals, there is little evidence of previous pollution of this character anywhere near the sites selected for barracks.

The site itself is very clean, and has apparently never been camped over. It was selected soon after the British occupation, and kept free from camps as a reserve for permanent barracks.

The soil around the civil habitations is polluted by reason of the absence of any system of drainage or removal of slops, and by the universal custom, until May of the present year, of disposing of excreta in open cesspits, of which each house had one.

Sanitary Administration.

Until the British occupation, Standerton was apparently without sanitary administration; and, with the exception of the fact that notification of small-pox, followed by orders relative to vaccination, was enjoined by the late Government, there appears to have been no sanitary organization whatever.

Since 1st May, 1902, there has been a Health Board, but as yet no bye-laws have been enforced. The Health Board consists of the resident magistrate, as chairman, and four of the local inhabitants nominated by the magistrate and approved by the Government. The Board meets once a week. A clerk to the Board and one sanitary inspector are the only permanent officials. The district surgeon, appointed under the new Government, acts as health officer. He is paid 150*l*. annually by the Government and receives various fees in addition. He engages in private practice.

The only sanitation attempted is under the supervision of the sanitary inspector, who has no assistance. No labourers or scavengers are employed under him; and his function is to find out and abate nuisances. Nuisances, however, are not defined under any Act or Bye-Law.

There are no water rates. Water supply is at the will of the individual. Water for domestic purposes may be drawn from private wells and rainwater tanks or from the standpipes erected by the Royal Engineers in the streets.

There is no removal of slops or foul water; and no proper guttering of streets or macadamizing of roads, channelling for removal of surface water and so on.

Since May last a pail system of sewage disposal has been introduced in place of the old cesspits. Each household is compelled to have one pail for every eight persons. The privies are placed irregularly, generally over the old cesspit, and not in a position readily accessible to the night-soil carts. The pails must therefore be carried by hand for some distance from the privy to the cart in the street. The night soil is removed by a contractor, and is carried in tumbril carts to a spot about 2 miles down the banks of the river and deposited there in pits measuring about 10 feet by 10 feet by 10 feet. The contractor employs two carts only and empties the pails twice weekly. There is no system for cleansing, disinfecting and tarring pails.

Dry refuse is also removed by the contractor and deposited near the night-soil pits. There is no attempt at burning dry refuse.

The cost of carrying out these attempts at a sanitary system is defrayed by levying a charge of 6*s*. monthly for night-soil pails and 4*s*. monthly for refuse removal. If a householder wants his pails emptied daily he is charged 20*s*. monthly; and owners of stores or business premises pay 7*s*. 6*d*. instead of 4*s*. monthly for removal of refuse.

There are no dairies or cowsheds in the town. Tinned milk is generally used, but a few bottles come in daily for private customers from farms, at a cost of 6*d*. per bottle. There are two aerated water factories. Town water is used in them. It is passed through a 7-candle Berkefeld filter under pressure in one factory, and the owner states that he has to change the candles three or four times daily on account of the mud in the water. The arrangements for washing are similar to those seen in Natal, viz., tubs of water in which the bottles are washed by hand and brush; the same tub of water being used for an unlimited number of bottles. Town water, unfiltered and unsterilized, is used for washing bottles.

There are four bakeries in the town.

Notification of infectious diseases is carried out under Proclamation No. 21 of 1900, 2*s*. 6*d*. being allowed as a fee for each notification; but there is no provision for isolation and disinfection. Notification, at present, simply supplies the information for a return which is sent to the Medical Officer of Health for the Transvaal at Pretoria by the resident magistrate. No local action is taken to isolate and disinfect in accordance with any public system.

There is a public slaughterhouse, consisting of an enclosure of corrugated iron, and a slaughtering shed of corrugated iron, at a spot on the river bank below the Kaffir location. The blood and offal are collected in cement catch pits.

Health Statistics.

(a.) *Civil Population.*

There has been no death registration under the old Government, and the office of the Civil Government is without any records of the health of the locality previous to 1901. Medical practitioners, who have resided here some years, state that the town is exceptionally healthy, but statements of the kind are unreliable.

Since January, 1901, a death register has been kept. The entries in the register have been examined. An approximate statement of the total deaths from all causes, and the deaths from Zymotic disease for 1901, as extracted from this register, are shown in the table appended, Table III.* The statement does not, however, indicate the true statistics of the locality, as the excessive number of deaths from dysenteric diarrhœa was chiefly in the Burgher and native refugee camps, which were not established to any great extent until the end of the year.

A new system of registration was commenced in February, 1902. The system involves the entry of two totally distinct items in the same column, and deaths amongst the military, as well as the civil population, are included. Thus, "occupation" and "date of death," "usual place of residence" and "age," are put together in one column; while such an item as "conjugal condition" has a column to itself. There are 15 items of information regarding the deceased, and the new arrangement of the register makes it practically impossible, without more expenditure of time than it is worth, to disintegrate the facts bearing upon the health of the normal population for 1902.

(b.) *Military Population.*

The hospital records are also unreliable, as an indication of locally-contracted disease, at any rate up to the close of the war.

However, the incidence of enteric fever and dysentery, amongst the more or less permanent hospital staff may give some indication, and this is shown in Table I., Appendix, for the past 12 months. The incidence of these diseases amongst the members of this staff has not been very marked, but special precautions have been taken to boil and filter water on a large scale; and aerated waters have been provided from a factory, which belongs to the hospital and is under the control of the Senior Medical Officer, where boiled and filtered water only is used, both for filling and for cleansing the bottles. A table is also given showing the statistics of the principal diseases amongst the troops since the close of the war (Table II.). It does not show any marked prevalence, comparatively speaking, of disease, but the period covers the healthy season only.

* 68 per cent. of the deaths are due to zymotic disease, 45 per cent. being due to diarrhœal diseases, and about 12 per cent. to enteric and other fevers.

(c.) *Railway Population.*

The railway location contains 200 European employés and their families, and about 400 Indians and natives. No health statistics have been kept, and the sick are transferred at once by rail to the railway hospital at Johannesburg. The Resident Medical Officer, who has been in charge of the location for 2 years, states that during the last hot season there was a severe epidemic of enteric fever, and scarcely anyone, European or native, escaped. The location is within a few hundred yards of the military hospital encampment; and the families are well and comfortably housed. As already noted, their water supply is unpurified river water taken from an intake below the town. The epidemic was coincident with an epidemic of dysenteric diarrhœa in the Burgher camp, the soil and refuse pits of which are on the river bank higher up the stream.

No enteric fever cases have appeared in the location during the present season so far as the Resident Medical Officer is aware; but, as cases of sickness are at once transferred, he does not know the ultimate diagnosis.

Meteorological Records.

No meteorological records, public or private, appear to have been kept, and an estimate of the meteorology must be mere guess work. At present the weather alternates between dry sunny days with cool breezes, or hot muggy days with heavy rain and thunderstorms. In the winter months the temperature during the night falls below freezing point.

Conclusions.

(1.) The site of the new barracks is an ideal site as regards cleanliness and natural slope, but the soil is apt to retain surface water and work into stiff mud after rains.

(2.) The barracks at present being erected are generally well planned. Items requiring consideration are noted under the heading of recommendations.

(3.) The main water supply of the locality is river water, which is muddy and not altogether free from the risk of specific pollution at the town and Burgher camp intakes.

(4.) Filtration and purification of such a supply are essential.

(5.) The water supply laid on to the railway station and to the railway location is an immediate danger not only to the railway employés but also to the passengers and troops passing through. It is little less than criminal to continue to have such a supply laid on to human habitations, and to a railway station frequented by the public.

(6.) The well waters of the town are liable to cause outbreaks of dysentery and enteric fever. Specific pollution may occur at any time.

(7.) The deep borings do not at present yield a sufficient water supply for garrison purposes, although the water from them is a safe water so far as it goes. It is, however, sunk in slopes below and near habitations, and fissuring of the rock might lead to serious pollution.

(8.) Water supplies from underground sources in the geological formation of the locality are unreliable as to quantity.

(9.) Rainwater collected from the roofs of the barracks will provide a safer water than the river water, but it will not be sufficient for all purposes.

(10.) The town system of sanitation and sanitary administration is insufficient to maintain a high standard of sanitation in any populated or growing district.

(11.) The disposal of Burgher camp soil and refuse in pits on the river bank, as at present, is a dangerous source of river pollution.

(12.) The climate of the locality ought not to be unfavourable to the health of British troops.

(13.) Dysentery, diarrhœa, and enteric fever are bound to prevail under the present systems of water supply and general sanitation, irrespective of climate.

Recommendations for the New Cantonment.

(1.) *Water Supply.*

The present river supply and its intake are not safe. It is muddy, flows through farms, and there is a considerable backwash just below the intake from a donga which in time will convey a considerable proportion of the barrack drainage to the river.

If river water is to be continued as a supply, the following measures are essential :—

(1.) *Removal of the intake* to a point as far up stream and as far below any farmhouse or kraal as is practicable without prohibitive cost. A point above Myburgh's farm is recommended ; but much stress cannot be laid on the necessity of moving the intake more than 100 or 200 yards higher up than the present intake, if the filtration and sterilization installations noted below are properly constructed and maintained. The donga just below the point marked on the plan could be dammed and the drainage area conserved as a future water supply. The only objection to this is the fact that old camping grounds drain into part of this area ; otherwise such a scheme would have the advantage of a water supply from an area completely under local supervision and control.

(2.) *Filtration at reservoirs.*—This is the most important and most essential requirement of a river water supply. The plan of filtration proposed by the Commanding Royal Engineer is as follows :—

(*a.*) *A series of four settling tanks,* delivering about 75 gallons per minute over the weirs, with a normal flow from the storage reservoirs of 5,000 gallons per hour (the capacity of the proposed pump).

(*b.*) *A double filter tank,* giving 6 feet of stone and gravel and sand filter by downward filtration, and 6 feet of sand and charcoal by upward filtration. The arrangement of the various filtering media is as follows :—

	ft.
Downward filtration—	
1. Broken stone	2
2. Gravel	2
3. Sand	2
Upward filtration—	
1. Sand	4
2. Carbon	2
Total	12

Passage from the downward to the upward beds is by five openings each 2 feet by 1 foot.

The superficial area of the filter is 20 square yards, and this will yield 10,000 gallons in one hour at 500 gallons per square yard. With the pump working at 5,000 gallons per hour, the rate of filtration would not exceed 250 gallons per square yard.*

(*c.*) Two storage tanks of 20,000 gallons each, from which the water is pumped to a water tower with a distributing tank of 10,000 gallons, connected with subsidiary tanks of 2,000 gallons at each ablution room (*i.e.*, there will be five 2,000 gallon tanks).

These proposals are barely sufficient for a garrison of 2,000 with horses, and I would venture to make the following suggestions as to purification and storage :—

(*a.*) To reduce the rate of flow over the weirs in the settling tanks by one-half, *i.e.*, by doubling the width of the weirs.

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* For proper biological filtration the rate of flow should not exceed 500 gallons per square yard in 24 hours.

(*b.*) To add alumino-ferric to the water as it enters the settling tanks in the proportion of 4 grains to the gallon, during the rains when the river water is full of suspended mud.

(*c.*) To arrange the filter beds as follows instead of as proposed :—

	ft.	in.
Downward filtration—		
1. Sand	2	6
2. Polarite	1	0
3. Gravel..	1	6
Upward filtration—		
1. Gravel..	1	6
2. Polarite	1	0
3. Sand	2	6
Total	10	0

This arrangement is suggested to allow of the superficial layer of sand being cleansed from time to time without disturbing the rest of the filter. The polarite will act chemically as an oxidiser, while the sand will act biologically in arresting bacteria on the surface mud deposited from the water.

(*d.*) To make the passages from the upward to the downward filtration 4 feet wide by 6 inches high instead of 2 feet by 1 foot. The lower height and greater width will distribute the water better through the bottom layers.

(*e.*) To duplicate the filtering beds, in order that they may be cleansed without interfering with the water supply. The storage of 40,000 gallons is an insufficient daily supply for the full requirements of a garrison of 2,000 men in addition to horses, and this along with the water in the distribution tanks is all that could be drawn upon, while the filters were being cleansed. No doubt the additional quantity in the latter tanks wuold give a sufficient supply for 24 hours; but it is best not to be dependent on one filter bed only.

(*f.*) To double the capacity of the storage tanks; or at any rate to make them large enough to take a greater proportion of the water from filter beds working for 24 hours than at present.

(*g.*) Duplication of pumping gear is advisable, but probably this is contemplated.

(*h.*) Finally, a recommendation, which is of the highest importance in connection with the installation of filter beds, is that the filtering media (sand and gravel) be obtained from an absolutely unimpeachable source, preferably sand quarries, and well below the surface soil. It is imperative that sand or gravel from a polluted river bed, such as the sand at present being taken from below the filth pits for building purposes, shall not be used. It is advisable to bake the sand and gravel in a kiln before laying them down in the filter beds.

(4.) *Sterilization of River Water.*—Although a sound system of sand filtration may make river water biologically pure up to a certain point, if the rate of flow is regulated as noted in the footnote on page 7, the water requires careful watching and testing in order to detect the time when the beds are becoming ineffective and require cleansing. For drinking purposes, therefore, sterilization of such a supply is essential, and an installation of Pasteur filters in each barrackroom, similar to that in the French barracks, is recommended. A pamphlet on this subject has been prepared and is issued from the School of Military Engineering at Chatham.

(5.) *Other Water Supplies.*—These details of river water supply are entered into because it is extremely doubtful whether a sufficient supply of water for all purposes is available from any other source, and a dual supply should be avoided.

Failing proper sterilization of river water for drinking purposes, water from deep borings would be the best source of supply. It is impossible to determine definitely where or at what depth the water bearing strata will be found in shale and sandstone formations. The direction of flow of water or accumulation of water in the sandstone strata is apparently decided by the intrusive dykes and sills, the course of which is irregular and impossible to follow beneath the surface. All borings for water must therefore be purely tentative, but, if a sufficient number of borings with adits into the sandstone were made, a quantity of water, equal to that of the requirements of the garrison, could no doubt be obtained. The cost, however, is likely to be prohibitive.

The only other comparatively pure source worth considering is rainwater collected on the barrack roofs. The yield for every inch of rain is calculated at 100,000 gallons approximately from the roofs of the buildings already in course of erection in the cantonment. This, if collected and stored, would yield two gallons per head of drinking water for a garrison of 2,000 for a period of 50 days, and if storage were provided to cover about 6 or 7 months of dry weather (*i.e.*, storage for 400,000 gallons at 2 gallons per head, or 200,000 gallons at 1 gallon), a rainfall of four or two inches towards the end of the rains would fill the tanks of that capacity respectively. There are mechanical contrivancies for preventing the first washings of the roof entering tanks, and the painting of the roofs with oxide of iron need not be an objection to such a supply. Neither need one consider seriously the objection that dust lodges on the roofs if the first washings are not allowed to enter the tanks. From June to September the absence of enteric fever and dysentery is marked, and the river water is usually clear. It is therefore during the rainy season only that a change in drinking water may possibly be required, and the storage of rainwater need not be so great.

The chief objection, which I have heard, is that mosquitoes will breed in the tanks. This may be ignored if the tanks are properly constructed. There are, indeed, distinct advantages in conserving the rainwater in properly constructed tanks, in view of possible breakdown in the river waterworks, or in the method of purifying the river water, and also in view of a possible desire to alter the water supply for drinking purposes, should an epidemic of dysentery or enteric fever occur.

(2.) *Disposal of waste products.*

(1.) *Latrine soil.*—With an ample river-water supply there seems no reason why a water-carriage system of sewage disposal should not be introducéd. It is the best system in common use for the prevention of endemic enteric fever. A sewer from the south side of the barracks would, if it followed the natural line of drainage, be carried down the southern slope, and the effluent must eventually pass into the donga running through the town. This is the best line of drainage for a water-carriage system, as a sewer from the barracks could be converted into the main sewer of the town. The donga is the natural drain of the town, and discharges into the river below the habitations. It would not pollute the river more than at present, but in any case the crude sewage should be submitted to biological treatment, which would render it non-putrescent before it discharges into the river. There is a good site for such an installation near the entrance of the donga into the river if the gradients admit of an installation there. In fact, a scheme for water carriage removal of town and barrack sewage combined seems necessary in the interests of the future health of the garrison and civil population of the town.

The effluent from the north side of the barracks and stables would have a large area of veldt land for land treatment, before discharging into the river above the town or for land treatment combined with biological treatment.

It is in view of the introduction of such a water-carriage system of sewage disposal, that an alteration in the locality of the intake of river water for the water supply becomes a matter for serious consideration. It is wiser policy to place the intake at a safe point at once, in view of future contingencies, than to retain the existing intake simply because it may satisfy present needs.

If no water-carriage system is introduced, it is better to instal the American trough, or the trough system of Majors Firth and Horrocks, than to continue the pail system.

Essential features of such systems are the employment of disinfectant solutions in troughs or other receptacles, and removal of the contents by vacuum cart to a distance. In districts where enteric fever is of such wide prevalence, and of so serious a character as here, there should be no hesitation in introducing such systems in place of the pail system. They are not likely to be more costly in the long run, once a suitable equipment of vacuum carts is obtained and the troughs have been installed in the latrines.

Foul water.—Urine, slops, and stable drainings, would all pass into a water-carriage system of sewage disposal. But as the latrines already erected have not provided for this, a drainage system has been constructed by which foul water is removed in wrought-iron drains with screw joints, discharging on to the slopes north and south of the barracks. It is proposed to use the effluent of these drains for irrigating gardens on the slopes, and to have the outfall near the barracks at the top of the slope. The construction of these drains is now going on. There are disconnecting manholes at each bend, the sections are straight and gully and grease traps are inserted in the line of drains, so that there is no reasonable objection to the work already carried out, although it would have been better to put down earthenware drains instead of iron, in consequence of the corrosion that may possibly take place from a foul water containing much grease. The outfall of the system should be well down the slope, if possible about 400 yards from the barracks. A strip of land just above the donga is the most suitable area for irrigation, and irrigation must be carried out according to a definite plan, and under a responsible caretaker. A small acreage (6 to 8 acres) would be sufficient for a garrison of 2,000; but it should be intelligently and carefully cultivated. Otherwise these irrigation areas are likely to become a source of ill-health in the garrison. The donga should be cleared of all natural obstruction to drainage. Otherwise foul and stagnant pools will be formed when the barrack drainage passes into it.

(3.) *Prevention of Soil Pollution.*

(1.) Surface drainage is essential over the barrack area. It is not yet provided.

(2.) The nature of the surface soil also demands that the roadways and paths should be constructed of material that will not work into stiff mud, as at present, and that they should be channelled to side gutters.

Unless this point is attended to, a condition of affairs similar to that existing in Fort Napier, Maritzburg, will be created after the barracks have been occupied for some time.

(3.) The soil underneath and around the barrackrooms will also become objectionable from a sanitary point of view, after the barracks have been occupied for some time, unless the surface is concreted underneath and for 2 or 3 feet round each hut, and channelled to side gutters. Nothing will prevent men throwing water, &c., out on the ground around barracks, and concreting, as suggested, is the best way of dealing with this evil.

At present, as the barracks have already been constructed, there may be some difficulty in concreting under the floors, although these are 1½ feet from the surface; but there should be no difficulty in concreting and channelling round the huts where the pollution is likely to be greatest. If the cost of concreting all round is prohibitive, then the whole length below the verandah and for some extent round doors should be concreted, the sides without verandahs or doors being left with gutters only.

(4.) The drainage of stables, and concreting or paving in and around stables, also requires to be attended to in the same manner.

(4.) *Miscellaneous Points.*

(1.) *Huts for married families.*—None are in course of erection at present, but it is necessary to have these provided if the families come out to South Africa. The town houses, with the exception of the better class houses, are not suitable, and the town sanitation is bad.

(2.) *Accommodation for native employés.*—It is important that the accommodation for native employés should be provided, planned, and brought into line with the general sanitary system of the cantonments.

(3.) *Warming of barrackrooms.*—It is understood that no warming is to be provided. Considering the high elevation and the fact that the thermometer falls below freezing point during winter, the non-provision of means of warming may eventually become a source of complaint.

Recommendations as to Civil Surroundings.

An imperative and urgent measure of sanitation is the removal of the railway water tap from any portion of the railway station to which the troops or public have access. Although it is scarcely within the scope of this report to say so, it is equally imperative that such a supply should be cut off from the houses in the railway location. In my opinion all railway stations should be provided with installations of sterilizing filters for the convenience of the travelling public, and no one passing through should be subjected, in his or her ignorance of the locality, to dangers such as these existing at Standerton.

(2.) The next most important and essential measure is the construction of proper filter beds for the town water supply. It may be found possible to combine the filter beds for the garrison and town in one waterworks scheme, but the consideration of such a scheme should not be made a cause of delay in the purification of river water for the garrison. Since writing this report I have seen a sanitary report on Standerton by Colonel J. L. Notter, R.A.M.C., dated February, 1901, in which he points out the necessity of sand filtration of the river water, yet nothing has been done to put Colonel Notter's recommendation into effect.

(3.) As regards other points in town sanitation, the possibility of any advance being made must depend on Government and Municipal action, such as the introduction of a Public Health Act, Local Bye-Laws, and the appointing of a sufficient and efficient staff to carry out and supervise local sanitation. Little improvement need be expected until sound systems of sewage disposal, water supply, and road paving and guttering are introduced, and this improvement is not likely to take place until the town is larger and richer, unless the works are carried out at the Government expense. Until they are carried out, isolated cases of enteric fever and dysentery contracted in the town are likely to occur year by year amongst the troops, even although the garrison system of sanitation and water supply is unimpeachable.

W. G. MACPHERSON, *Major,*
Royal Army Medical Corps.

Pretoria,
24th November, 1902.

APPENDIX.

TABLE I.—Showing the Incidence of Enteric Fever and Dysentery amongst the Staff of No. 17 General Hospital at Standerton for 12 months—November, 1901, to October, 1902.

Month.	Average strength.	Number of admissions.		Percentage of admissions to strength.	
		Enteric fever.	Dysentery.	Enteric fever.	Dysentery.
1901.					
November	188	5	1	2·6	·5
December	204	7	1	3·4	·4
1902.					
January	218	9	3	4·1	1·3
February	233	3	1	1·3	·4
March	222	1	5	·4	2·2
April	213	8	..	3·7	..
May	215	2	4	·9	1·8
June	173	..	..	..	..
July	144	..	..	..	..
August	135	..	..	..	..
September	116	..	..	..	..
October	107	..	..	..	..
Total	180 (average).	35	15	19·4	8·3

TABLE II.—Showing Incidence of Principal Diseases on Troops at Standerton since termination of the War.

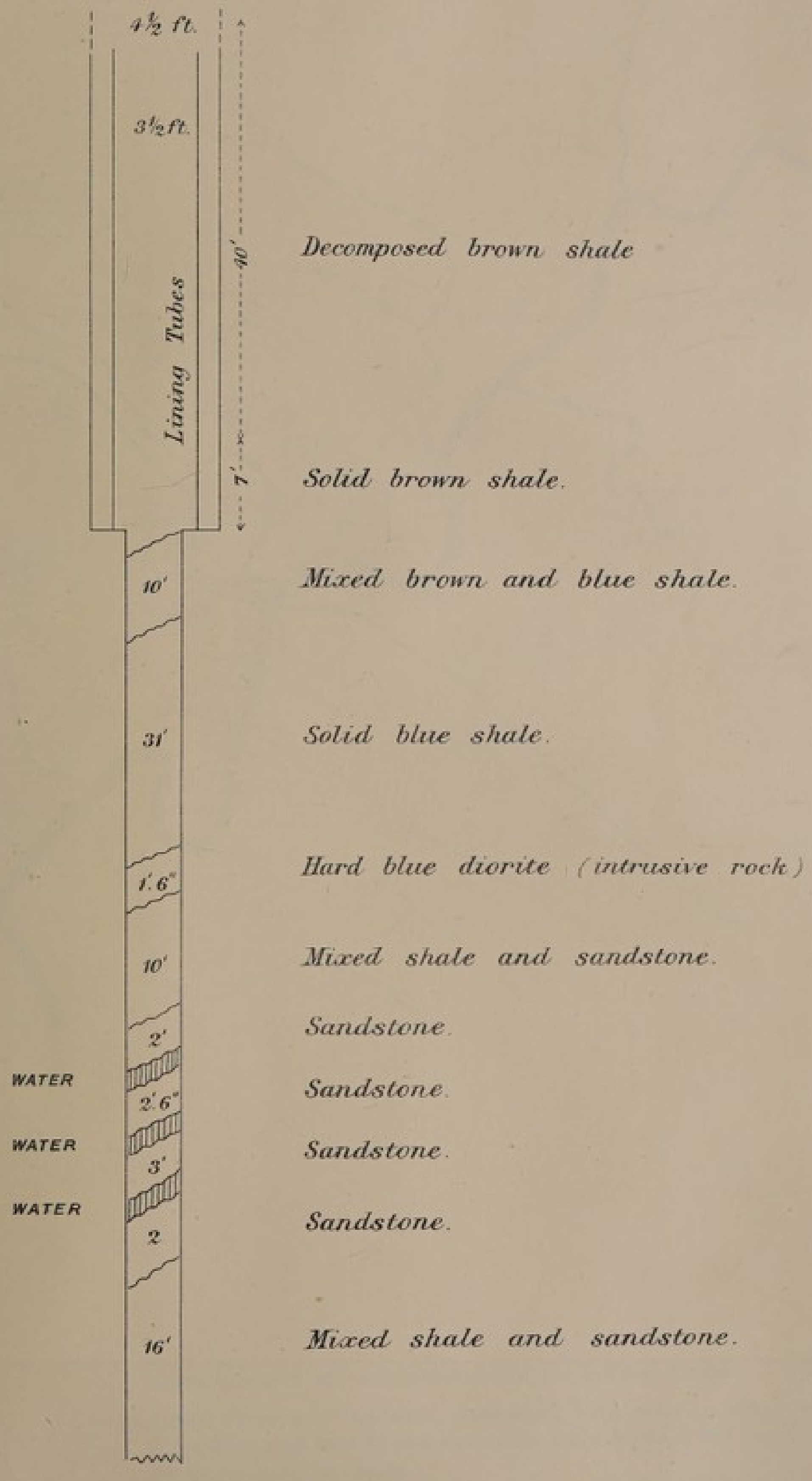
Weeking ending, 1902.	Average strength.	Admissions for							
		Enteric fever.	S.C. fever.	Dysentery.	Diarrhœa.	Throat affections.	Respiratory affections.	Primary syphilis.	Gonorrhœa.
6th June	..	2	2	6	2	1	1	..	..
13th "	..	4	6	2	1	1	2	..	..
20th "	..	3	1	3	..	5	2	..	1
27th "	..	2	1	4	..	6	4	..	..
4th July	..	1	..	1	..	2	4	..	1
11th "	5592	3	..	1	..	3	2	..	..
18th "	7115	2	..	..	..	4	8	..	1
25th "	6785	1	..	2	..	4	5	1	1
1st August	6911	2	..	3	..	7	7	..	..
8th "	6490	..	2	..	1	..	10	..	1
15th "	6531	2	2	..	1	3	3	..	1
22nd "	5783	1	1	1	2	5	4	1	2
29th "	6224	..	..	1	..	7	2	2	2
5th September ..	6279	..	..	3	1	9	2	1	3
12th "	5454	..	1	4	..	7	3	1	1
19th "	4724	..	..	1	..	7	3	1	1
26th "	4214	1	..	1	..	3	..	2	2
3rd October	4183	1	1	1	..	5	2	1	5
10th "	3517	1	..	1	..	2	1	1	4
17th "	3278	..	..	1	..	4	1	..	..
24th "	3123	..	1	12	2	2	..	..	..
31st "	2519	..	..	6	2	1	3	..	..
7th November ..	2577	..	..	6	2	4	1	..	..
14th "	2735	..	..	6	6	10	1	..	5
Total.. ..	..	26	18	66	20	102	71	11	31

TABLE III.—SHOWING the number of deaths from Zymotic Diseases and from all causes, recorded in the Death Register of the Civil population at Standerton during 1901.

Month.	Deaths from all causes.	Deaths from principal zymotic diseases.	Principal zymotic diseases.						
			Enteric and continued fevers.	Dysentery and diarrhœal diseases.	Diphtheria and croup.	Smallpox.	Measles.	Scarlet fever.	Whooping cough.
1901.									
January	19	14	7	7	..	..	..	..	..
February	16	14	8	6	..	..	..	..	..
March	16	11	6	5	..	..	..	..	..
April	42	21	6	10	1	..	..	..	4
May	37	17	9	6	1	..	..	..	1
June	40	19	7	10	1	..	..	..	1
July	63	24	8	7	1	..	..	..	8
August	51	29	15	9	..	..	2	..	3
September	26	13	3	6	..	..	2	..	2
October	98	59	11	44	..	..	2	..	2
November	212	189	7	136	..	..	26	..	20
December	169	134	3	109	..	..	11	..	11
Total	789	544	90	355	4	..	43	..	52

SECTION OF BORE-HOLE AT STANDERTON.

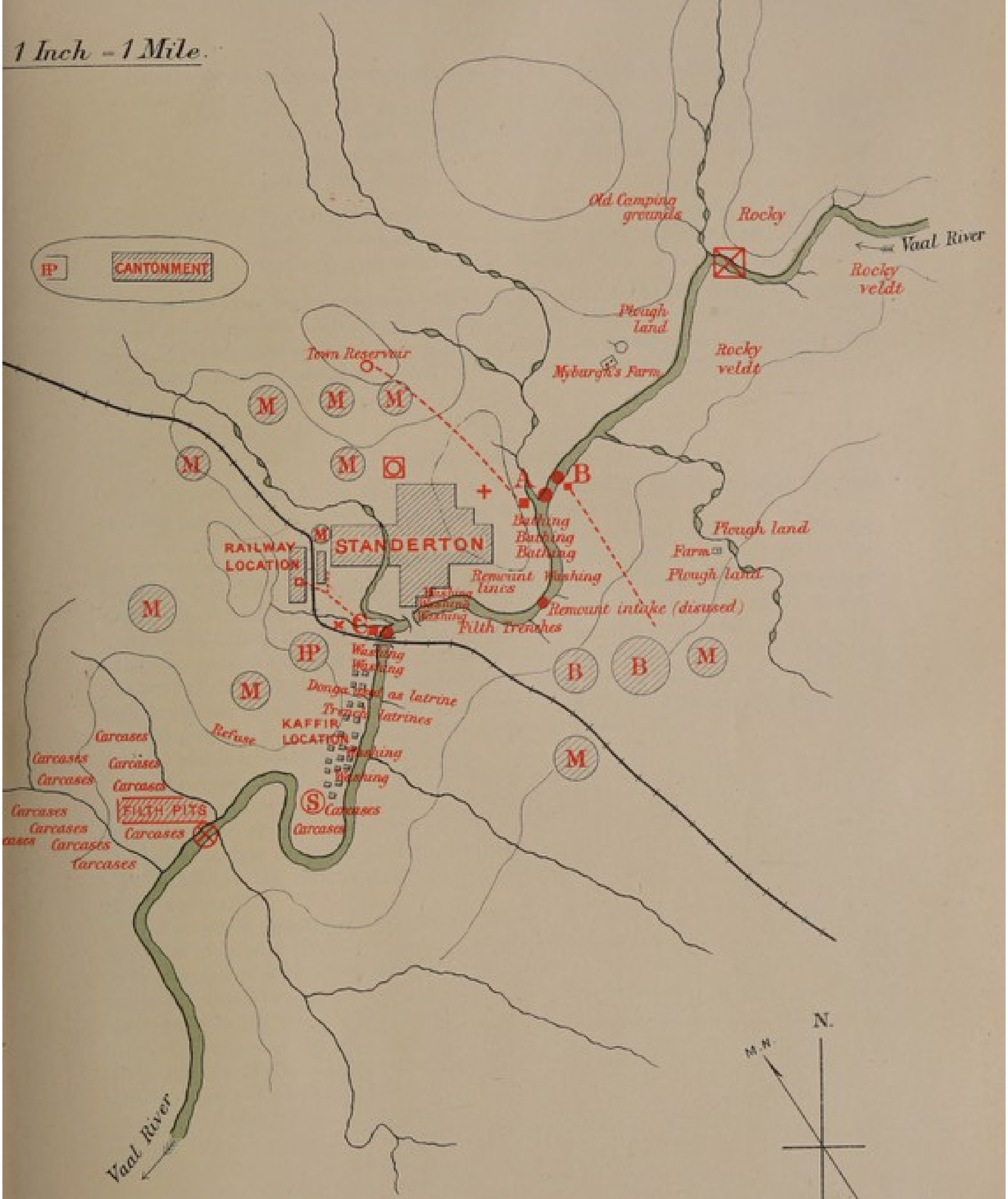
(YIELD FROM ADITS IN SANDSTONE IS 2,000 GALLONS DAILY).



AN OF THE VAAL RIVER AT STANDERTON

SHOWING THE CONDITION OF THE RIVER AS REGARDS WATER SUPPLY.

1 Inch = 1 Mile.



= Town intake Intake = ● Pumping station. ■

= Camp intake " "

= Railway intake " "

= Safest intake for future supply.

= Point on river, where sand is taken from the river bed for building purposes.

= Cantonment hospital site. × = Cemetery near hospital. + = Town cemetery.

= Existing Camp hospital. (S) = Slaughter house.

= Burgher Camp.

= Military Camps.

= Deep boring

W. E. Macpherson
Major R.A.M.C.

Standerton
22. 11. 02

REPORT ON THE PROPOSED CANTONMENT FOR BRITISH TROOPS AT MODDER RIVER.

Two sites have been the subject of report by a Board of Officers—

(1.) A site on the bank of the Modder River, just above its junction with the Riet River, namely, the tongue of land shown on the Map A between the bend of the Modder River and the railway station and bridge.

(2.) A site about 2 miles north of the railway station and west of the line on a plateau about 100 feet higher than the river, shown on the map with sites of units blocked out.

The lower site has been abandoned and the upper site is undoubtedly the most suitable site for a cantonment. This report deals with the latter only, and has been drawn up on the same lines as previous reports, the first part detailing the data upon which the conclusions and recommendations in the second and third parts are based.

PART I.

Physical Characters.

The south bank of the river is an open plain sloping gently towards the river, and has not been considered in connection with this report.

The country on the north bank is a flat plateau covered with red sandy earth on the surface. Grass grows sparsely and not sufficiently close to bind the soil together, and the soil is consequently loose and easily blown about. This plateau extends in the immediate neighbourhood of the line of railway for about 2 miles northwards before it rises to higher ground. The higher ground forms another extensive plateau extending northwards for 5 miles to the Lange Berg Kopjes on the west of the line and the Magersfontein Kopjes on the east of the line. This higher plateau is also covered with a red sandy earth and sparsely growing grass, but there is also a considerable growth of stunted mimosa and "Vaal Bosch" scrub over it, and it is rocky in many places.

The surface of the lower plateau has several outcrops of a limestone (chalky) conglomerate of recent formation. This conglomerate covers the surface in strata of varying thickness, according to the surface contour of the underlying strata. A similar surface deposit is seen on the upper plateau, but not nearly so frequently. The banks of the river are formed in some places of a thick stratum of this conglomerate.

The strata underlying the surface deposits are the ecca beds (shale and sandstone) of the lower Karoo system, overlying the dwyka conglomerate. Throughout both the lower and upper plateaux there are intrusive dykes and boulders; the latter are found in crops all over the surface of the upper plateau. Ecca sandstone and quartzite are found within 30 to 70 feet from the surface, *e.g.*, about 70 feet from the surface in the lower stratum of the well near the ganger's hut, east of the proposed site of the cantonment, and about 30 feet from the surface in a well in the cemetery near the railway station.

The Modder River runs east and west through the lower plateau and is joined by the Riet River just above the railway bridge. The railway to Kimberley runs in a north to north-east direction across the area in question.

There are three groups of habitations in the area—

(1.) The village of Rosmead, about one mile down stream from the railway bridge, consisting of a few farmhouses in irrigated and well-cultivated gardens along the north bank of the river, and a few scattered houses further away from the river bank.

(2.) The village of Modder River, consisting of an hotel and a group of a dozen houses in the neighbourhood of the railway station.

(3.) A native location of scattered improvised huts, covering about 80 acres of ground near to and east of the railway line, a few hundred yards north of the station.

In addition to these groups of habitations there are scattered farms and houses along the river bank, especially along the section of the river from the camp intake to the junction of the Modder with the Riet River.

The tongue of land between the Modder River and the Riet River, known as the island, also contains scattered habitations, and remains of irrigation works.

The banks of the river and the district generally are singularly free from dongas, and there are no spruits or streams entering the river. In this respect the river banks and surface of the plateau are very little broken up. The general slope of the ground from the higher to the lower plateau is towards the south, but the selected site also slopes slightly to the north-west, and more abruptly to the west; south-east of the railway the higher plateau slopes gently down towards the river. The lower plateau opens out into a wide plain to the south and west of the site for the cantonment, and it contains one or two swamps or "pans" where surface water collects. The principal "pan" is about ½-mile south-west of the selected site. There are a few trees near the railway station, and in some of the isolated farms. Rosmead Village gardens are full of fruit trees, and the main road through it is an avenue of trees. The country is otherwise destitute of trees except along the river banks which are thickly lined with willow and mimosa in most of the reaches.

Water Supply.

At present the only sources of water supply are from the river and surface wells. On the south bank of the river there have been deep borings. There are no springs in the neighbourhood.

(1.) *River Water.*

The Modder River is a somewhat sluggish muddy river. It has apparently no towns or villages along its banks from its source downwards, and it also appears to be singularly free, as already noted, from entering spruits and streams for at least 100 miles above its junction with the Riet River. In this respect it is less liable to pollution from habitations than the Riet River, which has the town of Jacobsdal on its banks about 14 miles up stream, and Koffyfontein some 30 miles higher. There are also several entering streams between these two towns. The contrast between the Modder River and the Vaal River as regards these sources of pollution is still more marked, and, generally speaking, the Modder River should be one of the least polluted of South African rivers, so far as human habitations along its banks are concerned. Paardeburg Drift is 30 to 40 miles up stream, and the serious pollution that occurred there about 3 years ago from Cronje's laager can scarcely be a source of pollution now.

As regards pollution of the river in the neighbourhood of Modder River Village, this may be said to commence at the point shown on the plan as the intake for irrigating the "island." At present, pollution at this point is a negligible quantity, but there is considerable probability of there being irrigated cultivated lands along the south bank from this point downwards in the near future. As the river approaches the Riet River, pollution is liable to occur on the south bank from habitations, and especially from the hotel at the extreme end of the island.

On the north bank pollution is apt to occur at the farmhouse and donga, shown on the map, just above the present camp intake. Immediately below the camp intake, and above the dam, the bank of the river has been used as a cemetery for natives from the native location in the neighbourhood. There are about 100 graves there on a very small area immediately overlooking the river.

Below this point the Modder joins the Riet River, and the water of the combined streams is then liable to any pollution carried down from Jacobsdal; while along the north bank in the neighbourhood of the village and Kaffir location, there are signs of fouling by excrement, washing, &c., as well as by irrigated farms and habitations between this point and the railway bridge. Below the railway bridge there is an intake and pumping station on the south bank, supplying water to two reservoirs (33,000 gallons and 8,000 gallons) at the railway station, which supply a standpipe on the station platform, two railway schools, and the houses of the local railway officials (three or four families). This water is laid on without filtration or other purification.

Below the railway bridge the sources of pollution are from bathing, washing clothes, and drainage of the houses and irrigated gardens in Rosmead. A considerable amount of water is pumped from the river in this section for irrigation purposes, and for houses near the banks. The Veterinary Surgeon of the 7th Mounted Infantry informs me that the horses, after heavy rains, drink very sparingly the water at the watering-place below the railway bridge, on account of the putrid smell of the water. This is below the junction with the Riet River. A recent analysis of the river water collected at the camp intake is appended.* The intake is amongst weeds close to the bank, and is pumped by hand into watercarts. When the pump is out of order, the watercarts have been seen collecting water at the dam just below the native cemetery. An analysis is now being made at the Military Laboratory, Bloemfontein, of samples of water collected at mid-stream opposite the present intake.

(2.) *Well Water.*

Nearly all the houses in the vicinity have wells. They are surface wells. In some the water is drawn by rope and bucket, in others by windmill pumps. They are usually covered with wooden covers. None of them examined were steined, or in any way protected from percolation from the surrounding surface. The water in most of them is said to be brackish; "brack" wells as they are described in the locality. The brackishness is probably derived from the surface lime conglomerate, but it is said that there are salt beds in the vicinity of Kimberley and Belmont. I have not been able to verify the statement. The level of the water in the wells along the lower plateau seems to correspond with the height of the water in the river, usually about 30 feet from the surface, the lower plateau being about that height above the river bed. The well of the ganger's hut, which is on the higher plateau, has water at a depth of 70 feet from the surface in quartzite rock. Surface water percolates into it and it is considered brackish. A recent analysis of some of the surface wells is appended.* They are apparently highly polluted. This is inevitable from the nature of their construction and surroundings.

(3.) *Deep Borings.*

During the time when Lord Roberts's army was encamped here, water was supplied from deep borings on the south side of the river.† The details of these are being obtained from the Inspector of Borings at Cape Town.

Both the Inspector of Borings (Mr. Ritso) and the Professor of Geology Cape Town University (Professor Young) have told me that the district is one in which deep borings of 150 to 200 feet are likely to give an ample and good water supply, but, until trial borings have been made, it is impossible to determine the quantity or quality of the supply. As stated in previous reports this depends on the position of intrusive dykes.

Condition of Surface Soil.

On the lower plateau, west of the railway line, several temporary camps have been formed and are now occupied. The whole of the lower plateau east and west of the railway and north and south of the river, as well as the island, is said to have been occupied by Lord Methuen's and Lord Roberts's Army in 1899 and 1900, and the line of the upper plateau south of the Lange Berg and Magersfontein Kopjes by the Boer entrenchments.

The actual site selected for the cantonments was occupied by outposts, and there are the remains of defence works on one part of the site. The Naval 4·7 gun was mounted on a spot between the ganger's hut and the site. At present evidence of previous occupation of the ground is seen around these works, and on the lower plateau near the existing camps. The sites plotted out for units on the plan have apparently been unoccupied.

The lower plateau must have received a large quantity of excrement from men and animals, and the area must be regarded in this respect as a polluted area. Local information points to the fact that the most polluted area was the area east of the

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* Table I.

† This information was obtained from the Inspector of Borings, and the fact is referred to in the Report of the "Dysentery Commission," but Officers, who were at Modder River in 1899-1900, state that they do not know of such borings.

railway, between the station and the river, but the centre of the plain west of the railway and camps has been used for trenching night soil, and refuse has been dumped down irregularly in the neighbourhood of the camps. The soil around the village habitations is not in any way protected by drainage or concreting from pollution, and as most of the inhabitants keep poultry and pigs, and as slops are thrown out anywhere, the soil pollution around habitations is great. The camp sites are being polluted by urine and slops and from imperfect construction of the latrines, the pails of which are placed on the surface soil with a considerable space between them and the seats.

Sanitary Conditions of Civil Surroundings.

Modder River and Rosmead Village are under the sanitary administration of the District Council of the Kimberley Division and the Kimberley Board of Health. A special Act of Parliament was passed in 1884 constituting a Board of Health of five members, under the Chairmanship of the Civil Commissioner as the local authority for carrying out the provisions of the Public Health Act of 1883 in the Kimberley Townships, and such areas of the Division as they might determine. The Act of 1883 is, however, concerned only with matters affecting notification of infectious disease, vaccination and quarantine. In 1897 a Public Health Amendment Act was passed conferring powers and obligations on local authorities (more especially on Urban local authorities) to institute proper sanitary control over their areas, on lines similar to the Public Health Acts in England, but it is not clear whether the Kimberley Board of Health has power to control the sanitation of Modder River or Rosmead under this Act or not. Their Medical Officer of Health (Dr. Monck) informs me that when an attempt was made by him to do so a decision was given to the effect that such sanitary control was *ultra vires*, and the Field-Cornet of the Ward informs me that no action has been taken to impose sanitary regulations on the locality. At present, therefore, there is no sanitary system in these villages. Water supply is from private wells. Private wells are surface wells, and they are sunk anywhere and anyhow, usually in farms, yards, and in the neighbourhood of poultry yards, pigstyes, privies and cesspits. [*See* photograph.] There is no drainage, surface or deep. A system of pails for night soil has recently been introduced into some of the houses, each individual either employing a contractor to remove the contents or removing them himself. On account of the extent of gardens around habitations and the sparseness of the population, the evil effects of this want of system are not apparent, but as the habitations and population increase they will become serious. There is no sanitation in the native location. The open veldt is its latrine, the river its water supply. Yet there is no apparent nuisance. There are no dairies but good butter and milk are obtained from the farms in the neighbourhood.

There are two aerated water factories in Modder River village. In both the water used is from private surface wells. One of the wells is sunk practically in a pigsty; a photograph of this well is appended. The other well is sunk in an hotel yard, which is kept clean. The water is drawn by windmill, but until a month or two ago an open cesspit and stable were within 20 or 30 yards of the well. These are not now used. The aeration of the water is from gas cylinders; no filters or other means of purification of the water are employed. The washing of bottles is by hand in tubs. The premises are mud houses with wooden floors. These factories supply or have been supplying the camps. In two other houses gingerbeer is made and sold to the troops at refreshment booths. River and well water are used indiscriminately.

Health Statistics.

(*a.*) *Civil Population.*

No records are available at Modder River to enable the health of the civil population to be gauged. The inhabitants, like most village inhabitants, state that no one is ever ill in Modder River. I have also been unable to obtain reliable *data* regarding the health of the railway location. Two cases of enteric fever have recently occurred amongst the civil inhabitants, one a boy of 12, living near the banks of the river below the camp intake; the other a man living in Rosmead village. The mother of the former makes and sells gingerbeer to the troops. Local inhabitants inform me that they frequently suffer from diarrhœa from drinking river water after the rains, and the Field-Cornet states that the natives have been dying in large numbers from what he describes as pneumonia.

(*b.*) *Military Population.*

There was a severe outbreak of enteric fever in the Modder River camps in 1899-1900. The diary of the Principal Medical Officer of Lord Methuen's force has been consulted with reference to this, but it throws no light on the subject, and, in fact, goes so far as to say that water supply could not have been the cause, and that the sanitary state of the camps was satisfactory. These statements, however, are not supported by any details. Lord Methuen's force is noted in the diary as being 13,500 strong, exclusive of non-combatants and followers, and this number was afterwards increased to 40,000 or 50,000 men.

After Lord Roberts's advance the camps were reduced to 300 or 400 until recently, when the strength of the camps has increased to some 1,400.

The statistics showing the health of these since the declaration of peace are appended (Table II.). These figures show a comparatively small incidence of disease, the number sick in hospital being only 3·5 per cent. of strength at time of writing this report; but the camps are in charge of civil surgeons, and it is a fact that many cases of venereal disease and diarrhœa have been attending hospital and have not been shown as admissions. The venereal disease, of which there is a preponderance, is stated to have been contracted mainly from Kaffir women in a kraal on the south side of the river. The outbreak of enteric fever in August was in the 3rd Bn. Essex Regiment, which was encamped on the site east of the railway station, and near polluted river and wells.

The preponderance of venereal disease in the neighbourhood of Kimberley is remarkably high for the short period during which statistics are available. This is shown on Table III., where the actual numbers are reduced to an annual admission ratio. The results for primary venereal affections are higher than in any garrison elsewhere, outside South Africa, and markedly in contrast with Natal garrisons. They approximate to the state of affairs in Cape Town, previous to the passing of a Contagious Diseases Act there in 1888.

Meteorological Observations.

No records have been kept at Modder River. According to local information the prevailing wind is west or north-west; this is a hot, dry wind in the summer months. The rains come with east or south-east winds. Thunderstorms are severe, and dust storms are said to occur about twice a week. There are no means at present of verifying these statements, but the severity of a dust storm was experienced on the 18th December, 1902, when a hospital marquee was blown down, and the tents and their contents covered with red earth during a storm lasting less than a hour. This is the only dust storm during a week's personal experience of the camps. The climate generally corresponds with that of Kimberley, which is 300 feet higher, the height of Kimberley being about 4,000 feet above sea-level, and Modder River about 3,700. The official heights of the railway stations are 4,012 and 3,668 feet respectively.

In Kimberley, during a 10-year period (1888-1897) the mean of maxima was highest in December, viz., 92·7 degrees, and of the minima lowest in July, 36·50 degrees. The absolute maximum was 108·5 degrees in January, and the absolute minimum, 20 degrees in July. *See* table appended (Table VI.).

Modder River has a local reputation as a health resort. The air is certainly clear and bracing, and free from the putrid smell experienced during the night in the neighbourhood of towns such as Standerton. The rainfall is probably similar to that of Kimberley, but the rainstorms are often local and of short duration, and are not evenly distributed over the area.

Note.—An elaborate series of observations is being maintained by Mr. Sutton, of the De Beers Goldmining Company, at his house in Kenilworth, Kimberley. The observations on barometric pressure, wind, evaporation, &c., are made by constant self-recording apparatus, unique in South Africa. The results are consequently of the highest value, and Mr. Sutton has recently published a paper on "The Winds in Kimberley" (Transactions, South African Philosophical Society, Vol. XL., Part I., 1901). His constant observations for 3 years establish the fact that there is no prevailing wind in the district, or indeed elsewhere in South Africa, but that there is a tendency to diurnal variation, the direction of the wind changing with the position of the sun, *i.e.*, the vane goes right round the compass about 30 degrees in advance of the sun. The popular idea that the prevailing wind is north or north-west is got from the fact that about noon the wind has its maximum velocity, and raises dust at the time when its diurnal variation brings it from these directions. The impression that there is a prevailing northerly wind is further confirmed by the single diurnal observation of wind about 9 a.m. at the Government Observatory, when, according to the diurnal variations, wind blows from north-east to north.

PART II.

Conclusions.

(1.) The climate of Modder River is healthy and bracing.

(2.) It is marred chiefly by dust storms.

(3.) The best site for a cantonment in the vicinity of the river and railway station is that shown on the plan A, as already selected by a Board of Officers.

(4.) A water supply from the river at the present intake is not altogether safe from pollution, and a water supply from any other intake lower down is dangerous.*

(5.) A river water supply from an alternative intake higher up is fairly safe from pollution.

(6.) At all points the river water is muddy and requires clarification.

(7.) Surface wells of the houses in the locality are dangerous.

(8.) Good water will probably be obtained from deep borings, but the quantity can only be determined by trial borings.

(9.) Rain-water collected from roofs is an unreliable source of supply on account of the irregularity of the rains and the fact that the roofs are likely to be covered with sand from the dust-storms, which are apt to precede the showers.

(10.) The railway station water supply is dangerous.

(11.) The chief sanitary defect on the river bank above the railway intake is the native cemetery and the pollution from the banks and habitations and also from the Riet River, which carries down the drainage of Jacobsdal.

(12.) The soil of the lower plateau has been and is being polluted by camps.

(13.) The soil of the civil habitations is being polluted by cesspits, by absence of drainage or other sanitary systems, and by animals.

(14.) The aerated waters manufactured in the locality are unsafe, as at present prepared, if not actually dangerous.

(15.) The results of defective water supply and general sanitation are shown in occasional outbreaks of enteric fever and diarrhœa.

(16.) The most important points to attend to in establishing a cantonment in the locality are—

(*a.*) The provision of water supply from deep borings or, failing that, a careful selection of intake and purification of river water.

(*b.*) Improvement of civil sanitary surroundings or, failing that, making the garrison more or less independent of them for supply of aerated water, &c.

(*c.*) Careful protection of the surface soil from pollution by waste water, latrine soil, &c.

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* The water above the dam is practically stagnant and the native cemetery drains into it.

(*d.*) Planting of trees and cultivation of surrounding soil as far as practicable in order to minimise the dust storms.

(*e.*) Macadamizing of roadways and paths for the same reason.

(17.) The diseases likely to cause the greatest amount of inefficiency are venereal diseases. With good arrangements for water supply and preservation of surface soil from pollution, enteric fever should become a negligible quantity, provided the risks of disease from the insanitary civil surroundings are avoided.

PART III.

Recommendations.

(a.) *Water supply and general sanitation.*

(1.) As regards water supply, the first point to determine is the possibility of obtaining an underground water supply sufficient in quantity and satisfactory in quality, and for this purpose trial borings should be undertaken without delay under the supervision of the Cape Colonial Government Inspectors of Borings. These officers have very large experience of water borings and Karoo formations, and in the method of preventing surface formations from affecting water found in deeper formations, as well as in detecting the lines of the intrusive rock, which dams up the water in the deep strata.

The requirements of a garrison of 2,000 should be at least 20,000 gallons daily without a water system of sewage disposal, and this should be estimated as a minimum, irrespective of that required for animals. It is recommended, therefore, that a supply of that quantity should be obtained if possible from deep borings, and that the borings should, preferably, be made in the higher plateau above the cantonment, and not in the lower plateau into which it drains.

It is estimated that borings of 200 feet would suffice, and the cost of boring is stated to be 10*s.* per foot.

(2.) If trial borings prove unsuccessful there is no other alternative for a cantonment in this vicinity but to use river water. In such a case it is recommended that the intake be moved higher up stream to the site shown in the accompanying Plan A, for the following reasons:—

(*a.*) The present intake is apt to be polluted by habitations and irrigation areas higher up stream.

(*b.*) The point selected is the nearest point to the cantonment above the area of probable future pollution.

(3.) The river water must be purified. The simplest plan is to purify it by sand filter beds, and the remarks upon this subject in my report on Standerton apply equally here. The essential points are—

(*a.*) The rate of filtration through the beds must not exceed 500 gallons per square yard of filtering surface in 24 hours.

(*b.*) The filtering medium must be fine sand carefully selected and washed, and if possible kiln-baked, the bed being 2½ feet thick, with a similar thickness of gravel underneath (fine above, and coarse stone below).

(*c.*) The filtering beds should be duplicated to enable one to be cleaned while the other is working.

(4.) Preliminary precipitation in a series of settling tanks, as proposed at Standerton, is advisable.

(5.) As an alternative to purification by sand filters, sterilization by boiling and precipitation by aluminoferric or alum, as carried out at Ladysmith, may be employed. This consists of raising the water in the storage tanks to 190 degrees Fah. by steam and then adding alum. It is found that it takes 4 hours to raise two 1,500-gallon tanks to this temperature with an expenditure of 1 ton of coals.

For a large garrison the system is not so practicable, and is more costly than sand filtration.

(6.) With a small filtration installation it is recommended that the beds should be made large enough to filter at least 40,000 gallons daily, so that both men and animals of a garrison of 2,000 may have the one supply of clear water.

With a Ladysmith sterilization installation the cost of supplying animals with a purified water would be prohibitive.

(7.) No recommendation is made regarding the collection and storage of rain-water. The nature of the surface soil and frequency of dust storms almost preclude the possibility of obtaining satisfactory rain-water supply from the roofs of hutments.* Heavy showers are usually preceded by dust storms that cover everything with red surface sand. For this reason the storage tanks for filtered or sterilized water should be closely covered.

(8). With regard to protection of the surrounding soil from surface pollution, the requirements already noted for Standerton hold good for Modder River, and are, if anything, more essential. Briefly they are—

(*a.*) An American trough system of latrines.

(*b.*) Surface concreting under and around huts.

(*c.*) Surface channels leading to irrigated areas.

(*d.*) Surface concreting around stables and watering troughs, with channels to concrete sumps or irrigation areas.

(*e.*) Concrete bases for refuse and manure receptacles. Any suitable impervious material may, of course, take the place of concrete.

(9.) It is also recommended in this connection that huts should be placed on plinths 1½ to 2 feet high.

(10.) As regards cultivation and planting of trees, it is understood that a clause in the contract prohibits gardening and growing of crops. It is strongly recommended that this clause be cancelled or modified. Cultivation and planting of trees are essential for two reasons:—

(*a.*) To use up the waste water.

(*b.*) To minimise the effects of dust storms in the vicinity.

There is a suitable area for irrigation and cultivation in the lower part of the slope from the upper to the lower plateau, and the results at Rosmead indicate how much can be done by irrigation and cultivation of the red sandy soil. Drainage towards the surface "pan" to the south-west should be avoided.

(11.) The roads and pathways should be macadamised with a view to minimising effects of dust.

(12.) The watering of parade grounds with petroleum from time to time is likely to have beneficial effect in a cantonment here. This is only suggested for future consideration.

(13.) As regards civil sanitary surroundings, little can be done except to bring pressure to bear on the civil administration, but no aerated water manufactured under present conditions in the village should be allowed in the cantonment. It is therefore strongly recommended that an aerated water factory should be established for the troops under garrison and medical supervision. The attention of the railway authorities should be drawn to the danger arising from laying on unpurified river water (from an intake below many sources of pollution) to the platform, or to any of the railway premises to which troops and the public have access. In fact, the condition of affairs at many railway stations demands that the question of railway station water supplies be raised as a general question. Modder River and Standerton are sufficient examples of the need of radical reform in this direction.

* The rainfall, too, is uncertain, varying from 8 to 31 inches, *see* Table VI.

(b.) *Plan of Proposed Cantonment.*

The accompanying map (Plan A) shows the proposed block plan of the cantonment, but it is understood that the site blocked off in the continuous lines shown on the map are intended for an encampment, and not for hutments. These areas are approximately of the following dimensions :—

	Acres.
(1.) Infantry battalion	20
(2.) Mounted Infantry	25
(3.) Battery, Royal Field Artillery	20
(4.) Military Hospital	15

These areas, with the exception of the hospital area, which is more than sufficient for a hospital of 150 beds, are not sufficient for a semi-permanent cantonment of hutments, and the blocks have been enlarged by dotted lines on the plan to indicate the probable extent of area required for each unit, an additional area being blocked off for a second battalion of Mounted Infantry.

As regards the hospital, two alternative sites are shown, marked A and B. Of these B is, on the whole, the best. The areas of these extended sites will be approximately :—

	Acres.
(1.) Battalion of Infantry	45
(2.) Battalion of Mounted Infantry	45
(3.) Battery, Royal Field Artillery	25
(4.) Military Hospital (150 beds)	10

These areas admit of ample space between huts and for parade grounds, recreation rooms, Officers' quarters, &c. The area of the hospital gives 2,000 square feet per bed, which is a high estimate, and allows 3 acres in addition for extension if necessary. If the area, however, proves insufficient, there is open plateau on all sides of alternative site B. For head-quarter offices and other garrison accessories, there is ample ground on either of the alternative hospital sites.

It is understood that the transport and supply depôts will be placed near the railway station. It is advantageous from a sanitary point of view to have these depôts at some distance from the hutments, so as to avoid as much traffic as possible and thus minimise the dust.

With the exception of the hospital hutments detailed plans of siting of huts, &c., have not been prepared, I have no modifications to propose in connection with the detailed plan of hospital hutments. It is understood that no arrangements have yet been made for hutments for troops. The locality is not suited, from a sanitary point of view, for a garrison under canvas, and, in any case, a site selected for future cantonments should never be occupied beforehand by camps.

(c.) *Existing Camps.*

(1.) *Water supply.*—All the camps are supplied with river water from the intake shown on the map, and each camp has an organization for boiling and filtering through Berkefeld filters, which provide good clear water for drinking purposes. In most cases these installations are well managed and much interest is taken in them. The installation of the 2nd Bn. Royal Irish Rifles is admirable in every respect, and may be taken as a model. It should be stated that the credit of these installations is due to the Royal Engineers, who first started them in their camp. Generally speaking the quantity of water so purified is very small, amounting to little more than ½ gallon per man per diem.

(2.) *Latrines and disposal of night soil.*—All the latrines are on the pail system, but the pails are placed on the ground and are of a pattern too low for the seats. Either the seats should be lowered or the pails raised. At present there is much risk of urine and paper dropping on to the ground instead of into the pail. The pails are moved by contract every 24 hours, and the contents deposited in trenches in the open veldt about a mile beyond the rifle ranges. The pits are square pits 3 feet by 3 feet by 3 feet.

The contractor's cart is able to carry the contents of 100 3-gallon pails, and has a compartment for carrying the pails to the cleansing station. The removal of the soil is worked on what is known as the "dual" pail system. The pails are cleansed by handscrubbing in large wooden tubs by native labour. They are kept admirably clean in this way. Until recently the contents were deposited in pits on the rifle ranges. These pits are still incompletely covered, and it is strongly recommended that—

(*a.*) A zareeba be formed round them.

(*b.*) Trees be planted on the edges of the pits.

This will serve not only to absorb the filth, but to mark the place in future and prevent camps being placed on the site of these old trenches. For the same reason trees should be planted along the trenches at present in use.

If the camps, as is likely, are to remain some time on these sites pending construction of the cantonment, the floors of the latrines should be concreted.

3. *Refuse.*—Refuse is removed by the Royal Irish Rifles to a distance of about 3 miles up the line and burnt. Other units appear to dump the refuse irregularly over the veldt. In all camp garrisons it is imperative that an enclosure should be marked off at a convenient spot, and refuse from all camps brought to that spot only, and burnt there.

4. The ablution arrangements in the camps are practically *nil*, and special attention should be directed to this point in view of the probable lengthy stay of troops in a camp garrison at Modder River. Apparently the only ablution arrangements are one bucket for 30 men, and in the mounted units the bucket seems to be used indiscriminately for washing horses' docks, nostrils, or for personal ablution by the men.

5. The number of men in bell tents should be very much reduced for a peace garrison under canvas. Eight men are at present in the tents. Four is quite enough for comfort.

6. Variety of food and vegetables seems desirable.

(*d.*) *Alternative Proposals for a Cantonment in the neighbourhood of Kimberley.*

1. A proposal has been made to establish a cantonment at Riverton on the Vaal River, north of Kimberley. There is no advantage in doing so, as the Vaal River water will present the same difficulties and expense with regard to purification as the Modder River water. The river itself is, as already stated, much more liable to serious pollution than the Modder.

2. Another proposal is to establish a cantonment on a site to which the purified Kimberley water can be laid on. Such a site is shown on Plan B attached, between the Rifle Ranges and Wimbledon Siding. It will be seen that the centre of the site, which is also its highest point, is under 4 miles from the Kimberley Waterworks. The price of Kimberley water is 10*s.* per 1,000 gallons. 20,000 gallons per diem, which is estimated as the minimum requirement of a garrison of 2,000 without watering animals, would be 3,650*l.* annually, and this would, no doubt, be exclusive of laying pipes and any pumping that might be required. The site shown in Plan B is more than sufficient for a cantonment, and is merely marked off as an area on which suitable sites could be selected if necessary. As regards watering animals, there are indications of surface well water being abundant in the neighbourhood.

For a temporary garrison this might prove the least expensive cantonment to establish, and it would have the advantage of placing the troops near more cheerful surroundings than those at Modder River.

Kimberley town sanitation is, however, far from perfect, and venereal disease is very prevalent, although, as regards both of these conditions, the troops are liable to be exposed to the same risks wherever they are stationed in South Africa.

The purification of the water supply is a good feature in the sanitation of the town, the arrangements for filtering, on a large scale, being carried out in accordance with the principles laid down for sand filtration of river waters, the filter beds being formed as follows :—

	ft.	in.
Sand..	2	6
Fine gravel	1	0
Road stone	0	6
Large stone	1	0
Total	5	0

The rate of filtration is 400 gallons per square yard in 24 hours. The sand employed is taken from the bed of the Vaal at the intake. It is scarcely fine enough. A recent analysis of this water is shown on Table I (footnote), and a sample has also been sent to the Military Laboratory, Bloemfontein, for further analysis.*

The filtered Kimberley water brings it barely within the chemical requirements of a pure water. Unfiltered water is supplied from the works for fire hydrants and municipal purposes. The free and albumenoid ammonia and oxygen consumed are double that of the filtered water, and this gives a result worse than the Modder River water analyses on Table I.

The Kimberley supply is from the Vaal, the intake being about 1 mile below Riverton Hotel.

W. G. MACPHERSON, *Major*,
Royal Army Medical Corps.

KIMBERLEY,
23rd *December*, 1902.

* This analysis showed the water to be practically sterile.

APPENDIX.

TABLE I.—CHEMICAL Analysis of Waters from Wells and River at Modder River Village, (made by Captain Norman, R.A.M.C., in the Laboratory of the Medical Officer of Health, Kimberley).

Source of sample.	Date of collection.	Total solids (grs. per gallon).	Hardness (parts per 100,000).	Chlorine (parts per 100,000).	Free ammonia (parts per 100,000).	Albuminoid ammonia (parts per 100,000).	Oxygen absorbed in 15 minutes (parts per 100,000).	Nitrites qualitative.	Nitrates qualitative.
Well in Rosemead village ..	6th Sept., 1902 ..	..	..	6·3	..	..	..	Large.	..
Well in garden in Rosemead village, proposed as drinking water for troops.	21st Sept., 1902 ..	38	..	7·4	·003	·01	·86	Trace.	Nil.
Ditto after pumping and cleaning .	21st Sept., 1902 ..	186	..	6·6	·005	·014	·86	Trace.	Nil.
Well used in manufacture of soda water at hotel.	21st Sept., 1902 ..	126	..	13·6	·002	·014	·64	Trace.	Large.
Modder River water from intake just above dam, apparently below native cemetery.	21st Sept., 1902 ..	31	14	2·9	·008	·021	1·10	Nil.	Nil.

NOTE.—Filtered Vaal water at Kimberley gives 7 of hardness, ·002 to ·001 free ammonia, ·006 to ·008 albumenoid ammonia, and ·67 oxygen absorbed in parts per 100,000. No biological examination has been made. (But see footnote on page 11, referring to subsequent analysis at Bloemfontein.)

TABLE II.—TABLE showing Sickness in existing Camps at Modder River.

Week ending	Average strength.	Sick remaining in hospital.			Percentage remaining to strength.	Number of admissions for				Remarks.
		Kimberley.	Modder.	Total.		Enteric.	Dysentery.	Diarrhœa.	Primary venereal sores and gonorrhœa.	
6th June	862	2	..	2	0·23	..	..	..	..	Many cases of slight ailments and venereal diseases have been lost in statistics, as they attended hospital and were not shown as admissions.
13th "	841	4	..	4	0·47	..	..	..	..	
20th "	883	6	..	6	0·67	..	..	..	..	
27th "	849	2	..	2	0·23	..	..	..	..	
4th July	831	..	..	..	..	..	..	..	..	
11th "	933	2	..	2	0·21	1	..	..	..	
18th "	926	7	..	7	0·75	..	..	..	..	
25th "	918	10	..	10	1·08	..	1	..	..	
1st August ..	921	17	..	17	1·84	..	1	..	..	
8th "	1,130	17	..	17	1·50	..	..	..	..	
15th "	1,264	14	..	14	1·10	..	..	..	..	
22nd "	1,351	15	7	22	1·62	1	..	..	..	
29th "	1,351	15	7	22	1·62	2	..	1	2	
5th September ..	925	18	3	21	2·10	3	..	..	1	
12th " ..	967	24	5	29	2·97	1	..	..	..	
19th " ..	1,012	16	5	21	2·07	..	..	..	1	
26th " ..	1,031	14	6	20	1·93	..	..	..	1	
3rd October ..	1,033	28	9	27	3·58	..	..	1	3	
10th " ..	1,029	31	10	41	3·98	..	1	1	3	
17th " ..	1,022	39	17	56	5·47	..	..	1	4	
24th " ..	993	36	14	50	5·03	..	3	4	3	
31st " ..	968	36	9	53	5·67	..	1	2	6	
7th November ..	911	47	6	53	5·81	..	3	1	6	
14th " ..	921	42	1	43	4·67	..	..	2	3	
21st " ..	921	35	9	44	4·77	..	..	..	2	
28th " ..	933	35	9	114	4·77	..	..	..	4	
5th December ..	1,148	42	19	61	5·30	..	..	1	11	
12th " ..	1,370	44	15	59	4·30	..	..	1	19	
19th " ..	1,353	33	15	48	3·54	..	..	1	2	
Total	29,597	591	166	757	2·55	8	10	16	71*	

* Equals an annual ratio of 124 per 1,000 of average strength.

TABLE III.—ADMISSIONS for Venereal disease among troops at Kimberley from 1st June to 12th December, 1902.

A.—Actual Numbers.

Corps.	Number of weeks present.	Average strength.	Admissions for		
			Primary venereal sores.	Gonorrhœa.	Total primary venereal sores and gonorrhœa.
1st Bn. Rl. Munster Fus. ..	15	739	85	40	125
7th Mounted Infantry ..	23	400	55	36	91
Departmental Corps ..	28	224	14	7	21

B.—Ratio per 1,000 of average Strength Per Annum.

Corps.	Annual admission rate for		
	Primary venereal sores.	Gonorrhœa.	Total primary venereal sores and gonorrhœa.
1st Bn. Royal Munster Fusiliers	399	189	588
7th Mounted Infantry	310	205	515
Departmental Corps	116	58	174

TABLE IV.—CERTIFIED Deaths from the principal Zymotic Diseases amongst Europeans in the Kimberley District (1895–99).

Year.	Enteric fever.	Dysentery and diarrhœa.	Diphtheria and membranous croup.	Smallpox and scarlet fever.	Measles.	Whooping cough.	Total certified deaths, zymotic diseases.	Zymotic death-rate per 1,000 of estimated population of 15,000.
1895	11	58	3	Nil	1	19	92	6·1
1896	11	46	6	Nil	20	21	104	6·9
1897	26	64	8	Nil	Nil	5	103	6·9
1898	10	64	7	Nil	12	5	98	6·5
1899	15	86	8	Nil	14	3	126*	6·5*

* Figures include entries to 15th April, 1900. Zymotic death-rate is reduced to an annual ratio, *i.e.*, for 52 instead of 67 weeks.

NOTE.—The figures are taken from the official returns of deaths, births and marriages for Cape Colony. The estimated population is calculated approximately from figures given in the Annual Report of the Medical Officer of Health, Kimberley, with 500 added for outlying country districts.

TABLE V.—NOTIFIED Cases of Enteric Fever in Kimberley.

(Civil Population—European and Coloured.)

Month.	1898.	1899.	1900.	1901.
January	No record.*	23	17†	..
February	15 (last 10 days only.)	10	79†	..
March	46	15	57	..
April	19	18	103	..
May	12	29	187	..
June	3	12	89	..
July	2	4	28	..
August	1	Nil	4	..
September	Nil	6	4	..
October	2	3	16	..
November	6	5†	45	..
December	10	47†	34	..
Total for year ..	116	172	716†	248‡

* Notification Regulations came into force on 1st January, 1898. A Medical Officer of Health was appointed for the first time in February of that year.

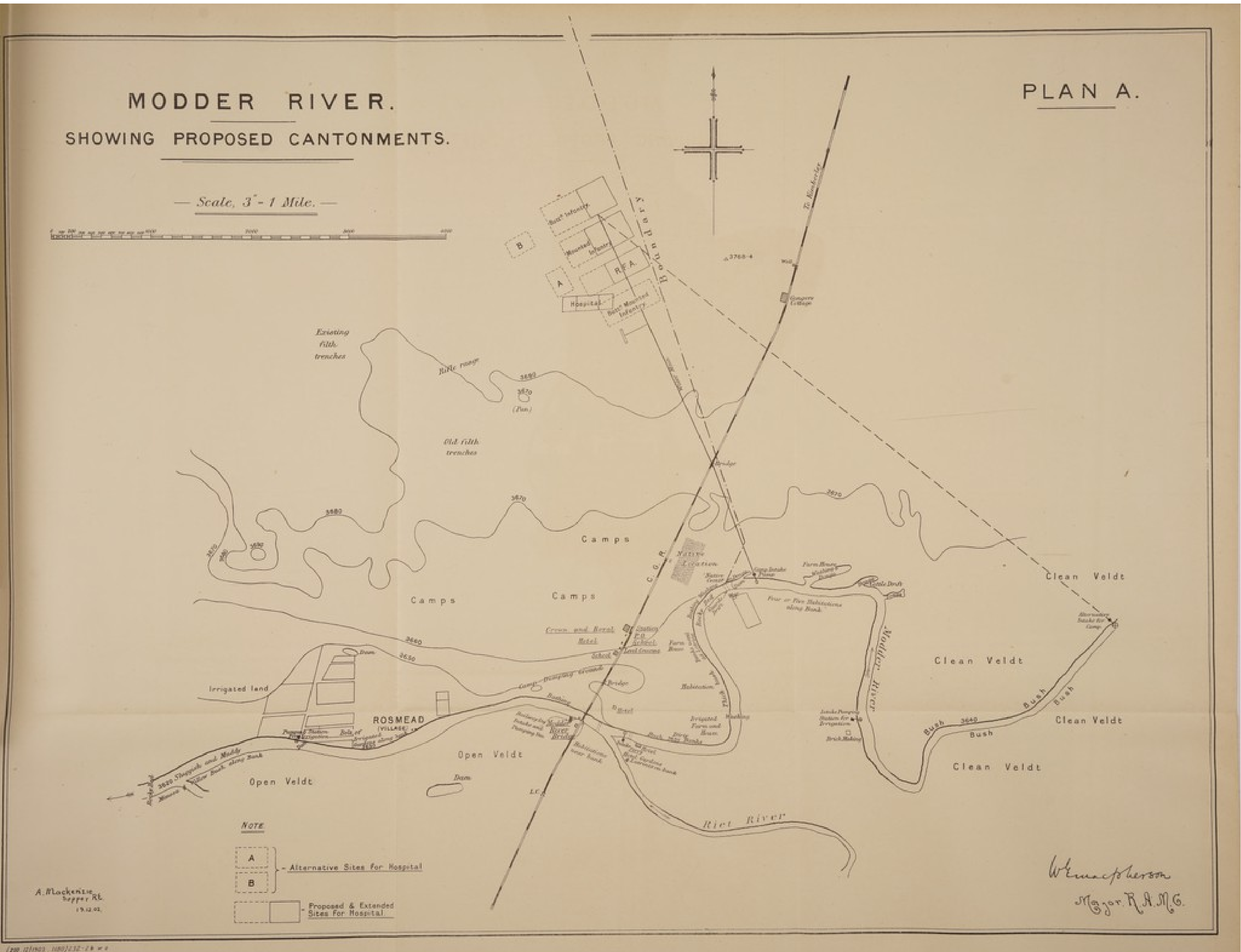
† Months of siege.

‡ Exclusive of Refugee Camp, which had 24 cases.

TABLE VI.—MONTHLY Range of Temperature and Relative Humidity at Kimberley (1888–1897); also average annual rainfall (1874–1901).

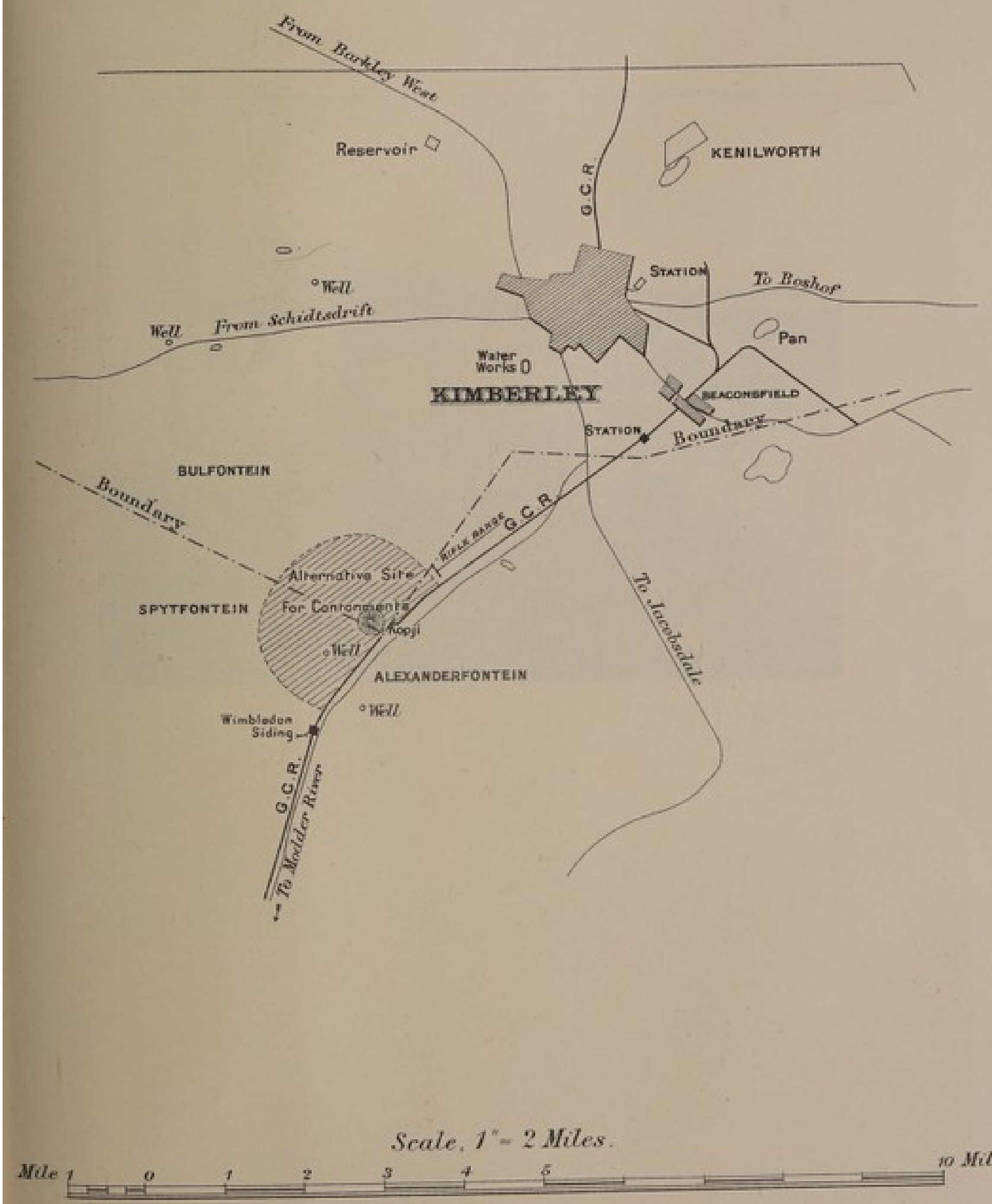
From "Some Pressure and Temperature Results for the Great Plateau of South Africa," by J. R. Sutton (Trans. S.A. Phil. Soc., Vol. XI., Part 4, 1902.)

Month.	Mean of maxima.	Mean of minima.	Mean of maxima and minima.	Absolute maxima.	Absolute minima.	Relative humidity.	Mean rainfall, 1874–1901.
	degs.	degs.	degs.	degs.	degs.	per cent.	inches.
January ..	92·0	60·6	76·3	108·5	45·5	56	2·925
February ..	88·9	60·1	74·5	106·2	48·5	56	2·935
March ..	84·0	57·7	70·8	100·6	41·5	62	3·103
April ..	75·4	50·5	62·9	92·2	35·0	63	1·408
May	67·4	42·4	54·9	82·7	27·3	63	·832
June ..	63·3	37·5	50·4	76·6	25·0	62	·324
July ..	64·3	36·3	50·3	80·0	20·0	55	·425
August ..	70·5	40·7	55·6	85·6	26·5	54	·338
September ..	78·3	45·0	61·6	96·6	25·5	48	·688
October ..	85·1	51·8	68·4	103·0	30·3	46	1·033
November ..	89·9	55·8	72·8	107·5	37·6	48	1·571
December ..	92·7	59·3	76·0	107·3	42·5	57	2·418 inches.
							Average rainfall for whole year .. .. .. 18·000
							Highest annual rainfall (1891) .. .. .. 31·30
							Lowest (1897) .. .. 8·85


MODDER RIVER.
SHOWING PROPOSED CANTONMENTS.
PLAN A.
— Scale, 3" - 1 Mile. —
Boundary
To Kimberley
Bost. Infantry
Mounted Infantry
R.F.A.
Hospital
Bost. Mounted Infantry
A
B
3768·4
Existing filth trenches
Rifle range
3690
3670
(Pan)
Old filth trenches
Bridge
3680
3670
Camps
Camps
Camps
C.G.R.
Native Location
Farm House
Four or Five Habitations along Bank
Clean Veldt
Modder River
Crown and Royal Hotel
Station
P.O.
School
3660
3650
Dam
Camp Dumping Ground
Bridge
Bathing
Habitation
Irrigated land
ROSMEAD
(VILLAGE)
Irrigated Farm and Barn
Washing
Habitations near Bank
Riet River
Open Veldt
Open Veldt
Dam
L.C.
Clean Veldt
Clean Veldt
Clean Veldt
Bush
Bush
Bush
3640
Brick Making
NOTE
A
B
Alternative Sites for Hospital
Proposed & Extended Sites for Hospital
A. Mackenzie Sapper RE.
19.12.02.
W. G. Macpherson
Major R.A.M.C.

PLAN . B.

KIMBERLEY & DISTRICT.



W. McPherson
Major R.A.M.C.

(1903.1150) 232-2 C. a.s.

SURFACE WELL IN MODDER RIVER VILLAGE.

Wh...
22-12-02

(3. 1180)232-2a. W.O.

SANITARY REPORT ON BURGHERSDORP, CAPE COLONY, AS A SITE FOR A CANTONMENT.

Physical Features of the Locality.

Burghersdorp and the immediate neighbourhood are practically on the watershed of the Orange River at an elevation ranging from 4,500 feet in the lowest-lying areas to 5,000 feet on the highest lands and kopjes.

Geologically the district belongs to the Upper Karoo system, sandstone intermixed with shale forming the underlying strata. Sandstone or shaly sandstone predominates. A surface deposit of limestone conglomerate similar to that seen at Modder River appears irregularly in pockets on the surface.

The sandstone outcrops are seen in horizontal strata along the bases and contours of the numerous kopjes in the neighbourhood.

The main physical feature, however, is the extensive intersection of the district by intrusive rock, forming lines of kopjes and dykes in all directions. These practically divide the district into a series of basins of smaller or greater extent, the basins forming upland veldts with the more depressed portions covered with a clayey surface soil or rain wash.

There are exits from one basin to another by the formation of neks or "poorts" over the intersecting dykes, and dongas lead to and from these "poorts" towards a spruit called the Stormberg Spruit, which collects the drainage of the locality and flows eastwards, through a narrow ravine between the high kopjes east of the town, into the Stormberg River, a tributary of the Orange River. (*See* plan appended.)

The town of Burghersdorp is placed in a narrow valley or hollow at the north-east extremity of the area in question, high kopjes rising abruptly on the east to a height of 350 to 500 feet above the town, and somewhat lower kopjes and more open country bounding it on the north-west, west and south.

The area over which the town is built was a swamp originally, but it is now thickly planted with eucalyptus, poplar and acacia trees, and there is no longer any sign of swampy ground. On the east and south the town is bounded by deep dongas and broken ground. The native location lies beyond the donga on the south, on higher and rocky ground.

The general impression of the surrounding district is that of a stony arid wilderness, relieved by the trees of the town and occasional farmsteads.

The main line of railway from East London to Bloemfontein runs south to north, between the line of high kopjes, bounding the district on the east, and the town.

With the exception of the native location, there are practically no native habitations on the area under consideration.

The surface soil is thin and sparsely covered with short grass, except where there are depressions in the basin and the alluvial deposit is deep. There is little or no veldt bush.

Water Supply.

With the exception of the Stormberg Spruit there are no rivers. The spruit itself contains only a few surface pools, unsuitable as a source of water supply, though used by the townspeople for laundry purposes. Very little reliance is placed on rainwater, the rainfall being uncertain and occurring usually as infrequent, though heavy, thunder showers.

The district depends, therefore, on the following sources :—

(1.) Springs.
(2.) Borings.
(3.) Surface wells.

(1.) *Springs.*

These are formed usually in dongas or along sandstone outcrops, where the water is led to the surface by intrusive dykes.

They are small and do not yield a very large quantity of water. The yield is increased by cutting adits into the sandstone, and a considerable quantity of the town water supply is obtained in this manner. (*See* below, under Civil Sanitary Surroundings.)

A spring of this kind was examined on Van der Heever's Farm (*see* plan). It was oozing from the sandstone in the middle of an upland basin and yielded sufficient water to form a large pool or lake when dammed up above the farms.

The water from these springs is clear and limpid.

(2.) *Borings.*

There are several borings in the neighbourhood, but they are all shallow borings, 7 to 15 feet deep.

They are usually in the beds of the dongas north-west and west of the town and they are sunk in the sandstone.

The water wells up to the surface and is clear and sparkling. Four of these borings in the bed of the main donga draining into the Stormberg Spruit yields about one-half of the town water supply.

A boring in this donga on Van der Heever's Farm, about 4 miles higher up than the town water supply borings, was examined. The bore was 2 inches in diameter and sunk apparently by a jumper to a depth of 7½ feet. The water welled up to the surface forming a limpid pool. A gauging was made of the yield, the estimate being about 20,000 gallons in the 24 hours. The water was clear, sparkling and palatable.

No deep borings have been made in the neighbourhood, so far as can be gathered.

(3.) *Surface Wells.*

The principal surface wells are those sunk for the supply of the troops in camp. There are two series of wells—

(*a*.) The "upper wells," a series of four wells, as shown on the plan appended.

(*b*.) The "lower wells," a series of two wells below the camp.

From a sanitary point of view these wells require detailed notice.

(*a*.) The Upper Wells.

These wells are sunk in a narrow tongue of alluvial soil washed down against a "poort" in the main donga draining from Van der Heever's Farm. The tongue of land is formed between two short dongas leading into the main donga at the "poort."

The wells are sunk in line at a few yards distant from one another, parallel to these dongas.

They are 20 to 24 feet deep with a diameter of 10 feet at the mouth and 8 feet at the bottom.

A pump worked by steam is placed over the second well, taking the uppermost of the line as the first.

They are all connected with one another by horizontal channels, made by a 2-inch jumper, at the bottom of the wells.

At present they are open wells, but they are being lined for 5 or 6 feet from the surface with corrugated-iron. They are sunk entirely in alluvial soil, no rocky strata being encountered.

The yield of the wells is shown in Table I. appended. The water is usually clear and sparkling, but is apt to become muddy at times.

The surroundings of these wells are of the greatest importance from a sanitary point of view. They are as follows :—

(1.) A foreman of works' tent, placed on the edge of the uppermost well.

(2.) Troughs for watering animals, about 20 yards east of the wells.

(3.) A concrete trough for watering animals, about 30 yards above the uppermost well.

(4.) A washing place for washing hospital clothing close to this trough, the number of articles washed being between 600 and 700 weekly.

(5.) Three 400-gallon tanks on a platform near (2) east of the wells.

(6.) An encampment for the hospital laundry personnel, consisting of six native women, two men, and three children, about 60 yards above the uppermost well.

(7.) A donga bounding the tongue of land on the east, and containing carcases of animals and other signs of pollution. The native encampment is on the well side of this donga.

(8.) A donga bounding the tongue of land on the west.

(9.) The main donga, about 40 yards on west and north, containing a considerable amount of surface water in pools and swampy ground.

(10.) A small brickmaking establishment and tent for natives about 100 yards to the east of the wells, on the slope of the adjoining kopje.

The water in the wells is subsoil or ground water, and the depth varies with the rainfall. The yield of the four wells combined is about 6,000 gallons on an average. No analysis has apparently been made, but an analysis of the water in the adjoining "donga" was made by the Government Analyst in Cape Town in August last. It showed an excessive amount of albuminoid ammonia and oxidizable matter. The chlorine was low, the solids high. No biological examination was made. It was declared to be polluted with organic matter.

(*b.*) The Lower Wells.

These are 80 to 100 feet lower level than the present encampments and about $\frac{1}{2}$ mile from the nearest and 1 mile from the furthest camp. The area of the camps drains towards the wells.

The camp filth trenches and refuse dumping ground are also on the same area and at a higher level, about $\frac{3}{4}$ to 1 mile distant, draining towards the wells.

Two wells have been sunk about 50 yards from one another, with five 400-gallon storage tanks on a platform on the intervening ground. They are parallel to one another, and not, as in the upper wells, on the same line of drainage. The depths of these wells is 32 to 33 feet. The section shows surface soil for 4 or 5 feet and then a series of layers of shale, the lowest being a hard blue shale with a shaly sandstone below at the bottom of the well. At varying levels there is a thin layer of blue porcellaneous clay. The water appears to enter the more northernly of the two wells in the form of a spring, entering the rock from the north side or the side nearest some adjoining kopjes.

The more southernly of the wells appears to have been sunk in the line of an old donga, *i.e.*, there is more alluvial soil, embedding rocky débris, above the layers of porcellaneous clay.

These wells are not yet completed, nor their yield gauged. The water is clear and sparkling, and is at present being drawn by rope and bucket. There is apparently no record of analysis. A trough for watering animals has been erected below the wells, and there is a donga containing the carcases of animals above them.

There are no encampments or washing in the immediate neighbourhood.

Condition of Surface Soil.

The Town Commonage, an area of about 7,000 acres, has been camped over during the recent war. The evidence of encampments, old refuse grounds, &c., is well marked, especially on the slopes north, west and south of the town.

At present no camps exist on the commonage with the exception of the small area occupied by the Royal Engineers and Army Service Corps near the railway station.

Near the south-west limits of the commonage and close to the road leading to the existing camps, a large amount of refuse has been deposited in swampy ground.

The immediate surroundings of the town are fouled by the deposit of refuse in the dongas and by the filth trenches on their banks. The ground between the native location and the camps of the Royal Engineers and Army Service Corps is also very much fouled by latrines and refuse.

On the farm, at presented rented for encampments, the ground is being fouled by refuse and latrine pits on the more open parts of the farm, and the kopjes above the slopes have been used as the dumping ground of innumerable dead animals.

Adjoining farms have fairly clean surfaces, although moving columns are said to have occupied temporarily a considerable portion of Kidwell's Farm.

Civil Sanitary Surroundings.

The sanitary condition of Burghersdorp is very unsatisfactory. The situation is insanitary originally, being in a deep and narrow hollow, surrounded on all sides by higher land.

There is practically no sanitary administration under the guidance of trained sanitary officials. There is no medical officer of health, and the district surgeon apparently exercises no sanitary control. There is one sanitary inspector, recently retired with a pension from the position of gaoler at the Government gaol. There is no borough or sanitary engineer, and the general sanitary control is in the hands of the Town Clerk and Municipal Council.

The *water supply*, until March, 1899, was from private wells and three public wells. They were surface wells, and all, except a few, are now closed.

In March, 1899, the present water supply was laid on. It is collected from surface springs and borings in two series of dongas, the first being immediately below Kidwell's farmstead, about 3 miles north-west of the town, and the other in open country about 1½-miles south of the farm.

The drainage of the farmstead is into the first series, the second is on the line of drainage from the "upper wells" and farms beyond, about 2 and 4 miles distant.

In the first series of dongas, well constructed concrete and masonary catchpits have been placed over the springs. They have good protecting covers which are kept locked. The number of these catchpits below Kidwell's farm is four. They are all over springs except one, which is connected with two adits in sandstone, one a few yards long into a spring in the adjoining bank, and the other about 100 yards long up the bed of the donga. At the head of the long adit there are two borings 15 feet deep, and the adit is cemented on the sides and covered over, so that the water oozes out from the floor of the adit only. The floor is about 6 feet from the surface of the donga.

In the second series there are four borings in the bed of the donga, collecting into a catchpit, above a "poort" on a long line of kopjes. The water wells to the surface in these borings, and is conducted by gravitation in 4-inch wrought-iron pipes to a collecting tank for the two series placed below the junction of the dongas in which the series of catchpits has been constructed.

When this collecting tank was inspected (28th December, 1902) the two inlet pipes were each discharging about an equal quantity of water, the combined yield being 50,000 gallons in 24 hours.

This is stated to be lowest gauging recorded. Originally the yield was 80,000 to 90,000 gallons.

The water is led from the collecting tank in a 5-inch main to a service tank sunk in the rock of a kopje immediately overlooking the town. There is a 25 feet fall from the collecting tank to this service reservoir and the latter is about 50 feet above the town. Its capacity is 90,000 gallons. It is well covered, ventilated, and enclosed by a barbed-wire fence. The water is laid on to the town, to stand pipes, and a water-rate of ¾*d.* in the £ of assessed value of property is levied.

Any householder can have it laid on to his house on paying an additional rate of 2*l.* annually.

The water is also laid on to the railway station reservoirs and to two stand-pipes on the platform, 10,000 gallons being supplied daily.

There is no record of an analysis of this water supply. It is clear and sparkling, and the fact that the water wells up to the surface in the bore holes indicates that its source is below an impervious surface stratum.

The precaution taken to cement and build round the bores and surface springs also prevents liability to pollution from surface water.

The chief danger is that the dongas may at any time become flooded with drainage from Kidwell's Farm above and the precautions taken to avoid surface pollution break-down.

Sewage disposal.—Until 1896 domestic sewage was discharged into open cesspits on the premises. The cesspits were closed in that year and a pail system introduced.

Pails are supplied by the Municipality to each householder. There are no bye-laws regulating the number. A municipal contractor removes the pails and their contents once a week.

The contents are deposited in pits, 8 feet deep, on the banks of the donga, (the Stormberg Spruit) south-east of the town, and the pails are said to be washed and disinfected before being replaced. One cart only is used. The rate levied for this and other sanitary purposes is 1*d*. in the £.

There is no pail system in the native location; but moveable screens over trenches are placed on somewhat thin soil to the south of the location, between it and the Royal Engineer and Army Service Corps camps.

Two similar latrines are placed on the far bank of the donga, bounding the town on the east, for the use of native servants living in the town. The donga itself is, however, commonly used as a latrine.

The latrines for the native location were only instituted this year. Previously, the natives went into the open ground around the location.

Slop water.—The municipal contractor removes slop water when required, and disposes of it in the Stormberg Spruit below the railway station.

Dry refuse.—This is removed twice a-week to the broken ground about the dongas and Stormberg Spruit, with the intention of filling up the hollows, and eventually forming a public park. The dry refuse from the native location is placed in the dongas south and west of the town.

Slaughterhouses.—There are no private slaughterhouses. The public slaughterhouse is a well-constructed stone building with three compartments and an enclosure, situated at the entrance to the narrow valley through which the Stormberg Spruit runs.

Milk shops and dairies.—Milk is sold in glass bottles, direct from farms and cow-keepers in the town; many of the town houses having yards in which cows and other animals are kept.

Aerated water factories.—There are three factories. Town water is laid on to all of them, and is used for filling and washing the bottles. In none is the water previously boiled or passed through sterlizing filters.

Gas is generated from carbonate of soda and sulphuric acid. Bottles are washed by hand and in tubs. There is a well in the factory supplying the camps. It is an unprotected surface well, containing 8 feet of water and it is 35 feet deep. The water is clear, and is said not to be used; but there is a rope and bucket at the well, and every facility for using it. The proprietor of this factory uses permanganate of potash in the washing tubs, and is erecting a spray washer. One of the factories, (Fleetwood's), is kept remarkably clean and tidy, but apparently not much aerated water is manufactured in it.

Laundries.—Washing is done in pools in the Stormberg Spruit below the town and native location. The hospital washing, as already noted, is done at the "upper wells."

Surface pollution.—There are no concrete or brick channels for the removal of surface or foul water from the streets or houses. The streets are, however, macadamized, clean, and dry. Organic impurities and foul water soak everywhere into foundations of houses and yards, from habitations, refuse, and animals.

House construction.—Nearly all the houses are one-storey houses, not raised above the ground, and with flat roofs. They are of poor and insanitary construction.

Rates.—In addition to the water and sanitary rates already mentioned, there is a general purposes rate of 2*d.* in the £.

HEALTH STATISTICS.

(a.) *Civil Population.*

Notification of infectious diseases is supposed to be enforced, but no record of notification existed, apparently, beyond a book kept by the sanitary inspector and Town Clerk, showing the number of notifications, but not the diseases. They are very imperfect records, and appear to have fallen altogether into abeyance this year.

The death register has been examined, and, although the arrangement of the columns makes it difficult to extract anything but approximate figures for the town of Burghersdorp without devoting much longer time to it than it is worth, an attempt has been made to work out the total and zymotic death-rates in Table II. appended. The Town Clerk estimates the population at 2,500 (Europeans 1,750, and coloured 750) in 330 European and 150 native houses. This is, if anything, an over-estimate, and the real rates are probably higher than those shown on the table.

The main facts disclosed by this table are:—

(1.) A very high percentage of uncertified deaths. As a rule this exceeds 40 per cent. of the total number of deaths registered, and, in recent years, the percentage is increasing instead of diminishing.

(2.) An exceptionally high zymotic mortality, 6 to 10 times greater than the zymotic mortality of sanitary communities in England and Wales.

(3.) An exceptionally high mortality from enteric fever, from 8 to 60 times as high as that of sanitary communities in England and Wales.

In scrutinizing the death register one is impressed by the fact that the diagnosis of enteric fever has been made with no uncertainty. No typho-malarial or other indeterminate fevers are recorded. The local inhabitants themselves recognize the fact that enteric fever has been their scourge, and the present water supply was introduced with a view to its abolition. No definite improvement is however apparent as yet, although in 1902 the enteric mortality has been much lower than in previous years.

The records for 1895 seem very incomplete. It was the first year of death registration, in accordance with the Births and Deaths Registration Act of 1894.

It has been impossible without expenditure of much time and labour to disintegrate the deaths of coloured from European population; but, judging from the records of other localities in South Africa, the death-rate amongst the former is three or four times as high as amongst the latter. Enteric fever seems to have been as prevalent in the native location as in the town.

(b.) *Military Population.*

The average strength of the military population has been 629 for the 30 weeks (6th June to 26th December) since the declaration of peace. The chief statistics of this period are shown on Table III. appended. During that time only one case of enteric fever and five of dysentery have been admitted.

Primary venereal diseases have been comparatively few, the admissions being equivalent to an annual admission rate of 81 per 1,000 of average strength.

The percentage of sick remaining to average strength is neither low nor high for a South African garrison, the average for the 30 weeks being a fraction over 5 per cent.

METEOROLOGICAL RECORDS.

Records of rainfall have been kept at the gaol and by Mr. Roex. The latter has also kept records of temperature. I have only been able to consult the goal records and an abstract of them is given in Table IV. appended.

The chief points are—

(1.) The comparatively small rainfall, seldom exceeding 20 inches.

(2.) The absence of continuous rain and the dependence on thunderstorms for most of the fall.

(3.) The irregularity in the monthly distribution of rain. Thus, 1893 shows a rainfall during every month of the year, while 1901 shows no fall in January, which is normally one of the wettest months.

As regards temperature, Burghersdorp appears to be hotter than neighbouring towns. Thus, Aliwal North, although its elevation is about 200 feet lower, showed in 1900 a mean of maximum temperatures and a mean of absolute maxima 3 degrees lower than the means of Burghersdorp. This may be accounted for by the situation of the town in a narrow hollow surrounded by sandstone and igneous rock.

Existing Camps.

The existing camps have been on their present site about 4 months. The site selected is on a farm, rented for the purpose, about 2½ miles south-west of the town, and the camps have been placed on and around an outcrop of igneous rock.

The units encamped are a battalion of Infantry, a battalion of Mounted Infantry, Army Service Corps transport lines, and a military hospital.

The soil is generally sandy, and the sites dry and well drained. These sites are the best sites on the farm.

The water supply has already been described as coming from the upper and lower wells. There is no regimental or other organization for boiling or filtering.

Latrines are on the pail system. There are no concrete foundations. The contents of the pails are removed nightly by a contractor, one cart only being employed, making two journeys between the camps and the filth trenches. The pails are not removed for cleansing and disinfecting.

The filth trenches are wide pits dug in stony ground about 1 mile south of the camps, the soil being a surface limestone conglomerate, covering a gravelly shale. There appears to be little or no surface earth on the site selected for the trenches.

Dry refuse is deposited over the surface of the soil about halfway between the filth trenches and the camps.

Slops are led into sumps and removed by carts to the Town Commonage north-east of the camps.

Ablution stands have been constructed over a concrete channel discharging on to the surface soil adjoining. The channel is a narrow channel, and the stands are not surrounded by screens.

Conclusions.

(1.) Suitable sites for a permanent garrison on the town commonage have already been extensively fouled by old encampments and columns. Town commonage is, moreover, said not to be available for the selection of sites.

(2.) Suitable sites, on the farm hired for garrison purposes, are occupied by existing camps, or have been used as dumping grounds for refuse and for filth trenches.

(3.) It is consequently difficult to point out suitable sites in the locality without going to other farms, and to a greater distance from the line of railway.

(4.) One or two areas, still clean and admitting of proper drainage, are available on the farm rented for the camps, but they are of small extent, and suitable for a very limited garrison—(one battalion and hospital).

(5.) The only safe water supply in the locality is from borings. The surface wells are liable in time to become seriously polluted, and the surroundings and character of the upper wells render them an extremely unsafe source of supply.

(6.) There is reason to believe that borings will yield an ample supply of water for all purposes, the geological formation being specially favourable, and the gauging of the boring on Van der Heever's Farm giving evidence of the probable yield.

(7.) The sanitary administration and general sanitary arrangements of the civil surroundings are extremely backward, and the health statistics point to the town being an exceptionally insanitary area.

(8.) The situation of the town makes it difficult to improve, except at great cost, the generally polluted state of the soil on which it is built.

(9.) The water supply of the town is liable to pollution from the drainage of Kidwell's Farm.

(10.) The sanitary arrangements for the disposal of nightsoil, refuse, &c., from the camps, and the prevention of surface soil pollution in and around the camps are inadequate.

(11.) The arrangements for purifying the drinking water are inadequate.

(12.) Purification of drinking water, collected from the present sources, is essential.

(13.) An analysis of water in the surface wells, town supply and from borings is desirable.

(14.) The municipality require to increase their equipment and personnel for the removal of nightsoil from the town habitations. Nightly instead of weekly removal should be the rule.

Recommendations.

As regards site, it is recommended that a small garrison only of one unit should be kept at Burgersdorp unless new areas can be rented or bought. Suitable sites for such a garrison are indicated on the plan on the farm at present rented.

Kidwell's and Van der Heever's Farms have the best sites in the neighbourhood, should a larger garrison be determined upon.

There is no necessity however for altering the arrangements of the existing camps.

As regards water supply it is recommended that borings should be undertaken immediately. Borings into the rock above the upper wells are almost certain to yield a good supply.

The upper wells should be entirely abandoned as a source of water for human consumption, and if, in the meantime, they must be used for the camps, the wells should be lined and the surroundings cleared of the watery troughs, washing encampments, foreman's tent, &c.

Further, the water should be boiled or passed through sterilizing filters, a proper regimental organization being established for the purpose, as is done in camps elsewhere, when the troops are dependent on water from an impure source.

Should deep borings fail to give a good and sufficient supply of water for a permanent garrison, such supply being estimated at not less than 10 gallons per head of troops and animals, it is recommended that any proposal to establish a permanent garrison in the locality be abandoned.

It is recommended that all the washing of clothes and watering of animals should be carried out below the lower wells without delay.

Latrines and disposal of nightsoil of the existing camps require considerable improvement in the following directions:—The bases of the latrines should be concreted and channelled into concrete sumps or catch pits. There should be a supply of pails equal to 7 per cent. of the rank and file. The allowance of 5 per cent. seems too little, and the custom of including the pails supplied for serjeants' messes, mess orderlies, and Officers' servants in the percentage is wrong in principle. Thus the Mounted Infantry here have a latrine of nine pails only for a strength of about 400, although there are other pails for serjeants' mess and servants.

Latrines for native followers should be supplied in the same proportion.

The system of removing of nightsoil should be carried out on the dual pail system, the pails being removed by the contractor and cleaned and disinfected near the filth trenches, fresh clean pails being left in their places.

The filth trenches should be removed from their present site to a spot below the lower wells, where the soil is suitable for trenching nightsoil.

Water should be laid on from these wells to troughs or tanks where the pails could be cleaned and disinfected, and the whole area connected with disposal of nightsoil enclosed.

The old trenches should also be enclosed and marked as the site of old filth trenches.

It is a good plan, where the soil is suitable, as it ought to be, to plant young trees along the edges of filth trenches, in order to mark the place of these trenches in the future, and aid in absorbing the organic refuse.

The use of disinfectants should be universal in the camps—

(1.) In the latrine pails.

(2.) For watering the surface round latrines and other surfaces liable to pollution from refuse or foul water.

Chloride of lime in solution is the best disinfectant for the purpose. It gets rid of flies.

Ablution.—Screens or sheds, placed round or over concrete channelled flooring should be provided for the camps, and the waste water led to suitable ground, and used for irrigating garden plots. This is done in some of the garrisons in South Africa at present under canvas, with good results.

Dry refuse should not be dumped down as at present. A dumping ground should be fenced off, preferably below the lower wells, and a horseshoe mound 4 feet high constructed in the enclosure, surrounding an area sufficient to contain the camp refuse of 1 or 2 days. All the refuse should be deposited within this horseshoe enclosure.

A ring of fire should then be formed round the outer base of the mound and one or two natives employed daily in raking the refuse within the enclosure over the mound on to the fire. This is an effective and simple way of incinerating daily the dry refuse of camps, and is the method recommended by the Quarter-Master-General's Department in India.

As regards a permanent garrison in hutments the following recommendations, based on an experience of hutments in other localities in South Africa, are urged :—

(1.) A battalion of Infantry or Mounted Infantry should be given an area of 40 to 50 acres, to include Officers' quarters, recreation rooms, canteen, &c.

A lesser area, with the present pattern of corrugated-iron hutments, will present too crowded an appearance and impede circulation of air. Brick or stone two-storey barracks require a considerably less area and are more economical from a sanitary point of view.

(2.) The area for hospitals of the corrugated-iron type should be about 10 acres for every 100 beds, this area giving sufficient space for Royal Army Medical Corps barracks in addition to hospital wards and administrative buildings.

(3.) Huts should be raised 1½ to 2 feet above the surface, and the surface underneath and for 3 or 4 feet around, covered with impervious material channelled to surface drains.

(4.) The latrines should be constructed on the American trough system, seven seats and one trough per company.

Details of these latrines have been communicated to General Officers Commanding in South Africa by the War Office. They can be obtained from the Commanding RoyalEngineer, Pretoria, if they have not yet reached the Commanding Royal Engineer, Cape Town.

With an ample and reliable water supply, and a garrison likely to be permanent for many years, a water-carriage system of sewage disposal is the best, the sewage being treated first in septic tanks and contact beds, and eventually passed over land, wherever the soil is suitable.

With this double treatment, one acre per 1,000 persons is sufficient area for sewage irrigation over suitable ground, but in South Africa it is advisable to dominate 3 acres.

(5.) Ablution water and slops should be run in surface channels, or underground pipes, to irrigation plots, not less than 300 yards from the barracks, and the plots should be cultivated.

(6.) Roads and pathways should be macadamized and an avenue of trees formed if the surface soil appears suitable.

(7.) The hutments should not be occupied by troops until all these arrangements for preventing pollution of the surface soil and for the immediate removal of waste products are completed and in working order.

(8.) A garrison aerated water factory, under garrison and medical supervision, is strongly recommended.

In connection with the sanitary recommendations relative to the existing camps, the present Senior Medical Officer, Lieut.-Colonel H. J. Peard, R.A.M.C., has already fully realized their necessity and has been urging the adoption of similar measures. There should be no delay in remedying the existing defects of water supply and disposal of nightsoil, and sanitary organization for the purpose of initiating and maintaining good sanitary arrangements in camp garrisons is much needed.

W. G. MACPHERSON, *Major*,
R.A.M.C.

BURGHERSDORP,
30th December, 1902

TABLE I.—RECORD of Water in Wells supplying Drinking Water to Troops Encamped at Burghersdorp (*i.e.* the Upper Wells.)

Date.	Depth of water before pumping, in feet.					Amount of water supplied from wells.			
	No. 1.	No. 2.	No. 3.	No. 4.	Total wells.	To water-carts at 100 galls. per cart.	To watering troughs.	For hospital washing.	Total gallons.
1902.									
3rd December ..	6	9	5	..	20	3,700	(?)	400	4,100
4th " ..	6	9	5	..	20	3,700	..	400	4,100
5th " ..	6	9	5	..	20	3,700	..	..	3,700
6th " ..	5	8	4	..	17	3,600	..	..	3,600
7th " ..	4	7	3	..	14	3,200	..	..	3,200
8th " ..	4	7	3	..	14	4,200	..	500	4,700
9th " ..	2	5	1	..	8	3,700	..	500	4,200
10th " ..	2	5	1	..	8	3,400	..	150	3,550
11th " ..	3	6	2	..	11	4,700	..	..	4,700
12th " ..	4	7	3	..	14	4,000	..	..	4,000
13th " ..	4	7	3	..	14	3,500	..	..	3,500
14th " ..	5	7½	3½	..	16	3,200	..	..	3,200
15th " ..	5½	8	4	..	17½	2,800	400	900	4,100
16th " ..	5½	8	4	..	17½	3,400	300	800	4,500
17th " ..	5	7½	3½	..	16	4,000	400	200	4,600
18th " ..	4½	7½	3	1	16	4,300	400	..	4,700
19th " ..	5	7½	3½	2	18	4,000	400	..	4,400
20th " ..	6½	9	5	3¼	23¾	3,800	400	..	4,200
21st " ..	7	9½	5½	3¾	25¾	4,600	400	..	5,000
22nd " ..	7¼	9¾	6	4½	27½	4,200	400	400	5,000
23rd " ..	7	9½	5¾	4	24¼	4,400	1,300	200	5,900
24th " ..	6¼	8¾	5¾	3¼	26	4,500	800	..	5,300
25th " ..	6¼	8¾	5¾	3¼	26	2,400	800	..	3,200
26th " ..	6¾	9¼	5½	3½	25	..	..	..	..

NOTE.—The diameter of the bottom of each well is 8 feet. Each foot of water = 312 gallons approximately.

TABLE II.—HEALTH Statistics of Burghersdorp, Cape Colony.

(Extracted from Death Register.)

Year.	Registered deaths from all causes.	Number of deaths uncertified.	Percentage of uncertified to certified deaths.	Deaths from principal zymotic disease.								Death-rate per 1,000 of population.		
				Enteric fever.	Dysentery and diarrhoea.	Whooping cough.	Measles.	Scarlet fever.	Diphtheria.	Total zymotic.*		All causes.	Principal zymotic diseases.	Enteric fever.
1895	47	14	30·0	4	1	..	..	..	1	6		18·8	2·4	1·6
1896	94	8	8·5	32	16	9	..	..	..	57		37·2	22·8	12·8
1897	82	15	18·3	7	23	7	7	..	1	45		32·8	18·0	2·8
1898	106	26	24·5	18	23	1	6	..	..	48		12·5	19·2	7·2
1899	69	16	23·2	7	6	1	1	..	..	15		27·2	6·0	2·8
1900	92	39	41·3	9	13	8	1	..	..	31		36·8	12·4	3·6
1901	155	63	40·6	12	24	10	28	1	1	76		62·0	30·4	4·8
1902	101	49	48·5	4	17	24	2	..	1	48		40·4	19·2	1·0

* There were no deaths from small-pox.

NOTE.—The population is estimated at 1,750 Europeans and 750 coloured, a total population of 2,500. The death-rate is estimated from total population. The death register commences on 1st January, 1895, in accordance with the Births and Deaths Registration Act No. 7 of 1894.

All deaths of military patients in military hospitals have been excluded from the above table. The number of houses is 320 in the town proper and 150 in the native location.

TABLE III.—HEALTH Statistics of the Troops at Burghersdorp (since the Declaration of Peace).

Week ending	Average strength.	Sick remaining.	Percentage remaining to strength.	Number of admissions for: Enteric.	Dysentery.	Diarrhœa.	Gonorrhœa.	Enteritis.
1902.								
6th June	1,065	6	0·56	..	..	..	1	..
13th "	1,086	11	1·01	..	..	..	1	..
20th "	1,082	31	2·86	..	1	1	1	..
27th "	457	25	5·68	..	..	..	1	..
4th July	472	20	4·23	..	..	..	..	..
11th "	317	23	7·25	..	..	1	..	..
18th "	427	34	7·93	..	..	..	..	..
25th "	457	29	6·34	..	..	..	1	..
1st August	482	26	5·39	1	..	..	..	..
8th "	544	28	5·14	..	..	..	..	..
15th "	522	41	7·85	..	..	..	..	..
22nd "	501	40	7·98	..	..	1	..	..
29th "	499	26	5·21	..	..	1	..	..
6th September	526	16	3·04	..	..	..	..	..
12th "	90	5	5·55	..	..	..	..	..
19th "	152	14	9·21	..	..	..	1	..
26th "	393	21	5·34	..	..	..	..	..
3rd October	726	17	2·34	..	..	..	1	..
10th "	857	29	3·38	..	..	..	5	..
17th "	853	42	4·92	..	..	..	3	..
24th "	787	45	5·71	..	1	..	3	..
31st "	799	33	4·13	..	..	1	..	..
7th November	764	34	4·45	..	..	..	..	1
14th "	745	35	4·69	..	.	1	1	..
21st "	739	36	4·86	..	..	1	1	..
28th "	745	37	4·96	..	..	3	2	..
5th December	713	29	4·05	..	1	1	..	
12th "	703	36	5·12	..	..	6	1	..
19th "	702	43	6·11	..	..	1	6	..
26th "	673	45	6·60		2	..	1	..
Total for 30 weeks ..	18,876	857	151·97	1	5	18	30	1
Average	629	..	5·06	..	..	..	..	..

TABLE IV.—RECORDS of Rainfall at Burghersdorp, Cape Colony.

(From observations registered at the Government Gaol.)

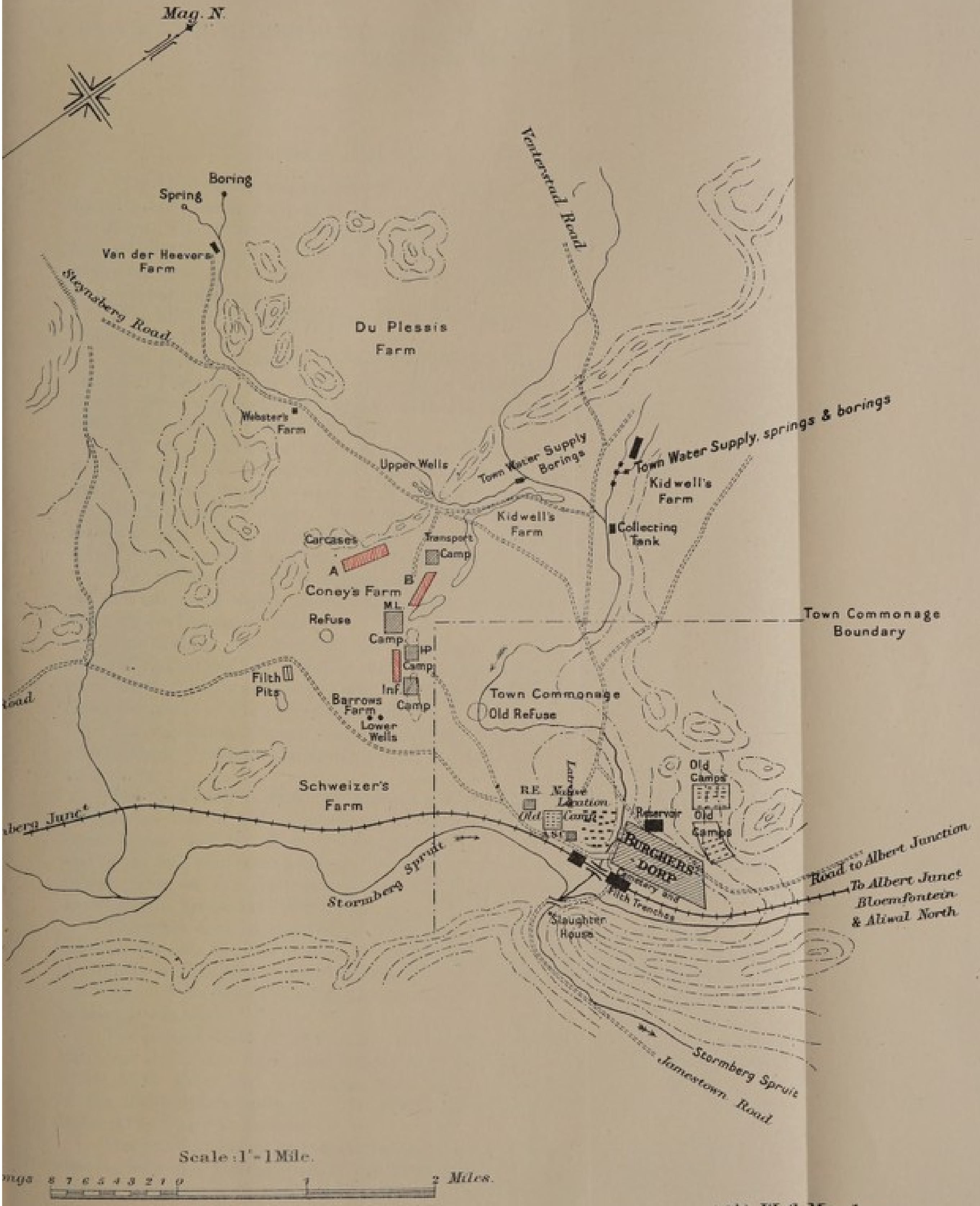
Month.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January ..	No record kept.	3·38	1·08	2·56	1·30	2·20	5·68	0·94	1·88	Nil	0·78
February ..		3·27	3·58	3·14	2·76	2·76	2·70	3·50	3·13	5·80	3·29
March		4·14	2·07	1·39	1·79	2·90	0·71	4·81	4·43	3·47	4·98
April		0·90	1·28	3·75	0·79	0·99	1·32	4·43	1·52	1·84	1·15
May		0·06	1·01	0·99	2·01	1·36	0·70	2·08	0·15	0·17	0·55
June		0·52	0·35	Nil	1·73	Nil	Nil	1·52	0·93	1·85	1·47
July		0·74	Nil	0·22	Nil	Nil	Nil	2·21	0·77	0·07	0·26
August ..		1·84	0·35	0·30	3·30	0·22	Nil	1·15	1·45	0·49	0·07
September ..		0·48	0·86	0·11	0·12	Nil	Nil	0·28	Nil	2·90	2·09
October ..	1·89	0·84	2·98	0·70	0·05	0·58	4·43	2·43	0·20	3·69	Rain gauge broken.
November ..	1·80	6·59	2·62	1·42	1·09	Nil	1·97	(?)	0·17	0·24	
December ..	1·29	2·31	0·73	4·73	6·49	1·49	3·10	0·14	5·45	1·67	
Total rainfall in inches ..	..	25·07	16·91	19·31	21·43	12·50	20·61	(?)	20·08	22·19	(?)

NOTE.—During these years the records do not show any continuous rains. The rainfall has generally been from heavy thunderstorms or slight rains. Rain continuously for more than one day has not been recorded.

ROUGH PLAN OF BURGHERSDORP AND SURROUNDING DISTRICT.

TO ILLUSTRATE WATER SUPPLY AND SANITARY CONDITIONS.

(Reduced from Rough Sketch in R.E. Office, Burghersdorp.)



(Sd) W. G. Macpherson,
Major, R.A.M.C.

NOTE.—The red hatching patches are, approximately the only sites on the rented farms suitable for a permanent Garrison; they are suitable for a small garrison only.

The patch marked A is admissible only if the Kopjes above are completely cleared of carcases and cleaned.

The patch marked B is rocky.

REPORT ON MIDDELBURG, CAPE COLONY, AS A CANTONMENT FOR BRITISH TROOPS.

Physical Features of the Locality.

The area in the neighbourhood of Middelburg is an open plateau surrounded by hills, some being lines of kopjes rising 50 to 500 feet above the plateau on the north-east, others forming mountainous country such as the Rhenoster Berg range, some 2,000 feet higher, on the south-west. The plateau itself is about 4,000 feet above sea level, and is some 8 miles wide in its longest diameter, and about 6 miles in its shortest diameter.

The town of Middelburg and the site of the present camp are near its north-eastern corner.

The plateau is broken by the Little Brak River and a number of entering dongas. The river and dongas are more or less dried up at present. The general flow is from the north-west to the south-east, draining the plateau by the Little Brak River into the Great Fish River.

The geological formation is that of the Upper Karroo system, intersected with well-defined lines of intrusive rock which form smaller kopjes or foothills and enclose smaller valleys along the boundaries of the main plateau.

Well marked "poorts" are formed by breaks along these lines of kopjes at several places. They indicate generally where underground water is being dammed up by natural barriers, and where the water appears often as surface springs.

The underlying rock throughout the Middelburg plateau appears to be a hard compact sandstone with a conchoidal fracture, intermixed with shale. Outcrops of this rock are frequently seen.

The surface soil covering the sandstone and shale is generally thin, and frequently there are 2 or 3 feet of a chalky conglomerate on the surface. The only place where there is any great depth of surface alluvial earth is above the poorts and along the banks of the river and dongas.

The vegetation is sparse and stunted, and, with the exception of a considerable growth about ½ mile to the north-west of the town near the river, there is little or no bush.

The town itself is laid out in avenues of poplars, acacia and cypress, and the gardens are full of fruit trees of every variety. Many of the plots are irrigated (*water erven*), and the effect of irrigation is seen in the luxuriant growth of trees and in the well-cultivated gardens. Similar effects of irrigation are seen at Grootfontein farm, on the north-east corner of the plateau, near the existing camps; elsewhere the appearance of the hills and valley is arid and bare.

There has been no opportunity of determining personally the effects of heavy rains on the soil, but it is stated that it is porous, and that water runs off quickly. A slippery surface mud is however formed. The surface soil washed down against the "poorts" contains a considerable amount of clay, and in rainy weather is bound to become swampy.

The general slope is towards the site of the town from the line of kopjes on the north and east. From these kopjes there is a slope towards a tributary of the Little Brak River, fed by springs rising above a poort on the north-east corner of the Grootfontein springs. The donga formed by this tributary through the town valley is dry at present.

The existing camps are on the slopes of a very slightly elevated "hog's back," running into and forming part of the town valley from the higher kopjes on the north to the junction between this donga and the river donga. This "hog's back" slopes on the north-east towards the former, and on the south-west towards the town.

The town of Middelburg is situated on the north-eastern bank of the river. The line of railway runs along its eastern boundary and then turns southward. The native location is placed on the tongue of land between the railway and the river, on the south bank of the latter, opposite the town. A wooden suspension bridge over the river leads from it to the town.

There are no suitable maps or plans of the town and neighbourhood by which the physical features can be illustrated.

Water Supply.

The sources of water supply in the town and neighbourhood are—

(1.) River water.

(2.) Surface springs and dams.

(3.) Well water.

(4.) Rainwater.

(5.) Borings.

(1.) *River Water.*

This is used for irrigating the town, for washing, and to some extent for drinking and domestic purposes.

The river is dammed about a quarter of a mile above the town, and the water is led into an open masonry conduit. This was gauged on the 7th January, 1902, during a period of drought, and yielded water at the rate of about 400,000 gallons in the 24 hours. The water in the river feeding the conduit was clear but it flowed, for about half a mile above the entrance to the conduit, over a muddy bottom, with shallow banks. The bed of the river above the dam is much used by cattle. A portion of the water issues from surface springs in dongas about half a mile above the dam, and these dongas contain the carcases of animals above the source of the springs. There are no habitations, apparently, higher up. The river passes through a poort of intrusive rock above these dongas, and two boreholes in the rocky bed there yield an abundance of clear pure water, which is added to the volume of water in the river and town irrigation channels.

Below the dam the river skirts the south-western boundary of the town. The native location is on the opposite bank, as well as a number of brickfields, where sun-dried bricks are being made. After leaving the town the river passes under the railway, and from the town to this point the various pools, (for there is practically no running water at present), are used for washing clothes and bathing. After passing under the railway it is joined by the donga from the Grootfontein Springs already mentioned.* Town refuse is deposited on one bank, and the town and camp night-soil on the other below this point.

About half a mile lower down is a smallpox hospital near the bank, on the north-eastern side. It is supplied with water from a surface spring on the bank, issuing above a dyke of intrusive rock.

The water led into the town by the masonry conduit is distributed along the streets in open earth channels. The gardens are irrigated from these, and drain eventually back into the river or into the surface wells of the locality.

The owners of gardens or *water erven* have fixed hours once or twice weekly for the opening of their own and closing their neighbours' sluices.

A considerable number of the inhabitants use the water in these surface irrigating channels for domestic purposes. The coloured population appear to use it extensively, and the Sanitary Inspector told me that he considered it the best water supply in the town and used it himself. It is more or less clear, but it is the natural drainage of the streets, habitations, and gardens through which the channel passes, and must be greatly polluted with organic matter.

(2.) *Surface Springs.*

In addition to the surface springs feeding the river, there is a considerable surface spring area above the poort leading to Grootfontein Farm at the north-eastern corner of the valley in which the town is situated. The camps lie between this poort and the town, and most of the water supply of the camps is taken from these springs.

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* The plan of the Hanover district, 3·94 miles to the inch, shows the junction of these two dongas on the town side of the railway and to the east of the railway station. This is wrong.

The springs well out into a surface soil of black alluvial earth, forming a swamp. The surrounding surface has been used for grazing, and much cow dung is seen in the immediate neighbourhood of the area of the springs. Carcases of animals are also seen near these swamps.

The water itself wells out clear and sparkling, and has apparently burst through an impermeable stratum from pressure against a barrier of intrusive rock below. The water is evidently the upland surface water collected on the mountains surrounding the large upland valley to the north-east of the town plateau. The water is not the surface water of the surrounding soil but has apparently flowed beneath an impermeable stratum from a distance, until it has become welled up against the "poort" and burst through argillaceous surface stratum above. (Since this was written a bore has been made through the soil. The surface springs are apparently from the bed of a river or donga that has become silted up with sand, clay and alluvial deposits. *See* section appended.)

A dam has been formed and water is pumped from this dam into the water-carts, the delivery hose being carried on a trestle from the pump in order to avoid contact with the soil. It is however led *beneath* the soil from the dam to the pump and from the pump to the trestle. There are three pumps connected with this dam, and it is stated that 30 watercarts, or approximately 3,000 gallons are supplied in one hour.

The yield of the springs has not been properly gauged but must be at least 70,000 gallons in 24 hours.

A sample of this water was sent for analysis to the Military Laboratory at Bloemfontein on the 23rd December, 1902. The report states that "*chemically* there are signs of contamination, *bacteriologically* the presence of some of the colon group of bacilli has been ascertained."

This analysis is somewhat indefinite, but the conditions of soil through which the water passes before collection are such as to lead one to expect chemical impurity and contamination with the foecal matter of grazing animals, as well as contamination from pollution of surface soil by animals dying in the neighbourhood.

Water from these and neighbouring springs is led in irrigation channels to Grootfontein farmstead in the town valley below the "poort" and the channels are used as—

(*a*.) A bathing place for troops.
(*b*.) A washing place for clothes.
(*c*.) A washing place for milk bottles.
(*d*.) A watering place for horses.
(*e*.) An ablution, bath and washing place for the camps.

The last is just below the watering place for horses.

The water is pumped up to tanks from the horse dam, which is constructed in such a manner that the horses cannot stand in or disturb the water, but can only drink from it as from troughs. The water from the tanks is laid on to pipes and taps, feeding ablution basins and baths, the surface being roughly paved with stone.

The bathing dam is higher up and has a latrine placed up stream above the bathing shed. It is on a different surface channel from that supplying the ablution place.

The washing of milk bottles and clothes at the farm takes place on a third line of irrigation channels leading to the Grootfontein farmhouse. The household washing is done in this channel.

Another spring feeds a donga to the west of the spring-bearing area above the Grootfontein "poort" while a donga to the east is also fed by a spring higher up the valley.

The former is used to supply a watering trough for horses. It is not used to fill watercarts.

The latter is not used for military purposes, but feeds the irrigation channels of the farm below the "poort."

The yield of these springs has not been gauged, but the water entering the watering troughs at the "poort" is estimated at 20,000 gallons in 24 hours; the farmstead supply is far greater, probably as much as 200,000 gallons in 24 hours.

With the exception of these springs and the springs feeding the river no other springs have been observed, but there should be similar springs above all the "poorts" entering the area in question, such, for example, as those which are bound to exist among the foothills of the Rhenoster Berg, where a large amount of rain must be collected and become dammed up against intrusive rocks intersecting the underground strata of the valleys below.

(3.) *Well Water.*

The native location and town of Middleburg depend on well water for domestic purposes.

The wells are all surface wells, sunk 20 to 30 feet in surface soil. With the exception of a well in the gaol and in the market square, the wells are private wells sunk in yards and gardens.

The gaol well is built with stone and cement. The others are open wells. In some the water is raised by bucket and rope, in others by aeromotors or hand-pumps.

The public wells have hand-pumps. They are all more or less imperfectly covered and coped.

The water in them is, as a rule, clear and sparkling but hard or "brak."

The water from the gaol well is used for supplying some of the camps.

(4.) *Rainwater.*

Many of the better class inhabitants of the town use rainwater for drinking and cooking. They do not trust the well water and consider both it and the water in the irrigation channels dangerous for drinking purposes.

For example the district surgeon, Dr. Holzmann, collects rainwater from his roof and uses no other water except for washing and irrigation. His rainwater tanks are filled with rain collected on the roof of his house and have a total capacity of about 1,000 gallons which gives him five gallons daily, or about one gallon per head of his household for 6 months.

(5.) *Borings.*

Some deep borings have been made above a "poort" on the eastern corner of the town plateau. They are said to be 60 feet deep. They have been sunk through sandstone and shale into a rock resembling quartzite. The water wells to the surface in these bore holes and the quantity is said to be 45,000 gallons per diem. There has been no opportunity of verifying this. There are also borings in the solid rock of the river bed above the town, from which a clear pure water wells in considerable force and volume to the surface.

Condition of Surface Soil.

Much contamination of the surface soil is taking place in the town and sites of surrounding camps. Old camping grounds existed on the north-east corner of the town valley, and also on the south-west of the town and railway line.

Until 1901 the whole of the town waste products was deposited in gardens and cesspools belonging to habitations. The natives in the native location had no conveniences and went into the surrounding country.

The native followers in the camps had no latrines and acted similarly.

The old camp used trench latrines. The filth pits of the present camps, until quite recently, were within 200 or 300 yards of the camp.

The present latrines have pails, but latrine paper is seen everywhere in and around the camps, blown from the latrines.

Camp refuse is deposited about 300 or 400 yards from the nearest camp, but there is evidence of non-removal of camp refuse in some of the lines and in the camps where there are animals. The surface dust is a mixture of surface earth and stable litter. Until quite recently there were 1,516 horses, 2,568 mules and 142 oxen on the camp sites. The numbers were reduced by the removal of a company of the Army Service Corps with 44 horses and 867 mules to Naauwpoort a few days ago.

Generally speaking the state of the town and camps, as regards pollution of surface soil from the waste products of men and animals, is highly unsatisfactory from a sanitary point of view and must lead sooner or later to an outbreak of disease.

Suitable sites which are apparently uncontaminated and clean are the slopes below the kopjes on the western boundary of the Grootfontein plateau, and similar slopes along the north-east and south-east boundaries of the town plateau.

There are no other sites in the neighbourhood which afford suitable space and drainage for large camps and cantonments, and are at the same time comparatively clean.

The surface soil generally, where the camps are now placed, is a dry dust full of camp and animal refuse. The hospital camp which is placed on a higher slope, and which is sheltered by surrounding hills, is placed on deeper and less dusty soil, and is more favourably situated in this respect.

Civil Sanitary Surroundings.

The civil habitations on the area in question consist of one or two farms, the town and native location of Middelburg and the railway buildings.

The farms in the immediate neighbourhood have no sanitary systems, and water is derived from the surface channels leading from the springs.

The farm of Grootfontein, near the camps, has not a good medical history judging from the records in the death register. There is a native cemetery in the neighbourhood containing about 50 graves.

The town sanitation is under the control of the Chairman and Municipal Council.

The water supply is from wells and surface channels as already noted.

Until martial law came in force, waste products disappeared in private cesspits* and gardens, or were deposited on the surrounding surface in the dongas and on the open veldt by the poorer classes.

In 1901, under martial law, cesspits were closed and a pail system introduced. The regulations were promulgated in Government Notices, No. 428 and No. 473 of 1901.

The system is administered as follows:—

The municipality provide two regulation pails and one cover to each house at a cost of 20*s*. It is a large 6-gallon galvanized-iron cylinder, and the cover is close fitting.

Each pail is numbered to indicate the house to which it belongs.

The pail is removed weekly and the second pail is put in its place.

The cover is placed over it on removal and it is placed bodily in a cart, specially constructed to contain 60 pails on four tiers of shelves inside, the general shape of the cart being that of a caravan, with a central passage, the shelves for the pails being on either side of the passage.

The contents are deposited in deep trenches on the veldt near the river bank below the town and railway.

The pails are washed and tarred near the trenches, a well being sunk for the purpose in the neighbourhood.

Each householder pays 7*s*. 6*d*. quarterly for the removal of pails weekly, or double that sum for bi-weekly removals.

Other sanitary regulations published in 1901 relate to—

(*a*.) Keeping premises clean.
(*b*.) Prevention of pollution of water.
(*c*.) Slaughterhouses.
(*d*.) Butchers' shops.

Among the enactments it is legislated that the local municipal authorities may relax or abandon any of the requirements of these regulations, with the previous consent of the Ministry and by special resolution, and, further, that the cleaning of premises, construction and ventilation of privies, &c., shall be carried out to the satisfaction of the sanitary inspector.

There is no borough engineer or medical officer of health. The district surgeon only acts, in a sanitary capacity, on instructions from the Cape Colony Government and in connection with the outbreak of infectious disease.

The houses are constructed without any system of surface drainage for the

* The soil has received the contents of these cesspits for the last 80 years or more.

prevention of soakage into foundations and surrounding soil. Many of them are of a poor class and inhabited by poor people. The material generally used in construction is sundried bricks or local sandstone and shale.

Notification of infectious disease is made to the Town Clerk, who forwards a return weekly to the Colonial Secretary in Cape Town. No notification is made to the district surgeon except indirectly from Cape Town.

The register in the Town Clerk's Office shows the notification of some 90 cases of enteric fever since 1899, but apparently no action is taken.

At present there is an outbreak of small-pox.

Patients and contacts are all removed to a lazaretto, about a mile below the town on the river bank.

It is a stone whitewashed building with central passage, and six wards off it. A few bell tents are also pitched near it. It is in no sense constructed as an isolation hospital should be constructed.

There are no arrangements for burning, disinfecting, or otherwise rendering discharges, dressings, &c., from patients innocuous, and the surrounding ground is covered with old rags and other infectious material thrown out from the hospital. There are no proper cookhouses or ablution, bath, or latrine arrangements. There are no responsible attendants or caretakers. The contacts are supposed to undertake these duties. Rations are deposited at guard tents, and patients and contacts are fed in this way. There is no fenced off enclosure.

Disinfection of houses is by means of sulphur fumigation and whitewashing of walls. Vaccination, during the epidemic, appears to be carried out fairly completely. The District Surgeon submits an Annual Report, under various headings, to the Colonial Secretary. In his Report for 1900, he notes the following points in connection with sanitation :—

(*a*.) Very serious overcrowding of the houses of natives and the poorer whites.

(*b*.) The bad condition of the slaughterhouses.

(*c*.) The absence of sanitary conveniences for the natives.

(*d*.) Nuisances from the deposit of refuse in the yards and streets.

(*e*.) The acceptance of model bye-laws by the Municipality, only to be thrown out subsequently on the petition of some of the inhabitants.

In his Report for 1901, the last submitted, the District Surgeon notes that the introduction of the pail system and the regulations for the cleansing of the yards, &c., under martial law, has had an excellent effect, but the conditions of the water supply and the state of overcrowding are as bad as before.

The milk supply of the town is from the farms in the neighbourhood. It is supplied in bottles. The bottles are washed in any kind of stream. They were seen being washed in a surface irrigation channel on a farmstead by Kaffir women, below a spot where clothes were being washed and pigs wallowing.

The slaughterhouse is concreted and channelled into sumps, from which the blood and offal are collected by Kaffir boys in a primitive fashion, and deposited in pits dug in the soil in the neighbourhood.

The aerated water factories are at present three in number. Two derive their water from private surface wells, the third from the public well in the market square. Sterilization of water is carried out in none.

In one only is any attempt made at washing bottles by spray washer. In others, 200 or 300 bottles are washed in one tub, the last bottle being washed in the accumulated filth from the previous 200 or 300. The empty bottles before being washed have been seen lying in dirty yards in the midst of surface pollution.

One manufacturer showed me an analysis made of the well water, in proof of its satisfactory character. It was made by a local chemist. It stated that, after evaporation, sulphuric acid was added, and showed signs of organic pollution, and that permanganate of potash was rapidly decolorized. It declared the water to be bad, to require boiling before drinking, and recommended a more expert analysis than he was able to give. The manufacturer of aerated water had, however, done nothing to purify the water. All these factories supply aerated waters to the camps, directly or indirectly.

The population of the town has not been definitely ascertained. Up till 1899 is said to have been about 2,000 Europeans and natives. In 1901, a census was taken under martial law, and the population returned as 3,620 Europeans and coloured inhabitants.

In 1902 it is estimated at 2,000 whites and 2,500 coloured inhabitants. The latter are not compelled to live in the native location, and many of them occupy houses alongside the white population in the town.

No sanitary or water supply rates are levied on the inhabitants beyond the quarterly sum paid for the removal of nightsoil pails. There is a rate of 1*d.* in the pound of assessed value of property for general purposes, and certain school and church rates, amounting to something less than that, are also levied.

Existing Camps.

The existing camps contain strengths ranging during the past few weeks from 2,000 to 2,500 British troops and 430 to 530 native followers, with over 4,000 animals.

The mounted branches, four batteries Royal Artillery, one battalion Mounted Infantry, and one regiment Cavalry, have their horses picketed inside the lines of tents, and there is a large transport camp in the neighbourhood.

Bell tents with six to eight men in each tent are used for accommodating the troops, but a few marquees, huts and covered sun shelters have also been erected.

There is no general sanitary organization of the camps, sanitation consisting mainly of sanitary inspections and subsequent recommendations.

Some units boil water for drinking, some boil and filter, some filter only. In some the boiled water is stored in tanks in the open, in some under partial shelters, in others under bell tents.

In all, the protection against contamination from dust is inadequate.

The surface generally is extremely dusty, and, as already stated, polluted by animal droppings and litter. This dust is blown about the camp almost daily in dust storms and "dust devils."

Latrines are open corrugated-iron screens with the pails placed directly on the surface soil; there are no concrete foundations. Latrine paper is constantly dropped on the surface outside the pails, and is carried all over the camps with the winds. This is a characteristic feature of the camps. For the troops, the number of pails is about 5 per cent. of strength, and for the native followers half that number.

The only camp in which there is a systematic arrangement for collecting camp refuse in buckets or other receptacles is that of the Infantry battalion, which is much better organized from a sanitary point of view than the camps of the mounted branches.

Until recently one unit was using pits dug near the tents as urinals; now, there are urine pails in all the latrines. The contents of the pails are removed nightly; they are emptied into tank carts at the latrines. The use of dry earth and disinfectants is inadequate for keeping the pails in a satisfactory condition.

There are no definite ablution places in each camp, the bathing and ablution arrangements for the whole of the camps being placed, as already noted, along the line of irrigation channels connected with Grootfontein Farm.

There are one or two booths on the camp grounds where men are supplied with drinks. The aerated water comes from one or other of the town factories already described. There is at present no garrison aerated water factory, but it is understood that more than one will be erected shortly.

Health Statistics.

(a.) *Civil Population.*

Compulsory death registration was introduced in 1895. Table I. appended shows the total number of deaths, uncertified deaths, and deaths from zymotic disease for the town of Middelburg, as extracted from the death register.

The figures resemble those of Burghersdorp. The death register has been kept in a manner in which it is difficult to disintegrate white from coloured population, but as the two races are much mixed up together in the habitations of the town, it is questionable whether disintegration of their death rates would be of much value.

The main features of the health of the locality are :—

(1.) A high general death-rate.

(2.) A high zymotic mortality.

(3.) A high mortality from enteric fever, dysentery, and diarrhœa.

(4.) A high percentage of uncertified deaths.

Smallpox is prevalent at present in the town, and the death register shows a considerable mortality from tubercular diseases both amongst Europeans and natives.

A considerable number of the deaths from enteric fever occurred in the native location, as also the greater proportion of deaths from dysentery and diarrhœa. During the measles epidemic of 1900 and 1902 a large number of deaths from bronchitis is registered, especially uncertified deaths amongst natives.

(b.) *Military Population.*

The statistics of the military population in the locality have only been recorded definitely since 12th December, 1902. Previous to that date many of the sick were transferred to Naauwpoort and the records in the locality are consequently imperfect.

Such as they are, the statistics are given in Tables II. and III. appended. The chief Zymotic diseases are dysentery and diarrhœa. Only one or two isolated cases of enteric fever have occurred and most of the venereal disease was imported. Throat affections are fairly common. There is an absence of inflammatory affections of the eye, and, on the whole, the health of the troops has been, so far, much better than the water supply and sanitary state of the camps would have led one to expect. The percentage of sick to strength is, however, comparatively high.

Meteorological Records.

The only meteorological records of the locality are those of rain fall. These are shown in Tables IV. and V. appended.

The rain fall is comparatively small. Rain appears to be exhausted in the surrounding mountains, and very little appears to fall on the town plateau. The summer temperature is consequently hot and oppressive, and not often relieved by thunderstorms. The condition of drought is exemplified at present by the fact that the river and dongas are practically dry, although it is the middle of the rainy season elsewhere. The water supply is however unaffected, as the rains, of which there is abundance in the neighbouring mountains, appear in the locality as permanent springs. The winter temperature is said to be extremely pleasant.

Conclusions.

(1.) There are suitable sites for a comparatively large cantonment on the slopes below the kopjes east of the town plateau and south of Grootfontein Farm homestead.

(2.) There are also suitable sites on similar slopes extending to the north of the existing hospital camp.

(3.) The drainage of the former site would be towards the donga leading into the Little Brak River below the town, and there is a considerable area along this donga, which could be converted into irrigation areas for disposal of foul water from a cantonment.

(4.) The drainage of the latter site would be towards the Poort, from which the present camp water supply is being derived.

(5). Of the two sites the second has the best soil, slope, and aspect, but the first has greater facilities for water supply and irrigation.

(6). The existing water supply from wells and surface springs is liable to contamination from surface soil.

(7.) There is every reason to believe that an abundant water supply could be obtained from deep borings in the plateaus about the poorts. The borings in the river bed above the town afford evidence of the abundance and excellence of such a supply.

(8.) The condition of the surface soil of the camps is liable in time and after heavy rains to create disease amongst the troops.

(9). The town sanitation and the town sanitary administration are inadequate to maintain a high standard of health in the civil surroundings.

(10.) The pail system employed by the town is good and better than in most towns where the pail system of sewage removal exists, but a weekly removal of nightsoil is totally inadequate.

(11.) The water supply of the town is unsafe in every respect.

(12.) The aerated water factories are unsafe in consequence of the water supply, and also in consequence of the methods adopted for cleaning the bottles.

(13.) The chief sanitary defects in the camps are—

(*a.*) The absence of an organized system for purifying water for drinking.

(*b.*) Defective construction and management of latrines.

(*c.*) Absence of regimental ablution places.

(*d.*) Absence of irrigation plots and formation of gardens in order to allay dust.

(*e.*) Absence of an organization for the collection, storing, and incinerating of refuse.

(*f.*) Pollution of the surface, surrounding the tents, by horse lines.

(*g.*) A supply of aerated water from factories not under sanitary supervision and control.

(14.) The health statistics of the civil population indicate bad water supply, pollution of soil, and inadequate sanitary administration.

(15.) The health statistics of the camps do not indicate at present any marked tendency to ill-health amongst the troops in the locality, in any particular group of diseases, although the sick rate is somewhat high.

Recommendations.

(1.) *Permanent Cantonment.*

It is understood that the available ground for permanent cantonments is confined to the portion of the town plateau belonging to Grootfontein Farm (namely, the north-east corner of the town plateau), and to the adjoining plateaux lying above the Grootfontein Poort.

The slopes below the kopjes on either of these plateaux cannot be regarded as ideal for cantonments on account of the proximity of steep kopjes on one or more sides, and on account of the arid dusty nature of the soil.

The sites are, however, extensive, and have good slopes towards natural drainage, &c., and the soil can be made luxuriant with vegetation by irrigation.

As regards sites on the slopes above the Grootfontein Poort, their occupation should depend upon water being obtained from deep borings above the "poort," or from other sources than the surface springs of the plateau; otherwise there is a risk of drainage from such slopes finding its way into the water supplies.

As already noted, the "poort" holds up the whole drainage of the area into which these slopes drain. Further, it will not be easy to irrigate these slopes except by pumping.

The slopes below the Grootfontein poort on the town plateau present, therefore, the most feasible sites as regards drainage and water supply.

The essential sanitary requirements of a cantonment on this site are—

(1.) The obtaining of an ample water supply, from deep borings, for drinking and domestic purposes. The plateau above the Grootfontein Poort should contain a good supply from such sources.

(2.) The irrigation of the sites for cultivation of trees, grass plots, and gardens, so as to convert the area into a less arid and dusty district. There is an excellent water supply from surface springs above Grootfontein Poort for this purpose; and the luxuriant appearance of Grootfontein Farm and of the town of Middelburg is evidence of what can be done by the irrigation of similar surface soil.

(3.) The construction of barracks, &c., in such a way that pollution of the surface soil around does not take place. The principles which should be carried out in this connection are:—

(*a.*) Raising hutments $1\frac{1}{2}$ to 2 feet above the surface.

(*b.*) Rendering the surface under and around hutments impermeable and channelling to surface drains.

(*c.*) Construction of surface drainage for the removal of all waste water to irrigation areas.

(*d.*) Macadamizing of roadways and pathways.

(*e.*) Providing stables, horse lines, and watering troughs, &c., with impermeable floors channelled to surface drains.

(4.) The erection of latrines on a water-carriage or American trough system, and disposal of contents in septic tanks and contact beds, or over irrigated land. The details of these systems must be worked out, whenever permanent cantonments are decided upon. There are suitable irrigation areas at a level some distance from and below the sites.

(5.) Limitation of the strength of the garrison to the minimum amount of water that can be supplied daily and to the space available.

The minimum water supply for drinking, cooking, and ablution should be 10 gallons for each man and animal without taking into consideration general baths, a water-carriage system of sewage disposal, or irrigation, and 20 gallons if a water-carriage system and general baths are introduced. Even then these amounts are a low estimate for comfort and cleanliness. The minimum space for corrugated-iron hutments should be 40 acres for a battalion of Infantry, Mounted Infantry, or similar unit, or 50 acres if regimental parade grounds are added.

(6.) No gauging of water supply, or plans of sites having been made out, it is impossible to give a definite opinion as to the number of troops which it would be advisable, from a sanitary point of view, to put on the site, but it may be assumed that a sufficient number of borings would readily give about 100,000 gallons daily. No dependence should be placed on the surface springs immediately above the Poort unless very considerable precautions are taken to maintain the purity of the supply. The water is too much in contact with surface deposits to be entirely satisfactory.

(7.) Non-occupation of any hutments until all arrangements for removal of waste products and prevention of soil pollution around barracks are completed and in working order.

(2.) *Existing Camps.*

It is difficult in camps which are supposed to be moved at any time to put forward sanitary recommendations that are likely to be carried out, but camps ought not to be established for more or less prolonged occupation before arrangements for proper latrines, urinals, and refuse receptacles, ablution places, removal of waste water to irrigation areas, such as soldiers' gardens, protection and sterilization of water supplies, maintenance of watercarts in cleanly and disinfected condition by units, &c., are thought out and completed by responsible officers under responsible sanitary advice.

The large encampments here were commenced when there was only a detention ward for sick on the spot, under a civil surgeon, and opportunity for carrying out a detailed sanitary organization here from the commencement has been missed.

The result is that the camps are now in a state of considerable pollution from the intermingling of men and animals. The latrine and ablution arrangements are imperfect. The water supply is exposed to contamination and dust, and the organization of means of purifying water by units is far from perfect, while aerated waters from unsafe sources are the only supply of cool drinks to the troops.

To change all this will mean a complete reorganization of the camps in the following directions:—

(1.) Latrines should be made with impermeable floors, channelled to a sump, which should be cleaned out daily. The latrine screens should be brought down to the floor to prevent paper being blown about the camp. The latrine pails should be duplicated and removed for cleaning and disinfecting near the trenches or at some other suitable place.

Instead of dry earth and dry disinfectants each latrine pail should have a solution of chloride of lime placed in it every morning, to a depth of 4 or 6 inches, and the clean pails washed with lime inside and exposed to the sun. These measures are essential in order to prevent latrine dust being blown about and for the diminution of flies.

(2.) Urine tubs should be similarly treated, placed during the day in the latrines, and during the night on slabs of concrete or other impermeable material near the lines of tents.

(3.) Ablution stands over channelled concrete bases should be placed in the camp of each unit, and the water led to plots which should be irrigated and cultivated as gardens.

(4.) The water supply arrangements should be placed under responsible non-commissioned officers of each unit, and an installation for filtering and boiling at least 1 gallon per head per diem provided in each unit under shelter from sun and dust.

A suitable and convenient addition of a tap at the bottom of the boiler of the Soyer's stoves, used for boiling water, has been made by Major Elderton, the Senior Medical Officer, for drawing off the boiling water into the storage tanks. This is much to be recommended, as the Soyer's stoves can readily be fitted with these taps.

The watercarts should be thoroughly cleansed every 3 or 4 days with boiling water, painted a clean bright colour, and numbered or otherwise marked for each unit; this may induce units to take some interest in the maintenance of the cleanliness of their watercarts.

The storage tanks should be properly covered, conveniently placed, and sufficient in size and number to provide enough sterilized water for all in camp at the rate of 1 gallon per head per diem. These precautions are absolutely necessary, so long as the present water supply continues. It may be said that such precautions are taken, but they are not taken according to any general organized plan, and the opportunities of dust and other contamination getting into the boiled water and carts are innumerable.

For example, the mouths of the watercarts are bunged up with old bits of sacking and the native drivers sit on these.

The chief essential, however, in connection with water supply is to obtain it from borings and abandon the present supply. The present supply could be much improved by sinking a stone and concrete wall all round the springs down to the rock, cleaning out the surface mud which has silted up in the spring bearing area, and covering the reservoir so formed. This however will take time as the surface deposit appears to be some 15 feet deep, and a supply from deep borings seems the more rapid way of obtaining a purer water.

(5.) A garrison aerated water factory under military and medical supervision and control should be established.

(6.) Receptacles for refuse and manure should be provided for lines of tents and horses.

(7.) Horse lines should be placed between the guardroom tents and the men's tents or further away, if possible, instead of between the lines of men's tents. It would not do, however, to alter the present arrangement, if, by doing so, the men's tents would have to be pitched on old horse lines.

(8.) The dumping ground for refuse should be enclosed and the refuse systematically burned by being raked over a mound on to a ring of fire outside, the mound being constructed about 4 feet high and made to enclose a space into which the daily refuse could be placed.

(9.) Finally it is essential in large camp garrisons such as this to have an Officer told off specially for sanitary work, with sufficient authority and power to organize and maintain a high standard of sanitation amongst the various units.

The present garrison camps at Middelburg contain all the elements necessary for a serious outbreak of enteric fever. It is useless and hopeless to expect Officers who are engaged in hospital work and whose sanitary duties are, according to the present system, more those of sanitary inspectors than sanitary organizers, to effect any real sanitary organization and reform.

Prevention of camp epidemics can be avoided not so much by sanitary inspection as by systematic organization of the numerous elements involved in creating and maintaining a high standard of sanitation, and for this purpose the appointment of a special Officer with authority and power to act on the lines indicated in the above recommendations is required.

(3.) *Civil Surroundings.*

There is no necessity for Middelburg displaying such unfavourable health statistics.

About ¾ mile above the town there is one of the best water supplies which I have yet seen in South Africa. In the rocky bed of the river two borings have been made above all sources of contamination. The borings are about 30 feet deep, and the water wells out at all times in a powerful stream of cool, clear, sparkling and palatable water.

The flow from the borings is at least 50,000 gallons daily, and at a comparatively small cost the borings could be conserved from all danger of surface pollution, and the water laid on in pipes by gravitation to the town, giving about 10 gallons per head for drinking and domestic purposes, without materially affecting the existing supply for the irrigation of the "water erven."

It is understood that such a scheme has been put forward already, and it is difficult to understand any hesitation in its adoption. There is, at present, no water rate, and the cost will be small and covered by a comparatively small water rate.

Such a water supply, along with an increase in the latrine accommodation for the native location, an increase in the personnel and equipment for the removal of refuse, slops, and nightsoil, to ensure a daily removal instead of weekly removal of the latter, would make a vast difference in the sanitary condition of the locality. Such measures, combined with better construction of houses, and better arrangements for surface drainage, and for the prevention of the pollution of soil around habitations, under the active supervision of an independent Health Officer, would convert the town into a healthy instead of, as at present, an unhealthy locality. Few towns have the same facilities for affecting this at a comparatively low cost; and, should a large cantonment be established in the neighbourhood, it seems essential that the standard of sanitation in the town should be raised to a higher level.

In concluding these recommendations it should be noted that Colonel Magill, who was principal medical officer of the district during the latter stages of the war, submitted a report in August last in which he drew attention to the following points:—

(1.) That the town of Middelburg is notoriously unhealthy.

(2.) That this state of affairs is remediable.

(3.) That an ample supply of good water can be obtained.

(4.) That pressure should be brought to bear on the municipality to improve—

- (*a*.) The town water supply.
- (*b*.) The town sanitation.
- (*c*.) The state of the river.
- (*d*.) The state of the native location.

(5.) That the site selected for encampments is excellent.

(6.) That until the encampments are complete no troops should be stationed near Middelburg.

These recommendations, although they do not go into details, are entirely in accord with the recommendations in this report.

W. G. MACPHERSON, *Major*,
R.A.M.C.

MIDDELBURG, CAPE COLONY,
11*th January*, 1903.

TABLE I.—EXTRACTS from the Death Register of the Civil Population, Middelburg, Cape Colony, showing the deaths from all causes, uncertified deaths, and deaths from zymotic diseases.

Year.	Deaths from all causes.	Number of uncertified deaths.	Percentage of uncertified to total deaths.	Deaths from the principal zymotic diseases.							Death rate per 1,000 of population.	
				Enteric fever.	Dysentery and diarrhœa.	Diphtheria and croup.	Whooping cough.	Measles.	Small-pox.	Total zymotic diseases.	All causes.*	Zymotic diseases.*
1895	69	26	37·6	7	6	1	..	..	..	14	34·5	7·0
1896	107	36	33·6	9	17	..	29	..	..	55	53·5	27·5
1897	126	43	34·1	2	26	2	1	11	..	42	63·0	21·0
1898	139	58	41·7	4	23	3	..	..	..	30	69·5	15·0
1899	122	45	36·8	11	33	6	..	1	..	51	61·0	25·5
1900	207	118	57·0	6	45	1	5	22	..	79	103·5	39·5
1901	191	71	37·1	11	40	1	1	..	..	53	52·7	14·6
1902	215	71	33·0	4	50	1	1	14	3	73	47·7	29·2

* Calculated on a white and coloured population of 2,000 until 1900, of 3,620 in 1901, and 4,500 in 1902.

TABLE II.—SHOWING the Principal Health Statistics of the Troops in camp at Middelburg, Cape Colony.

Week ending	Average strength.	Number of sick transferred.	Number remaining in hospital.			Percentage of sick remaining to strength.	Number of admissions for						
			Naauwpoort.	Middelburg.	Total.		Enteric fever.	S.C. fever.	Dysentery.	Diarrhœa.	Primary syphilis.	Soft chancre.	Gonorrhœa.
1902.													
31st October.. ..	998	21	..	3	..	..	1	..	..	..	..	..	..
7th November ..	2,454	32	..	10	..	..	..	..	1	..	2	2	5
14th " ..	2,300	32	..	12	..	..	..	1	1	2	2	..	4
21st " ..	2,091	24	..	38	..	..	..	..	3	4	1	3	6
28th " ..	2,580	14	..	47	..	..	..	..	3	4	1	1	2
5th December ..	2,090	22	..	68	..	..	..	..	4	7	..	..	3
12th " ..	2,070	..	67	84	151	7·2	..	..	6	7	..	..	..
19th " ..	2,092	..	50	92	142	6·7	..	..	1	..	1	..	4
26th " ..	2,089	..	32	87	119	5·6	1	..	1	2	..	..	3
1903.													
2nd January ..	2,096	..	24	111	135	6·4	1	..	3	4	1	2	3

TABLE III.—TABLE showing distribution of chief causes of sickness amongst the different units in camp at Middelburg, Cape Colony.

Diseases.	16th Lancers. Average strength, 492.		9th Mounted Infantry. Average strength, 428.		Royal Inniskilling Fus. Average strength, 489.		Royal Artillery. Average strength, 448.		Royal Engineers. Average strength, 56.		Departmental Corps. Average strength, 83.	
	Number of admissions.	Percentage admissions to strength.	Number of admissions.	Percentage admissions to strength.	Number of admissions.	Percentage admissions to strength.	Number of admissions.	Percentage admissions to strength.	Number of admissions.	Percentage admissions to strength.	Number of admissions.	Percentage admissions to strength.
Enteric fever	1	0·2	2	0·4	..	..	..	..	..	..	..	..
S.C. fever	1	0.2	1	0·2	..	..	..	..	..	..	..	..
Dysentery	9	1·8	5	1·1	7	1·4	4	0·8	..	..	..	..
Diarrhœa	9	1·8	1	0·2	5	1·0	9	2·0	1	1·7	2	2·4
Primary venereal affections	20	4·0	3	0·7	16	3·2	1	0·2	3	5·3	1	1·2
Throat affections	19	3·8	7	1·6	10	2·0	4	0·8	..	..	3	3·6
Inflammatory eye infections.	1	0·2	..	..	1	0·2	..	..	..	..	..	..

TABLE IV.—RAINFALL at Middelburg, Cape Colony.

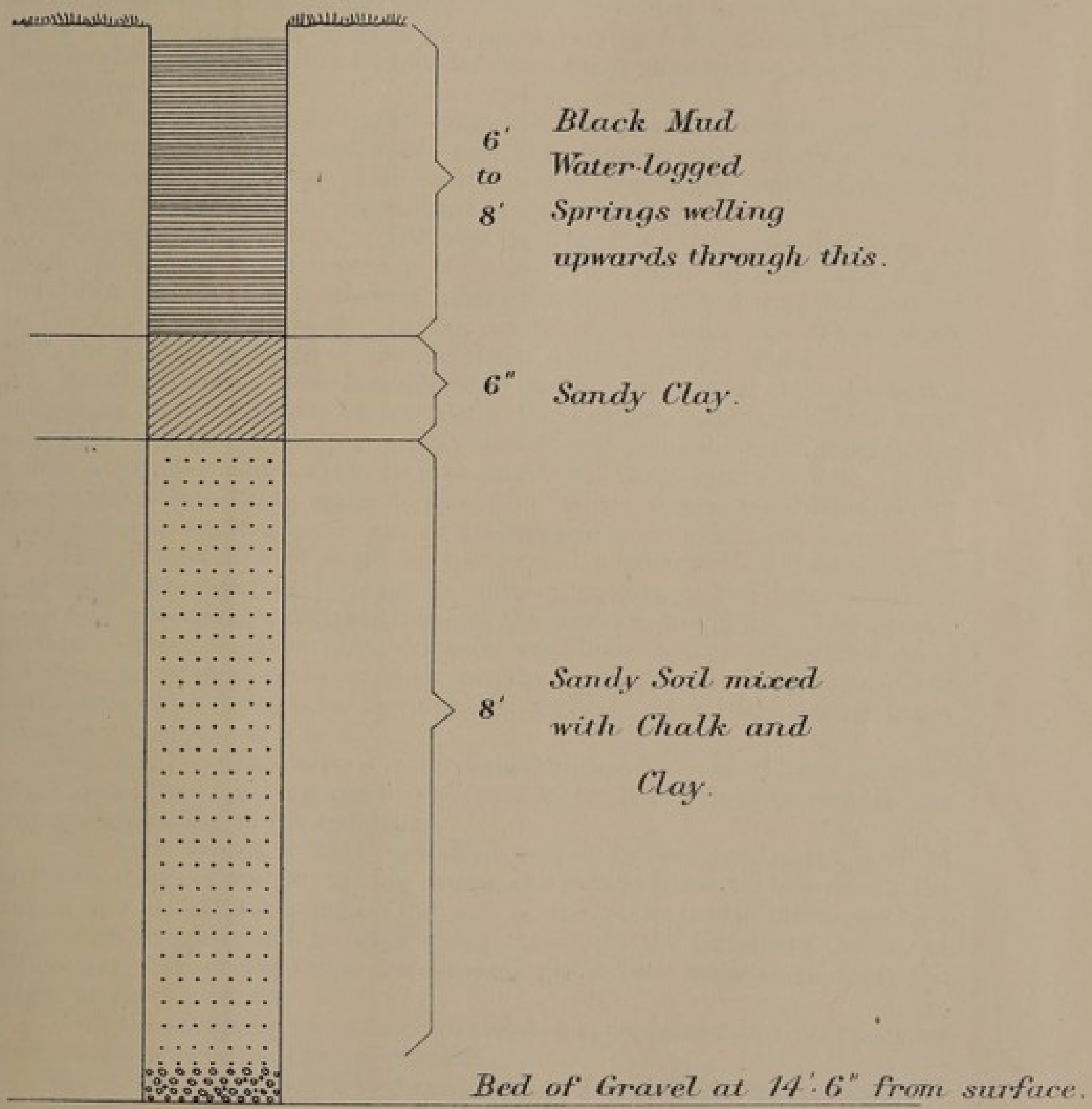
Month.	1900.			1899.			1898.			1896.			1895.		
	Total in inches.	Number of days of rain.	Maximum in 24 hours.	Total in inches.	Number of days of rain.	Maximum in 24 hours.	Total in inches.	Number of days of rain.	Maximum in 24 hours.	Total in inches.	Number of days of rain.	Maximum in 24 hours.	Total in inches.	Number of days of rain.	Maximum in 24 hours.
January ..	0·52	3	0·30	0·47	4	0·28	6·38	13	1·39	1·68	5	..	3·12	7	..
February ..	1·75	7	1·11	3·89	8	1·81	2·32	7	0·94	1·35	4	..	1·33	4	..
March.. ..	2·59	6	1·18	2·51	7	1·31	1·59	7	0·63	1·23	5	..	0·91	4	..
April	0·17	1	0·17	2·01	7	0·58	1·03	6	0·29	2·90	3	..	2·53	5	..
May	0·10	1	0·10	0·67	7	0·23	0·39	3	0·15	1·32	5	..	0·60	4	..
June	6·00	..	..	0·96	5	0·72	..	..	..	1·05	3	..	..	..	..
July	0·37	1	0·37	0·46	6	0·16	0·01	1	0·01	..	..	..	0·09	1	..
August ..	0·75	1	0·75	0·93	5	..	..	..	..	0·65	3	..	0·03	1	..
September ..	..	..	..	0·02	1	0·02	0·73	1	0·73	..	..	..	..	..	..
October ..	0·05	1	0·05	0·30	2	0·25	1·59	4	0·92	..	..	..	0·26	2	..
November ..	..	..	..	0·20	1	0·20	1·28	4	0·88	2·12	5	..	0·85	3	..
December ..	8·05	6	2·17	0·77	4	0·29	0·26	2	0·24	3·27	7	..	2·34	8	..
Total ..	14·33	27	2·17	13·19	57	1·81	15·58	48	1·39	15·57	40	..	12·06	39	..

TABLE V.—AVERAGE rainfall, mean monthly.

	Lat. 31·33′ S. Long. 24·58′ E. } 4000′	Lat. 31·15′ S. Long. 25·10′ E. } 4884′
	Middelburg, (1885–94).	Naauwpoort, (1886-94).
January	2·47	2·29
February	2·87	2·78
March	2·84	2·75
April	1·49	1·48
May	0·76	1·19
June	0·43	0·76
July	0·59	0·39
August	0·53	0·48
September	0·59	0·48
October	1·45	1·17
November	1·81	1·72
December	1·84	1·47
Total	17·67	16·96

From Meteorological Commission. "A discussion of the rainfall of South Africa during the years 1885-1894," by Alex. Buchanan, M.A., LL D., F.R.S.E. Published 1897.

SECTION OF SURFACE BORING AT GROOTFONTEIN SPRINGS.



232-19 W.O.

REPORT ON NAAUWPOORT, CAPE COLONY, AS A CANTONMENT FOR BRITISH TROOPS.

Physical Features of the Locality.

Naauwpoort is a large railway centre on the junction of the line of railway between Cape Town and Bloemfontein and Cape Town and Port Elizabeth.

It is 4,884 feet above sea level and is one of the highest stations on the Cape Colony line of railways.

It is situated on the Karoo and is only a few miles north of the watershed between the Great Fish River and the Orange River.

The surrounding district forms a large upland basin, about 10 miles across from north to south and about 8 miles from east to west at its widest parts. It is surrounded by lines of kopjes, varying from 200 to 1,000 feet in height above the basin, the highest being on the south and east and the lowest on the west.

On the north-east and north-west the basin narrows into "poorts," and on the south, south-east and south-west into long narrow valleys or smaller horseshoe-shaped valleys. The main line of valley on the south narrows into a cutting at its south end, which leads to the watershed.

The general drainage of the area is from this cutting along a donga of considerable size, which traverses the basin from south to north and drains towards a poort on the north-west, where the line of railway from Naauwpoort to De Aar leaves the valley. In the centre of the basin this donga passes from the west to east side of the line under a 100-ft. girder bridge.

Another donga of considerable size drains from two or three horseshoe valleys on the south-east, passes along the western boundary of the town, under the railway close to the railway station, and joins the main donga about a mile above the point where it runs under the large girder bridge. Minor dongas drain into these main dongas from minor slopes and basins, chiefly from slopes on the south-west and north-east and east of the main basin.

The general line of slope to the central portion of the basin is from a long low ridge of kopjes, forming its western boundary, and from a line of kopjes of considerable height, forming the eastern boundary. The greater portion of these slopes is wide, extensive and little broken by watercourses; but there are several areas on their surface, especially on the south-west and south-east, which have been traversed by torrents, apparently during heavy rains from the adjoining hills.

The only populated area is in the neighbourhood of the railway junction, which is near the southern end of the basin, where it begins to narrow into the long valley leading to the watershed.

The town, which will be described as the railway settlement, and its native location, as well as existing camps, are grouped around this point; the bulk of the habitations being on the east of the railway, with the camps on a ridge of an irregular saddle-shape, rising for 100 to 150 feet above the bed of the dongas. This ridge forms the extremity of a long wide slope from the kopjes on the south-east.

With the exception of one or two isolated houses and farms, there are no other habitations in the area in question.

The railway lines form a Y-shaped intersection through the district; the line from Port Elizabeth running south to north and branching off, at the junction, to De Aar on the north-west and Colesberg and Bloemfontein on the north-east.

Geologically the features of the locality are those of the Upper Karoo system, intersected by intrusive rock. Hard blue shales and compact sandstones predominate, along with areas of metamorphosed sandstone and shale. The surface soil is sandy and is fairly thin over the slopes. In minor depressions, however, there is a considerable amount of clay and "pans" are apt to form. The lower portions of the main basin between the dongas and along their banks is a deep bed of alluvial earth and rain wash. Over some portions of the surface there are deposits of lime and large stone conglomerates.

The dongas and district generally are dry at present, but the main depression is said to become a lake or swamp during heavy rains.

The surface is covered with a thin scrub or Karoo bush, and with the exception of mountain pine and other trees in the gardens of the railway settlement, the district is destitute of trees.

Water Supplies.

The water supply of the locality is from surface wells, borings in the compact shales and sandstones, and rain water. There are no river supplies, and surface springs, a few of which exist in the valleys and against the narrow poorts, are either neglected or conserved by formation of reservoirs and borings in the neighbourhood.

The water supply of the railway settlement and camp is laid on from four different sources, a description of which will indicate, better than anything else, the nature of the water supply of the district. The arrangements are complicated and difficult to explain in writing, but they may be followed with the aid of the diagrammatic sketch appended. (Plan II.)

The sources of supply are known as—

1. Heathwell Spring.
2. Edendale Spring.
3. Windmill Well.
4. Pumping Station Well.

(1.) *Heathwell Spring.*

This source consists of a deep cutting, about 20 feet deep, in an elevated horseshoe valley on the south-east of the Naauwpoort basin. It is above all possible sources of contamination, and is just below the watershed.

In the bottom of the cutting two 3-inch boreholes have been sunk, and water wells out from these on to the surface of the cutting, forming the so-called springs.

The cutting has been converted into a reservoir of excellent construction, the ends being built of solid masonry and the whole covered with a good cement cover.

The water is led direct from the reservoir by gravitation to the camp ridge, above the railway settlement, in a wrought-iron socket-jointed main, lying practically along the surface for nearly its whole length, but covered with earth and stones.

The daily yield of the spring is gauged at a minimum of 8,000 gallons in October, 1898, and a maximum of 49,248 in October, 1899. The water is pure and clear.

(2.) *Edendale Spring.*

This is somewhat similar in construction to the Heathwell Spring, a good covered reservoir being constructed out of two long rectangular cuttings in the centre of the narrow valley running southwards from the main basin.

The cuttings are in the rock, and the springs are formed of three boreholes in the rocky bottom of the cutting, through which water wells to the surface.

The cuttings are 8 feet deep. They unite at the point of exit from the reservoir, forming a Y-shaped reservoir, one limb being 70 feet and the other 160 feet long. Both sides and ends of this reservoir are constructed of good masonry.

It is situated just below a large dam in the centre of the valley containing a considerable amount of surface water, and above the dam there are cultivated fields and a farmstead. They are, however, some distance higher up the valley, and the reservoir has been constructed and trenched in such a manner as to avoid contamination from the surface soil.

The water from the reservoir is led by gravitation in a 4-inch socket-jointed wrought-iron main, carried under the surface, to the camp ridge.

The yield is gauged at a minimum of 16,982 gallons daily in August, 1898, and a maximum of 51,800 in October, 1899. The water is clear and pure.

(3.) *Windmill Well.*

This is a well sunk close to the Colesberg line of railway, about ¼ mile north of the camp ridge. Its depth is 29 feet in surface soil, shale and sandstone. In the rocky bottom two 2-inch bores, 30 feet deep, have been sunk, and the water wells into the well from these. The upper part of the well is lined with masonry for about 8 feet, *i.e.*, down to the rocky strata. Its diameter is 10 feet, and when no pumping is going on, the water rises for about 5 feet.

Water is conveyed from it to reservoirs on the camp ridge by a windmill pump and by a steam-engine pump. The rising mains from each of these run close to one another in a furrow, only slightly covered over. An overflow pipe from the reservoir flows back to the well in the same furrow.

The site of the well, as regards questions of contamination, is on the edge of a donga draining a slope on which the refuse is deposited and nightsoil trenches sunk. These trenches are about a mile further up the slope.

Within a radius of 200 yards, and also draining towards the point where the well is sunk, there are horse lines, latrines, camp ablution, bath and washing stands, and an acre of ground, which has been used until recently as trenching ground for the nightsoil of the camps. A considerable portion of the camp ridge also drains towards this donga.

The ablution and washing stands are placed along the line of the rising mains, and the waste water from these is soaking into the soil around the mains. Below this point, the overflow pipe leading to the well has become broken and presents an open mouth in the furrow, through which, in heavy rains, the drainage into the furrow would be conveyed to the well.

The maximum and minimum yield of this well has not been gauged, but it is estimated to yield on an average 20,000 gallons daily.

The water is clear. Its purity is open to question on account of the liability to surface pollution, and also the fact that the pumping operations appear to drain a large surrounding district.

An instance of this is given by the district engineer of the railway (Mr. Rose). Just below the hospital there is a cutting in the rock, of which the camp ridge is composed. In this cutting two boreholes were sunk, from which water welled into the cutting. When the windmill well was sunk these boreholes dried up; and, when pumping ceases for some time, water commences to appear from them again. The boreholes are at a higher level than the well and about 300 yards distant.

The cutting in question is at present dammed up, and the drainage from the hospital kitchen and ablution rooms drains into it, forming a stagnant pool of foul water, which must soak into the boreholes in question. As a source of contamination of the water-bearing strata, in which the Windmill Well is sunk, this fact is of much sanitary importance. Qualitative examination of the water indicates the presence in it of a considerable amount of nitrates and oxidizable water. Although no records of analyses can be discovered here, the district engineer informs me that the water has been frequently analyzed and that one analysis gave 35,000 colonies in gelatine plate cultures per cubic centimetre. I am unable to verify this. A sample of the water was forwarded to the Military Laboratory, Pretoria, on 7th January, 1903, but the results have not yet been obtained.

(4.) *The Pumping Station Well.*

This is a well sunk in the soft alluvial soil, about a mile below the railway settlement on the west side of the De Aar Railway line. It is 25 feet deep and essentially a surface well; exposed to the usual sources of contamination from surface soil, and within 200 or 300 yards of large remount camps on a higher level. These camps are only partially occupied at present; but there are about 2,700 animals in them. The water from this well is pumped by steam-engine pump to a reservoir on the camp ridge.

Its maximum and minimum yield has not been gauged, but it is estimated to yield on an average 60,000 gallons daily.

No records can be obtained showing the quality of this supply. As already stated, however, the water is a surface water, and in this respect differs from the other supplies, which are obtained from rocky strata.

The arrangements for the storage of the water from these sources are as follows:—

There are three reservoirs, well constructed of masonry and covered with cement, on the camp ridge; No. 1 Reservoir being on the southern extremity of the ridge, No. 2 near the centre, and No. 3 on the northern extremity. All the reservoirs are above ground.

Their capacity is as follows:—

	Gallons.
No. 1	50,000
No. 2	10,000
No. 3	40,000

They are supplied from the various sources, detailed above, as follows:—

No. 1 receives the Edendale supply direct, and the overflow from No. 2 and No. 3 Reservoirs. It also receives water from the Pumping Station direct by a recently constructed by-pass.

No. 2 receives the Heathwell and Windmill Well supplies direct.

No. 3 receives the Pumping Station supply only.

It is apparent, therefore, that none of the reservoirs contain water from the purest sources that is not mixed with or liable to be mixed with water from the less pure sources.

The distribution of water to the town is by mains and house connections, and by standpipes, from all three sources. The native location is also supplied with water from the mains laid on to standpipes.

The camps are supplied as follows:—

On the northern slope of the ridge above the remount and transport camps there are two wooden reservoirs of 4,800 gallons capacity. Water is pumped to them direct from the Windmill Well, and they have also an overflow from No. 3 Reservoir. These reservoirs supply the remount and transport camps, mainly for watering horses.

Another wooden reservoir is placed near the southern end of the camp ridge, with a standpipe near it. It is supplied by a rising main, which is stated to be taken direct from the Edendale Spring main before the latter enters No. 1 Reservoir. This wooden reservoir supplies the camp ablution, bath and washing stands, and the standpipe the drinking water of the Infantry battalion encamped on the south end of the ridge.

There are standpipes in the Ordnance camp, and at the ablution, bath and washing stands of the Infantry encampment in the centre of the ridge, supplied from No. 2 Reservoir.

The hospital has water laid on to some of the wards and to standpipes from No. 3 Reservoir, and also to a standpipe from No. 2 Reservoir.

A standpipe at the Station Staff Offices is stated to be supplied direct from the Heathwell main before it enters No. 2 Reservoir. The water from this standpipe, and the mixed Windmill Well and Heathwell Water in No. 2 Reservoir were analysed, qualitatively at the same time. The former gave indications of being free from nitrates and oxidizable matter, the latter gave marked indications of both.

The whole of this complicated system of water supply, storage, and distribution at Naauwpoort belongs to and is under the control of the Cape Government Railway and its officials at Naauwpoort; it is comparatively of recent date. The Windmill Well and No. 2 Reservoir were the first constructed, the former being sunk in 1895, and the latter opened in 1896. The Heathwell and Edendale supplies, and No. 1 Reservoir, were added at the end of 1897 and beginning of 1898. The Pumping Station well and No. 3 Reservoir were constructed during the war in 1901.

Formerly the water supply of the railway station and settlement was from a well sunk near the station. This well was originally 13 feet deep, but as the settlement increased it became exhausted even after successive increase of its depth and subsequent boring into the rock. For some time, and until the end of 1897, water was taken from a place 14 miles down the Port Elizabeth line to supplement this supply. This source was abandoned in consequence of a severe outbreak of enteric fever, which was attributed to it, the water being found contaminated with dead animals at the source.

Rain Water.

All the houses in the railway settlement are supplied with well constructed rain-water tanks of 200 to 500 gallons capacity. They are connected with the roof gutters, and have overflow pipes, constructed in such a manner as to prevent dust being blown into them.

Private Wells.

There are five or six private wells in the locality, some sunk in soft alluvial soil like the Pumping Station Well, others constructed like the Windmill Well.

Three of these are likely to affect the health of the locality. The first is a well sunk in insanitary surroundings and used in the manufacture of aerated water. The second, a well sunk near slaughterhouses and liable to pollution by surface soakage from the washing of clothes; it is used in connection with a cowshed and the water is used for cleansing milk bottles. The third is sunk in the line of drainage between the camp filth trenches and the Windmill Well; it is sunk in the rock and is used at present only for watering a park and polo ground. Other private wells are connected with an hotel and private stores.

Without taking into account those private wells and the rain water in the tanks of the railway cottages, or the storage in the temporary wooden reservoirs in camp, the daily yield of water to the locality varies from 100,000 to 180,000 gallons with a storage capacity of 100,000 gallons.

This supplies not only the railway settlement, native location and camps, but also engines and railway works, in which a large quantity of water is used.

The supply is frequently intermittent in distribution.

CONDITION OF SURFACE SOIL.

The railway location and surrounding habitations are better constructed and drained than most localities in the colony which have come under my notice, and, comparatively speaking, the surface soil around habitations is fairly clean. The roads of the settlement are well made and covered with a good hard ballast taken from a quarry of weathered or disintegrated basalt at the north end of the settlement.

The whole of the ridge and slopes, referred to above as the camp ridge, have been occupied by camps and by a general hospital during the war. At one time 8,000 troops are stated to have been encamped here and 1,000 patients have been in the hospital. There was also a large remount camp on the lower ground north of the camp ridge. A minor rise of ground north of the Windmill Well was also used as camping ground.

The soil over these camping areas is thin, and appears to have been kept comparatively clean, the rock lying immediately underneath having rendered the use of bucket, instead of trench, latrines necessary almost from the commencement of the war.

However, according to the sanitary diary, which is still preserved in the military hospital, trench latrines appear to have existed in the Army Service Corps camps, which are on lower ground near the dongas, where the surface soil is deep.

An important area of soil pollution also exists on the north-eastern slopes of the camp ridge, where the nightsoil appears to have been trenched until quite recently, within a few hundred yards of the camps and hospital.

Another source of soil pollution in the neighbourhood of the camp ridge is the pollution that is taking place from the hospital kitchens and ablution rooms on the northern slopes of the ridge. Most of this waste water is led in badly constructed brick or cement channels to earth channels, eventually discharging into the cutting and boreholes already described in the notes on water supply.

The soil around the Kaffir location, and the banks of the donga above the town and location, have been used for trenching the nightsoil from the railway settlement. The dongas themselves in the immediate neighbourhood of the settlement have been used for depositing refuse of all kinds.

The slopes on the south-east above the settlement and camp ridge have been used for depositing camp refuse in the past, and are used at present for trenching the nightsoil from the camps.

The extensive slopes leading from the eastern and western boundaries of the Naauwpoort basin are clean, and have apparently never been camped upon.

Sources of surface soil pollution over limited areas, from private sources, are noticed in connection with a private slaughterhouse on the line of the Heathwell main water supply pipe in connection with clothes' washing near the adjoining well, and at the farmyards connected with the aerated water factory, already referred to.

Civil Surroundings.

The main area of civil habitations consists of a street or boulevard of well-built, trimly kept cottages, running parallel to the railway line along the lower contours of the camp ridge. Several irregularly-built cottages run on to the camp ridge, and there are also several similar cottages and a railway settlement school in the angle formed by the junction of the De Aar and Colesberg lines.

The native location consists of a number of scattered shanties, of rough-and-ready construction, along the Port Elizabeth line of railway, south of the junction.

The local cemetery separates this location from the European settlement.

The water supply has been already described.

Sewage disposal is carried out by the railway officials, under the supervision of the railway surgeon. No contractor is employed. The system is a single pail system. Latrines and privies are well constructed, and the contents are removed daily in tank carts. Four tank carts and 19 native labourers are employed for this purpose.

The native location is placed under the same system of sewage disposal, and is provided with latrines for men and women, the number of pails being equal to 5 per cent. of the population.

The contents of these pails are deposited in deep pits along the banks of the donga about 500 yards above the town and 400 yards from the native location.

Refuse and slops are collected from receptacles in each of the houses and deposited in the dongas adjoining and below the settlement. A considerable amount of dry refuse is at present being used for creating a made soil to widen the Port Elizabeth railway line south of the junction.

Surface drainage is provided for the railway settlement but not for the native location. There are brick or cement channels from each cottage to lines of surface drains, which are carried under the railway and discharge into earth channels leading to the donga on the west of the line.

There is no public slaughterhouse. There are two private slaughterhouses; they are placed in the open veldt; their construction is insanitary. One of them has been placed on the Heathwell line of water-main, and blood and offal are deposited in the ground immediately adjoining the main.

There are two aerated water factories. One is placed in the open veldt below the town in the tongue of land leading to the junction of the two main dongas. The water used in the factory comes from an unprotected surface well sunk 30 feet deep in soft soil. The surroundings of the well are a farmyard. The drainage of the floor of the factory and the dirty water from the tubs used for washing bottles soak into the surface soil within 20 feet of the well. Pigs wallow in this surface water.

The water is not purified before use; it is apt to be turbid and is clarified in a carbon filter and in felt filter bags.

The bottles are washed in tubs by means of a revolving brush.

The other factory is in the town and close to the camps. It has been constructed and managed under military supervision, and is called the "Military Mineral Water Factory."

The water supply is from the town main; it is led by pipe from the main to a boiler; from the boiler it passes into two 160-gallon tanks, which feed the bottling machine. The bottles are washed in tubs by hand.

The installation for purifying water by boiling is perfect, but the manager states that he can only use it when the supply of water in the main is constant. At present he does not boil the water, because the supply is intermittent, and he fills the feeding tanks by hand from a standpipe.

Aerated waters are sold in refreshment booths near the camps. They are obtained from the factory in the farmyard already referred to, and from the worst of the aerated water factories in Middelburg, noted in my report on Middelburg.

Existing Camps.

The existing camps are small; two Infantry battalions, the combined strength of which is 510, with an Army Service Corps company, and some 2,700 transport animals, forming the garrison at present. An Ordnance depôt, military hospital, (the old hutments of No. 6 General Hospital), and a small Royal Engineer camp complete the camps. They are all close to and practically run into the civil surroundings.

The water supply of the camps has already been noted, and is shown graphically in the diagrammatric sketch appended. Watercarts are used for conveying the water from the standpipes to the camps, a hose being arranged to lead into the carts by gravitation without pumping or coming into contact with surface soil.

In one camp, the Bedfordshire, the water is not boiled or purified. In the other Infantry camp, the Wiltshire, 150 gallons are boiled and cooled during the night in Flanders kettles and stored in the morning in three 50-gallon corrugated iron tanks for drinking purposes. The amount of boiled water so provided is about $\frac{1}{2}$ gallon per man daily. It is said to supply all the drinking water required.

It will be noted, in the diagrammatic sketch appended, that the Bedfordshire camp obtains water from No. 2 Reservoir, or Heathwell and Windmill Well water mixed, and the Wiltshire from the Edendale main direct.

All the camps are provided with a pail system of latrines, the number of pails being equal to 5 per cent. of strength both for Europeans and natives. The pails are placed direct on the surface soil, and the seats of the latrines, such as they are, are sometimes as high as 1 foot above the pails. The surface of the soil is not, however, littered with latrine paper as at Middelburg. The contents of the pails are removed daily to pits situated amongst old refuse heaps on slopes above the camps about 1 mile to the south-east of the camp ridge. The pits are about 30 feet long by 4 feet wide and 6 feet deep. The soil is a lime conglomerate, not well suited for trenching nightsoil. The pails are kept clean by lime washing.

In the Wiltshire camp the latrines are under the direct supervision of one of the pioneers, with native labourers under him. The contents of the pails are removed in daylight, morning and evening, the pails being lime washed immediately after they are emptied.

Both Infantry camps are provided with ablution, bath, and washing stands, water being laid on from standpipes and tanks. In one installation only (the Wiltshire) has any provision been made for removing the waste water in channels. In the other the waste water soaks into the ground around, as noted in describing the pipes leading to and from the Windmill Well.

In the Wiltshire camp some attempt is being made to use up slop water by forming gardens near the kitchen.

Dry refuse is at present being conveyed to an enclosed field on a farm at the mouth of a valley about $2\frac{1}{2}$ miles south-east of the camps. In the contract for the lease of the camp ground, the owner has power to use the camp refuse and deposit it where he likes.

The laundry is in the centre of the Naauwpoort basin at the place where the main donga passes under the 100-ft. girder bridge. A well has been sunk there for supplying water.

The camps are formed of bell tents, eight men being accommodated in one tent. The camp of the Wiltshire battalion is markedly trim, clean and tidy, but the tents are very crowded together, the distance between tents and lines of tents being only 9 feet.

Health Statistics.

(a.) *Civil Population.*

There are no records bearing upon the health of the population of the Railway Settlement and Kaffir location, beyond a record of the names and ages of people dying in the locality. The full details are kept in the register at Colesberg.

The number of deaths noted in this local register, eliminating as far as possible deaths amongst the military population, is as follows :—

1896	..	..	24 (June to December only).
1897	..	..	25
1898	..	..	26
1899	..	..	27
1900	..	..	145
1901	..	..	103
1902	..	..	99

There are no reliable records or information regarding population for these years. The present population is stated, however, to be 600 Europeans and 1,300 natives.

If this is correct, then the death rate for 1902 is 52 per 1,000 in a population of 1,900. This corresponds very much with the death rates of mixed European and native populations, as noted elsewhere in Cape Colony. The number of deaths noted for the years previous to the war includes scarcely any deaths amongst natives, judging, that is to say, by the names entered in the book. It is probable therefore that in these years death registration amongst the natives was incomplete.

As regards diseases in the locality the railway surgeon informs me that there was a severe epidemic of enteric fever in 1897, and that this led to changes in the water supply as already noted. A few isolated cases occurred afterwards previous to the outbreak of war. During the first year of the war the settlement again suffered from enteric fever, some 61 cases having occurred. In the second year there were 16 cases and in 1902 four cases. At present there are said to be three or four cases. The native location is said to suffer much from enteric fever.

The settlement, it may be noted, has only existed since 1893, when Naauwpoort was made the centre of a railway district. Previous to that date there were only a dozen houses in the place. It is now rapidly increasing but the building of houses, other than those in the settlement under railway control, is discouraged.

(b.) *Military Population.*

The principal health statistics since the close of the war are given in Table I. appended. So far as they go they do not show any marked condition of ill-health.

The incidence of throat affections is however high, and in the sanitary diary of the military hospital kept during the war, it is noted that tonsilitis was the prevailing disease from September, 1900, to the end of the year. This corresponds with what the figures in Table I. indicate during a similar period in 1902.

As the admission and discharge books contain entries of many cases sent direct from other stations, which cannot now be disintegrated, it has been impossible to work out a sick rate to strength for each week.

The admission rate has, however, been worked out at 1032·7 per 1,000 per annum, and this, according to an empirical formula, is calculated to represent a constantly sick rate of about 6 per cent. of strength.

In consequence of the difference in the water supply of the Bedfordshire and Wiltshire camps an attempt has been made to compare the health of the camps with one another.

The Wiltshire camp shows 11 admissions for dysentery and diarrhœa, the Bedfordshire camp shows 12 admissions. As the strength of the former is about one-third as great as the latter, the percentage of admissions to strength in the Bedfordshire camp is about double that of the Wiltshire camp. The numbers and data are too small to draw any conclusions from, but one would expect more diarrhœal diseases in a camp deriving its water from a mixed source than in a camp obtaining it from a comparatively pure source, and also boiling the water.

As regards the incidence of throat affections, the Bedfordshire camp shows 13 admissions and the Wiltshire camp 25. Both battalions arrived at the same time (10th October, 1902), so that the period covered is the same. Allowing for the higher strength of the Wiltshire battalion, the incidence of throat affections has been somewhat greater in it than in the Bedfordshire camp.

Meteorological Records.

The only records are those of rainfall. They are shown in Tables II. and III. appended. The rainfall is small and similar to that of Middelburg.

As regards temperature, this is influenced by altitude, and Naauwpoort is consequently cooler and more bracing than most stations in the colony. On the 13th January, 1903, the temperature fell within 12 hours from between 80 and 90 degrees Fah. to 48 degrees Fah., and until towards mid-day the following day had not risen above 60 degrees Fah. This is given as an example of variation in temperature during the height of summer. The change was unaccompanied by local rains or cloud, and appeared to depend upon change in wind direction.

As compared with Middelburg, Naauwpoort suffers much less from dust storms. Although there have been high winds, I have personally seen very little dust blown about in the locality.

In the winter months the climate is apt to be very severe. During the last winter there was a considerable depth of snow, and deaths from exposure to cold are said to have occurred.

Conclusions.

(1.) The climate and situation of Naauwpoort are healthy and the chief provision required as regards climate is against extreme cold in the winter months.

(2.) As regards sites of camps or permanent cantonments, there are extensive clean slopes for a garrison of considerable size, the best line of slopes being those on the west of the Naauwpoort basin and north of the Richmond Road.

(3.) In selecting sites for camps or cantonments the places to avoid are—

(*a.*) The flat veldt in the centre of the basin.

(*b.*) The minor basins leading to the main basin where there are signs of "pan" formation.

(*c.*) The slopes close under the mountains where there is evidence of the soil being swept by torrents.

(*d.*) The sites of old camps, old refuse ground and latrine trenches. A considerable area occupied by the last is very apt to be camped upon, unless care is taken.

(4.) The water supply is pure at the Heathwell and Edendale source.

(5.) Both these sources of supply are apt to be polluted by imperfec jointing in the mains, the former when it passes Shaw's farm and the slaughterhouse, and the latter when it passes the Kaffir location.

(6.) The Windmill Well supply is liable to pollution from various sources, and especially from leaking joints and overflow pipe into the well.

(7.) The Pumping Station Well is an unsafe supply in consequence of its being sunk in surface soil below the camps and habitations.

(8.) The mixture of good, suspicious, and possibly dangerous water in the storage reservoirs is objectionable, from a sanitary point of view, and is liable to lead to outbreaks of epidemic disease.

(9.) The quantity of the water supply is likely to be exhausted by pumping if a large population has to be provided for, and reliance can only be placed on supplies obtained by gravitation from sources similar to the Heathwell and Edendale supplies.

(10.) There are several localities in the neighbourhood where similar supplies are likely to be obtained.

(11.) The general sanitary condition of the civil surroundings is fairly good, as compared with other localities in the district; the construction of the houses and the arrangements for working the pail system of sewage disposal being distinctly better than in most places.

(12.) The arrangements for prevention of soil pollution are not satisfactory so far as the Kaffir location is concerned.

(13.) The slaughterhouse arrangements are insanitary, and the purest of the water supplies is apt to be polluted by the existence of one of these slaughterhouses on the line of the main pipe.

(14.) The aerated water factory, which depends on a surface well for its water supply, is an unsafe source of aerated waters. The military mineral water factory is safe, only if the arrangements for boiling are strictly adhered to, or a pure water supplied.

(15.) The arrangements for washing bottles in aerated water factories requires radical reform.

(16.) The existing camps have the following insanitary conditions:—

(*a*.) An absence of proper drainage from ablution, bath, and washing places.

(*b*.) Improper disposal of waste water from the hospital kitchen and ablution room.

(*c*.) Absence of concrete or other impermeable bases in the latrines.

(*d*.) Imperfect construction of latrines, so far as the relative height of pails and seats is concerned.

(*e*.) Disposal of nightsoil in unsuitable ground, both as regards site and nature of soil.

(*f*.) Overcrowding of tents, both as regards number of men in the tents and space between tents.

(*g*.) Imperfect organization for the purification of doubtful water supplies.

Recommendations.

(a.) *Permanent Garrison.*

There are two fairly good sites for a permanent garrison, the best being the slopes on the west side of the basin and north of the Richmond or Hanover Road. An alternative site is the slopes on the east of the basin, leading from the north-east neck to the south-east corner.

The drainage of either of these sites could readily be led towards the centre of the basin below habitations. There is better ground for irrigating here than elsewhere, and the effluent of irrigation plots would pass into the donga about the spot where the donga passes under the railway bridge

As regards construction of any permanent cantonment, it is strongly urged that the principles laid down in previous reports should be adopted.

Briefly, these principles are—

(1.) Sufficient area for each unit.
(2.) Raising huts 1½ to 2 feet above ground.
(3.) Concreting and channelling under and around the huts.
(4.) Complete system of surface drainage.
(5.) American trough latrine system, or a water-carriage system, if the water supply admits.
(6.) Macadamizing pathways and roads.
(7.) Planting trees and forming gardens wherever possible, using bath and ablution room waste water, if necessary, for irrigating these.
(8.) Provision of garrison aerated water factories.
(9.) Provision of sanitary laundries.
(10.) Control of milk supply.
(11.) Finally, limitation of the strength of the garrison to a minimum water supply of 10 gallons per head, without general baths or a water-carriage system of sewage disposal.

As regards a water supply for a permanent cantonment, or temporary garrison under canvas, the proper source, from a sanitary point of view, must be from deep borings, or from surface borings at sites above all possible contamination and conserved as in the case of the Heathwell and Edendale supplies.

There appear to be several places where similar supplies can be obtained, especially the "poort" at the north-east corner of the basin, and the valleys on the south-east and south-west. From any of these points water could be laid on by gravitation to the slopes on the east or west of the basin.

Water supplies from wells in the depression of the basin and below occupied slopes should on no account be used except for flushing, irrigation, watering horses, or laundry purposes.

It is difficult to foretell the quantity of water likely to be obtained from borings at suitable spots, but judging from the Heathwell and Edendale supplies, 50,000 gallons at least might be reckoned upon. This would suffice as a minimum for a garrison of 5,000. For watering animals and other supplementary purposes, surface wells near the centre of the basin should afford an almost unlimited supply, judging from the general slope of the country, and the fact that the Pumping Station Well yields about 60,000 gallons in the 24 hours.

One point requires consideration in connection with possible exhaustion of supplies from borings. The extent of country between the watershed and suitable spots for boring is comparatively small, and it is recommended that pumping should not be resorted to. The gravitation system adopted in the Heathwell and Edendale supplies is the system that should be attempted, as pumping is liable in time to exhaust a large area supplying the boreholes, and eventually diminish the yield.

(b.) *Existing Camps.*

The points which appear to require immediate attention in connection with existing camps are—

(1.) Alteration of the drainage of the hospital, ablution, bath and kitchen waste water, and clearing away the foul stagnant water from the cutting, into which it drains at present.

(2.) Alteration of the site or drainage of the ablution, bath and washing place of the Bedfordshire camp, in order to prevent soakage into the ground around the pipes leading to and from the Windmill Well.

(3.) Alteration of the site of camp nightsoil trenches to more suitable ground and to a spot below and not above the line of drainage towards wells.

(4.) Enclosing sites of existing, or previous latrine trenching ground, and planting them with trees or otherwise marking the locality.

(5.) Removal of horse lines and latrines from the neighbourhood of the Windmill Well.

(6.) Better control over the military aerated water factory so as to ensure boiling of the water at all times and to ensure more sanitary methods of washing the bottles.

(7.) Prevention of sale of other aerated waters to troops.

(8.) Obtaining of water for drinking purposes from the station staff standpipe or Wiltshire camp standpipe only.

(c.) *Future Encampments.*

It is strongly urged that no encampments be taken up here, until they are carefully thought out and planned as regards sanitary arrangements, ablution places, horselines, latrines, water supplies, &c., in such a way that there is provision for—

(1.) Immediate removal of waste water and other waste products, in a manner to ensure that pollution of soil is avoided.

(2.) Organizations for purifying water supplies of doubtful quality, and for collecting, conveying, and distributing water in a sanitary manner.

(3.) Arrangements for irrigating plots as gardens, in order to allay dust in the camps.

(4.) Construction of latrines with concrete channelled bases leading to sumps.

(5.) Similar construction of ablution, bath, and washing places, leading to sumps or garden plots.

(6.) Setting apart and enclosing areas for the disposal and incineration of refuse.

(7.) Avoidance of areas, which might eventually be taken up for permanent cantonments.

(d.) *Civil Surroundings.*

Although there is no military jurisdiction over the civil surroundings, and although the comparative excellence of the sanitary arrangements of the railway settlement must be acknowledged, it is recommended that representations be made to have the jointing of mains examined, especially where the mains run near farms, slaughterhouses, or other spots where soil pollution is taking place; and, further, if the water supply for the troops is to continue to be provided from the railway supplies, that an endeavour should be made to fill temporary tanks direct from the Heathwell or Edendale supplies sufficient for the requirements of the garrison.

In any case, the insanitary conditions connected with the overflow into the Windmill Well, already described, should be remedied, and only the Station Staff standpipe, and Wiltshire camp standpipe, used for drinking water supplies.

W. G. MACPHERSON, *Major,*
R.A.M.C.

NAAUWPOORT, CAPE COLONY,
18*th January*, 1903.

TABLE I.—HEALTH Statistics of Troops at Naauwpoort, Cape Colony.

Week ending	Average strength.	Admissions. From all causes.	Enteric fever.	S.C. fever.	Dysentery.	Diarrhœa.	Primary syphilis.	Soft chancre.	Gonorrhœa.	Sore throat.	Tonsillitis.
1902.											
6th June	170	1	..	..	..	..	..	..	..	..	..
13th "	211	2	..	..	..	..	1	..	..	..	..
20th "	223	3	..	..	..	..	..	..	1	..	..
27th "	231	3	..	..	..	..	..	..	..	..	..
4th July	447	9	..	..	1	..	..	..	1	..	..
11th "	505	21	1	..	..	..	3	..	..	2	..
18th "	593	13	..	..	..	..	1	..	..	1	..
25th "	645	18	..	..	..	..	1	..	..	1	3
1st August	1,060	30	..	..	..	..	1	..	..	..	2
8th "	1,304	26	..	..	..	..	1	..	1	..	2
15th "	1,374	24	..	..	..	1	..	..	2	..	2
22nd "	1,415	21	..	..	..	..	..	1	..	1	..
29th "	1,390	31	..	..	..	..	..	1	2	..	5
5th September	1,218	22	..	..	..	..	..	..	3	1	3
12th "	1,127	25	..	..	..	..	1	1	..	1	10
19th "	1,290	26	..	..	1	..	1	..	4	1	3
26th "	1,512	24	..	..	..	..	1	3	2	2	5
3rd October	1,159	32	..	..	1	..	..	2	3	..	5
10th "	1,327	38	..	..	..	..	1	1	3	1	11
17th "	1,361	26	..	..	2	..	1	1	3	..	1
24th "	1,389	21	..	1	1	..	..	..	..	1	2
31st "	1,420	27	..	..	1	..	..	1	1	..	1
7th November	1,275	18	1	..	1	..	1	..	..	..	1
14th "	807	10	1	..	..	..	..	..	1	1	1
21st "	753	15	..	..	..	..	..	..	1	..	2
28th "	744	12	..	..	..	1	..	2	..	..	..
5th December	945	18	..	..	..	2	..	..	..	..	8
12th "	964	16	..	..	..	2	..	1	2	..	6
19th "	950	22	..	..	..	5	..	..	2	..	7
26th "	909	11	..	1	..	3	..	..	..	..	1
31st "	634	19	..	..	3	1	..	..	..	1	1
Total for 31 weeks ..	29,352	583	3	2	11	15	14	14	32	14	82
Admission ratios per 1,000 of average strength per annum .	947	1032·7	8·8		39·2		106·2			170·0	

TABLE II.*—AVERAGE Rainfall, mean monthly.

Naauwpoort, 1886–1894.

January	2·29
February	2·78
March	2·75
April	1·48
May	1·19
June	0·78
July	0·39
August	0·48
September	0·48
October	1·17
November	1·72
December	1·47
Total	16·98

TABLE III.*—RAINFALL.

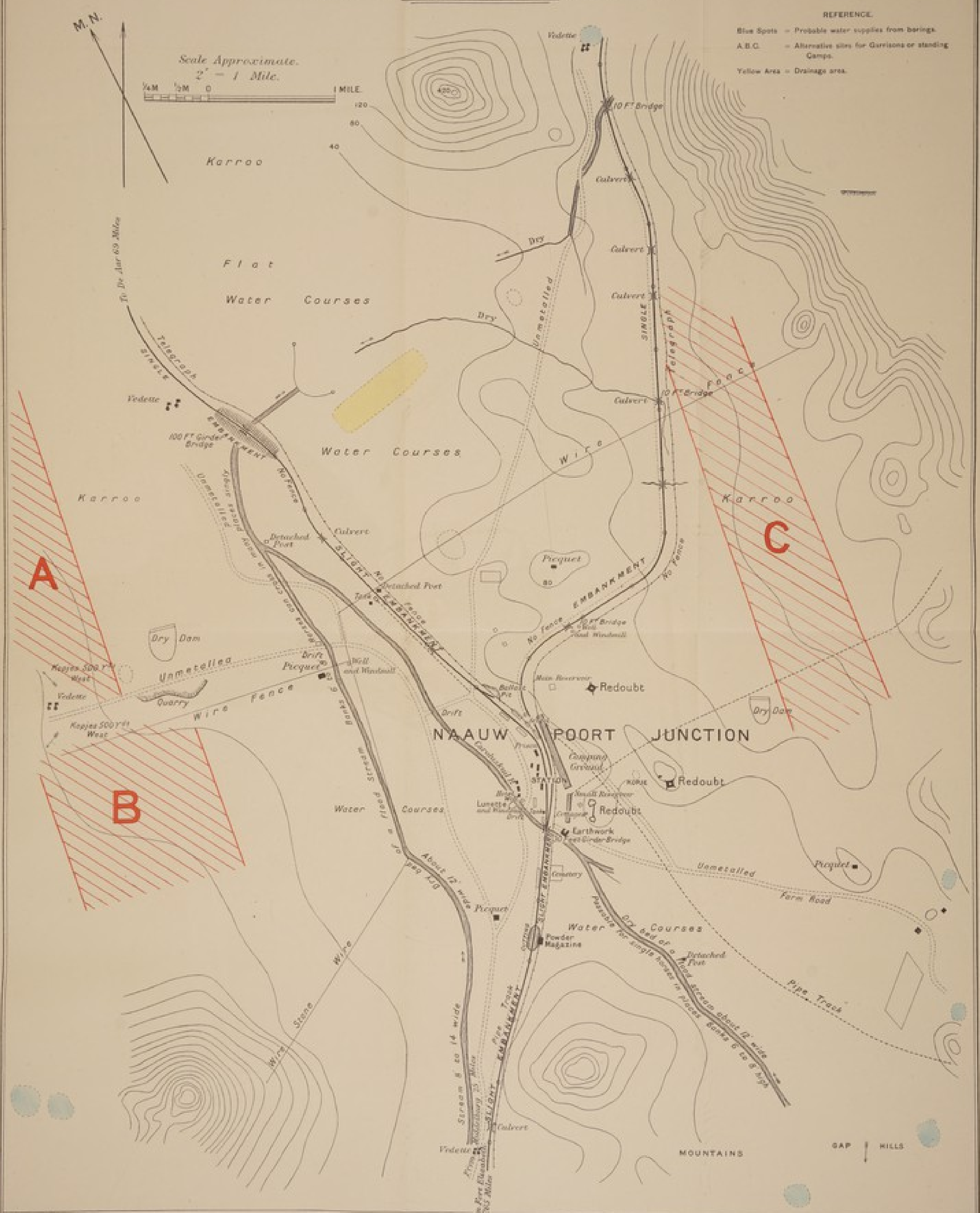
Naauwpoort, Cape Colony, 4,884′.

Month.	1895.			1896.			1898.			1899.			1900.		
	Total in inches.	Number of days' rain.	Maximum in 24 hours.	Total in inches.	Number of days' rain.	Maximum in 24 hours.	Total in inches.	Number of days' rain.	Maximum in 24 hours.	Total in inches.	Number of days' rain.	Maximum in 24 hours.	Total in inches.	Number of days' rain.	Maximum in 24 hours.
January ..	4·30	7	..	1·60	3	..	5·13	11	1·01	0·06	2	0·03	0·00	0	0·00
February .	2·51	6	..	0·01	3	..	1·76	7	0·50	3·76	9	1·45	1·55	2	1·30
March ..	2·49	3	..	1·82	3	..	3·15	4	2·30	4·57	9	0·93	3·13	3	2·00
April ..	3·92	5	..	2·97	4	..	1·58	5	0·44	1·44	5	0·45	1·47	3	0·82
May ..	0·92	2	..	0·00	0	..	0·60	3	0·30	1·69	3	0·90	0·36	1	0·36
June ..	0·00	0	..	1·35	2	..	0·20	0	0·00	1·24	2	0·75	0·21	1	0·21
July ..	0·34	2	..	1·35	2	..	0·00	0	0·00	1·36	6	0·40	0·52	1	0·52
August ..	0·13	2	..	0·43	1	..	0·00	0	0·00	0·92	2	0·55	0·50	1	0·50
September	0·00	0	..	0·00	0	..	1·15	1	1·15	0·00	0	0·00	0·00	0	0·00
October ..	0·00	0	..	0·00	0	..	0·79	1	0·79	0·00	0	0·00	0·00	0	0·00
November	0·95	3	..	1·79	5	..	0·26	1	0·26	0·00	0	0·00	0·00	0	0·00
December	3·45	8	..	2·18	5	..	0·00	0	0·00	2·98	3	1·90	3·90	8	1·50
Total ..	19·01	38	..	14·46	28	..	14·42	33	2·30	18·02	41	1·90	12·64	20	2·00

* From Meteorological Commission, "A Discussion of the Rainfall of South Africa during the 10 years, 1885–94," by Alex. Buchanan, M.A., LL.D., F.R.S.E. Published 1897.

PLAN I.

PLAN SHOWING BEST SITES, WATER SUPPLY AND DRAINAGE OF CANTONMENTS OR STANDING CAMP.



* From Meteorological Commission, "...

the 10 years, 1885–94," by Alex. Buchanan, M.A., LL.D., F.R.S.E. Published 1897.

PLAN II.

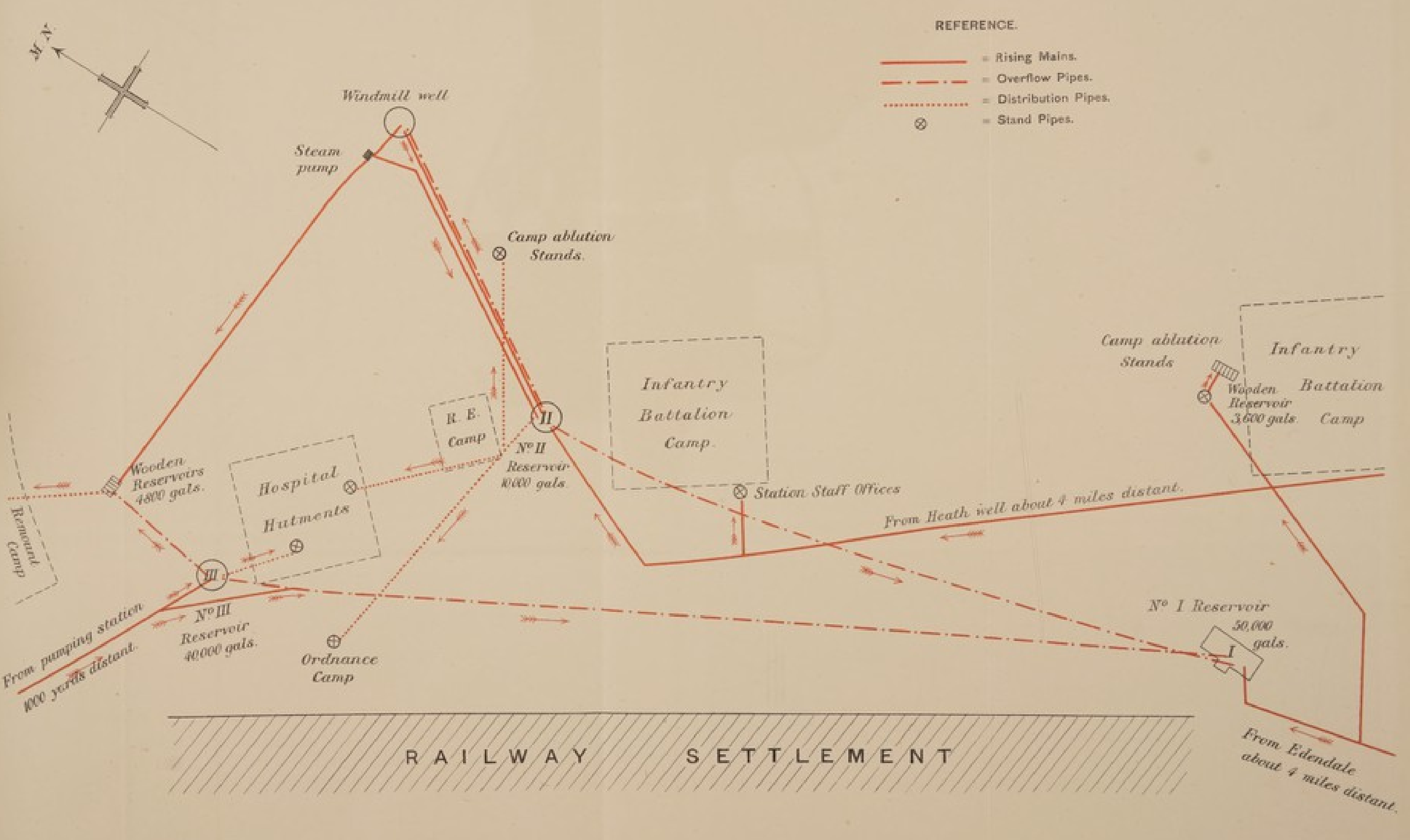
DIAGRAMATIC SKETCH OF WATER STORAGE

AND

DISTRIBUTION, ON CAMP RIDGE, NAAUWPOORT, C.C.

(16TH JANUARY, 1903.)

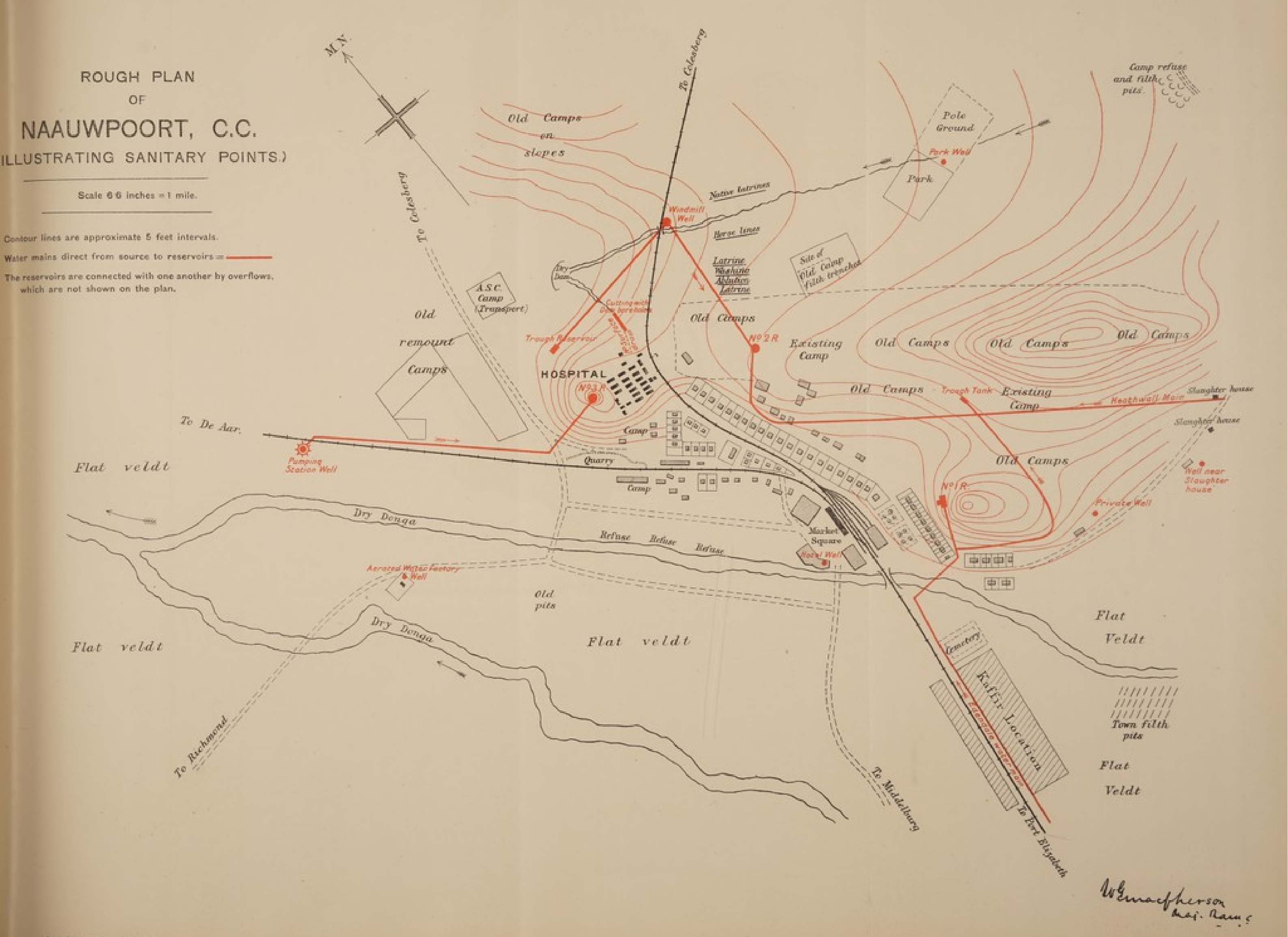
N.B.—The relative positions and distances are taken from a map drawn to Scale of 13·2 inch to the mile.



(200 12/1902. 1180.) 232-14 & W O.

W. L. Macpherson
Major R.A.M.C.

PLAN III.



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REPORT ON BLOEMFONTEIN AS A CANTONMENT FOR BRITISH TROOPS.

The following report has been prepared on the same lines as previous reports, viz.:—

(1.) A statement of the various physical features, water supply, condition of surface soil, civil sanitary surroundings, previous health statistics and meteorological records, which it is necessary to collect before conclusions can properly be drawn and recommendations submitted.

(2.) Conclusions from the data.

(3.) Recommendations based upon the conclusions.

PART I.

Physical Features.

Bloemfontein, as a population centre, has grown around a neck or poort on a dyke of intrusive rock, between an extensive area of kopjes on the north and one or two minor outlying kopjes on the south

The height of this dyke at the railway station, which is practically at its most depressed point, is 4,517 feet above sea level. The highest kopjes rise abruptly on the north of the town, and are about 500 feet higher; the minor kopjes are about 100 feet higher. The town lies in the concavity between the north and south kopjes. The sites of the new cantonments are on the area of kopjes lying to the north of the town. This area extends from the town for about 5 miles to the north, and is about 5 miles wide from east to west. The north-east corner is the highest point in the area; it is known as Naval Hill, and rises abruptly and precipitously from the town. The plateau on the top of this kopje forms the first portion of the sites of the new cantonments, and is planned to accommodate one battalion of Infantry. The area of the plateau is about 150 acres; it is rocky, and falls abruptly on all sides to valleys and plains.

The remaining portion of the extensive area of kopjes north of the town is formed of undulating valleys and plateaux with easy ascent to the higher plateaux on the top of the kopjes. The intervening valleys and slopes are generally occupied by farms which are irrigated by dams holding back the surface water collected on the surrounding slopes.

The site of the remaining portion of the new cantonment, including married quarters for officers and other ranks and hospital accommodation, has been selected on more or less undulating ground on the top and slopes of kopjes, on the south-west corner of the kopje area north of the town, and about 2 miles west of the Naval Hill site.

This second site is known as the Tempé site. The area available for cantonment, hospital, married quarters, &c., is approximately 400 acres.

The country to the east of the town is an open plain. To the south of the town the country rises in undulating slopes to various isolated kopjes, which crop up at a distance of 3 to 5 miles from the town. On the west of the town the country is also a series of undulating slopes.

The general line of drainage is towards the Bloemfontein Spruit, which rises in broken dongas in the various valleys of the northern area of kopjes, where the sites of the new cantonments have been placed. These dongas pass into the undulating country on the west of the town, and unite in a main line of donga (the Bloemfontein Spruit) running west to east. The spruit bisects the town and escapes into the plain on the east over the poort, around which the town has been built. This "poort" is about 1 mile across from kopje to kopje. The spruit is bridged in four points where the main streets from north to south pass over it.

There are two large native locations as suburbs of the town. One is known as the Waaihoek location, and extends south of the town along the base of the southern kopje; the other is a native location extending over a large area on the southern slopes, about 1 mile south of the town, and is known as Kaffirfontein.

The railway runs through the district from south-west to north-east, and lies along the eastern boundary of the Waaihoek native location, the town, and the Naval Hill line of kopjes and kopje area north of the town. The line of railway separates the two native locations. The inhabited areas in the remaining portion of the district consists of three or four farms, chiefly in the valleys of the area of the kopjes north of the town.

The undulating slopes on the west and south and a portion of the plain on the east have been or are occupied by temporary encampments, including military encampments, and encampments of refugees and of labourers employed in the erection of the new cantonments.

The general surface of the ground is a fairly rich loam, over most of the undulating slopes, and is covered with a short grass. There are several "vleis" or areas where the ground water is held up by dykes of intrusive rock, both in the undulating slopes and in the valleys of the kopje area. On the kopje area the surface soil is only 1 to 2 feet deep. In the valleys and undulating slopes there is a considerable depth of soil.

The underlying strata are the shales and sandstones of the upper Karoo system. The intrusive rock intersects these formations in all directions, and forms natural barriers to the flow of the underground water. Several of these dykes can be traced by the tendency to vlei or marsh formation above them.

The line of drainage of the district has already been indicated, namely into the Bloemfontein Spruit, which bisects the town and passes to the plain on the east, and thence to the Modder River. The greater portion of the cantonment area on the Tempé site forms the watershed of this spruit, but the northern slopes, which form the most abrupt portion of the Tempé kopjes, drain into a line of dongas running to the north-west corner of the area of kopjes.

The Naval Hill site drains southwards into a donga, which joins the Bloemfontein Spruit below the town, and northwards into dongas, which run north-east towards the Modder River along a line of valley north of the Bloemfontein Spruit.

The lines of drainage are, therefore—

(1.) Mainly towards the town.

(2.) Partially away from the town towards the north-west.

(3.) Partially away from the town towards the north-east.

WATER SUPPLIES.

The local sources of supply are—

(1.) A river water supply laid on from the Modder River.

(2.) Surface wells.

(3.) Deep bores.

(4.) Rain water.

(5.) Surface dams.

(6.) Springs.

(1.) *River water.*—The existing town and camp water supply is taken from the Modder River. The intake is at Sannah's Post, about 22 miles from the town. There are two settling tanks and three sand filter beds at the intake. The settling tanks are each 95 feet by 190 feet superficial area, with a capacity each of 1,000,000 gallons.

The filter beds are each 50 feet square. The filtering media are—

Sand, 2 feet (the sand is obtained by crushing sandstone rock); fine gravel, 3 inches; coarse gravel, 3 inches; broken stone.

An equilibrium chamber between the settling tank and the filter beds, and a regulation chamber between the filter beds and clear water storage tank, maintains a level of 2 feet of water above the sand during filtration.

The filtered water is pumped to a reservoir on a low spur of the Naval Hill kopje. The reservoir has a capacity of 800,000 gallons. It is well constructed, covered, and ventilated.

Water is distributed from the reservoir to houses and standpipes. For camp purposes it is laid on to standpipes, as near camps as possible, under gravitation. Water-carts continue the distribution. They are filled from a watering hose fixed on a trestle, and kept from contact with the ground. The barracks on Naval Hill site are supplied with water pumped direct from the reservoir to tanks of 20,000 gallons total capacity on the top of the hill.

The works on Tempé site are supplied by water-carts from ten 600-gallon tanks, filled by gravitation from the reservoir, and placed as near the site as possible.

The Modder River at the intake is dammed, and holds the drainage of an extensive area, being fed higher up by numerous spruits rising in the southern watershed of the Orange River Colony. The only town of importance up stream is Dewetsdorp, but numerous native locations and farms are said to exist on the feeders of the river throughout the collecting area.

The water is turbid, and causes considerable difficulty at the filter beds. Clogging is said to take place rapidly, and the beds have to be cleaned once a-week.

The amount of water consumed in the town and camps has increased to nearly 300,000 gallons daily. With the three filter beds working continuously, the rate of filtration is slightly over 360 gallons to the square yard in 24 hours. No periodical analyses are being made, with a view to watching the efficiency of the filter beds, but analyses which have been made do not give good biological results.

Owing to the increased consumption of water, and the requirements of the new garrison, plans are now being prepared to form a second waterworks station on the Modder River at Mazel's Poort, about 12 miles from the town, and 15 miles down stream from Sannah's Post intake.

The dam at Mazel's Poort holds up the drainage of an area of feeding spruits to the east of Modder River, the principal spruit being the Sepani Spruit. The town of Thaba' Nchu is on this spruit, about 30 miles up stream from the proposed intake at Mazel's Poort.

The plans of the new waterworks comprise three settling tanks (90 feet by 350 feet each) and five filter beds, each 80 feet square. The filter beds will consist of—

	ft.	in.
Sand	2	6
Fine gravel	0	6
Coarse gravel	0	6
Broken stone	1	0

A head of water, 2 feet above the sand, is maintained by equilibrium and regulating tanks. The proposed storage reservoirs will consist of a 2,000,000-gallon low level, and 300,000-gallon high level, reservoir.

(2.) *Surface wells.*—There is a large number of surface wells in the locality. Until the river supply was introduced, the main supply of the town was from seven such wells. They have since been closed, but many private wells are still used. One, for example, supplies the water used in the principal aerated water factory of the town. It is sunk on the premises, is steened with masonry in its upper portion, and is 90 feet deep. It yields about 1,000 gallons daily. Other surface wells which were examined, are situated in the valleys between the lines of kopjes north of the town. They are open unprotected wells containing turbid water. They are used by native camps in connection with brickfields. The main supply of the native location at Kaffirfontein is from a surface well sunk in a spring-bearing area near the location.

(3.) *Deep bores.*—Several bore holes were made for supplying the camps during the war. Three of these are sunk on a line of donga and valley leading to the Tempé cantonment site. The number of bores made has been considerable. A table is appended, showing the size, depth, and yield, of those made by the Royal

Engineers. The positions of some are shown on the map appended. The yield has varied, and is said not to be constant.

The lowest of these bores is on the undulating slopes west of the town. It is a $2\frac{1}{2}$-inch bore and is at present unused. It is 87 feet deep, and is apparently sunk on ground which is on nearly the same level as the surface well in the aerated water factory referred to above.

This water has recently been analyzed, and was found remarkably pure; 1. cc. on agar plates yielding only 100 colonies after 6 days incubation. Chemically, the water was free from organic impurities. It is proposed to use this water for the manufacture of aerated waters for the garrison, under military supervision and control. The yield has been gauged at 6,000 gallons daily.

(4.) *Rainwater* is much used in the town for domestic and other purposes, most houses having rainwater tanks connected with roof gutters. In the new cantonment, two to four 600-gallon tanks are placed at the ends of each barrack hut for rainwater storage. There is no purification of rainwater, nor automatic means for letting the first washings run to waste.

(5.) *Surface dams.*—There are many large dams in the neighbourhood for holding up surface water. The surface ponds, so formed, are of considerable size, and are used for irrigating farms. Water erven in the town are supplied by a dam of this kind on the south-west of the town. The water is invariably muddy, and the collecting surfaces are exposed to all kinds of contamination.

(6.) *Springs.*—The springs are all surface springs, rising through surface soil above necks of intrusive rock. The spring from which Bloemfontein derives its name rises above the poort on which the town is situated. It is on the banks of the Bloemfontein Spruit, near the upper part of the town, and is still used by some of the inhabitants for drinking water. The water in the Bloemfontein Spruit is very scanty, and lies in a few stagnant pools, receiving all kinds of refuse from the town. There is no evidence of clear running springs of any strength in connection with the spruit.

At Kaffirfontein there is a spring in an artificial cutting. The water in this cutting wells up clear and sparkling from the rock underlying the surface soil in which the cutting has been made. The yield is extremely scanty, yet it forms apparently the chief supply for the natives of the adjoining location. The natives crowd round this spring, and jostle one another to obtain water. They bring with them all kinds of vessels, and there is barely enough water to fill them, except at a very slow rate.

No records or other data can be obtained by which the quantity of water obtainable from other than river sources may be gauged; but the amount is obviously totally insufficient for the requirements of the population of the locality. Hence the necessity of obtaining a water supply from a distant river which was forced upon the Bloemfontein population just before the war broke out in 1899.

Civil Sanitary Surroundings.

There is as yet no Public Health Act for the Orange River Colony, but the sanitary arrangements of the town of Bloemfontein and the native locations are administered under municipal regulations. There is a Medical Officer of Health, who holds other appointments, including that of surgeon to the civil hospital, and engages in consulting, though not in general practice. He has two European sanitary inspectors and one native inspector under him, and acts as chief inspector himself.

Generally speaking the sanitary conditions are similar to those of other townships in South Africa. The water supply has already been indicated. The present consumption of water in the town does not admit of any proper resting periods for cleansing one filter bed without throwing extra work on the other two. The water supply of the native location, Kaffirfontein, has also been indicated, the quantity being inadequate and the facilities for obtaining water very small.

The conservancy arrangements are on the dual-pail system, and are carried out by the municipal staff. Removal is nightly, or twice or thrice weekly, according to individual wishes, and the number of pails is one for every five individuals. This does not, however, hold good for the native locations, where the pails are removed nightly or bi-weekly as required, and the number is consequently about one in 10 of the population. The pail and contents are removed bodily in carts from the town, the pails being kept covered, and clean tarred pails being left in their place. They are not numbered pails, and may be passed indiscriminately from one house to another. Special pails are used for houses where there is infectious disease. In the native locations the contents of the pails are tipped into tank carts.

Until 2 years ago cesspits were in use in the town. Properly constructed surface drainage does not exist. Slops and foul water are removed in tank carts by the municipality daily in the case of offensive trades, bi-weekly in other cases, and deposited in a spruit east of the town, but as frequently as not they are thrown out around habitations. Some of the streets are metalled, paved and guttered to side channels, but not all.

Houses are fairly well constructed of sandstone or brick, but many of the older houses are not raised above the surface soil, and are built of mud or sundried bricks. The pail privies are constructed with little or no light and ventilation. Refuse is removed in well-constructed covered refuse carts, bi-weekly as a rule. The inhabitants of the native locations, however, have no system of refuse or slop removal, and deposit refuse in neighbouring dongas. The municipal rates are 1*d.* in the £ assessed value of property for general purposes, with payment for water at 5*s.* per 1,000 gallons by meter, or 5*s.* per month without meter; 7*s.* 6*d.* monthly is charged for bi-weekly removal of night soil, 10*s.* for tri-weekly removal, and 12*s.* for nightly removal per pail. For removing slops a charge of 6*d.* per 30 gallons is made, and for removing dry refuse 1½*d.* per basket load.

There are four aerated water factories; two are old established firms doing a large business, two are small and only recently opened.

In the largest factory water from three sources is used:—

(1.) Rainwater collected from the roofs and stored in tanks above the ground.

(2.) Well water from a deep well on the premises.

(3.) Town water.

The rainwater is used for ginger ale and the well water for other aerated waters. The town water is only used for bottle washing and other cleansing purposes. The character of the well has already been noted. The water used is boiled and passed through Berkefeld filters before going to the filling machine, a 36-candle and a 17-candle filter being installed. Bottles are washed by means of a revolving brush and spray.

In the other of the two principal factories town water only is used. It is passed through a 14-candle Berkefeld filter, the bougies of which are changed sometimes every half-hour, according to the owner's statement. Bottles are washed by means of a revolving brush and spray.

In the two smaller factories town water is also used. A 3-candle Berkefeld filter is used in one and a single candle Berkefeld filter in the other. The bottles are washed by hand in tubs. Hop stout, fruit cider, &c., are manufactured in one of these factories. These "cooling drinks" are bottled in old beer, wine or spirit bottles picked up anywhere. There is a large stack of them in the open yard. They are covered with dirt and dust of all kinds, and many have the appearance of having been collected from refuse heaps. They are washed by hand in tubs.

Cowsheds and milk shops were the subject of legislation in 1900. There were then some 40 or 50 cowsheds in the town, apparently without sanitary arrangements. The regulations of 1900 provide for drainage, ventilation and limewashing of the sheds, for cleansing of the utensils, and for cooling and storing of the milk not sold immediately. As yet these regulations have not been fully enforced, and the condition of cowsheds is much the same as formerly.

Private slaughterhouses are permitted; they are open places on the veldt, without water supply, and with no arrangements for the disposal of blood and offal except in pits in the adjoining soil.

Until 1900 the cemetery was close to the town and on unsuitable soil, clay and shale. The regulation depth of grave was not or could not be adhered to in consequence of the underlying soil. A new cemetery has been opened in more loamy soil on the veldt 2 miles south of the town.

There are no public laundries. Washing is carried out in private houses or in the Bloemfontein Spruit below the town. Some washing takes place in the spruit above, and during its flow through the town. The spruit receives a considerable amount of surface drainage and trade refuse in passing through the town. There is a laundry below the town on the banks of the Bloemfontein Spruit fitted for laundry purposes by the military authorities, and supplied with town water, but it is in no sense a public laundry.

There is no municipal organization for effectually dealing with infectious disease. There are no proper means of disinfection or isolation.

Sanitary Condition of Camps and New Cantonments.

(a.) *Camps.*

One battery of Artillery is encamped on the open country west of the town, near the Tempé site of the new cantonments, the Military Hospital (formerly No. 8 General Hospital), is about ½ mile south-east of the Artillery Camp, and one battalion of Infantry about 1 mile south of the hospital. Another battalion of Infantry and a regiment of Cavalry are encamped on the open country to the south-west and south of the town. Army Service Corps, transport, and ordnance camps are on the south-east and east of the town.

All of these camps draw their water from standpipes connected with the town water supply. The water is conveyed from the standpipes to the camps in water carts. The hospital alone has the water laid on to the site. There is no sound organization for boiling or filtering and storing water for drinking purposes, although boiling of water is carried out to some extent.

Latrines are on the pail system. The pails stand on the surface soil. There is no prepared base or other means of avoiding pollution of soil by urine, excrement, or latrine paper. The pails are emptied at the latrines into tank carts, and then replaced in the latrines. The work is carried out by a contractor. The pails are tarred, according to contract, twice a month.

Ablution arrangements are imperfect. In the case of the Cavalry regiment, for example, there is no ablution place of any description set apart for the men. They wash themselves from pails near the kitchen as best they can. In one Infantry battalion there is a washing and ablution shed, with stands for basins and tubs, but no provision is made for removing waste water. The soil under and around the shed is consequently a dirty puddle.

Refuse is deposited irregularly over the surface soil in the neighbourhood of the camps. The Army Service Corps camps are near dongas. The dongas are the receptacles of refuse and excrement, probably from the adjoining encampment of native drivers.

(b.) *New Cantonments.*

(1.) *Naval Hill cantonment.*—Barrack huts, staff-serjeants' quarters and mess, canteen, recreation room, ablution rooms, kitchens, and latrines, Officers' quarters and mess for one battalion of Infantry have been erected, and are already occupied.

The constructions are the corrugated-iron type, with ridge ventilation and lined with wood. The huts are, in some cases, raised for a few inches, in other cases, for 2 to 4 feet above the ground, according to the slope of the ground. The aspect is about north-east and south-west with verandah on the northern aspect. The ground under and around the huts has not been prepared for prevention of soil pollution. It is rocky irregular ground with crevices and pockets filled with surface soil. The verandahs are also as yet unfinished, and there is no surface drainage.

The latrines have been constructed on the American trough system. There are four latrines. Each latrine contains four troughs of six seats each. The floors are concreted, and a free circulation of air throughout the latrines is obtained by the introduction of several louvred panels in the corrugated-iron screen.

There are two vacuum carts on the site for use in connection with these latrines. The hose enters the cart at the bottom, and not at the top of the tank. These latrines are not in use, and temporary bucket latrines have been erected for the battalion occupying the barracks.

Although the floors of the trough latrines are well concreted and channelled there is no outlet as yet except into imperfect surface drains or on to the surface soil. They are, in fact, unfinished at present.

The ablution rooms are constructed with concrete floors. At either end there are three compartments for baths; the centre portion is well ventilated with louvred sides. In two of the four ablution rooms the floor is channelled to the centre, in the other two it is channelled to side gutters. The waste water discharges at present on to the surface soil, or into imperfectly constructed surface drains, or, in the case of one ablution room, at present being used, into earth channels leading to an earth sump (a pocket in the rock) from which it is pumped into carts and removed. There is at present no surface drainage, made roads or pathways.

The kitchens are in a corrugated-iron hut containing also meat store and bread store. The windows of the meat store are covered with gauze in one of the huts. There are no kitchen sinks, or wash-up places, and the kitchen slops drain into the surrounding soil, or are received into corrugated-iron receptacles.

In some of the occupied huts earth has been banked up against the base and planted as gardens, in others washing goes on in the verandahs and the slops are soaking into the soil and under the huts. Refuse is also beginning to accumulate under the huts.

Water is laid on to standpipes from tanks on Naval Hill overlooking the town reservoir, which is situated some 200 feet lower down. The tanks are filled by pumping from the reservoir direct.

About 14 contractor's workmen are living in one of the barrack huts. Cooking, washing, &c., are carried out on the verandah or in the temporary structure near it. Dry refuse has been deposited in the neighbourhood.

(2.) *Tempé Cantonment.*—None of the barracks on this site have been completed so far as ablution rooms, kitchens, and latrines are concerned; but most of the huts for the Royal Engineers, Mounted Infantry, Cavalry, battery of Artillery and battalion of Infantry have been erected. No stables, married quarters, Officers' quarters, with the exception of the Royal Engineers Officers' quarters, have been constructed as yet. The hospital has also not yet been commenced.

The construction of huts, &c., is the same as on the Naval Hill site. The aspect is north-east and south-west, or approximately so, with the verandahs on the northern aspect.

Some of the huts, such as Officers' quarters and Officers servants' quarters, have no ridge ventilation; the latter are also without through ventilation. They are raised, or not, above the ground according to the conformation of the surface. The surface underneath or around is not prepared.

The Royal Engineers' huts are occupied by the Construction Company, Royal Engineers, and one of the Mounted Infantry huts by 23 contractor's men; while another Mounted Infantry hut is occupied by a store accountant of the Army Service Corps and his family.

Temporary latrines and cooking arrangements are used, and waste water in the case of the Royal Engineers' barracks is conveyed in stone channels to a sump. There is no provision for prevention of fouling of the sites occupied in the Mounted Infantry lines, and refuse is being deposited on the surface about 80 feet from the Officers' quarters of the Mounted Infantry lines. According to the plans, the huts are placed 42 feet distant from one another end to end, and 80 feet side to side.

The huts are placed in parallel lines, with the ablution rooms and latrines on the flanks. The Artillery huts are, however, placed in the form of a square, with the ablution rooms and kitchens on two sides of the square. The acreage covered, if Officers' quarters and stables are included, varies from 30 acres in the case of the Infantry battalion, to 47 acres in the case of the Cavalry lines.

The stables are planned for erection at a distance of 80 feet from the line of ablution rooms, and 120 feet from the nearest occupied hut. It is understood that no provision is being made for concreting and draining any but Officers' stables.

The site selected for the military hospital is on a gentle slope between two lines of kopjes, and just above a dyke of intrusive rock connecting the kopjes. The drainage of the slopes and kopjes is towards this dyke. The higher portion of the slope is reserved as sites for quarters for married Officers and other ranks.

Health Statistics.

(a.) *Civil Population.*

The statistics of the civil population are unreliable. Under the Municipal Regulations, proclaimed by the State President of the Orange Free State in July, 1898, registration of deaths was made compulsory, but there appears to have been laxity in carrying out the regulations, especially with regard to the native locations. This has been recognized in the reports of medical officers of health.

In June, 1902, the law relating to the registration of births and deaths in the Colony was amended, but it has not yet come into operation in the rural districts or native locations.

Population statistics are also unreliable. A census made on 20th July, 1900, gave a total population of 4,783 whites and 4,716 natives. In June, 1901, the medical officer of health estimates the "corrected average population" at 6,350 "for white civilian population."

According to the health reports the number of deaths recorded are—

1896	118
1897	142
1898	150
1899	139
1900	126
1901	193

These figures referred to white population only, and, where estimates of population have been made, give death rates of 26·8 per 1,000 for 1900, and 30·38 per 1,000 for 1901.

For previous years, with a population presumably much less, the death rates would be higher. The chief cause of death has been enteric fever. The deaths from this disease equalled—

In 1896	24·5	per cent. of the total deaths.
" 1897	16·2	" " "
" 1898	16·6	" " "
" 1900	19·8	" " "
" 1901	9·3	" " "

The death records in 1899 are unreliable, and no percentages need be considered, and those for 1902 are not yet completed.

No other zymotic disease occupies the same prominent position in the records, and the opinion of successive medical officers of health is that enteric fever is, and has been, endemic in Bloemfontein for several years. Amongst the diseases notified, enteric fever is also the chief disease. In 1900, the notified cases were 115 out of a total of 139 notified diseases; and in 1901, 231 out of a total of 299. In 1902, there were 235 notifications amongst whites and natives, and of these 114 were cases of enteric fever, including 27 amongst natives. In 1900, the death rate amongst the native population was roughly estimated at 51 per 1,000. In 1901, no attempt was made to estimate this death rate, on account of the absence of reliable data.

(b.) *Military Population.*

The table appended shows the chief statistics for the standing garrison since the declaration of peace.

The chief feature of these statistics is the comparatively high admission ratio for enteric fever, especially when the fact, that the period embraced does not include the season of maximum prevalence, is taken into consideration. This is accounted for to some extent by admissions in June from units arriving from other localities. Although the admission rate is so high, the number of deaths has been only five, of which three occurred in June.

Another feature is the comparatively low admission rate for primary venereal affections.

Statistics of the health of the hospital staff are also appended. There is low incidence of all classes of disease.

Meteorological Records.

The principal records are shown in the table appended. The features are those generally of localities in the Upper Karoo.

The dust storms, especially over the sites occupied by existing and old camps, are frequent and severe, and at this season of the year the weather has been hot and oppressive.

The effect of thunderstorms on the new cantonment sites has not been determined.

PART II.

Conclusions.

(1.) The climate of Bloemfontein ought to be healthy.

(2.) Dust storms are the most important climatic conditions which should be mitigated by sanitary measures.

(3.) Generally speaking the sites of the new cantonments are sanitary sites, but their position on dolerite kopjes renders them liable to be played upon severely by lightning.

(4.) Without proper drainage, especially around huts, kitchens, ablution rooms, latrines, &c., foul water is apt to pollute surface soil and lodge in pockets in the underlying rock.

(5.) The site proposed for the military hospital is not the best site for a hospital. It is not sufficiently exposed to a free circulation of air, and lies too near a line of possible swampy ground.*

(6.) A more suitable site is the upper part of the same slope.*

(7.) The occupation of the cantonments in their present unfinished state is liable to cause pollution of the sites, and the longer this state of affairs continues the greater will be the risk of ill-health amongst the troops.

(8.) The chief danger will lie in the pollution of soil under and around the huts, and no proper provision has been made to prevent this.

(9.) The American trough latrine constructions are good, but the vacuum carts provided are those employed for emptying large cesspits, and may not prove suitable for emptying a series of troughs one after the other.

(10.) The most reliable water in the locality as regards quantity is the town water supply.

(11.) The water from the deep borings is the best as regards quality, but it is insufficient for a large garrison.

(12.) The town water supply can be greatly improved in quality by adding to the number of settling tanks and filter beds, and by increasing the depth of the filtering media.

(13.) The general sanitary arrangements and condition of the town and Kaffir locations are sufficient to account for the prevalence of enteric fever in an endemic form, and for a general mortality considerably in excess of that of healthy communities.

(14.) Prospective sanitary works and administration are likely to effect considerable change in this respect, and the present sanitary administration of the town is progressive.

(15.) The existing camps are without any definite sanitary organization. As in most other places, sanitation is very much a matter of weekly inspection by a Medical Officer, and of individual effort on the part of Regimental Officers.

(16.) The garrison does not show a high sick rate so far, but the enteric fever admissions are in excess of what should be expected in sanitary localities.

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* On re-examination of the site after heavy rain I find that it has a good slope on both sides, and is perfectly dry, a line of donga carrying away the surface water. There is, therefore, a considerable area which may be regarded as a good site without going to the top of the slope.

(17.) The high admission rate for enteric fever is to some extent influenced by:—

(a.) The number of admissions in June just after the declaration of peace.

(b.) A tendency to diagnose continued fevers of short duration as probable enteric cases.

(18.) The last point is supported by the low death rate from enteric fever in the garrison.

PART III.

Recommendations.

(a.) *New Cantonments.*

(1.) One of the most important sanitary principles to be followed in connection with placing troops on new sites for more or less prolonged occupation is that none of the lines should be occupied by units until the arrangements are complete so far as all sanitary works are concerned.

Unfortunately this principle has been transgressed with regard to the Naval Hill site and a portion of the Tempé site.

As the bad effects of such occupation do not show until continuous occupation has taken place, matters can now be put right by completing without delay the surface or other drains for the immediate removal of waste water, and by covering the surface soil under and around the huts with material which will prevent soakage into the soil and enable the surface to be kept clean. Concreting has invariably proved the best material for this purpose, but it seems hopeless to expect any satisfactory improvement to take place with regard to the surface soil under the huts already erected, because many of them are not raised sufficiently high enough above the ground, and also because the surface underneath is, in some cases, an irregular outcrop of hard igneous rock.

In such cases it is recommended that, for the present, the huts should be left as they are, but that the verandahs and surrounding soil should be properly prepared and channelled to surface drains. As time goes on it may be found possible to raise the huts and concrete underneath, and this should always be contemplated as an essential sanitary work, should there be undue prevalence of enteric, other fevers, or throat affections among the men occupying the huts.

In temporary barracks constructed without these necessary sanitary precautions in other commands, raising of huts and concreting underneath have had subsequently to be carried out. It is, therefore, strongly recommended that when lines have not yet been commenced, the sites of the huts should be prepared in a way that will prevent soakage of organic matter into the soil in and around the hut, before the hut is erected.

(2.) Another point, in connection with the occupation of the huts before sanitary works are completed, is that the kitchen, ablution and latrine accommodation is not yet ready in the full sense of the term. It is essential that these should be finished and the waste water, slops or scourings from these places led into properly constructed drains or sumps without delay.

In fact these details should have been completed *first* and the huts *last*; then there would have been no fear of the huts being occupied before they were, in a sanitary sense, fit for occupation.

This point has been so little attended to in the past, and is apparently receiving so little attention in the present, that it requires to be prominently brought to notice and insisted upon.

(3.) As regards details of construction and plans of cantonments, there is little to be added to what has been already decided upon. The spaces between the lines and between huts meet sanitary requirements, and the aspect and position of verandahs are the most suitable for the climate.

(4.) The worst feature in plans of hut construction is the absence of ridge ventilation in the quarters for Officers' servants. These quarters are back to back, and are bound to be extremely hot in summer and badly ventilated at all times. It is recommended that ridge ventilation be added.

(5.) The American trough latrines, as constructed, do not suggest any improvements; but it will probably be found necessary to make an inlet for the hose in the top of the vacuum cart instead of in the bottom, leaving the existing inlet as a discharge hole.

(6.) As regards the ablution rooms, these are so constructed that a line of shower bath compartments could readily be introduced down the centre of the hut. Plans for this have been brought to the notice of the Commanding Royal Engineer, Bloemfontein, Orange River Colony, and it is strongly recommended that a system of shower baths, such as is adopted in the armies of Continental Powers and in the United States, should be introduced into the South African cantonments. The system for barrack purposes has sanitary advantages which no other system of ablution possesses. Complete cleansing of the body takes place with greater economy in space, time, and water than in other systems, and the foul water is carried away at once. Further, the effect of the shower bath is more refreshing and stimulating than in tub, bath or basin methods of ablution.

It is, therefore, strongly urged that the ablution rooms erected in the new cantonments here should be fitted up with shower baths, especially as their construction is admirably adapted for the purpose.

As regards kitchens, meat stores, and bread stores, the provision of gauze for the windows and doors is recommended throughout, and not for the windows of the meat store alone, as at present.

(7.) Proper provision should be made for cleansing cooking utensils, and for the immediate removal of slops and refuse. This should be done without delay in the occupied portions of the cantonments, and, in other portions, before they are occupied.

(8.) As regards the ultimate disposal of latrine contents and foul water, it is understood that the municipal authorities have approved raising a loan of 250,000*l.*, for increasing the water supply and introducing the water-carriage system of sewage disposal; and it is stated that these works will be completed in 2 or 3 years. It would be safer, however, not to reckon on this, and to make immediate arrangements for conveying the surface drainage on to enclosed irrigated areas, which should be cultivated as gardens, on the grassy slopes below the sites, or to avenues of trees along the roads leading to the cantonments. There is no sanitary objection to ablution water running on to these irrigation areas; but vegetables grown on them should be grown on the ridge and furrow principle, and the irrigation and cultivation should be in the hands of a competent and intelligent manager.

(9.) The latrine contents should be removed from the military area, and deposited at the municipal trenching sites, or in that neighbourhood. There should be no difficulty in converting the trough latrines into a water-carriage system, and connecting them with the town sewerage scheme, when the latter is completed.

(10.) It is understood that a garrison aerated water factory will be established near one of the boreholes in the slopes below the Tempé site. The water is at present pure, and the proposal is a good one; but it is strongly recommended that both this water supply, and the town water supply, as laid on, should be systematically and regularly analysed, and that there should be a laboratory, sufficiently equipped for this purpose, in connection with the cantonment.

(11.) No detailed plans of stables have been seen, but it is strongly recommended that the decision, if such decision has been made, to construct stables without paving, channelling, or draining, be reconsidered. It is essential that the sites should not be fouled by the soakage from stables, or from the neighbourhood of watering troughs; and this cannot be well avoided, unless the surface of the stable and water-trough areas are covered with impermeable material and properly drained.

(b.) *Existing Camps.*

The chief requirements of the existing camps are—

(1.) Better latrine construction, to prevent soil pollution.

(2.) Removal of refuse to enclosed areas, and incineration of refuse there.

(3.) Proper ablution arrangements and removal of slop and ablution water to garden plots in the neighbourhood of the camps, instead of letting it soak into the ground anywhere.

(4.) Better organization of arrangements for sterilizing and storing drinking water for troops.

(5.) Reduction of number of men in tents. In standing camps, in peace time, and where there is abundance of space and no deficiency of tents, there seems no reason why more than four men should occupy a bell tent.

(6.) Appointment of a special sanitary officer to work up the sanitary organization of the camps to a higher level than at present.

In the present incomplete state of the new cantonments, as regards sanitary requirements, it is not admissible, from the sanitary point of view, to move troops into them, and it is, therefore, all the more necessary to improve the sanitary condition of the camps.

(c.) *Civil surroundings.*

(1.) The responsible civil sanitary authorities are aware of the defects and the works required to remedy them. But notification, disinfection and isolation in the case of infectious diseases, for native locations as well as for the town, are measures which the military authorities could help in urging on, with a view to the prevention of the spread of infectious disease amongst the troops.

(2.) Constructive works, with a view to improving the sanitation of the town, must necessarily be left to the municipal authorities, and no practical recommendations can be made in this direction by the military authorities.

(3.) In connection with supplies from the town, representations with a view to urging on improvements in milk supplies and the erection of well-constructed public slaughterhouses would probably have practical results.

(4.) The difficulties of obtaining good sanitary arrangements for washing clothing might be represented as a means of urging on the erection of public laundries.

W. G. MACPHERSON, *Major,*
R.A.M.C.

9*th February*, 1903.

TABLE I.—PRINCIPAL Health Statistics of British Troops at Bloemfontein.

Week ending.	Average strength.	Sick remaining.	Percentage to strength.	Admissions for: Enteric fever.	S.C. fever.	Dysentery.	Diarrhoeal diseases.	Sore throat.	Tonsilitis.	Primary syphilis.	Gonorrhœa.
1902.											
6th June	1,041	99	9·51	12	3	2	3	2	5	1	4
13th „	1,697	160	9·48	4	..	4	5	..	3	1	2
20th „	2,078	228	10·97	6	1	4	1	1	8	2	.
27th „	3,472	253	7·28	3	4	3	3	..	10	..	1
4th July	4,644	325	6·99	3	1	1	1	..	6	2	6
11th „	4,303	290	6·73	9	..	2	1	..	9	..	1
18th „	5,154	276	5·35	..	..	3	..	..	9	..	6
25th „	5,103	319	6·25	4	..	3	..	..	10	1	3
1st August	5,210	332	6·37	1	..	1	..	..	4	..	3
8th „	5,310	272	5·12	..	..	2	..	1	2	..	3
15th „	6,537	246	3·76	1	..	..	2	..	3	1	1
22nd „	6,836	224	3·27	1	..	3	..	..	4	1	..
29th „	6,982	221	3·16	1	.	4	1	..	7	..	3
5th September	3,558	204	5·73	..	1	1	2	..	9	1	4
12th „	2,998	182	6·07	1	1	..	2	..	5	1	2
19th „	2,555	205	8·02	..	..	1	3	..	5	1	5
26th „	2,218	166	7·48	..	..	1	1	..	2	..	1
3rd October	4,798	125	2·60	..	..	..	2	..	1	1	..
10th „	4,210	140	3·32	..	..	..	1	..	2	4	10
17th „	2,595	128	4·93	1	1	1	2	..	3	..	2
24th „	3,339	149	4·46	1	.	1	6	..	1	1	4
31st „	3,241	129	3·98	..	..	1	7	..	2	..	5
7th November	2,873	124	4·31	1	..	..	2	..	4	..	3
14th „	2,944	133	4·52	..	2	..	8	..	2	3	3
21st „	3,137	139	4·43	3	3	..	5	3	3	..	3
28th „	3,160	131	4·11	2	..	..	4	3	1	..	3
5th December	3,117	148	4·74	3	2	2	12	4	4	..	2
12th „	3,278	150	4·57	3	4	1	6	2	4	1	2
19th „	3,157	157	4·97	14	1	3	2	..	3	..	5
26th „	3,125	143	4·57	6	..	2	1	..	1	..	1
1903.											
2nd January	3,124	141	4·51	..	..	..	2	2	2	..	8
9th „	3,124	151	4·83	5	..	.	..	1	1	..	3
16th „	2,352	147	6·25	6	..	2	2	2	..	..	7
23rd „	2,330	154	6·61	1	..	..	2	..	..	..	..
30th „	2,341	148	6·25	1	..	1	1	1	..	..	4
				117		141		166		132	
Admission ratio per 1,000 of average strength per annum (average strength, 3,598).				48·31		58·23		68·53		54·50	

TABLE II.—HEALTH Statistics of Royal Army Medical Corps, Military Hospital, Bloemfontein.

Week ending	Average strength.	Admissions for						
		All cases.	Enteric fever.	Diarrhœal diseases.	Primary syphilis.	Gonorrhœa.	Sore throat.	Tonsilitis.
1902.								
6th June	106	..	..	..	..	..	..	..
13th "	107	1	..	..	..	..	..	..
20th "	108	..	..	..	..	..	..	..
27th "	110	..	..	..	..	..	..	..
4th July	109	1	..	..	..	..	..	..
11th "	131	..	..	..	..	..	..	..
18th "	139	1	..	..	..	1	..	..
25th "	140	1	..	..	..	1	..	..
1st August	191	2	..	..	..	..	1	..
8th "	150	2	..	..	..	..	..	..
15th "	150	3	..	..	..	..	..	..
22nd "	187	1	..	..	..	..	..	1
29th "	195	1	..	..	..	..	..	1
5th September	199	2	..	..	..	..	..	1
12th "	154	3	..	..	..	..	..	1
19th "	159	2	..	..	..	..	..	1
26th "	217	1	..	..	..	1	..	..
3rd October	199	2	..	..	..	..	..	..
10th "	204	2	..	1	..	1	..	..
17th "	213	..	..	..	..	..	..	..
24th "	259	3	..	..	..	1	..	..
31st "	263	1	..	..	..	1	..	..
7th November	260	5	..	..	1	1	..	..
14th "	273	1	..	..	..	..	..	..
21st "	272	3	..	..	..	1	..	..
28th "	269	1	..	..	..	..	..	..
5th December	236	5	..	..	..	..	1	..
12th "	233	2	..	..	..	1	..	..
19th "	164	2	1	..	..	..	..	..
26th "	193	3	..	1	..	..	1	..
1903.								
2nd January	200	..	..	..	..	..	..	..
Total	5,790	51	1	2	1	9	3	5
Admission ratio per 1,000 of average strength per annum	187	458·27	8·98	17·6	89·85		71·88	

TABLE III.—METEOROLOGICAL Observations at Bloemfontein.

Month.	Temperature in the shade.				Mean of rainfall.		Mean of relative humidity.
	Mean of maxima.	Mean of minima.	Absolute maximum.	Absolute minimum.	Inches.	No. of days.	
	degs.	degs.	degs.	degs.			degs.
January.. ..	86·0	59·0	94·7	49·9	2·13	8	54
February ..	85·0	58·6	94·1	52·0	2·74	8	56
March	80·2	53·8	88·0	39·0	5·16	9	75·5
April	74·5	45·6	83·0	34·7	2·49	8	68
May	67·7	36·8	74·9	26·0	1·51	4	64
June	64·4	30·9	69·0	20·6	0·25	2	61
July	64·4	29·2	72·5	20·7	0·42	3	65
August	69·1	34·4	79·9	24·5	0·97	3	58
September ..	75·5	41·9	86·0	31·0	0·99	3	53
October.. ..	80·9	48·0	90·0	37·0	1·62	6	49
November ..	83·4	53·0	94·5	40·7	0·69	4	46
December ..	86·1	56·2	94·0	45·0	2·32	8	52·5
Mean ..	76·5	45·6	..	..	21·29	66	58·5

NOTE.—There is no official meteorological station in Bloemfontein, although one is now being installed. Previous records have been made by private individuals and this table has been obtained from tables published in the Guide to South Africa. The temperature records are for the 15 years (1881–1895); the other records are for 5 years, but the years are not stated.

TABLE IV.—LIST of Boreholes at Bloemfontein made by Royal Engineers.

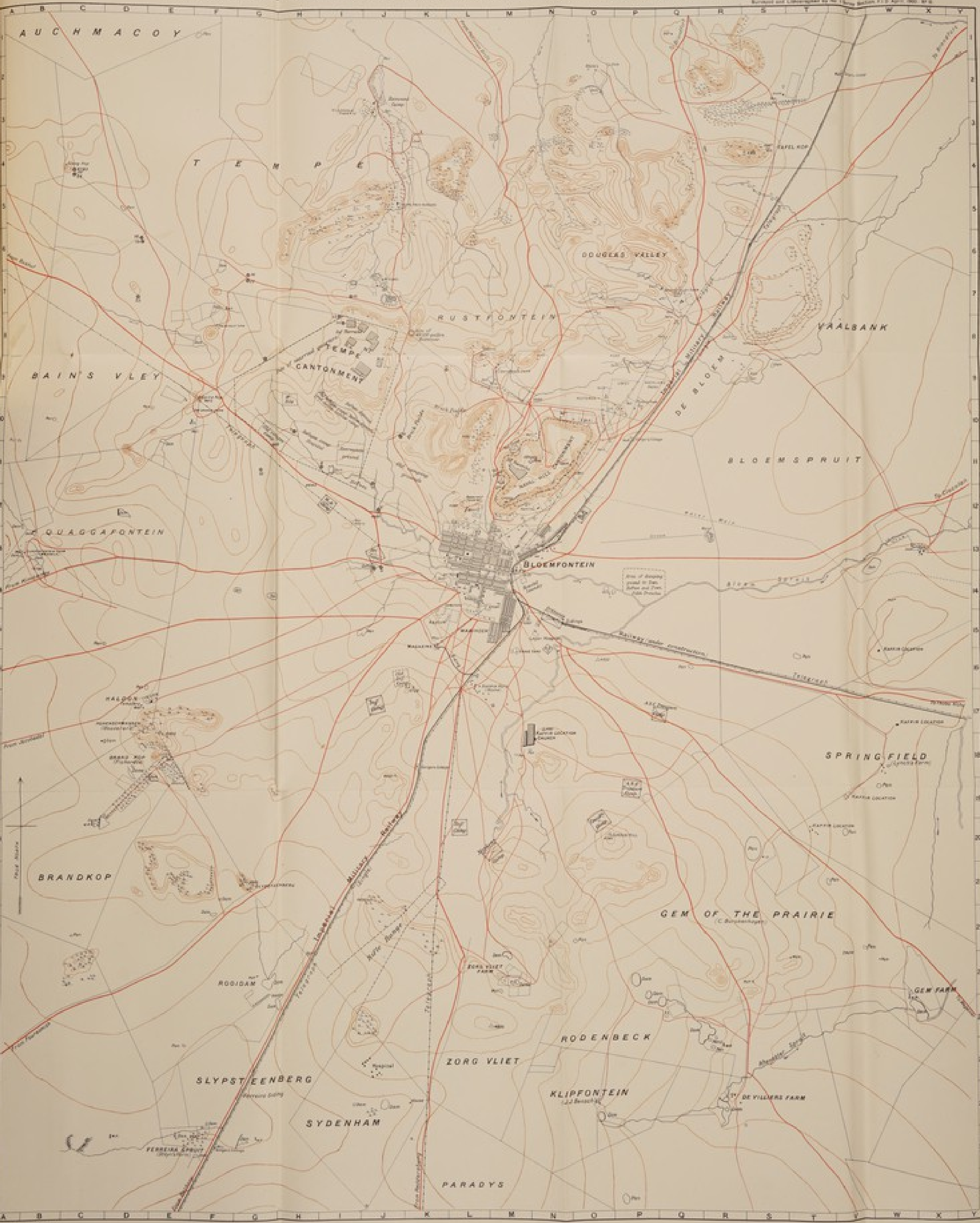
	Depth.	Diameter.	Supply in gallons per hour.
	feet.	inches.	per hour.
I.	51	3	500
II.	54	3	700
III.	204	3	350
IV.	48	6	4,000
V.	100	6	1,450
VI.	180	3	580
VII.	54	3	500
VIII.	133	3	500
IX.	165	3	500
X.	66	2	120
XI.	149	3	500
XV.	213	3	200
Ten other trials unsuccessful.			
Springfield	60	3	Abandoned.

TO ACCOMPANY MAJOR MACPHERSON'S REPORT ON BLOEMFONTEIN.

BLOEMFONTEIN.

Scale 2 inches to 1 Mile.

PLAN SHOWING SITES OF NEW CANTONMENTS AND EXISTING CAMPS, ETC., OLD BOREHOLES MARKED ⊗ AND NUMBERED.



REPORT ON LADYBRAND AS A CANTONMENT FOR BRITISH TROOPS.

Physical Features of the Locality.

Ladybrand is situated in a more or less horseshoe-shaped valley, surrounded from the south-west to the north-east by the sandstone cliffs of an undulating table mountain, the Plaatberg, and opening on the east to the Caledon River, which lies about 4 miles distant at its nearest point, but about 6 by the road. The valley is about 4 miles in diameter, and is about 5,200 feet above sea level, or 300 feet above the bed of the river.

The Plaatberg itself is a wide extent of grassy uplands rising to about 6,000 feet above sea level, and terminating abruptly in precipitous cliffs formed of masses of sandstone boulders and scrub. The cliffs are dented in about six places, forming kloofs or valleys. The more important of these kloofs are the "Maseru" hoek on the south-west, Lilyhoek on the west, and Bekker's hoek on the north-west. On the north there are two long valleys into the Berg. A series of dongas runs from these kloofs and minor valleys, and converge below the town in a donga leading to the Caledon. These dongas are more or less dry at present, with the exception of some pools used by the washerwomen of the locality, and a dam on the donga from one of the valleys on the north used for watering horses.

The slopes between the dongas are grassy undulating spurs, with their bases lying against the cliffs, and their apices reaching to the junction of the dongas. The town of Ladybrand is on one of these spurs, running from near the centre of the horseshoe, or western side of the valley.

The site selected for a cantonment is on a similar spur running from the south-western cliffs. Between the town and the proposed site of the cantonment, there is another slope, on which the existing camp hospital is pitched.

The camps of the Mounted Infantry, the old camps of the Infantry battalion, and the native location, are on meadow-like slopes on the northern side of the valley. The Army Service Corps and ordnance camps are placed between the town and the cliffs, on the upper end of the town spur.

Other camping grounds are the South African Constabulary camp on the lower end of the town spur, and old camps between the hospital camp and the proposed cantonment site.

There is a tendency to swamp or "vlei" formation between the hospital camp and the town, and on one portion of the proposed cantonment site.

The town commonage covers an area of 5,755 morgen (approximately 12,000 acres); and practically includes the whole of the horseshoe valley, and a narrow strip of the veldt above the surrounding cliffs. The town itself consists of 400 erven, each erf being somewhat more than an acre in extent (300 by 150 feet). A considerable proportion of the erven have not yet been taken up or built upon.

There are two Kaffir locations, an old location at the south-east corner of the commonage, about 2 miles from the town, and a new location about 1 mile north of the town. The former consists of 60 houses, the latter of 131. Until 1901, there was a location close to the town on the north side. This was demolished during the war, and the new location has taken its place.

There are one or two farms below the cliff on the north side, and two small houses and gardens below the cliffs on the proposed cantonment site. The remainder of the commonage is grassy veldt and meadow; but it includes also the surrounding cliffs and kloofs, where there is considerable bush and masses of boulders, and the belt of the undulating upland meadows on the top of the cliffs.

The geological formation of the Plaatberg is apparently cave sandstone, forming a thick bed of about 20 or 30 feet along the upper margin of the cliff. This bed of sandstone lies on shale, the line of the strata being well marked along the face of the cliffs.

The spurs below the cliff are apparently formed of shale and sandstone strata, similar to the shales and sandstones of the Karoo system. Some wells were examined, and one, sunk to a depth of 45 feet in the lower part of the town, showed blue shales and sandstones in a series of alternate strata, with one or two thin sills of intrusive rock. So far as can be ascertained from rough observation, the dip of the strata is slight, but towards the west.

The surface soil is a light sandy loam, overlying clay, judging from the section of the well examined. The surface loam was 3 feet deep, the clay 5 feet, and, beneath, there was a bed of sandstone about 3 feet thick, with another thick bed of clay below it, before the intrusive sills, shales and sandstones were struck.

The surface soil of the Plaatberg is a similar light sandy loam, overlying the sandstone mass which forms its chief geological characteristic. It is extensively cultivated and under crops, but in many places the rock is bare, and the soil is usually only a few inches in depth.

There is a marked absence of intrusive rock, such as is seen generally throughout the Karoo systems; the sandstone boulders and hills taking the place of the dolerite kopjes seen elsewhere. At the same time there is evidence of the presence of dolerite or finer grained igneous rock in several places, chiefly in the form of small boulders or stones imbedded in surface conglomerate. There is no apparent line of dyke formation.

The sandstone of the Plaatberg makes an excellent freestone for building purposes, easily worked, and hardening on weathering.

The town erven are cultivated, and form luxuriant gardens; otherwise the town commonage is devoted entirely to grazing, with the exception of the Lilyhoek kloof, which is picturesquely laid out as pleasure grounds, with trees and gardens, and paths leading amongst the boulders and along the cliffs. There is also a swimming bath in the grounds fed by one of the springs.

Water Supplies.

The whole of the water supply may be described at present as depending on springs. There are a few stagnant pools in the dongas where clothes are washed, and one donga has been dammed to supply water for horses, as already stated, while another dam above the town feeds irrigation furrows, which supply the town water erven. But the supply from these dams is precarious, the irrigation channels in the town being sometimes allowed to run only once a week.

None of the houses appear to have rainwater tanks for collecting and storing rainwater from the roofs, and only two or three private wells are known; these yield barely sufficient water for irrigating gardens. The well, referred to in connection with the geological strata, contained 6 feet of water, at a depth of 45 feet, and this could be exhausted by hand pumping during a day's work. It was about 6 feet in diameter, and had a 16-ft. bore in the bottom.

Reliance is placed, therefore, almost entirely upon the water obtained from springs. These are found at three different levels:—

(1.) On the Plaatberg above the cliffs.

(2.) On the line of cliffs about 20 or 30 feet from the top, *i.e.*, where the sandstone lies on the shale.

(3.) At the base of the spurs leading from the cliffs.

Approximately the number and character of the springs are as follows:—

(a.) *Springs on the Plaatberg.*

(1.) Two small surface oozings above the proposed cantonment site.

(2.) Two larger springs above the kloof, known as "Maseru hoek," *i.e.*, the kloof between the cliff of the cantonment site and the cliff above the town. (The upland mass above the town cliff is known as "Siege Hill.") One of these springs has been conserved by a masonry catchpit built round it and covered with a locked corrugated-iron cover. The water from it is led in pipes to the town storage reservoir.

(b.) *Springs on the face of the Cliffs.*

(1.) A small spring on the Siege Hill Cliff, also conserved and led into the town supply by junction with the "Maseru hoek" pipe.

(2.) A considerable spring issuing from the boulders high up on the Lilyhoek cliff. This is not conserved, but is used to feed the swimming bath in the Lilyhoek gardens below.

(3.) Another considerable spring high up on the Lilyhoek cliff, which is conserved in a masonry tank, cemented but uncovered, the water being led into it by an iron pipe sunk into the sandstone at the point where the sandstone and shale strata meet. The water is led from the tank to an ornamental fountain and garden below.

(4.) Two small springs high up on the north face the Lilyhoek cliff; these are conserved and led in pipes to the town storage reservoir.

(5.) A considerable spring in the cliff, known as Bekker's hoek. This spring is not conserved, and feeds the donga below.

(6.) Two small springs high up on the east face of the cliff, known as the Signal Hill Cliff, overlooking the new Kaffir location. These springs are not conserved, but the natives in the location draw water from them.

(c.) *Springs at the base of the Cliffs.*

(1.) Springs from cliffs on the northern side of the valley, supplying farms and the old native location.

(2.) Four small surface springs at the base of the proposed cantonment site. These are used in the gardens and houses on this site.

The quality of the water in all these springs is upland surface water percolating through sandstone. Where it can be obtained direct from the sandstone it is pure and good, but where it has not been conserved, or where it oozes out through surface soil, it has become contaminated.

The quantity yielded by each spring is very small, with the exception of the Lilyhoek garden and swimming bath springs, and the Maseru hoek and Bekker's hoek springs. Those on the new cantonment site were gauged roughly, and appeared to yield about 500 gallons only in the 24 hours. It is estimated, therefore, that 3,000 gallons would be the maximum obtainable by conserving the two springs on the Plaatberg above and the four surface springs below the site. The latter are at present in a filthy condition from pigs being allowed to wallow in them. Springs on the western side of the Plaatberg, on the side opposite to that of the Ladybrand valley, are stronger springs and are situated lower down the Berg. This tends to support the view that the dip of the strata is toward the west.

The yield of the springs supplying the town reservoir could not be gauged, as access could not be obtained for the purpose, and none of the town officials had gauged or knew the yield. The reservoir, however, has a capacity of 35,000 gallons, and this is apparently kept filled by the springs, with a probable consumption of 20,000 gallons daily, including the consumption in the camps. 20,000 gallons is, therefore, in all probability, a fairly approximate estimate of the combined yield of the springs feeding the reservoir.

The yield of the springs feeding the swimming bath and fountain in the Lilyhoek garden is fairly strong, and the two springs together probably yield about 30,000 gallons. The Bekker's hoek spring is said to have been gauged by a local doctor, who proposed building a sanatorium in the kloof. He says he gauged the yield at 30,000 gallons 4 years ago, but I am unable to verify this.

An additional spring was conserved and led to the town reservoir in pipes at a point high up on the southern side of the Siege Hill Cliff. The spring, however, is said to have shifted its position and no longer flows into the pipes.

An approximate estimate of the yield of all the springs enumerated, if the water were properly conserved, may be taken at 100,000 gallons daily.

Condition of Surface Soil.

The greater portion of the surface soil is a clean and grassy meadow land, but there has been important pollution irregularly over it.

(1.) The camps, with the exception of the hospital camp, still use trench latrines; consequently a considerable area around the Mounted Infantry Camp site is polluted by these latrines.

(2.) The town area contains open cesspits in all houses except one or two, where there are pail closets.

(3.) The contents of the pails from the hospital, and such of the houses as use pails, are deposited in deep pits on the grassy slopes below the proposed cantonment sites.

(4.) The native locations have no latrines, and the adjoining surface and dongas are polluted by them.

(5.) All slops and ablution water soak into the ground around the town habitations and tents. There is no gardening in the camps except at the hospital. The hospital water, however, is not used in the garden, but soaks into the surface soil.

(6.) Dry refuse is deposited irregularly at many points around the town, in the dongas, and on the slopes below the proposed cantonment site.

(7.) Carcases are buried or left on the surface near the cantonment site and filth pits.

(8.) The blood and offal from the two slaughterhouses, one on a grassy slope north of the town, and the other on a similar slope south of the town, are allowed to soak into the soil around.

The irregular distribution of these sources of surface soil pollution leaves only two or three slopes which are entirely free from one or other of them. There is an absence, however, of bare, worn and dusty patches of surface, and an universal covering of meadow grass gives a clean pleasing appearance to the surface soil of the locality.

Civil Sanitary Surroundings.

Sanitary administration is at present carried out under no Public Health Act for the Colony.

Municipal Regulations were published in August, 1901, and are in force. They affect sanitation in so far as powers are given to abate nuisances, to protect water supplies, and to control native locations, washing places, butchers' shops and slaughterhouses. But they are not definite in character, and do not provide for sufficient sanitary organization and administration; the only Officer of the Municipal Council, on whom lies the onus of carrying out the sanitary provisions of the regulations, being an old man, who has carried on the business of a carpenter in the town for very many years. The result is an absence of any sound sanitary administration.

The pipes leading from the springs to the water reservoir are indifferently laid. A 4-inch pipe, for example, is led into a 2-inch pipe. This occurs on the line of main leading from the Maseru hoek spring to the reservoir, and the joints have given way from the resulting.

The reservoir itself is leaking all round its base and has had to be puddled, otherwise it is well constructed and covered, although it has three loopholes, where pipes enter, which allow the dust to be blown in.

Distribution from the reservoir is to standpipes in the town and to houses. A water rate of 10*s.* annually is levied on all houses using the standpipes only, and of 2*l.* on houses to which the water is laid on.

The streets are unmade and are covered with grass. The side channels, used for irrigation water, are earth channels, and are also covered with vegetation.

There are no latrines. Open cesspits in the gardens, with privies over them or with no privies at all, are the rule.

Slops and ablution water are thrown out on the soil.

In the few houses with pail closets the pails are carried on poles by prisoners from the gaol to the nightsoil trenches. There is no organized system for dual pails, cleansing and disinfecting, nor is there any organized sanitary staff of labourers.

There are cattle kraals inside the town, and camps of settlers, &c., without any latrine arrangements, are frequently pitched in the centre of the town on the church square. There is no provision for the removal of dry refuse.

The two slaughterhouses of the town are merely a couple of poles and a cross bar in the open veldt. Blood and offal are received into open pits in the ground, and there is no enclosure, prepared slaughtering floor, or water supply.

There is one aerated water factory. It has only recently been opened. It has no laid on water supply, water being brought in old beer casks filled at a standpipe and rolled along the street, a distance of 300 or 400 yards to the factory. There is no purification of the water; the bottles are washed in tubs by hand outside in the street. The manufacturer is under the impression that aerating the water destroys all disease germs

The new native location is without a water supply. Water has to be brought by hand from the springs high up on the Signal Hill Cliff or from one of the town standpipes. The former source involves a climb of 500 feet steep ascent and a walk of ½ mile from the location. The latter source involves a walk of 1 mile from the location and a water rate of 5s. annually.

The number of houses in the location is 131, as already stated, and the probable population 600. The population of the town is probably about 1,000, but no census has been taken. The resident magistrate estimates it at 2,000, inclusive of the troops.

There are no special sanitary arrangements for milk shops, bakeries, or butchers' shops. There are no laundries. Washing is done privately in gardens or in the donga pools by the native washerwomen.

A feature of the locality is a swimming bath in the Lilyhoek gardens. It is fairly well constructed, but the spring supplying it becomes muddy from contact with surface soil before entering the bath, and the water in it is consequently turbid.

A cesspool with privy over it is sunk in the soil on a slope above the bath and drains towards the channel feeding the bath.

There are two cemeteries on slopes to the north-west and south-east of the town.

Existing Camps.

The existing camps are small—namely, a Mounted Infantry camp, South African Constabulary camp, supply, transport and ordnance camps, a provost prison and hospital.

Their position has already been indicated.

Their water supply is drawn from the town standpipes and conveyed in water-carts. There is no filtration or boiling of drinking water. On account of the purity of the town water, these are not considered necessary.

There is no special ablution arrangements except in the hospital; but in all camps the ablution water and slops soak into the ground in the neighbourhood of the camp; that is to say, there is no removal of foul water, nor irrigation of cultivated plots by it.

Trench latrines are used everywhere except in the hospital. Major Hale, D.S.O., the Senior Medical Officer, has devised a form of seat cover for the trenches, which is described as "light tight." The object is to prevent flies alighting on the trenches, on the principle that they will not enter dark places. It is said to give much satisfaction. It consists simply of a wooden box placed over the trench with a hinged cover over the seat. These seats are moveable, and the form of latrine is practically a moveable latrine. The result at present is that the camps using the trench latrines become more or less surrounded by latrine trenches, and the tents have to be shifted from time to time to new ground.

The horse lines are placed outside the line of tents.

Dry refuse is deposited at no fixed spot on the veldt.

At the hospital, where there are pail latrines, the pails are removed daily by prisoners from the gaol and brought back immediately after the contents are deposited in the filth pits, about ¾ mile distant.

Health Statistics.

(a.) *Civil Population.*

Death registration became compulsory only a few months ago. The first entry in the death register is 30th August, 1902.

Between that date and the end of December, 14 deaths have been recorded amongst the white population of the town.

Registration amongst the natives and rural population has not yet been enforced.

Only one of the 14 deaths is recorded as due to zymotic disease, namely diarrhœa.

14 deaths in the four months is equivalent to 42 in the year, or a death rate of 21 per 1,000 per annum in a population of 2,000. As this population includes the military population, the actual death rate of the town population will probably work out at a higher figure, but no reliable death rate can be ascertained from the short statistical period recorded.

The absence of zymotic deaths is a favourable sign of local health.

I have been unable to ascertain accurately the existence or otherwise of epidemics in the locality in previous years.

(b.) *Military Population.*

The table appended gives the principal health statistics of the troops in camp since the declaration of peace.

The figures are extremely small for ratios intended for comparative purposes, but so far as they go they show a low incidence of enteric fever, equivalent to 7·8 admissions annually per 1,000 of an average strength of 575 (*i.e.*, the average strength of the period during which average strength has been recorded). It should be noted, however, that the period does not include the period of maximum enteric prevalence. The incidence of dysentery, diarrhœa and throat affections is also comparatively small.

There appears to be a considerable amount of primary venereal diseases, but when an annual admission ratio is worked out there is, comparatively speaking, a somewhat low admission ratio for these diseases.

The percentage of sick to strength is also comparatively low, being only 3·5 on the 24th January, that is to say, in the middle of what is the unhealthy season in South Africa.

Meteorological Records.

I have been unable to discover any records. None are being kept at present.*

The extensive grassy meadows, with entire absence of baked denuded patches, cools the winds and prevents dust storms, while the high elevation keeps the summer temperature from becoming oppressive.

The rainfall is about 34 inches on the average.

Conclusions.

(1.) The situation and climate of Ladybrand ought to be extremely salubrious.

(2.) The water supply is good in quality but limited in quantity.

(3.) A considerable quantity of pure spring water is allowed to run to waste, or become contaminated by contact with polluted surface soil.

(4.) The quantity of pure water could be largely increased, doubled or trebled probably, by conserving springs, at present contaminated or running to waste.

(5.) A considerable addition to the water supply could also be obtained by collecting rainwater from roofs of houses.

(6.) Well supplies are unreliable, both in quantity and in quality, but it is probable that borings in the sandstone, below the level of saturation, in the slopes on the top of the Plaatberg, especially in the neighbourhood of the springs there, would yield a considerable supply of pure water.

(7.) Deep borings into the shale and sandstone strata of the valleys, are also likely to yield a considerable supply of good water.

(8.) The general sanitary organization of the town is primitive, and would inevitably convert the town into an insanitary area, should the population increase and the erven become more crowded with houses.

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* I have since found a statement of rainfall, published along with other tables in a Report issued by the Meteorological Commission, *see* Appendix.

(9.) A serious outbreak of disease is likely to occur sooner or later in the native location, in consequence of the extremely meagre supply of water and the difficulties in obtaining it ; and in consequence of the absence of sanitary arrangements.

(10.) The sanitary arrangements in the camps are not sufficient to maintain healthy conditions for long, without frequent shifting of the camping grounds.

(11.) The arrangements for disposal of nightsoil, carcases, and refuse on the town commonage are unsatisfactory, and tend to pollute a much larger area than is necessary, and to render good building sites insanitary and unsightly.

(12.) The same remark applies to the slaughterhouses.

(13.) The health statistics of both civil and military population are very favourable so far as they go.

(14.) The strength of any garrison would be limited in consequence of the limited water supply, but sites exist for a garrison of some size.

Recommendations.

(a.) *For Standing Camps or Permanent Garrisons.*

The site offered on the Town Commonage is limited and consists of 240 acres, of which only one-half is suitable for garrison purposes. The remainder is broken by dongas and is liable to be swampy, or lies on the cliff overlooking the site. There is room for one battalion with hospital, married quarters and other garrison accessories, and it is not recommended that any larger garrison be permitted to occupy the site unless the remainder of the slope is added.

As regards water supply it is recommended that this be obtained from one or other of the sources of the town water. The springs on the site itself are not sufficiently important to supply the needs of a garrison and consist of a mere oozing through the surface soil. The only possible way of utilizing them to advantage is to make a cutting in the soil down to the water bearing rock, and build it round with masonry. A trial cutting should certainly be made of this kind, preferably in connection with the springs above the cliffs, and trial borings made in the sandstone base of the cutting.

It may be that a considerable supply of water would be obtained in this way and the success of similar cuttings in connection with the railway settlement supply at Naauwpoort, where the physical features are somewhat similar, render this probable.

Should the trial fail, then the town supply ought to be increased by conserving the springs noted in the first part of this report and a sufficient quantity laid on to the garrison site. This could readily be done by gravitation but not from the present town water storage reservoir unless the proposed site were moved lower down the slope. From a sanitary point of view there is some advantage in moving it somewhat lower down as the site becomes more open there.

With regard to drainage the slopes and soil are well adapted for conveying waste water to irrigation areas at the debouchment of the town valley near the south-east corner of the commonage, and this is the site which it is recommended should be selected for any sewerage scheme, or for the deposit of latrine soil should a water-carriage system of sewage be impracticable on account of deficiency in water and temporary nature of the occupation of the site.

As regards construction it seems that two essential points have to be considered :—

(1.) If the garrison is intended to be under canvas only then the most essential accessory constructions from a sanitary point of view are—

- (*a.*) Latrines, preferably on the American trough principle.
- (*b.*) Ablution stands.
- (*c.*) Kitchens.
- (*d.*) Water tanks.
- (*e.*) Night urinal slabs.

With good and easily worked freestone on the site itself it is strongly recommended that this material be used in even temporary constructions of this nature. It should be possible to prepare good channelled bases for temporary purposes both for latrines, urinal slabs and ablution stands out of the sandstone, possibly at less cost than the cost of good concreting.

The waste water from the ablution stands should be conveyed by pipes or surface channels to irrigated gardens in the neighbourhood. The soil is admirably adapted for gardening, and utilizing of such waste water for growing plants, trees, vegetables or crops, is the most sanitary way of disposing of it.

What is urged most in the matter of construction is that such latrines, ablution rooms, urinal slabs and kitchens, should be the first consideration, mess huts, recreation rooms and canteens, the last.

(2.) If the garrison is intended to be placed in hutments, the use of the local freestone is again urged in place of corrugated-iron huts. Barracks of this material are in every way preferable from a sanitary point of view; but, if corrugated-iron huts are erected on the site, it is essential that the soil under and around the huts should be rendered impermeable, capable of being kept thoroughly clean and channelled to surface drains. The same remark applies to all stables and watering troughs.

(b.) *Existing Camps.*

The chief requirement is the establishment of some definite sanitary organization to remove latrine soil, slops and refuse from the camps, and deposit them in selected and enclosed spots.

The trench latrine system is gradually forming an area of trenches close to the camps, and it is time that a properly-organized pail system, (dual pail-system preferably), be introduced with concrete or sandstone slab bases for the latrines.

Ablution stands should also be constructed on similar bases, and waste water led into irrigated plots for gardening purposes.

There is little to be said with regard to water supply. The town water supply is good, and there is nothing to throw doubt upon its purity. Fortunately there are practically no other sources of water supply in the neighbourhood, and there is little likelihood of any other water being used for drinking purposes.

(c.) *Civil Surroundings.*

These are outside military jurisdiction, but the Municipal Council seem anxious to adopt any reasonable proposals for improving their sanitary arrangements. It is, therefore, recommended that they should be asked :—

(1.) To obtain a sufficient number of night soil and refuse carts for present needs.

(2.) To enclose an area of ground on the south-east corner of the commonage for trenching nightsoil and depositing and burning refuse and carcases.

(3.) To have the present depositing places cleared and cleaned as soon as possible.

(4.) To introduce sanitary systems and water supply into the native location.

(5.) To have a proper public slaughterhouse constructed.

(6.) To exercise sanitary control over the manufacture of aerated waters, especially with regard to method of cleansing the bottles.

(7.) To overhaul the water pipes, especially those leading from the springs to the tanks, to increase and improve the storage and to conserve more springs.

These are the more important measures of sanitation with which the Municipal Council should deal in the first instance.

As the population increases the making of the streets and surface channels, and the introduction of a sanitary system of closets, are matters which will have to be dealt with in order to prevent a high mortality from zymotic disease. In fact, the question of the abolition of the open cesspit system should be considered without delay.

W. G. MACPHERSON, *Major,*
R.A.M.C.

9th February, 1903.

TABLE I.—PRINCIPAL Health Statistics of British Troops at Ladybrand.

Week ending	Average strength.	Sick remaining.	Percentage sick remaining to strength.	Admissions for: Enteric fever.	S.C. fever.	Dysentery.	Diarrhœal diseases.	Sore throat.	Tonsilitis.	Primary syphilis.	Gonorrhœa.
1902.											
6th June	..	3	..	1	..	..	..	..	..	..	..
13th „	..	3	..	..	..	..	..	..	..	..	..
20th „	..	6	..	1	..	..	..	..	..	..	..
27th „	276	9	3·22	..	..	..	..	..	..	..	..
4th July	413	4	0·98	..	..	..	..	..	..	..	..
11th „	609	6	0·97	..	..	..	..	..	..	..	..
18th „	628	9	1·43	..	..	..	..	..	..	1	..
25th „	617	6	0·97	..	..	..	..	1	..	1	..
1st August	614	3	0·48	..	..	..	..	1	..	..	..
8th „	..	6	..	..	..	..	..	..	..	..	..
15th „	..	4	..	..	..	..	..	..	..	..	..
22nd „	381	7	1·83	..	..	..	..	..	..	..	..
29th „	369	6	1·62	..	..	..	..	1	..	..	..
5th September	283	4	1·41	..	..	..	..	..	..	..	..
12th „	293	6	2·04	..	..	..	..	..	..	..	..
19th „	292	4	1·36	..	..	..	..	..	..	..	..
26th „	293	14	4·77	..	..	..	..	..	..	..	1
3rd October	274	11	4·01	..	..	..	..	..	..	..	2
10th „	494	9	1·82	..	..	..	..	..	..	..	..
17th „	466	11	2·36	..	..	..	..	..	..	..	..
24th „	738	15	2·03	..	..	..	..	..	..	..	..
31st „	763	21	2·75	..	3	..	..	..	..	..	1
7th November	782	10	1·28	..	2	..	..	..	..	..	..
14th „ ..	783	12	1·53	1	..	..	..	..	1	..	1
21st „	781	15	1·92	..	1	..	..	..	1	..	2
28th „	737	12	1·62	..	..	1	..	..	..	..	1
5th December	737	22	2·98	..	2	1	..	..	..	..	3
12th „	755	18	2·38	..	1	2	..	..	..	..	1
19th „	742	17	2·28	..	1	1	..	1	1	..	1
26th „	763	15	1·96	..	1	1		..	..	..	1
1903.											
2nd January	754	24	3·18	..	2	..	2	..	..	1	5
9th „	543	21	3·86	..	..	..	..	..	..	..	2
16th „	543	20	3·68	..	..	..	..	..	..	..	..
23rd „	543	19	3·49	..	..	..	..	..	..	..	2
Admission ratios per 1,000 of average strength per annum				42·56		21·27		18·62		69·15	

TABLE II.—MEAN Monthly and Annual Rainfall at Ladybrand.

(Height above sea level, 5,000 feet; lat., 29° 15′ S.; long., 27° 47′ E.)

Mean of 8 years (1885 and 1887–93).

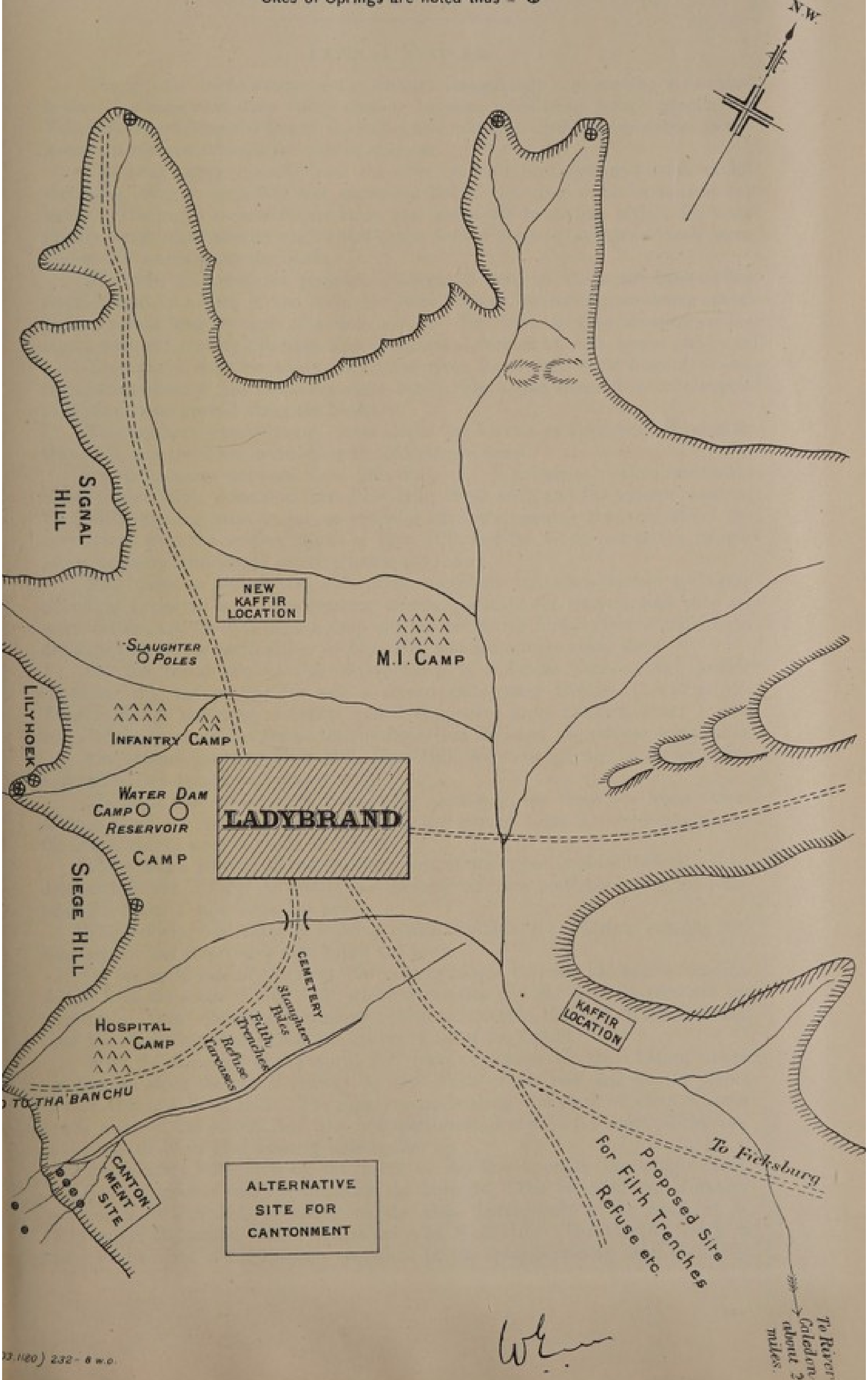
January	5·80 inches.
February	4·72 „
March	4·10 „
April	3·28 „
May	1·24 „
June	0·99 „
July	0·72 „
August	1·31 „
September	1·76 „
October	2·73 „
November	3·95 „
December	3·81 „
Year	34·41 „

(From Dr. A. Buchanan's "Discussion on Rainfall in South Africa," published by the Meteorological Commission.)

ROUGH SKETCH MAP OF LADYBRAND, ORANGE RIVER COLONY.

(Scale—Approximate 1 inch = 1 mile.)

Sites of Springs are noted thus = ⊕



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REPORT ON KROONSTAD, ORANGE RIVER COLONY, AS A CANTONMENT FOR BRITISH TROOPS.

Physical Features.

The general conformation of the district immediately surrounding Kroonstad is that of a somewhat deep valley running between undulating grassy uplands, the Valsch River marking the line of the valley and taking a winding course from south-west to north-east through the area in question.

The land slopes upwards from the river on both the north and south banks, the slopes rising to some 200 feet above the bed of the river within a mile of the banks. The banks themselves are steep and about 30 to 40 feet high. They are thickly lined with mimosa and willows, the former forming a belt of bush some 100 to 200 yards along the banks.

The town of Kroonstad occupies a tongue of land on the north bank of the river, formed by a loop of the river, the area covered by habitations being about $\frac{2}{3}$rds of a mile long by $\frac{1}{3}$rd of a mile across. The town is thus bounded on the south, west and east by the river, and is separated from it by high banks and bush.

The upland slope on the north of the river forms four main lines of slopes, terminating about 1 mile from the river banks, where they descend more abruptly to the low-lying ground along the banks.

The southern extremities of these slopes are known as East Hill, West Hill, Gun Hill, and the slope overlooking the old refugee camp.

The depressions between these hills form dry watercourses, which run southwards to the river; those from the East Hill, West Hill, and the eastern slopes of Gun Hill draining into dongas or artificial channels entering the river above the town, those from the western slopes of Gun Hill, and the slopes above the refugee camp, draining into dongas entering below the town.

The banks on the eastern side of the town are not much broken up, being somewhat preserved by a large masonry channel; but on the western side they are much cut up, and there is there a deep cutting or ravine forming the outfall of the drainage from the western slopes of Gun Hill and the refugee camp slope.

On the town side of this ravine there is a better class native location (Location A), and on the far side a second and poorer location (Location B). There is also a temporary location, called the native scout location, about 1 mile north of the town, on the slopes leading from Gun Hill and the refugee camp slope.

The uplands north of East Hill, Gun Hill, &c., rise gently to an extensive undulating and uninhabited grassy veldt.

The south side of the river rises in the same way, but there is a wider extent of bush along the bank opposite the town, the ground there is more swampy, and the slopes rise to a stony kopje of dolerite.

The western portion of the southern side of the river is much broken up by deep ravines and a large tributary, the Bloemspruit, runs northwards into the river, joining it about 1 mile below the town.

The railway line takes a winding course through the district, crossing the Bloemspruit and the river $\frac{1}{2}$ mile below the town.

On the north side of the river the railway passes between the native locations A and B to the south of Gun Hill, where the station and the station settlement are placed. It then continues a winding course northwards between West Hill and East Hill, following more or less the contour lines of the former.

With the exception of the supply and transport camps all the existing camps are grouped along the line of railway, on the north of the line and on the slopes of Gun Hill and West Hill. The supply camp is along the south of the line about $\frac{1}{2}$ mile north of the station, and the transport camp is also on the south of the line, at the base of West Hill, about $\frac{3}{4}$ mile further up.

The military hospital is on the north of the line opposite the supply camp. The Royal Engineer camp is alongside the hospital. The camp of one Infantry battalion is on Gun Hill, or rather on the slope immediately to the north of it. The camp of the second Infantry battalion is on West Hill. The Cavalry camp is about 1 mile north of the Infantry battalion, on the uplands leading from Gun Hill.

Old camping grounds were chiefly on the western slopes of Gun Hill, and between it and the town, or on the slopes south of the town, and on the slopes leading to the river west of the native location. There was a large divisional and detail camp about 1 mile south of the town, and until the 6th January, 1903, the Cavalry camp was pitched just above this old camping ground. There was also a large remount camp on the south side, between the railway and the Bloemspruit.

The river banks up stream from the town are free from habitations, the nearest town up stream on the Valsch being Lindley, at a distance of some 45 miles. There are some native kraals and farms up stream in the neighbourhood of Kroonstad, but they are about 1 mile distant from the river, on slopes overlooking it.

Geologically the district belongs to the upper Karoo system of sandstones and shales. Coal is being quarried some 30 or 40 miles away, and there are diamond fields in the immediate neighbourhood.

In most of the depressions and lower portions of the slopes leading from the higher uplands to the river bank, the surface soil is a clay alluvium or brick earth. The upland slopes beyond Gun Hill are a light sandy loam, overlying sandstone, in a thin stratum of 3 inches to 2 or 3 feet deep. The sandstone forms numerous outcrops and the surface is covered with a fairly thick short turf. On the southern slopes there are large areas of black alluvial soil.

There is no marked kopje formation of dolerite or basalt, except at East Hill and on the south side of the river, and lines of dykes of intrusive rock are not traceable on the surface, the only outcrops being sandstone or occasionally shale. There are numerous sandstone cliffs on the river banks and on the ravines of entering watercourses. This sandstone is quarried and is said to be excellent for building purposes.

At some places, notably on the apex of Gun Hill, the uppermost stratum is soft yellow shale.

The strata are, however, generally hard grey sandstone alternating with layers of blue shale. Quartzite is found amongst the grey sandstone.

Water Supply.

The water supply is mainly from the river and from deep bores. Rain water and surface bores form a portion of the supply, and dams and "vleis" are found here and there. Surface wells are not a feature of the locality.

(1.) *River Water.*

This forms the main supply of the town, Native Locations A and B, and the railway settlement, as well as a portion of the supply to the camps.

(a.) *Town Supply.*

The intake is about 1 mile up stream from the town, and about 50 yards below the entrance of the donga draining the western slopes of East Hill, the slopes of West Hill, and a portion of the western slopes of Gun Hill. An artificial intercepting masonry channel has however been made to take the drainage from the north of the line of the railway, and this channel diverts most of the drainage from the Gun Hill slopes and discharges below the intake, and just above the town.

The water is pumped from the river to two small filter beds, of 548 and 354 square feet superficial area respectively, on the south-west slope of Gun Hill, and passes from these to a storage tank of 333,000 gallons capacity. It is distributed to the town from this tank. Rising and distributing mains are 5-inch cast-iron pipes with rubber socket joints.

The pumps are said to pump at the rate of 4,000 gallons per hour to the filter beds, although the rate is questioned, and the correct rate is regarded as 2,448 gallons. There are no settling, equilibrium, or regulation tanks, and the water flows on to the filter beds over a small weir direct from the rising main.

The filtering media are sand, 15 to 18 inches, and varying sizes of sandstone fragments for 2½ feet. The sand is a good sharp sand, obtained by crushing the hard grey sandstone from town quarries on the river bank below the native locations.

The water is turbid, and the nature and capabilities of the filter beds are insufficient to completely clarify or purify the water. The rate of filtration is in excess of the maximum flow for good sand filtration of river waters, being calculated at 5·73 inches per hour in the larger and 8·88 inches per hour in the smaller bed, with pumps working for 24 hours. The water, after filtration, has been analyzed on several occasions. The principal analyses amongst the records are—

(*a.*) Cape Government Laboratory analysis of 31st October, 1900.

(*b.*) Staats Laboratorium, Pretoria, of 5th January, 1901.

(*c.*) Analysis by Lieut.-Colonel Birt, Military Laboratory, Bloemfontein, 20th December, 1902.

(*d.*) Analysis by Major Beveridge, Military Laboratory, Pretoria, 12th January, 1903.

All these analyses have been carefully examined. They do not present evidence of a sewage-polluted river, but rather those of a comparatively uncontaminated river water. None of the analyses indicates, however, that the filters are acting properly.

For distribution to the town and native locations water is laid on to ½-inch house connections and to standpipes. For distribution to camps water is pumped direct from the storage reservoir to tanks near it. Watercarts are filled from tanks and convey the reservoir water to camps for ablution purposes. 10,000 gallons are distributed in this way daily from the reservoir to the camps.

Water is also pumped direct from the reservoir to the Cavalry camp on the slopes north of Gun Hill through a line of pipes, which supply the watering troughs and tanks for ablution purposes.

(b.) *Railway Supply.*

The railway intake is about 300 or 400 yards below the town intake. The pump works at the rate of 4,000 gallons per hour and feeds two reservoirs, one of 3,000 gallons for supplying the houses of the settlement and railway station, and the other of 20,000 gallons for supplying the engines. The water is unfiltered and is not subjected to purification of any kind, except privately in houses.

The intake is well above the discharge of the intercepting surface drain from the camps north of the railway, and the water is practically the same as the town water as regards quality at the intake.

The river is dammed on the west side of the town, and the water above the dam forms a long reach as far as the intakes, the town intake being about 1¼ miles above the weir.

(2.) *Deep Bores.*

The drinking and cooking water of the camps and the water of the native scout location are from deep bores. Nineteen bores have been sunk, varying in depth from 70 to 390 feet. They are all in sandstone and shale strata, and water appears to be struck in the grey sandstone or quartzite below the blue shale. Six of the bores, including the deepest, gave no yield. The aggregate yield of the others is 64,000 gallons in 24 hours. Many have been used for 2 years, and there is no indication of the yield diminishing.

The water of several of these boreholes has been analysed from time to time. Excess of chlorine, solids and free ammonia, such as frequently characterizes water from deep strata, has been noted in some analyses, but otherwise the water is pure. It is invariably clear and sparkling.

(3.) *Shallow Bores.*

A shallow well (Rixon's Well) has been sunk in the uplands on a "vlei" in the line of the watercourse between the slopes above East Hill and West Hill, about 200 yards north of the railway line, and 2 to 3 miles distant from the river. It is sunk in the midst of extensive and uninhabited uplands, over which numerous herds of cattle are grazing. The well is sunk in 7 feet of alluvial clay and 13½ feet of hard grey sansdtone. Three 2½-inch bores are sunk in hard grey sandstone in the bottom of the well, *i.e.*, at 20 feet from the surface, and water rose to 2 feet from the surface. At the bottom of the bores there is a sill of basalt. The 7 feet of surface soil have been steyned with stone and cement (*see* plan appended). The yield is calculated at 20,000 gallons in 24 hours during a fortnight's gauging.

The water was analysed 21st December, 1902, at the Military Laboratory, Bloemfontein, and declared "chemically pure" and free from "sewage or pathogenic organisms."

This water is intended to be the drinking water supply of the permanent camps, and will be pumped to storage reservoirs and laid on by gravitation.

(4.) *Rain Water.*

A number of houses, especially those of the railway settlement, have well constructed rain-water tanks connected with roof gutters. The water is used for drinking and domestic purposes in preference to the turbid river water. Two such tanks, with taps, are on the railway platform and are used by the public.

(5.) *Surface Wells and Springs.*

There are practically none in the locality.

Condition of Surface Soil.

Generally speaking, the surface soil, considering the fact that Kroonstad had a large garrison during the war and was used by many columns as a refitting station, is comparatively free from evidence of camp refuse, filth pits, and other signs of pollution. There is also marked absence of dead animals and carcases. This is largely due to the fact that an incinerator was constructed and all carcases were burnt during the war.

The work of removing night soil, slops and refuse, was placed in the hands of the municipality, and the result has been that there is no haphazard deposit of refuse, &c., at various places over the surface.

The extensive uplands north of Gun Hill, which have been offered as a site for permanent camps, are remarkably clean and free from any sign of pollution by camps or human beings.

The filth trenches, used by the Municipality for depositing camp and town night soil, are being planted with eucalyptus trees and fenced off. They are in the middle of the slopes between Gun Hill and the slopes above the refugee camp, just above the native scout location.

The dongas near the river, between the town and Kaffir locations, are the least clean spots in the neighbourhood.

The soil around habitations and Kaffir locations is being polluted from want of proper surface drains. The chief streets of the town have fairly adequate sandstone side gutters, but no proper provision is made for the general drainage of the town area.

In the camps the only apparent soakage into the ground, apart from soakage from horse lines, is in and around the ablution places; but, with the exception of the hospital latrines, which have good concrete bases, the latrine and urinal pails are placed direct on the surface soil. The camping ground on the south of the river, just vacated by the 14th Hussars, is the least clean surface of all. The horse lines were between rows of tents, and the soil was a muddy black soil. The tents were practically pitched on soil saturated with soakage of organic matter from horses, and the horse and camp refuse was deposited some 200 or 300 yards higher up the slope.

An old cemetery is in the grounds of the existing military hospital, and another between the town and the railway station. The new cemetery is placed between the second native location and Gun Hill, on the western slopes of the latter.

An extensive refugee camp, with a population of some 6,000, was placed on a grassy plateau below the slopes to the west of the Gun Hill slopes. This plateau ends in a sandstone cliff and ravine, Leeuw Krantz, about 2 miles below the town. The ground is now almost clear of tents and huts. It has been kept clean. The refuse and filth trenches cover an area near Leeuw Krantz, and there is also a cemetery for the refugees near this area.

The dry refuse of the town is being deposited on the east boundary of the town, with a view to filling up a donga there.

Civil Sanitary Surroundings.

Civil sanitary administration is in the hands of the Municipal Council. There is a Medical Officer of Health, who receives 30*l.* annually and engages in private practice. There is no Public Health Act, but the Municipality works under the old Municipal Regulations of the Orange Free State with certain additions and alterations, issued under the instructions and authority of the Military Governor on the 24th October, 1900.

These latter regulations deal with the prevention of nuisances, notification of infectious diseases, conservancy and slaughterhouses. The existing sanitary arrangements are largely the outcome of regulations introduced under the military government of the town during the war.

The Municipal Council is progressive in sanitary matters and Kroonstad is rapidly becoming a well-managed municipality from the sanitary point of view.

The water supply has already been indicated. It is a river-water supply inadequately purified. At present new waterworks are under construction, by which the river water will be purified in filter beds constructed to filter at the rate of 2 to 3 inches vertical filtration per hour, with equilibrium and regulation tanks and covered storage and distribution tanks. The whole of these works have been planned and are being carried out in accordance with a report made by the Medical Officer of Health for the Colony in 1901.

The general scheme is as follows :—

(1.) One large settling tank for 500,000 gallons.

(2.) An influent well (equilibrium tank).

(3.) Two filter beds of 1,200 superficial feet each, with space for an addition of two similar beds if required.

(4.) Filtration through 2½ feet sand and 2½ feet coarse gravel and broken stone.

(5.) A trough for washing the sand.

(6.) An effluent well, covered, (regulating tank).

(7.) Two clean water reservoirs, covered, of 350,000 gallons each.

(8.) A distributing well, covered.

The number of erven is 342, the dimensions of each erf being 60 by 150 feet on an average. Most of the erven are taken up and built upon; and the number of houses is returned at 260 without counting the railway settlement.

In 1901 a census estimated the population at 2,400. This seems in excess of the estimate justified by the number of the houses; and 1,500 is more likely to be a correct estimate, even with the railway settlement included, (about 60 houses).

The native population is estimated at 7,000 to 8,000; but the number of huts in all three locations is only 800. This is not likely to give a higher population than 4,000.

The consumption of water is 16,000,000 gallons in the year. In December last it was 1,091,000 gallons. Approximately, this is equal to 35,000 gallons daily; 10,000 gallons of this amount goes to the camps, leaving only 25,000 gallons for the civil population, or between 4 and 5 gallons per head of a white population of 1,500 and a native population of 4,000. Were the population higher, as estimated by the census of 1901, the consumption of water per head of population, considering that the water is laid on to houses and that the consumption is unrestricted except so far as cost is concerned, would be incredibly low.

The provision, therefore, in the new waterworks scheme for filtering 90,000 gallons daily at a rate of 2 to 3 inches vertical filtration per hour is an ample provision for the present population, without a water-carriage system of sewage disposal. The situation of the town precludes any possibility of such a system unless pumping is resorted to, or the sewage discharged into the river without land treatment.

The latrine arrangements, on the pail system, were introduced in May, 1900; until then night soil was disposed of in cesspits on the premises. In this connection, it may be again noted that there are no surface wells in the locality, the present river-water supply having been introduced 8 or 9 years ago.

The pail system is worked by the Municipality with a staff of three inspectors and 48 native labourers. The contents of the pails are removed bi-weekly from private houses unless more frequent removal is demanded and paid for. From public establishments such as hotels, and from public latrines in connection with native locations, the removal is nightly.

Two tank carts, of 200 gallons capacity, are engaged in the work, with two in reserve. The pails are removed weekly in Scotch carts and cleansed by paper and rags being burnt inside them: they are afterwards tarred.

The night soil is deposited in deep trenches (about 8 feet deep), in black alluvial soil on the slopes leading from the high veldt beyond Gun Hill, and just above the native scout location. 2,000 eucalyptus trees have been planted over the site of night trenches already filled in, and the area is fenced in.

Slops and urine are removed bi-weekly in two tank carts similar to the night soil carts, but there are, in addition, a large 400-gallon and small 200-gallon tank, carried on wagons, in use for this purpose; the contents are deposited in the night soil trenches.

Dry refuse is removed bi-weekly in Scotch carts, and is being used at present to reclaim land in a donga running on the east of the town.

There are no public laundries. Washing is done in the river below the railway bridge and about ½ mile below the town. There is a military laundry on the Bloemspruit, but its construction as regards prevention of soil pollution is faulty. It is, however, well provided with laundry machinery and utensils.

There is one public slaughterhouse on the veldt at Leeuw Krantz, a sandstone cliff, about 2 miles west of the town, on a donga running into the north bank of the river. The slaughterhouse is to the west of the old refugee camp and cemetery. It has recently been constructed of sandstone and consists of four compartments with good concrete floors, channelled to a concrete sump. Blood and offal are removed from the sump and buried in the neighbourhood. There are cattle kraals in connection with the slaughtering compartments. Water is conveyed in water-carts from the river, or is obtained from a rain-water tank connected with the roof of the slaughterhouse. Only one compartment is at present being used for slaughtering; one is used as a store for skins; the other two are occupied as living rooms by a white family.

The old trenches and refuse dumping ground of the refugee camp is in the neighbourhood, and there are many litters of pigs on the premises.

There is only one aerated water factory; it is a large establishment; town water is used. The water is boiled by steaming, and then pumped through a 36-candle Berkefeld filter to the filling machine. Bottles are washed by revolving brushes in unpurified town water and rinsed out with a spray washer. Arrangements are being made to rinse out with a steam spray. The premises are well constructed. There are large stacks and sacks full of old bottles in the yard.

There are no milkshops or cowsheds in the town, and there is no sanitary control of milk supplies.

Houses are well constructed of sandstone, kiln-burnt bricks, or corrugated iron. The number of sun-dried brick or mud houses is small, except in the location. A sum of 6,500*l.* has been taken up for improving surface drainage. The streets are only partially metalled.

There are no means of isolation and disinfection in the case of infectious diseases, but disinfectants are issued by the Municipality at cost price to the inhabitants, and are purchased by the latter freely.

The rates for general purposes are 1*d.* in the £ of value of fixed property. For night soil removal a charge of 5*s.* monthly is made, or 10*s.* if the removal is nightly. A charge of 4*s.* monthly is made for removal of slops, and 2*s.* 6*d.* monthly or 1*s.* a Scotch cartload for removal of dry refuse. Water is charged at the rate of 2*s.* 6*d.* per 1,000 gallons.

The Municipality also carry out conservancy arrangements for the military camps at a charge of 2½*d.* per pail, nightly removal, and 2*s.* a cartload of dry refuse.

Existing Camps.

The sites of the existing camps and their water supplies have already been indicated. The surface soil is a clean sandy loam covered with grass, except at the hospital, where it is black alluvial soil denuded of vegetation.

The arrangements for purifying water vary with the units. Some boil the water, some do not; some boil and filter, and the Cavalry regiment has a definite regimental organization for purifying and storing drinking water.

The chief difficulty appears to be a deficiency of storage tanks. Thus, one Infantry battalion has only one 50-gallon tank for storing and cooling boiled drinking water for 500 men, the other battalion has only one 4½-gallon rum cask for the same purpose.

Latrines are without prepared bases; dry earth is used. The contents of pails are removed nightly. The pails are cleansed twice monthly and tarred. The proportion of pails is about 7 per cent. of strength.

Ablution sheds are erected in the camps. In one there is a concrete channel under the stands leading to a concrete sump, from which the water is pumped to tank carts and removed; in another a sail cloth is placed in the earth sump, and the water is pumped from it to the tank carts. In none is the surface of the ablution sheds concreted, and the ground has become dirty and sloppy.

In one regiment large wooden tubs are provided as baths for the men, they are also placed on sloppy surface soil under the shed.

A regimental aerated water machine has just been erected in one of the camps.

At the hospital, latrine and ablution places are well concreted and channelled, but the approaches are over a black alluvial surface soil.

Railway Station.

The latrines, &c., are well constructed and clean, with good concrete foundations and arrangements for removal of surface washings by gutters. The water supply on the platform is from two rain-water tanks connected with the roof gutters. This supply is rapidly exhausted. There are three taps to which water is laid on from the railway reservoirs, *i.e.*, unfiltered river water from the railway intake. One tap is over a washing trough beside the latrines, and is marked "for washing only," another is inside the latrines at the entrance, a third is at the back of the station, and is the main supply for passengers and troops when the rain-water tanks are empty.

Permanent Camps.

An extensive site of 650 acres, extending along the uplands north of Gun Hill, has been selected for permanent camps. It is an ideal site, a clean sandy surface soil, overlying sandstone and covered with fine grass, sloping gently to good lines of drainage on either side, and free from dongas or other broken ground.

The area has been planned to hold one regiment of Cavalry, one battery of Artillery, a military hospital of 200 beds, and Royal Engineer, supply, transport, and ordnance camps, giving considerably more than 50 acres to each of the larger units.

It is understood that the troops will be under canvas, with hutments for Officers' and serjeants' messes, and for canteen and recreation rooms.

The height of the site varies from 160 to 200 feet above the river, and its southern extremity is about 2 miles distant from the river and town; it is on ground overlooking the valley of the river, and the aspect is pleasant and cheerful. There are one or two pans on the south of the site. These are being drained.

Health Statistics.

(a.) *Civil Population.*

Reliable statistics for any length of time are wanting. Death registration is being carried out in the case of the white population only. The first entry is dated 15th August, 1902. Since then the following entries have been made:—

August	3
September	3
October	5
November	6
December	4
January	3

or a total of 24 deaths in 24 weeks. This is equivalent to 52 deaths in the year, which, in a white population of 1,500, is a death rate of 34·6 per 1,000 per annum. If the white population is 2,400, as estimated in 1901, the death rate would be 21·6 per 1,000.

Of the 24 deaths recorded since August two are noted as due to enteric fever, and 13 to dysentery or diarrhœa. 62 per cent. of the deaths are, therefore, due to these diseases.

Very little can be ascertained regarding the medical history of the town previous to the war, but in 1895 there appears to have been an epidemic of enteric fever, and the railway settlement was attacked severely.

It is stated in a report by Dr. Yule, the Medical Officer of Health for the Colony, on the town and railway water supply, that 86 cases were recorded in four months.

Since May, 1900, notification of infectious disease has been compulsory for white population only. In that year 28 cases of enteric fever were recorded out of a total of 29 notified diseases; in 1901, four out of a total of six; and, in 1902, nine out of a total of 11. In January this year four cases of enteric fever and one of scarlet fever have already been recorded.

The chief disease amongst natives at present is scurvy.

(b.) *Military Population.*

Tables appended give the principal health statistics of the military population since the declaration of peace.

The percentage of sick to strength has been comparatively low and does not exceed that of many stations in England and Wales.

The incidence of enteric fever and other continued fevers is high, but this is mainly due to admissions during the first three months after peace was declared. Latterly, isolated cases only have occurred.

Dysentery and diarrhœa have been prevalent during the past three or four months, and the incidence of sore throats and tonsilitis has also been considerable during the same period.

The excessive incidence of these diseases was attributed to the Cavalry regiment which was camped on the south of the river, about 3 or 4 miles from the sites of the other camps, and on or above ground which was a large camping ground for divisional and other details.

Tables appended have been prepared to elucidate this point. The result is that the Cavalry regiment gives admissions for enteric and S.C. fever, dysentery, diarrhœa and throat affections, equal to 21·5 per cent. of average strength for the period 25th September, 1902, to 30th January, 1903, as compared with 10 per cent. in one Infantry battalion and 4·6 per cent. in the other for the same period.

The state of the Cavalry camp ground on black soil, which works into a bog in rains, and with the horse lines inside and close to the lines of tents, as compared with the clean grassy sand slopes in the other camps, throws considerable light on these statistics. Further, the number of men in the Hussar tents was an average of seven and maximum of eight as compared with an average of four and a maximum of six in the tents of the Infantry regiment showing the lowest incidence of these diseases.

The incidence of venereal disease is at present comparatively slight. The old Dutch Contagious Diseases Act, which is still in operation, gives power to imprison persons disseminating syphilis, but not persons disseminating gonorrhœa. The Act is made use of in suppressing venereal disease.

Meteorological Records.

The only records which I have been able to obtain are those of rainfall. The first table gives a series of records by seasons (July to June) for 20 seasons. They are obtained from one of the local inhabitants, the observations having been recorded by Dr. Symonds. The second table gives the mean monthly rainfall for 10 years as recorded in Dr. A. Buchanan's Tables, published by the Meteorological Commission.

The minimum seasonal rainfall is 16·26 inches for 1888-89, and the maximum

43·56 for 1880-81. The wettest month is January and the driest July. The heaviest rainfall was apparently 12·41 inches in January, 1893.

The temperature must be regarded as similar to that of other localities in the grass veldt at the same elevation, and dust storms are mitigated by the wide extent of grass and belts of trees in the locality.

The climate generally is regarded as pleasant and bracing, and is much praised by military Officers who have been here throughout all seasons.

One of the inhabitants, who has taken a keen interest in meteorological observations, states that the lowest temperature recorded was 19 degrees Fah. and the highest 92 degrees Fah. during a long period of years.

Conclusions.

(1.) The natural characters of Kroonstad, as regards climate, physical features, soil, &c., are favourable to maintenance of a high standard of health.

(2.) The water supply from deep borings is apparently good and reliable in quantity.

(3.) The water supply from the river for both town and railway is collected at intakes, liable only to intermittent pollution during heavy rains, and otherwise no worse than other river supplies in South Africa, collected above habitations.

(4.) The municipal arrangements for purifying the river water are defective and inefficient.

(5.) The proposed water supply for the permanent camp is upland surface water percolating through sandstone.

(6.) It requires special works to make it thoroughly reliable in quality. The quantity is sufficient for a garrison of 2,000, without a water-carriage system of sewage or general baths.

(7.) The proposed site for a permanent camp to the north of Gun Hill is one of the best sites yet observed in South Africa for a garrison.

(8.) The sanitary arrangements and administration of the civil community are in many respects more progressive than those seen in other towns in South Africa.

(9.) The civil aerated water factory is the best arranged for maintaining purity of water and bottles yet seen in South Africa.

(10.) The chief sanitary defects of the town, in addition to the inherent defects in the quality of an unpurified river-water supply and pail system of conservancy, are those due to absence of sufficient surface drainage and means of preventing soil pollution in and around habitations, and the absence of Public Health Acts and Regulations by which infectious diseases can be isolated and controlled.

(11.) The chief sanitary defects in the existing camps are those due to imperfect construction of latrines and ablution places, defective arrangements for storing water for drinking and other domestic purposes, and liability to overcrowding of the bell tents.

(12.) The health statistics of the troops show remarkably good health in one Infantry battalion with a high incidence of diarrhœal diseases and throat affections in the Cavalry regiment.

(13.) The difference in the conditions of surface soil and overcrowding of tents is sufficient to account for the differences in these health statistics.

(14.) The health statistics of the civil population do not show anything very definite as yet.

Recommendations.

(a.) *For permanent Garrison or Camp.*

As regards site, it is strongly recommended that the selected site for a permanent cantonment be retained as a garrison site for British troops, should other considerations permit.

From a sanitary point of view it is a better and healthier site than any of those selected in Bloemfontein or Ladybrand; in fact, it is one of the best sites I have yet seen. There is a good line of drainage along the slopes to the ground at present used for trenching the night soil, and beyond that towards the refugee camp filth pits. The soil is suitable for drainage and irrigation schemes. The water supply from deep borings, from Rixon's Well, or eventually from river water purified in properly constructed waterworks, should be abundant in quantity and good in quality; and the sanitary prospects of a garrison at Kroonstad are good. Bad sites may be made sanitarily good, and good sites may be made sanitarily bad by expenditure or lack of expenditure on sanitary works, but a good site requires less expenditure than a bad site, and Kroonstad is distinctly one of the good sites.

The site wants for permanent garrisons or camps, in the first instance, well-constructed latrines, ablution rooms and kitchens, with good concrete channelled bases leading to concrete sumps or to pipes connected with irrigation areas. The existing latrine and ablution arrangements would soon foul the ground, and the first consideration should be to have these accessories carefully constructed and in working order before the sites are occupied. It is time enough afterwards to consider the erection of mess, canteen, and recreation huts.

In the construction of latrines and ablution rooms for permanent camps, where the pail system of removal of night soil and slops has to be used, an essential feature should be the construction of a concrete slab, channelled to the floor channels, on which the tank carts should stand when they are being filled.

A considerable sanitary difficulty arises in connection with horse lines in permanent camps. In a permanent garrison, concreted, paved, or bricked and channelled stables are essential for the prevention of soakage into the soil. In the Kroonstad sites a proposal has been made to kraal the horses. If this proposal is carried out, it is strongly recommended that the kraals should be well down the slope, and at some distance (200 or 300 yards) from the camp. The condition of health of the 14th Hussars, which was manifestly due to the intermingling of horses and men on unsuitable ground, is evidence of the condition of affairs likely to arise from want of attention to the prevention of soil pollution in and around camps by horse lines.

As regards the water supply, it is understood that this will be pumped from Rixon's Well to a storage reservoir, and laid on by gravitation to the camps, and that the well will be covered and protected from pollution. If the covering of the well is good, then the only danger of pollution will be from surface percolation in heavy rains from the surface soil into the well between the ashlar lining and sandstone. To obviate this, it is recommended that a good masonry channel be made above the well to divert the surface flow down the "vlei" in which the well is sunk.

As regards siting and area for units on the cantonment site there is little to say. The extent of land available is more than sufficient to give 50 acres to each unit; and, if the men in the permanent camp are to be under canvas, it is strongly recommended that not more than four men, or even three, be put into a bell tent. There is some indication of the effect of overcrowding in bell tents, in the difference in the health statistics of the 2nd Queen's and 2nd Worcesters. Both units are camped on the same kind of soil and practically on similar sites; both have the same kind of water supply; both are away from horse lines, and are surrounded by clean grassy veldt. The only difference apparently is in the average number of men in the bell tent. In the Queen's, the number (an average of seven and maximum of eight) is nearly double that in the Worcesters; and their statistics of admissions for fevers, diarrhœal diseases, and throat affections, are also nearly double.

In order to preserve the grass as much as possible on the permanent cantonment sites, the formation of metalled roads and cinder paths is strongly recommended in the camps.

The erection of a garrison aerated water factory is of less urgent importance in Kroonstad than elsewhere, the only advantage being that water from purer sources than the town river water would be supplied to it.

(b.) *Existing Camps.*

If the existing camps are to be shifted eventually to the permanent sites there is little to recommend at present, but no such change of site should take place until the recommendations regarding latrines, ablution places, &c., are carried out on the new site.

It is, however, strongly recommended that the latrines and ablution rooms of the existing camps be constructed as already recommended if the occupation of these camps is to continue, and the new cantonment site to remain unoccupied.

With regard to overcrowding there seems to be urgent need of reducing the number of men in bell tents to four in all camps.

The camp, which it is recommended should be moved first to its permanent site, is the hospital. It is on a black alluvial soil and its removal to good clean sandy veldt would be a good move from a sanitary point of view.

At the same time it should be noted that the health of the hospital staff and the general comfort of the hospital is good, and there should be no change to a new site until all the necessary accessories and comforts are as good as at present.

It is also recommended that, so long as the pail system of conservancy exists, the contract for removing night soil, slops, &c., should remain in the hands of the Municipality so as to ensure night soil being deposited in one place only for the whole of the locality. The action of the Municipality in planting eucalyptus trees around the trenches is also a strong reason why their filth trenches should be used.

An improvement in the cleansing and disinfecting of pails and their contents would be to whitewash them inside and out with chloride of lime instead of tarring, and to use a solution of chloride of lime (4 ozs. to the gallon) in the pails instead of dry earth.

(c.) *Civil Surroundings.*

All the questions of surface drainage, provision for isolation, and disinfection in the case of infectious diseases, better purification of water supplies, &c., have already been taken up by the Municipality.

A new slaughterhouse has been erected and it is understood that a public laundry will also be provided.

Under these circumstances it would be superfluous to urge reform in these directions.

I have suggested that it would be well to plant eucalyptus or other trees along the boundary of the area of the filth trenches at present in use, in addition to planting them over the old areas, and this suggestion might be represented to the Municipality by the local authorities.

The absence of notification of infectious disease and death registration in the native locations is a condition of affairs that should be rectified without delay. This is a matter for the Colonial Government to deal with.

The unpurified river water laid on to the railway station is a danger to the travelling public and troops using the railway, and strong representations should be made to ensure the filtration of the river water through sterilizing filters before it can be drawn off at railway platform taps. An installation of Pasteur-Chamberland or Berkefeld filters under pressure on the line of the delivery pipe would effect the purpose.

The stationmaster is keenly alive to the necessity of some such arrangement, and it only wants suitable representation to the railway management to have a very necessary sanitary reform of this kind effected.

In concluding this report it is fair to add that the present Senior Medical Officer, Lieut.-Colonel Moberly, R.A.M.C., has anticipated most of my recommendations, and that his personal influence with the Municipality and interest in prevention of disease have gone far to create a progressive attitude towards local sanitation.

W. G. MACPHERSON, *Major,*
R.A.M.C.

9th February, **1903.**

APPENDIX.

TABLE I.—PRINCIPAL Health Statistics of British Troops stationed at Kroonstad.

Week ending	Average strength.	Sick remaining.	Percentage to strength.	Admissions for: Enteric fever.	S.C. fever.	Dysentery.	Diarrhoeal diseases.	Sore throat.	Tonsillitis.	Primary syphilis.	Gonorrhœa.	Soft chancre.
1902.												
6th June	..	52	..	17	3	5	2	..	..	..	1	..
13th ,, ...	..	87	..	5	8	6	2	1	3	..	1	..
20th ,, ...	..	98	..	8	11	8	1	..	2	1	..	..
27th ,, ...	..	141	..	2	5	..	..	..	2	..	2	..
4th July	..	133	..	..	4	3	..	..	8	..	2	..
11th ,, ...	..	93	..	1	3	..	1	..	1	..	1	..
18th ,, ...	..	100	..	..	3	3	..	..	2	..	..	..
25th ,, ...	..	99	..	..	4	1	..	..	6	..	..	..
1st August	4,260	109	2·55	2	7	1	..	3	3	..	2	..
8th ,, ...	4,215	84	1·99	..	1	..	1	..	3	..	1	..
15th ,, ...	4,283	78	1·82	2	1	..	1	1	1	..	2	1
22nd ,, ...	3,723	85	2·28	3	3	1	3	7	1	..	..	..
29th ,, ...	3,636	80	2·20	1	..	..	3	3	4	..	..	..
5th September	2,355	69	2·93	..	..	..	..	1	..	2	..	..
12th ,, ...	2,114	67	3·16	..	..	2	..	..	2	..	..	..
19th ,, ...	1,493	60	4 01	..	..	..	..	2	..	..	..	..
26th ,, ...	1,504	61	4.0	1	..	..	..	..	1	..	..	..
3rd October	2,520	79	3 13	..	..	..	..	..	5	..	..	..
10th ,, ...	1,588	77	4 85	..	..	9	10	..	3	..	..	..
17th ,, ...	2,472	83	3·35	..	..	4	5	..	3	..	2	1
24th ,, ...	2,421	93	3·84	..	..	3	8	..	4	..	..	2
31st ,, ...	2,209	81	3·66	..	..	2	1	..	1	..	..	..
7th November	1,589	71	4·46	1	..	3	7	..	6	1	..	..
14th ,, ...	1,658	84	5.06	..	1	5	6	..	4	..	5	1
21st ,, ...	1,571	95	6·04	2	..	1	11	..	11	..	4	..
28th ,, ...	1,619	83	5·12	..	..	4	2	..	10	..	1	..
5th December	1,506	77	5·11	..	2	1	7	..	3	..	4	..
12th ,, ...	1,566	79	5·04	..	..	3	3	5	1	..	1	1
19th ,, ...	1,518	79	5·20	1	3	5	1	..	7	1	5	..
26th ,, ...	1,463	81	5·53	*4	..	3	4	1	4	..	..	1
1903.												
2nd January	1,463	81	5·53	..	2	..	..	..	2	..	1	..
9th ,, ...	1,481	73	4·9	..	3	1	4	..	..	..	..	..
16th ,, ...	1,479	66	4·4	..	..	3	1	1	1	..	..	..
23rd ,, ...	1,494	74	4.9	1	1	1	5	..	2	..	..	3
30th ,, ...	1,488	62	4·1	..	..	3	1	..	1	1	..	..
Admission ratio per 1,000 of average strength per annum.	Average strength, 2,200			80·64 (Enteric fever and S.C. fever)		118·13 (Dysentery and Diarrhoeal diseases)		91·76 (Sore throat and Tonsillitis)		35·45 (Primary syphilis, Gonorrhœa and Soft chancre)		

* Includes three cases diagnosed in January

TABLE II.—ADMISSIONS, average Strength, &c., 2nd Bn. Worcestershire Regiment, from 25th September, 1902, to 30th January, 1903.

Week ending	Enteric.	S.C. fever.	Dysentery.	Diarrhœa.	Sore throat.	Tonsilitis.	Total all causes.	Average strength.	Average daily sick.
3rd October	..	..	..	..	..	..	1	279	4
10th "	..	..	..	1	..	..	2	276	4
17th "	..	..	..	..	..	1	5	266	5
24th "	..	..	..	..	..	..	4	262	9
31st "	..	..	1	1	..	1	8	250	10
7th November	..	..	..	..	..	..	4	254	11
14th "	..	..	..	..	..	..	3	255	8
21st "	..	..	..	..	..	..	5	234	10
28th "	..	1	..	..	..	..	3	229	11
5th December..	..	..	..	..	..	..	5	230	12
12th "	..	1	..	..	..	..	3	235	12
19th "	1	..	..	..	..	1	8	232	19
26th "	..	..	..	..	..	1	5	220	14
2nd January	..	..	..	..	..	..	2	214	15
9th "	..	..	..	..	..	..	1	211	11
16th "	..	..	..	1	..	..	1	206	7
23rd "	..	..	..	..	..	..	..	227	3
30th "	..	..	..	..	..	..	..	225	2
Total..	1	2	1	3	..	4	60	..	..

TABLE III.—ADMISSIONS, average Strength, &c., 2nd Bn. The Queen's Regiment, from 25th September, 1902, to 30th January, 1903.

Week ending	Enteric.	S.C. fever.	Dysentery.	Diarrhœa.	Sore throat.	Tonsilitis.	Total all causes.	Average strength.	Average daily sick.
3rd October	..	..	..	..	..	..	2	730	23
10th "	..	..	2	1	..	1	12	733	24
17th "	..	..	..	4	..	3	21	732	33
24th "	1	..	1	2	..	2	20	729	32
31st "	..	..	..	4	..	1	10	623	30
7th November	..	..	..	2	..	1	43	546	31
14th "	..	..	..	1	..	1	7	544	23
21st "	..	..	..	1	..	..	8	537	24
28th "	..	..	..	1	..	3	7	536	20
5th December..	..	..	..	..	..	1	8	534	23
12th "	..	..	1	1	..	2	9	532	20
19th "	..	1	1	2	..	1	10	495	22
26th "	1	1	1	..	..	..	6	463	24
2nd January	1	..	..	1	..	2	11	462	28
9th "	..	..	..	1	..	..	10	501	31
16th "	..	..	..	..	1	1	10	504	31
23rd "	..	1	..	2	..	1	11	508	29
30th "	..	..	..	1	..	..	8	502	28
Total..	3	3	6	24	1	20	213	10,211	476
							Aver.	567	26

TABLE IV.—ADMISSIONS, average Strength, &c., 14th Hussars, 25th September, 1902, to 30th January, 1903.

Week ending	Enteric.	S.C. fever.	Dysentery.	Diarrhœa.	Sore throat.	Tonsilitis.	Total all causes.	Average strength.	Average daily sick.
3rd October	..	..	..	..	..	..	..	Not known	4
10th ,, ...	..	..	..	..	..	..	7	453	6
17th ,, ...	..	..	2	1	..	..	6	429	9
24th ,, ...	..	..	..	..	..	..	1	317	12
31st ,, ...	..	..	5	3	..	1	12	480	16
7th November	..	..	2	4	..	4	15	560	25
14th ,, ...	..	1	5	8	..	4	26	630	36
21st ,, ...	..	..	1	7	..	10	25	566	47
28th ,, ...	..	..	4	1	..	7	17	618	43
5th December..	..	2	1	3	..	2	12	538	35
12th ,, ...	..	..	1	2	..	4	13	597	35
19th ,, ...	1	..	2	..	..	4	11	592	36
26th ,, ...	..	..	2	2	1	2	15	587	34
2nd January	1	..	2	..	..	..	7	583	29
9th ,, ...	..	2	1	1	..	..	5	578	22
16th ,, ...	..	..	3	..	..	..	9	580	22
23rd ,, ...	1	..	..	3	..	1	13	571	30
30th ,, ...	..	..	2	..	..	1	11	572	28
Total	3	5	33	35	1	40	205	..	..

TABLE V.—STATEMENT of Deep Borings made at Kroonstad in connection with Military Camps.

Number of borehole.	Depth of borehole in feet.	Diameter of borehole in inches.	Yield in gallons in 24 hours.	Year when sunk.
I.	390	3	Nil	1901
II.	128	3	Nil	1901
III.	150	3	5,000	1901
IV.	143	4½	4,000	1901
V.	180	3	3,000	1901
VI.	155	3	9,000	..
VII.	170	3	Nil	1901
VIII.	120	3	Nil	1901
IX.	150	3	Nil	1901
X.	70	3	Nil	1901
XI.	100	5	2,000	1901
XII.	90	3	3,000	1900
XIII.	72	3	5,000	1900
XIV.	180	5	5,000	1901
XV.	104	3	4,000	1901
XVI.	148	3	4,000	1901
XVII.	135	3	5,000	1902
XVIII.	120	3	7,000	1902
XIX.	72	3	8,000	..

TABLE VI.—STRATA of Borehole at Kroonstad.

(Borehole No. 2.)

	ft.	ins.
Yellow sandstone	15	6
Yellow shale	34	0
Blue shale and sandstone conglomerate ..	26	0
Blue shale	15	0
Grey sandstone	6	0
Quartzite	16	0
Grey sandstone	30	0
Total depth	142	6

Water struck in quartzite at 90 feet, and rose in borehole to 61 feet.

TABLE VII.—RECORDS of Rainfall at Kroonstad.

Season.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Total.
	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.
1880-81 ..	..	0·04	0·55	4·53	9·14	3·27	7·96	4·70	11·27	1·27	0·81	0·02	43·56
1881-82 ..	0·05	1·40	0·43	0·54	4·32	0·91	4·86	3·23	2·09	0·99	0·88	..	19·70
1882-83 ..	1·04	0·59	2·21	2·76	2·60	4·77	4·93	1·26	2·49	0·26	0·05	..	22·96
1883-84 ..	0·23	0·14	1·21	1·22	2·10	1·18	1·58	3·73	3·25	0·87	..	..	..
1884-85 ..	..	..	..	..	..	..	2·62	4·22	1·19	1·48	0·66	..	..
1885-86 ..	..	0·80	4·61	1·42	2·77	3·56	6·26	3·46	6·10	2·88	..	..	31·86
1886-87 ..	0·38	0·11	0·32	2·55	4·52	3·36	2·24	4·97	8·47	1·94	3·79	0·65	33·30
1887-88 ..	..	0·83	0·15	1·22	3·64	1·71	2·47	4·17	6·88	6·08	1·03	0·06	28·24
1888-89 ..	0·33	0·87	..	4·86	1·06	1·72	1·86	1·27	1·61	2·37	0·31	..	16·26
1889-90 ..	..	0·37	..	1·35	4·46	1·90	2·99	3·74	2·99	1·50	2·69	0·68	22·67
1890-91 ..	0·68	0·05	..	2·38	4·82	6·23	9·45	1·11	3·64	2·53	2·05	1·26	34·20
1891-92 ..	..	0·03	0·03	0·24	4·22	3·95	4·69	5·88	4·20	0·92	0·89	0·86	25·91
1892-93 ..	..	0·21	2·78	4·83	2·36	0·53	12·41	1·99	2·62	1·30	..	0·51	29·54
1893-94 ..	0·45	0·15	1·47	1·46	4·80	3·83	8·45	3·96	3·81	0·95	2·68	0·04	32·05
1894-95 ..	0·25	0·59	1·50	0·60	1·64	4·04	2·34	3·80	3·07	3·48	0·61	..	21·92
1895-96 ..	..	..	..	2·66	5·01	7·18	1·74	2·31	0·59	3·65	0·93	0·33	24·40
1896-97 ..	..	1·49	0·73	0·82	2·33	4·18	4·63	3·05	3·43	0·96	0·62	..	22·24
1897-98 ..	..	0·94	0·92	0·44	0·16	1·86	6·33	1·21	2·84	0·51	2·29	..	17·50
1898-99 ..	..	..	0·82	2·23	1·77	2·47	7·30	0·17	3·51	2·97	1·10	0·71	23·05
1899-1900 ..	1·36	1·05	0·53	2·69	3·82	1·96	4·65	5·81	1·88	1·67	..	0·37	25·79

TABLE VIII.—MEAN Monthly and Annual Rainfall at Kroonstad for 10 years, 1885–94.

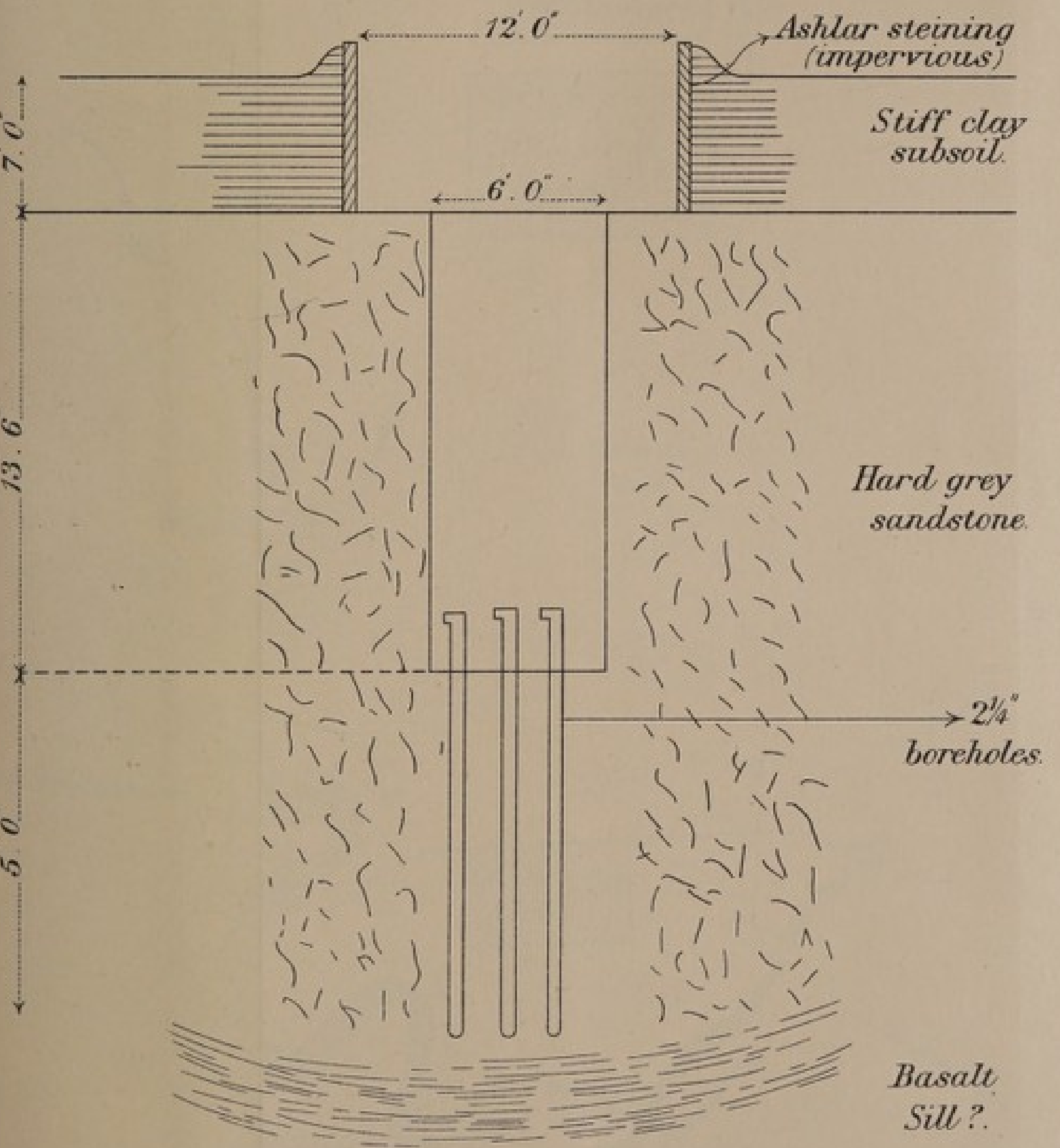
(Height above sea level, 4,500 feet; latitude, 27 degs. 29 mins. S; longitude, 27 degs. 64 mins. E.)

	inches.
January	5·24
February	3·48
March	4·15
April	2·20
May	1·22
June	0·41
July	0·21
August	0·40
September	1·09
October	2·07
November	3·57
December	3·13
Year	27·17

(From Dr. A. Buchanan's "Discussion on Rainfall in South Africa," published by the Meteorological Commission.)

PLAN A.

SECTION OF RIXON'S WELL, KROONSTAD.



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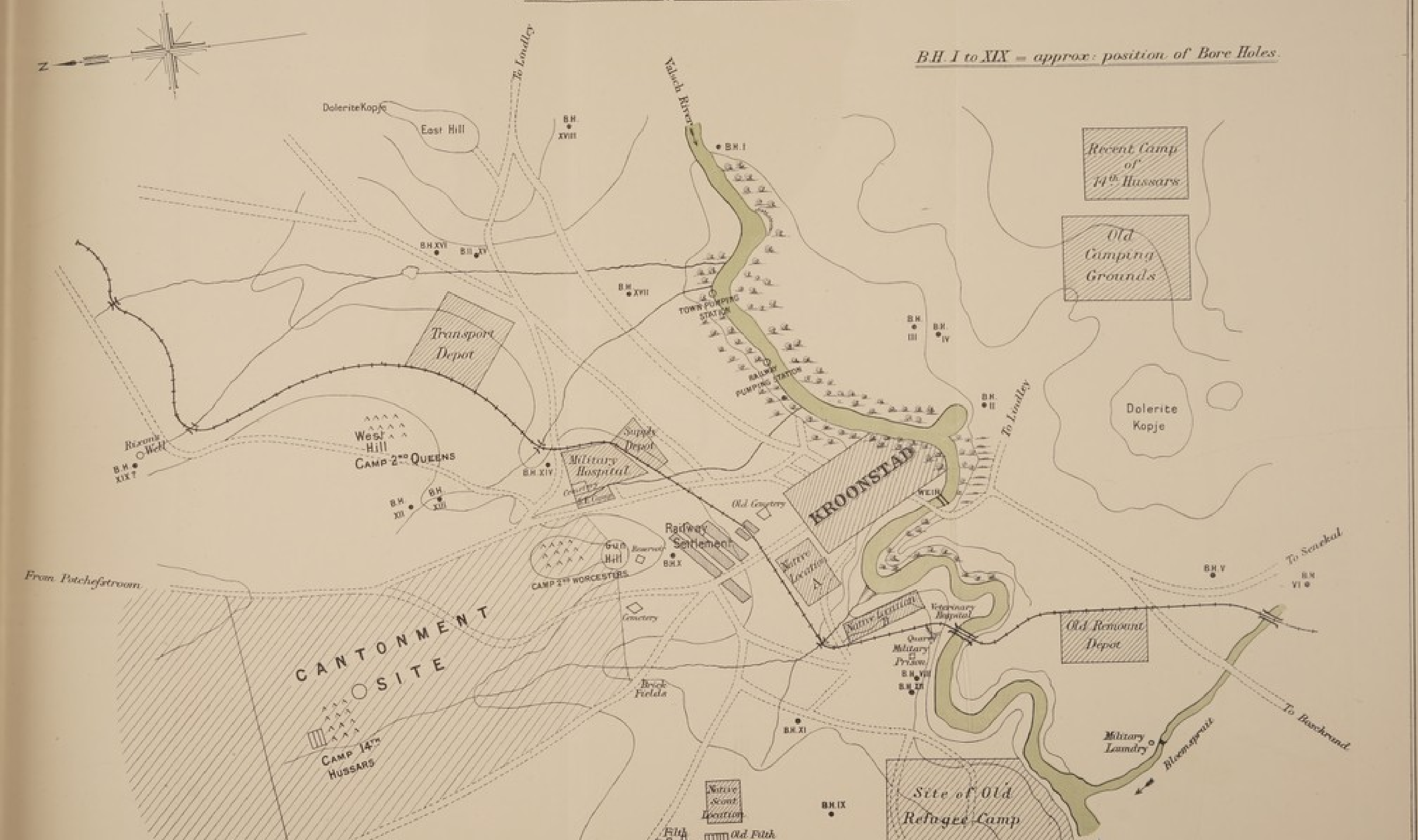
PLAN. B.

ROUGH PLAN OF SURROUNDINGS OF KROONSTAD.

(From Sketch Map. Scale, 2·67" = 1 Mile.)



REPORT ON PIETERSBURG, TRANSVAAL, AS A CANTONMENT FOR BRITISH TROOPS.

Physical Features of the Locality.

Pietersburg is in the centre of an open upland district lying amongst the foothills of the Zoutpansberg and Drakensberg ranges of mountains, which practically surround the area in question at a distance of 20 to 30 miles on the south and south-west, and 30 to 40 miles on the south-east, east, and north-east. On the west and north there are outlying spurs of the range, where the Pietersburg uplands join with the country extending to the Limpopo Valley.

Within a radius of 3 to 10 miles of the town there is a number of isolated peaks or kopjes rising for 100 to 300 feet above the surrounding land.

These kopjes are formed of granite, quartz, and schist, and the underlying rock in the uplands surrounding Pietersburg, and in the area over which the town itself is built, is also of this formation.

The surface soil is generally formed of lime conglomerate, or lime deposit, quartz gravel, or rich alluvial loam. There is a certain amount of brick earth along the banks of the streams, but a considerable amount of lime is found in the clay, and interferes with the manufacture of good bricks.

The watershed between the Zand River, which runs northward to the Limpopo, and the Oliphant's River, which runs eastward, lies about 10 miles south of the town, at an elevation of some 5,000 feet above sea level.

Smitsdorp, which is close to the watershed, is noted as being 4,750 feet above sea level. Pietersburg itself is stated to be 3,950 feet at the railway station.

The position of the watershed is peculiar, as the whole of the water collected on the northern slopes of the high mountains south of Pietersburg, instead of flowing into the Zand River, which is the main drainage line of the area, collects into water-courses which flow southwards, through several cuttings or "poorts" in the range, and join the main tributaries of the Oliphant's River south of the mountains.

Thus the watershed, instead of running along the top of the range of high mountains, follows a line passing from south-west to north-east along the upland district, at a distance about half-way between Pietersburg and the southern spur of the range.

The Zand River rises in this watershed and amongst an outlying range of hills called the Yzerberg, about 18 miles south-west of Pietersburg.

One of the main tributaries joins the river at Marabastad, about 10 miles south-west of Pietersburg; and another important tributary, the Sterkloop Stream, joins it about 1¼ mile below Pietersburg.

The Zand River itself runs from south-west to north-east from its source to within a mile of the town, and then turns northwards away from the town.

The Sterkloop Stream rises amongst isolated granite peaks 5 to 7 miles south of Pietersburg, and flows northwards to the Zand River, skirting the western boundary of the town.

The town itself covers an area of about 1 square mile, with about 200 houses; but, in addition to these, there are several tents and encampments occupied by mining prospectors, repatriated Dutch, and others, chiefly on a belt of meadow land between the town and the Sterkloop Stream, and on unoccupied town erven above the town.

The railway runs south-west to north-east, from Piet Potgieter Rust between the Waterberg and Yzerberg ranges, to its terminus about ¼ mile north of Pietersburg.

The native location of some 60 houses lies between the railway station and the town, and between the railway and the Sterkloop Stream, which the line crosses from west to east, before turning north to the station.

A belt of brickfields lies between the location and the stream.

The surrounding country contains several small native kraals and a few farm-houses. There are large native territories in the neighbourhood, the nearest being "Malietsie's Location" about 10 miles north-west, and "Molepo's Location" about 10 miles south-east of Pietersburg.

At Marabastad, and up the stream entering the Zand River there, there are several mining plots pegged out, and mining camps are likely to be formed over this area.

Along the Sterkloop stream, right up to its source, the banks on either side have been portioned out by the Government Land Settlement, and settlers are living on 50-acre plots in bell tents, over the collecting area of the stream, and along its banks.

A large Burgher camp, now nearly empty, is situated on the belt of land between the railway and the Zand River west of the town. It contained 2,000 to 3,000 refugees at one time.

A repatriation camp is situated to the north of the railway station. Supply and Royal Engineer camps are grouped near the station on the Sterkloop stream side, or west side of the line.

The other military camps are on the slopes above and east of the station on the north and north-east of the town, and within a few hundred yards of the station and town.

The site of the new cantonment is on the same slopes somewhat higher up, and about ¾ mile east of the station. A camp for the South African Constabulary is pitched just below the new cantonment site.

Generally the formation of the land which forms these areas of occupation and the district in the neighbourhood of Pietersburg consists of grassy undulating hills and valleys converging at the junction of the Sterkloop stream and Zand River, or running parallel to the latter and sloping towards its banks. The new cantonment, the military camps, and town are all on the slopes of one of these hills overlooking the river valley. These hills rise to 200 or 300 feet above the river.

The geological formation has already been indicated. It is an extensive belt of granite and quartz, with schists and other igneous formations, and it is difficult to say how far this extends, and in what direction. Although none of the isolated peaks are formed of dolerite or basalt, as is the case in the Karoo and northern Natal, several small basalt boulders are found among the surface debris.

The granites form outcrops in many places on the slopes near and around the town, and along the bed of the Zand River and Sterkloop. The granite is generally grey granite, but red granite is also found in outcrops along the bed of the river. Large masses of quartz are found, and one of the kopjes near the town, the Wittberg, is formed almost entirely of quartz.

Over a large extent of surface soil there is a lime deposit varying from a few inches to 3 or 4 feet thick. There is said to be fossiliferous lime formations near Marabastad, and good lime for building purposes is being quarried there. The summits of several kopjes are outcrops of chloritic schist.

Water Supply.

There are apparently only two main sources of water supply—

(1.) River or streams.

(2.) Wells.

There are no deep borings or springs except such as occur in wells, so far as can be ascertained, and rain water is not collected to any extent.

(1.) River Water.

(a.) *Zand River.*

This is not used in the town or camps, except in the Burgher camp, which is situated near it. The amount of water is comparatively small, about 500,000 gallons in the 24 hours. The bed of the river is a clean quartz sand, with outcrops of granite. The stream is clear, and, with the exception of the Burgher camp, practically without habitations along its banks until well below the town. The banks are low. The chief source of possible permanent pollution is from the Marabastad tributary about 10 miles up stream, and from one or two surface watercourses leading to the river above the Burgher camp, which pass through small Kaffir locations and mealie fields. The washings of these are liable to be carried down to the watercourses during heavy rains into the river.

(b.) *Sterkloop Stream.*

This stream is the present source of water supply to the troops and native location, and it also feeds irrigation channels which are distributed throughout the town erven and lead back to the stream as it passes by the town.

The water is as a rule clear, and flows in its course partly through alluvial land with gravelly or granite beds, and partly through surface lime formations and granite. It is a narrow meadow stream with low banks. The yield above the intake of the first irrigation channel was gauged at 288,000 gallons in the 24 hours, and below this intake at 57,600 gallons. A rough gauging of the first or main irrigation channel gave a yield of about 150,000 gallons.

The stream is fed at its source from somewhat extensive areas of marshy ground or surface springs in the depression of the upland basins amongst the kopjes south of Pietersburg. These basins are being farmed at present by settlers, who have their camps and plots at intervals right down the stream to where it enters town lands, about 2 miles above the town. At the farmstead of Weltvreden, about 4 miles upstream, there is the head-quarter camp of the Land Settlement, with stables, &c., close to an irrigation channel leading from and back into the stream. Stable refuse lies on the banks of this channel, and the men wash themselves and their clothes in it.

At the point of entrance to the town-lands the stream is dammed by a masonry dam, but is allowed to escape through a 6-inch pipe at the base of the dam. From this point to a point about a ¼ mile above the town the stream has been fenced in with barbed wire by the military authorities to prevent cattle fouling the stream. The intake for the camp water supply is from one or two pools in the stream 3 or 4 yards below the termination of the fencing. The water is there pumped into water-carts, the hose of the pump lying on the ground when not in use.

The clothes, bedding, &c., from the hospital are washed on the banks about 100 yards below this intake; and about 100 to 200 yards lower down the stream passes through the south-west corner of the town, where it receives pollution from habitations and from washing of clothes. From this corner of the town to the railway bridge there is a belt of meadow between the stream and the town. There are a few recent and old camps of prospectors or Dutch families on this area, and clothes are washed in the stream all the way down. In this section of its course it receives several re-entering irrigation channels from the town. Just above the railway bridge a channel running along the south side of the railway line enters the stream. This channel is dry, and is the receptacle of all kinds of refuse which would be washed into the stream during rains.

The inhabitants of the native location draw their water from the stream just below or above the railway bridge. Down stream from the railway bridge to a point opposite the railway station, the native location and brickfields are near the banks and the stream is used for washing clothes. It is practically no longer a running stream here but forms considerable pools.

Below the railway station to its junction with the Zand River the stream is too far from occupied areas to be used for domestic purposes, but there were several camps on the slopes leading to it, amongst others the Mounted Infantry, whose horses were watered in the stream in this neighbourhood. Government watercarts have also been seen drawing water from a pool in this section of the stream. The Kaffirs in charge of the cart stated that they were using it for building purposes.

The town filth trenches are about 300 or 400 yards from the stream on the west side opposite the point of intake of the camp water supply.

There is a brewery on the west bank where the stream touches the south-west end of the town. The water of the stream is not used in it except for washing the bottles.

(2.) Wells.

(a.) *Town Wells.*

The water supply of the town is from private wells. Each house has its own well or obtains its water from a neighbouring well.

The wells are usually about 30 feet deep in the centre of the inhabited portion of the town area. Higher up the slope the wells are deeper in proportion to the height of the slope, some being 50 or 60 feet deep.

On the banks of the stream, at the brewery for example, where there are two wells, one 14 feet and one 27 feet deep, the water rises to within 4 or 5 feet of the surface.

All these town wells are sunk through surface soil into granite rock. Some are steined down to the rock, others are not.

The water is fairly clear in the steined wells. The water generally is surface water percolating down to the granite and thence into the well in the rock. In a few instances an underground spring has been tapped.

The wells are imperfectly covered over. Water is raised from them by hand pump, rope and bucket, or windmill pump.

The water in wells used by aerated water factories was analysed on 24th January, 1903, after collection on 14th January, 1903, in the Military Laboratory, Pretoria. The chlorine, solids and hardness were high, and there was evidence of pollution by organic matter.

(b.) *Military Wells.*

Three wells are being sunk.

No. 1 is on the slope above the new cantonment site, about 400 yards north-west of it.

No. 2 is near No. 1, about 300 yards further down the slope.

No. 3 is about 50 yards from the Sterkloop stream, and about ¼ mile above the intake of the camp water supply.

The water in No. 1 and No. 2 is surface water percolating through surface soil (lime, alluvium, and gravel) to granite, and thence into the well.

No. 1 is at present about 50 feet deep, through grey granite, but its water supply, so far, is coming from above the granite at a point about 10 feet from the surface. Its yield has not yet been gauged properly.

No. 2 has only been commenced, and is at present abandoned, the surface water rising in it to within 4 feet of the surface.

No. 3 is totally different in character. It is sunk through surface lime and conglomerate deposits to a bed of chloritic schist 15 feet thick. Below the schist there is a hard black amphibolite schist rock containing veins of quartz. The well has been sunk through this to a depth of 34 feet. On the east face of the well, at a depth of 31 feet, there is a fissure in the black rock running almost horizontally eastwards and large enough to admit the hand and arm. This fissure is at the apex of what is probably a large fissure filled in with strata of hard blue shale-like rock* and soft schist debris and clay. The water is gushing out of the fissure and forms an underground spring, which is practically the only water supply of the well. It yields about 300 gallons per hour. Samples were collected direct from this underground spring in sterilized bottles, kept in ice, and taken to the Military Laboratory, Pretoria. A note on this is given in the Appendix.

A sample of No. 1 well was collected on 15th January, 1903, and analysed in the Military Laboratory, Pretoria, on 30th January, 1903. It was collected from the well during construction, and showed signs of organic pollution. The hardness was 17 parts per 100,000, the chlorine 3·4, and the total solids 44·8.†

With the exception of a few rain-water tanks in private houses, other sources of water supply have not been ascertained, but it is stated that deep borings were tried during the war without water being found even at a depth of several hundred feet. No records of these, however, can be found in the locality.

There have been one or two surface dams, notably one just above wells Nos. 1 and 2, but they are not used.

Condition of Surface Soil.

Generally speaking the fouling of the surface soil by the carcases of dead animals is considerable all over the uplands. This is specially noticeable in the neighbourhood of Wells Nos. 1 and 2 where there is a "vlei," and also along the meadows and watercourses leading to the Zand River and Sterkloop Stream. The

* Described by the Government Geologist as a heavy basic schistose rock.

† *See* Appendix, Table IV.

surface in and around the native location is covered with all kinds of refuse, and as there is no latrine accommodation for the inhabitants, the area between the railway and the Sterkloop, where the native location is placed, is much polluted.

Refuse from the repatriation and South African Constabulary camps is being deposited on the surface in the neighbourhood of the camps.

Slaughtering is carried on at the South African Constabulary camp just below the new cantonment site, the blood and offal being buried in the soil on the spot.

In the camp latrines the pails are placed on the surface soil. Ablution water flows into irrigation furrows, but other camp waste products are removed to a site below the repatriation camp and about 1 mile from the new cantonment and camping grounds and buried or deposited on the surface there.

Old camping grounds were placed on the west of the railway just beyond the native location. There is considerable evidence of surface soil pollution over these areas.

The town area, until 1901, had no latrines. Cesspits or gardens were used as latrines. This source of pollution has now ceased, but slops and other organic refuse still percolate into the surface in and around habitations.

There are several isolated tents of settlers, prospectors and repatriated families, over the town area. They are without sanitary arrangements and pollute the soil around. The unoccupied area of the town-erven on the slopes above the town is also much polluted by outspans and scattered camps of settlers, &c.

The surface of the new cantonment area has not been kept altogether clean. At present the native labourers live in tin-can huts in the centre of the area with a latrine adjoining, and Royal Engineers and contractor's men occupy some of the huts. Horses, fowls and pigs are kept by them close to one of the huts, the fowls making a run for themselves under the hut. Puddles under watertanks adjoining the hut have the appearance of being converted into a pig's wallow.

Civil Sanitary Surroundings.

The sanitary administration of the town is carried out under Proclamation No. 28 of 1901 "for the establishment of Health Boards." The Health Board takes the place of a Municipal Council, and its chairman is the resident magistrate. The law provides for the maintenance of general health, and indicates the lines upon which the Health Board acts. The district surgeon is Medical Officer of Health, but takes no active part in sanitary administration. A sanitary supervisor or inspector is executive sanitary officer.

The population of the town is indefinite. It is said to be 2,000 whites, of whom 650 are adult males; 510 native servants are estimated as living in the white area of the town, and a native population of 400 or 500 in the location.

The number of houses is about 170 to 200 for the white population and about 60 for the native population, but no accurate estimate appears to be kept. The houses of the former are usually built of brick, with lime or stucco rendering outside, there being good lime quarries near Marabastad. The native houses are of mud or sundried brick. Many corrugated-iron houses have also been erected, or are being erected.

The water supply is well water or irrigation furrow water for the white population, and Sterkloop stream water from below the town for the native location. There are no public wells in use. There is one at a corner of the market square, but it is without pump or other means of drawing water.

Since the promulgation of Proclamation No. 28 of 1901 a dual-pail system of latrines has been introduced. The latrines and privies are corrugated-iron sheds outside the houses, usually with boxed-in seats and door at back for the removal of the pails. The number of pails is not regulated according to the number of persons occupying the house. The pails are removed nightly from hotels and large establishments, and clean pails are left in their place. They are removed every second or third night from smaller establishments.

The system of removal consists of emptying the contents of the pails on the spot into a large wooden barrel, carried on a buck wagon, and of carrying the empty pail on the same wagon to the filth trenches. The pails are disinfected there by tarring or cleansing with carbolic solution or lime. The pails are not numbered, and they are passed indiscriminately from house to house.

The filth trenches are sunk in surface lime deposits, on the west side of the

Sterkloop, just above the town and about $\frac{1}{4}$ mile distant from the stream. The filth percolates into the lime and rapidly disappears into the subsoil. Slops, &c., are removed to the same pits in tipcarts. Dry refuse is removed in uncovered Scotch carts and deposited on the surface near the filth trenches.

There are no public slaughterhouses. There are two butchers in the town who have a private slaughterhouse on the veldt south-east of the town. Blood and offal are buried in the soil on the spot. There is an old slaughterhouse near to and above the cantonment site and well No. 1.

There are no public laundries. Washing is done in the Sterkloop or in private gardens. A private firm is erecting a steam laundry.

There are two mineral water factories. The water used is from surface wells in the yards. It is clear water and is not sterilized either by boiling or filtering. Analyses of the waters, made at the Military Laboratory, Pretoria, show organic pollution. The bottles are washed by hand. The sale of the waters has been prohibited in the camps since 3rd January, 1903.

There is no sanitary regulation of milk supplies. Cows are kept in the town; well water or furrow water being used for cleansing milk vessels.

Although there is a system of notification there are no adequate means of isolation or disinfection in the case of infectious diseases.

The native location is without a pure water supply, and without any system of privies or latrines or other conservancy arrangements.

There are no systems of surface or deep drainage, and the streets are only partially metalled. The soil is gravelly on the upper slopes of the town. On the lower slopes and near the banks of the stream and native location it is a brick earth alluvium with a considerable amount of lime.

The cost of sanitary administration is met by a system of "sanitary fees"; namely, 7*s.* monthly for removal of night soil of two buckets and 5*s.* monthly for each bucket over two from private houses; and 7*s.* monthly per bucket from hotels, public-houses and business premises. For removal of rubbish and slops the "sanitary fee" is 2*s.* 6*d.* monthly for private houses and 5*s.* monthly for hotels, &c.

The number of town erven is 970, of which 563 are water erven. The latter are 240 feet by 120 feet in size and the ordinary erven, 240 feet by 240 feet. Only about 200 of the water erven and scarcely any of the ordinary erven are occupied.

New Cantonments.

The cantonment area is on the town slopes about $\frac{3}{4}$ mile to the east of and about 100 feet above the railway station. It is near the north-east corner of the Town Commonage, and is placed close to the northern limit of the town erven, although it is about $\frac{1}{2}$ mile distant from the occupied portion of the town area. Its area is 605 yards by 800 yards, or 100 acres in extent. The surface soil is gravel. The area is enclosed by an iron railing.

At present barrack huts of the corrugated-iron type, 114 feet by 21 feet, with 6 feet verandah are being erected. The inside of the huts is lined with match-boarding, and there is ridge ventilation.

The accommodation is arranged for $\frac{1}{2}$ battalion of Mounted Infantry, $\frac{1}{2}$ battalion of Infantry, and a 52-bedded hospital, the strength being calculated at 32 Officers, 684 other ranks, with 272 troop and 20 Officers' horses, and about 80 transport animals.

The distance between huts, end to end, is 50 feet, and there is a similar distance between lines of huts.

The distance between the $\frac{1}{2}$ battalions is 150 feet.

The distance of nearest stables (Officers') from the huts is 70 feet. The troop stables are 50 feet from the Officers' stables, or 120 feet from the huts.

The distance between hospital ward huts is somewhat greater, viz., 70 feet between lines of wards, and 99 feet from end of wards to end of Administration huts.

The latrines for the troops are in alignment with the huts, and form the flanks of a line of ablution rooms and kitchens running within and parallel to the lines of barrack huts. They have consequently barrack huts on either side at a distance of about 50 feet.

The hospital latrines and ablution rooms are 70 feet from the line of wards.

The cookhouse huts contain bread and meat stores and baths.

The area covered by the hutments, exclusive of Officers' married quarters and parade grounds, is approximately as follows:—

1. ½ battalion Mounted Infantry, 10 acres.

2. ½ battalion Infantry, 10 acres.

3. Hospital, 3½ acres (without Nursing Sisters' quarters or recreation ground).

With the exception of transport and troop stables, none of the accessory buildings are as yet erected, but most of the barrack huts have been put up. They are raised 6 inches to 4 feet above the ground on wooden piles. There is no preparation of soil underneath or around huts, and the verandahs are floored with wooden boarding. The stables are nearer completion than other buildings. They are admirably ventilated. The flooring is being macadamized with quartzite and mud, and channelled to good concrete gutters.

It is intended to carry off storm water in surface channels, and foul water in surface or covered channels to a series of sumps at the lower corners of the unit areas, the slope of the area being approximately 50 feet from the south-east or highest corner to the north-west or lowest corner.

The latrines are planned on the American trough system, except for Officers' and serjeants' messes, married Officers' quarters and Nursing Sisters' quarters, for which it is intended to provide earth closets. The latrine seats are estimated at 5 per cent. of the strength approximately.

The contents of the latrine troughs and foul-water sumps will be removed in vacuum carts to trenching areas, the site of which has not yet been determined. The sumps are to be five in number, so far as present plans go, viz. :—

1. One on west side of the area, 6 feet by 14 feet by 6 feet, for foul water of stables, ablution rooms, and cookhouses of both ½ battalions.

2. One, 8 feet by 4 feet by 3 feet, on north-west corner for Officers' mess and quarters.

3. For the hospital, on the south-west corner of the hospital site.

4. For the transport stables and lines, on the south-west corner of the cantonment area.

5. For married Officers' quarters, near the centre of the north section of the area.

Provision has not yet been made for preserving the grass between and around huts and for formation of pathways, but two main roads, 20 feet wide, are being constructed, one running west to east between the barracks and Officers' quarters and between the hospital and Nursing Sisters' quarters, and the other running south to north between the ½ battalions. 600 trees have been planted along these roads and round the boundary of the cantonment.

The water supply is indefinite as yet. A temporary supply is expected to be obtainable by pumping to a storage and distribution tank on the south-east corner of the site from well No. 3. The yield of this well at present will not be more than 300 gallons per hour, or 7,000 in the 24 hours. It is impossible to say, at present, whether the yield will be permanent or vary in amount, but as it is of the nature of an underground spring it is likely to be permanent unless the spring is tapped by sinking wells higher up in the direction of the flow. No provision has been made for collecting and storing rain-water.

A water supply is expected to be obtained in a few years from a town water-work scheme, for which 20,000*l*. has been assigned by the Government.

The scheme consists of building a long dam, about ½ mile in length, across the valley 4 or 5 miles above the town and below most of the feeders of the Sterkloop stream. The dam will dam an upland catchment area of about 20 square miles, including some of the surface springs, which form the source of the Sterkloop. It is expected to conserve in this way about 50,000,000 gallons, with a permanent yield of 200,000 to 250,000 gallons daily from the springs.

The catchment area is partially cultivated, and occupied by settlers; and there are several hundred natives living on it in kraals. It is proposed to pass the water through filter beds before distribution to the town. The height of the dam above the town will be 200 feet, and this would probably admit of its being laid on to the cantonment area by gravitation.

Existing Camps.

With the exception of a small Royal Engineer, Army Service Corps, and Veterinary Hospital Camp, the only military camps are those of one infantry battalion and a hospital. The site of these camps is shown on the plan. The water supply has already been detailed. It is stored, boiled, and cooled, under good regimental organization. A 600-gallon corrugated-iron storage tank is filled from the watercarts, and four Soyer's stoves are in constant use for boiling water. The boiled water is stored and cooled in three 54-gallon beer casks, and further cooled in canvas bags. For each company there is a dining tent, and the company Berkefeld filter is kept in use there. Three watercarts are in use. They are washed out with permanganate of potash twice weekly. The storage tank is also scoured out with hot water and permanganate of potash, twice weekly. No aerated waters have been admitted into the camp since 3rd January, 1903; but gingerbeer is manufactured regimentally in the canteen. The water supply arrangements are under the supervision of a non-commissioned officer, and two men are constantly employed in connection with them.

The latrines have no prepared surface, and the seats are about 6 inches higher than the top of the pails.

The ablution arrangements are open pits fed by the town irrigation furrow. They are not screened off. One of the pits is used as a swimming bath. The water is stagnant. Animals, including pigs, were seen lying in the pit used for personal ablution and washing clothes.

Dry refuse is collected into an enclosed brick refuse pit, pending removal; and wet refuse is stored in a corrugated iron receptacle.

The whole of the conservancy arrangements are carried out by the military authorities with a staff of 1 corporal and 22 native boys. The night soil is removed in a tipcart, morning and evening; urine and slops in a wooden barrel carried in a buck wagon: dry refuse in a Scotch cart. The latrine and urine pails are lime-washed inside and outside. They are not removed from the latrines, but are emptied and lime-washed on the spot The number of latrine and urine pails is equal to 7 or 10 per cent. of strength.

The hospital latrine has a concrete floor, but it is channelled to the surface soil outside the latrine. A latrine for convalescent enteric patients has been erected. It has a wooden floor and a box seat, the seat being several inches higher than the top of the pail.

The number of men in tents, (single-fly bell tents), is 4 to 6.

Health Statistics.

(a.) *Civil Population.*

Very little can be ascertained about the health of the civil community. Death registration, until a month or two ago, appears to have been very imperfect. Books were kept with entries commencing in July, 1901, but the entries of town deaths are mixed up with other entries.

From July to December, 1901, apparently 12 deaths amongst the town population are entered (two from measles, two from enteritis, one from diphtheria, and one from malarial fever).

In 1902 only 16 town deaths appear to have been recorded (five from enteric fever, one from diarrhœa, and one from malaria).

In 1903, six deaths have been recorded in the town in January, and two up to the middle of February. Two of these eight are deaths from enteric fever, one of them being that of a native.

The death register has also entries of 617 deaths between June and December, 1901, in the Burgher Refugee Camp, about one-sixth being recorded as deaths from malaria, which is frequently noted as "malaria with acute diarrhœa." The greater proportion of the remaining deaths is from measles, whooping cough, or diarrhœa.

In 1902 about 48 deaths only are noted as occurring in the Burgher camp, three being entered as due to malaria, and two to typhoid fever. The majority of the remaining entries are measles, whooping cough, and diarrhœa.

The notification returns give six enteric fever cases in December, 1902, and one in January, 1903, and eight malaria cases in December, 1902. There was one diphtheria case recorded in October, 1902, and several cases of leprosy. No cases of infectious disease have been notified in February as yet.

Six deaths in January, 1903, represents a death rate for the month equivalent to 36 per 1,000 of population per annum in a population of 2,000.

(b.) *Military Population.*

Tables are appended showing the principal health statistics amongst the troops in Pietersburg since the declaration of peace.

The chief feature during the 3 months, November, 1902, to January, 1903, has been the marked incidence of enteric fever, and comparative absence of other important diseases.

There were two periods of prevalence of enteric fever, one amongst the Mounted Infantry in November, 1902, and the other amongst the Infantry battalion in December, 1902, and January, 1903. The Mounted Infantry at the time of the outbreak were encamped between the railway station and the Sterkloop and near the river. Their camp was moved to the slope above the railway station, and cases then ceased to occur in the battalion. The outbreak in the Infantry battalion was for some reason or other attributed to consumption of mineral waters supplied from the town factories. These supplies were stopped on the 3rd January, and, with the exception of an isolated case on the 16th January and another in February, no cases occurred in the battalion after the 9th January.

There were 75 admissions for malarial fever, but in no case has any typical malarial chart been recorded, or the diagnosis confirmed by examination of the blood. The troops have previously been stationed in lower and swampy country, chiefly at Nylstroom, and the question whether the neighbourhood of Pietersburg is in reality a malarial district or not has yet to be determined. No cases of malarial fever have been admitted since 19th December, and no specimens of anopheles mosquitoes have been noted in the neighbourhood, although the search requires to be much more prolonged to enable one to make any positive statement on this point. Mosquitoes exist in the camps, but those examined were of the culex genus. There are no swamps in the immediate neighbourhood; the nearest are on the spring bearing area forming the sources of the Sterkloop stream. There are, however, many irrigation furrows and earth water-channels.

Meteorological Records.

There are no official records in the locality; nor has the existence of any prolonged private records been ascertained. Records of rainfall are wanting. The resident magistrate has kept temperature records privately for the past 3 months. The highest temperature recorded in the shade is 98 degrees Fahr., the period covering the hottest months of the year. The rainfall is considered to be less than that of Pretoria, which has an average of 26 inches. The temperature is considered to be less oppressive than in stations of the same or even higher elevation further south. At present the nights are cool, even cold; and the day temperature far from oppressively hot. The country is open country and has the advantage from the point of view of temperature of being exposed on all sides to winds. Dust storms are not a feature of the locality.

Conclusions.

(1.) Pietersburg, as regards climate, should be favourable to maintenance of a high standard of health and vigour.

(2.) The water supply of the locality is sufficient in quantity for present population, but the quality and the means of collection, storage and distribution of water are not conducive to a high standard of health. The Sterkloop stream water is unsafe and at places dangerous.

(3.) The general sanitary arrangements are no worse and no better than in most civil communities in the neighbourhood of South African cantonments; and they are inadequate for the maintenance of a high standard of health in a growing population.

(4.) The arrangements for dealing with infectious diseases are insufficient for preventing or controlling epidemics.

(5.) The general site of the new cantonment is good, so far as soil, slope, elevation and drainage are concerned. In time the town is likely to extend to its boundary.

(6.) The plans of the new cantonment are satisfactory so far as they go; but the area is not large enough to hold more than it is now planned for.

(7.) The position of latrines and stables in relation to barrackrooms makes it essential that these be carefully constructed with a view to the immediate removal of waste products and prevention of soil pollution.

(8.) The water supply of well No. 3, if the gauging of the yield is correctly estimated at 300 gallons per hour and the quality is pure,* will be sufficient for the proposed garrison for drinking and cooking purposes and ablution without general baths, but it will be insufficient for watering horses, flushing surface and other drains, and general bath ablution.

(9.) The water from wells No. 1 and 2 is not satisfactory for drinking and cooking, but might be used for flushing purposes and for watering horses.

(10.) The proposed waterworks scheme for the town will give an ample supply for all purposes as regards quantity, and a fairly satisfactory supply as regards quality, provided the filter beds are properly constructed and worked, and the collecting area conserved.†

(11.) Deep borings are not likely to secure water supplies with any degree of certainty. Their success will depend on striking fissures in the granite, and there will always be some doubt as to the source from which these fissures are fed.

(12.) The arrangements for removal of latrine contents and foul water are the best that can be made, if no water carriage system of sewerage is to be introduced into the new cantonments, but the selection of good trenching areas for disposal of latrine contents and foul water will require special consideration.

(13.) The chief sanitary defect existing in the locality at present, apart from water supply, is the fouling of the surface soil by settlers and repatriation camps, and by the native locations.

(14.) The existing camps are fairly well organized, especially in connection with purification of water supplies, but latrine and ablution arrangements are defective for camps likely to be occupied for some time.

(15.) The health statistics of the civil community are insufficient at present to indicate the true sanitary state of the town, but so far as they go they do not show any marked prevalence of preventable disease.

(16.) The military statistics indicate liability to outbreaks of enteric fever, but not any marked prevalence of dysentery, diarrhœal, or venereal diseases.

(17.) The question as to whether malarial fever is contracted in the locality or not requires further investigation. There is some doubt regarding the accuracy of diagnosis, especially in the case of the deaths from malarial fever in the Burgher camp.

Recommendations.

(a.) *Permanent Cantonments.*

Generally these cantonments are well planned and the site is good; but, as is the case in other cantonments, the absence of any preparation of the surface soil under and around huts, so as to prevent soakage of organic matter into it, will lead to insanitary conditions after the huts have been in occupation for some time. The

* The samples have since been analyzed. *See* Appendix IV. and Special Note.

† *See* Special Note, Appendix, Table IV.

raising of the huts and concreting under and around them should, therefore, be contemplated as a necessary sanitary precaution within the next 2 or 3 years.

In the meantime the surface soil should be kept as clean as possible, and the native labour camp and animals removed from the cantonment area.

The nature of the construction of the stables will, to some extent, avoid soakage into the soil from that source, but it is doubtful whether the macadam floor will last, and a mixture of cement with the quartzite would make a stronger and more impermeable flooring. It is recommended that the surface around watering troughs be similarly prepared and channelled, and cement or brick manure pits provided.

As regards water supply, it is recommended that the water of well No. 3 be used rather than No. 1 and No. 2, and that well No. 3 should be steined and formed into a reservoir for the reception and storage of the water from the underground spring only, that is to say, all percolation from the surface soil or underlying schist should be cut off.* The water of No. 1 and No. 2 wells is evidently ground water, and should be abandoned unless subsequent analyses show it to be and to remain pure. When the new waterwork scheme for the town is completed, it will be time enough to say whether the filter bed arrangements are sufficient to remove impurities, the chief sources of which will be from the cattle or habitations on the collecting area; but it is strongly recommended that such a collecting area be conserved and fenced, kraals and other habitations being removed from it. In any case the surface springs and watercourses should be fenced off to prevent cattle dying in the neighbourhood of the main supply, or otherwise polluting it. It is recommended that the rain-water from the roofs be collected and stored as a supplementary water supply.

As regards ablution arrangements, considerable economy of water and better sanitary methods of ablution can be obtained by introducing a shower-bath system into the ablution rooms.

The provision of gauze windows and doors for kitchen bread and meat store is recommended.

As regards disposal of the contents of latrines and foul water sumps some difficulty is likely to arise, as the soil on the town lands below the town and the cantonments is generally a quartz gravel or surface lime overlying granite. There are, however, patches of loam and sandy soil, and an area should be fenced off in either of these soils, planted round with trees and cultivated. An area of about 5 or 6 acres will be required for a cantonment of this size.

As regards present pollution of the cantonment area, immediate steps should be taken to reduce the population living on it to lowest possible limits. There are about 186 natives and 40 Europeans, the latter scattered amongst the huts; and fowls, pigs, and horses are kept amongst the huts in course of erection, as already noted. All this source of pollution should be immediately removed and strict supervision maintained to prevent its recurrence. The native camp could quite well be placed outside the area.

Provision of a laundry and of an aerated water factory under military sanitary supervision is urged.

None of the huts, especially the stables, should be occupied until the means of removing waste products are complete and in working order.

As regards immediate surroundings, representations should be made to prevent the South African Constabulary camp refuse being deposited near the cantonment area, to stop the slaughtering of animals at this camp, and to improve the condition and structure of their latrines.

(b.) *Existing Camps.*

The chief sanitary requirements of these camps, taking into consideration the fact that they are likely to be occupied for some time, are properly constructed channelled floors for latrines and ablution places. The water from the latter can safely be led to the gardens, but the scourings of the former should be led to concrete sumps and removed with other slops.

The use of chloride of lime in solution (4 ozs. to the gallon) in the pails is preferable to dry earth and lime.

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* But *see* Note, Appendix IV. The analysis shows it to be unsatisfactory, and unless subsequent analysis shows it to be purer than the analysis in Appendix IV. (No. 11) the water will have to be purified in barracks, or other sources sought.

The provision of a separate latrine for convalescent enteric patients is a sound measure of sanitation, but the latrine at present in use allows urine to pass on to the soil and woodwork of the box seat and floor. Such latrines should be very carefully constructed to avoid any pollution of the kind. The seats should come down to the top of the pails, they should be open seats ; and the floor should be concreted and channelled to a sump in which disinfectants are placed.

The intake of the camp water supply on the Sterkloop stream should be inside, and not outside the fencing, and the hose of the pump should be carried on a trestle, and not laid on the ground.

(c.) *Civil Surroundings.*

The chief civil sanitary requirements affecting the health of troops in the locality are :—

(1.) General cleansing of surface.

(2.) Sanitary provision for settler's camps, native location, and native servants.

(3.) A water supply scheme.

(4.) Provision for isolating and disinfecting in case of infectious disease.

(5.) Public laundry.

(6.) Public slaughterhouse.

(7.) Sanitary control of milk and aerated water supplies.

None of these matters are at present contemplated from want of funds, but if the town, as is supposed, is going to grow rapidly, epidemics may be expected unless they are attended to.

The proposed water scheme is likely to meet the needs of the locality in a fairly satisfactory manner, provided the measures already indicated are carried out.

The question of metalling and draining roads, and immediate surroundings of houses, is also a sanitary problem which will have to be faced, if the town grows and is to remain healthy.

The disposal of the town night soil and slops in a lime deposit near the town, and disposal of refuse on the same area, without steps being taken to fence round, plant trees, cultivate soil, and burn refuse, is also a condition of affairs that, sooner or later, will require to be improved.

W. G. MACPHERSON, *Major,*
Royal Army Medical Corps.

PRETORIA,
18*th February,* 1903.

APPENDIX.

TABLE I.—PRINCIPAL Health Statistics of British Troops stationed at Pietersburg.

Week ending	Average strength.	Sick remaining.	Percentage sick remaining to strength.	Admissions for				
				Enteric fever.	Dysentery.	Diarrhoeal diseases.	Tonsilitis.	Gonorrhoea.
1902.								
6th June	784	12	1·04	..	..	2	1	..
13th „	1,228	13	1·05	1	..	..	1	..
20th „	1,499	9	0·60	1	..	..	..	..
27th „	1,790	15	0·83	1	..	..	..	..
4th July	1,945	10	0·51	..	..	1	..	1
11th „	2,084	15	0·71	..	1	..	3	1
18th „	2,026	27	1·33	..	..	..	1	2
25th „	2,045	31	1·51	1	2	3	4	1
1st August	1,822	44	2·41	..	..	4	1	..
8th „	1,732	24	1·38	..	..	2	1	..
15th „	1,413	17	1·20	..	1	1	..	1
22nd „	871	15	1·72	..	..	1	1	..
29th „	935	10	1·06	..	..	..	..	..
5th September	799	6	0·75	..	1	..	2	..
12th „	700	10	1·42	..	2	..	..	3
19th „	700	11	1·57	..	..	1	..	2
26th „	837	13	1·55	..	..	..	2	4
3rd October	833	16	1·92	..	..	..	..	2
10th „	824	11	1·33	1	..	..	..	2
17th „	823	18	2·18	..	1	..	1	3
24th „	784	22	2·80	..	1	1	1	..
31st „	662	25	3·83	4	..	..	1	..
7th November	638	24	3·76	1	..	1	1	1
14th „	639	19	2·97	5	..	2	1	1
21st „	647	19	2·93	3	..	..	..	..
28th „	617	35	5·67	3	..	1	..	..
5th December	588	37	6·29	1	..	..	..	..
12th „	591	35	5·92	1	..	1	..	..
19th „	550	29	5·27	1	..	..	1	..
26th „	560	28	5·09	3	..	..	..	..
1903.								
2nd January	553	30	5·42	2	..	..	..	..
9th „	409	29	7·09	12	..	1	..	..
16th „	291	21	7·21	1	..	..	..	..
23rd „	357	19	5·32	..	..	..	..	..
30th „	355	19	5·33	..	..	..	..	..
Total	33,901	..	..	42	9	22	24	24
					$\underbrace{}_{31}$			
Average strength for 35 weeks.	968·6	..	Admission rate per 1,000 per annum of average strength.	64·4	47·57		36·81	36·81

TABLE II.—PRINCIPAL Health Statistics of Infantry Battalions stationed at Pietersburg.

Week ending	Average strength.	Sick remaining.	Percentage sick remaining to strength.	Admissions for: Enteric fever.	Dysentery.	Diarrhœal diseases.	Tonsilitis.	Gonorrhœa.
1902.								
6th June	681	7	1·02	..	..	2	1	..
13th „	1,144	9	0·78	1	..	..	1	..
20th „	1,383	8	0·57	1	..	..	..	..
27th „	1,173	14	0·83	1	..	..	..	..
4th July	1,834	10	0·54	..	..	1	..	1
11th „	1,644	15	0·91	..	1	..	3	..
18th „	1,629	20	1·22	..	..	..	1	2
25th „	1,645	22	1·33	..	2	3	4	1
1st August	1,429	35	2·44	..	..	3	1	..
8th „	1,340	14	1·04	..	..	1	..	..
15th „	1,017	11	1·08	..	..	1	..	..
22nd „ *	469	7	1·48	..	..	..	1	..
29th „	538	4	0·74	..	..	..	..	..
5th September	530	..	..	..	1	..	2	..
12th „	520	5	0·96	..	..	..	..	..
19th „	521	..	..	..	..	..	..	..
26th „	520	3	0·57	..	..	..	1	3
3rd October	514	6	1·16	..	..	..	1	1
10th „	511	5	0·97	..	..	..	..	1
17th „	512	13	2·53	..	1	..	1	1
24th „	489	13	2·65	..	1	1	1	..
31st „	357	16	4·46	2	..	..	..	..
7th November	347	12	3·45	..	..	..	1	1
14th „	344	6	1·74	..	..	1	1	..
21st „	341	7	2·05	1	..	..	..	..
28th „	338	10	2·95	1	..	..	..	..
5th December	310	11	3·54	..	..	..	..	..
12th „	288	10	3·42	..	..	..	..	..
19th „	248	7	2·82	..	..	..	..	..
26th „	248	8	3·22	3	..	..	..	..
1903.								
2nd January	246	11	4·47	2	..	..	..	..
9th „	245	11	4·48	11	..	..	..	..
16th „	250	17	6·8	1	..	..	..	..
23rd „	316	15	4·74	..	..	..	..	..
30th „	314	17	5·41	..	..	..	..	..
Total	24,735	..	..	24	6	13	20	11
					$\underbrace{}_{19}$			
Average strength for 35 weeks.	706·71	Admission rate per 1,000 per annum of average strength.		50·4	39·94		42·04	23·12

* Northamptonshire Regiment only from this date. Previously there were two Infantry battalions.

TABLE III.—PRINCIPAL Health Statistics of Mounted Infantry stationed at Pietersburg.

Week ending	Average strength.	Sick remaining.	Percentage sick remaining to strength.	Admissions for Enteric fever.	Admissions for Dysentery.	Admissions for Diarrhœal diseases.	Admissions for Tonsilitis.	Admissions for Gonorrhœa.
1902.								
6th June..	..	..	..	..	..	..	..	..
13th ,, ...	..	..	..	..	..	..	..	..
20th ,, ...	..	..	..	..	..	..	..	..
27th ,, ...	..	..	..	..	..	..	..	..
4th July	..	..	..	..	..	..	..	..
11th ,, ...	324	..	..	..	..	..	..	1
18th ,, ...	324	7	2·16	..	..	..	..	..
25th ,, ...	322	9	2·79	1	..	..	..	..
1st August	325	8	2·46		..	1	..	..
8th ,, ...	322	9	2·79	..	..	1	1	..
15th ,, ...	324	6	1·85	..	1	..	..	1
22nd ,, ...	323	7	2·16	..	..	1	..	..
29th ,, ...	320	5	1·56	..	..	..	..	..
5th September	210	5	2·38	..	..	..	..	..
12th ,, ...	116	..	..	..	1	..	..	3
19th ,, ...	114	7	6·14	..	..	1	..	2
26th ,, ...	243	8	3·29	..	..	..	1	1
3rd October	257	8	3·11	..	..	..	..	1
10th ,, ...	253	4	1·58	1	..	..	..	1
17th ,, ...	251	5	1·99	..	..	..	..	2
24th ,, ...	236	9	3·81	..	..	..	..	..
31st ,, ...	238	8	3·38	2	..	..	1	..
7th November	230	12	5·21	1	..	1	..	..
14th ,, ...	234	13	5·55	5	..	..	..	1
21st ,, ...	240	17	7·08	2	..	..	..	..
28th ,, ...	223	23	10·31	..	..	1	..	..
5th December	222	23	10·36	1	..	..	..	..
12th ,, ...	252	22	8·72	1	..	1	..	..
19th ,, ...	246	20	8·13	..	..	..	..	..
26th ,, ...	246	16	6·50	..	..	..	..	..
1903.								
2nd January	251	16	6·37	..	..	..	..	..
9th ,, ...	108	15	13·88	..	..	1	..	..
16th ,, ...	..	..	..	..	..	..	..	..
23rd ,, ...	..	..	..	..	..	..	..	..
30th ,, ...	..	..	..	..	..	..	..	..
Total	6,754	..	..	14	2	8	3	13
					10			
Average strength for 27 weeks.	250·14	Admission rate per 1,000 per annum of average strength.		107·8	76·99		23·09	100·09

TABLE IV.—NOTE on Water collected from Well No. 3; and on the proposed Waterwork Scheme for Pietersburg.

The analysis of the water from well No. 3 gives somewhat unexpected results—

1. The evidence of organic pollution is considerable.
2. The number of micro-organisms is high.

The water was collected in glass-stoppered bottles; previously sterilized with sulphuric acid.

The method of collection was as follows:—

A glass funnel, also sterilized with sulphuric acid, was placed against the rock from which the water was issuing, and the water was thus led into the bottles. The bottles were rinsed out with this water several times.

After filling the bottles it was discovered that old rags were stuffed into the fissure from which the water was coming. These were removed, and the bottles again washed out and rinsed with water from the fissure, but there were no means on the spot of sterilizing them again. This circumstance may have had some influence on the number of micro-organisms.

Within an hour after the bottles were filled they were placed in a refrigerator and kept there for 42 hours previous to being conveyed to Pretoria. For conveyance they were packed in ice, and the samples plated out without previously being exposed to a higher temperature.

The possibility, therefore, of the number of colonies having greatly increased after collection is remote.

As regards the chemical analysis, it is scarcely possible that the amount of organic pollution comes from the old rags, unless some of these rags had remained undetected in the fissure.

It is quite possible that some undetected rags were stuffed far up into the fissure, and, if this is the case, an explanation of the character of the water may be afforded.

The surface of the ground was followed up eastwards of the well, *i.e.*, in the direction of the fissure, with a view to the detection of outcrops of formation similar to that of the well. These were found at a distance of 3 miles from the well, where there were some kopjes of chloritic schist on the top of the slopes leading towards the well. There were the remains of old and extensive native kraals on the slopes close to these kopjes.

It is possible that surface water leading to the fissure percolates into the subsoil over this area.

But before condemning the water it is recommended that the fissure in the well be opened up, carefully examined for extraneous articles, which the Kaffir labourers may have stuffed into it to check the flow of water, and samples again collected and conveyed to the laboratory with the same precautions as before.

As regards the evidence of pollution of the Sterkloop stream, the three analyses (1, 6 and 7 of attached tabular statement) give promise of a fairly satisfactory water being obtained from the proposed scheme for damming the Sterkloop below its collecting area.

The amount of organic pollution, although not sufficiently low to bring it within the limits of a pure water, is no higher than one expects in water flowing from upland grazing areas in a shallow bed, and does not indicate pollution from habitations, except in the case of No. 7 analysis, about the source of which more information is required.

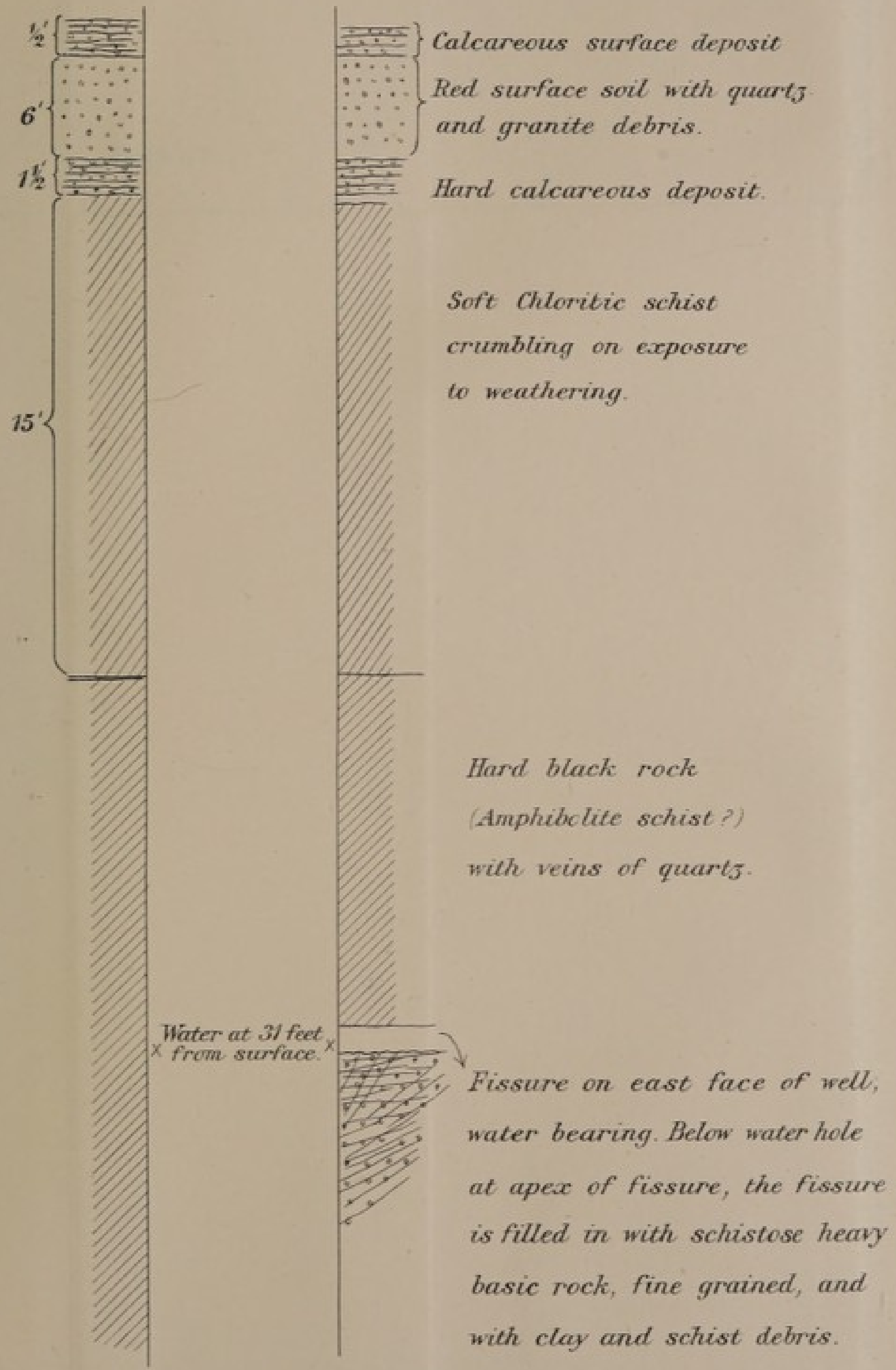
It was evidently collected after the settlers had taken up their plots along the banks.

TABLE IV.—Tabular Statement of Analysis of Water collected at Pietersburg, Transvaal, and analysed in the Military Laboratory, Pretoria, by Major Beveridge, R.A.M.C.

Source.	Date.	Parts per 100,000 of												Remarks by Analyst.
		Dissolved solids		Hardness			Ammonia				Oxygen consumed at 80° Fah.			
		Total.	Volatile.	Total.	Fixed.	Chlorine.	Free.	Albuminoid.	Nitrogen in nitrates and nitrites.	Nitrates.	In 15 min.	In 4 hrs.	Sulphates.	
1. Sterkloop Stream, above masonry dam.	16th Feb., 1902 ..	61·5	19·0	36·5	6·5	3·7	·005	·030	..	..	·06	..	..	Calcareous; doubtful purity.
2. Drinking water (source not mentioned).	16th Feb., 1902 ..	51·20	..	29·00	..	3·4	·002	·017	..	..	·06	..	..	Good water.
3. Town Well (which well not indicated).	24th April, 1901 ..	65·0	..	..	..	14·62	·002	·030	..	..	·08	..	..	Suspicious water. 42,640 colonies per c.c.
4. River water (which river, Sterkloop or Zand, not indicated).	24th April, 1901 ..	53	..	..	..	12·42	·016	·035	..	..	..	·1	..	Bad water.
5. Zand River (where collected not indicated; intended for new cantonment).	24th July, 1902 ..	31·70	6·6	22·9	4·6	3·6	·003	·011	..	Nil	·03	..	9·8	Not organically pure. Not recommended as a permanent supply.
6. Government Settlement Farm (Sterkloop Stream).	26th Nov., 1902 ..	57·9	12·9	..	..	2·6	·003	·019	·02	Nil	..	·04	..	Of doubtful purity. Evidence of former pollution.
7. Sterkloop Stream (when collected not indicated).	17th Jan., 1903 ..	..	..	..	..	3·2	·003	·204	·032	Nil	..	..	..	Doubtful water.
8. Well at Delamore's mineral water factory.	14th Jan., 1903 ..	55·8	7·4	8·8	4·8	5·9	·005	·021	·172	Traces	..	..	..	Organic pollution.
9. Well at Symons' mineral water factory.	14th Jan., 1903 ..	67·8	9·2	9·4	5·0	6·3	·005	·016	·279	Heavy traces.	..	..	..	Organic pollution.
10. Well No. 1, near new cantonments, in course of construction.	15th Jan., 1903 ..	44·8	8·6	17	1·8	3·4	·004	·019	·204	Heavy traces.	..	·352	..	Organic pollution.
11. Well No. III., near Sterkloop, in course of construction. (*See* special note.)	14th Feb., 1903 ..	19·6	5·6	20·6	7·0	2·9	·007	·394	·204	Nil	..	·012	..	167,966 colonies in 1 c.c. Fluorescens liquefaciens, B. Subtilis, a micrococcus. No B. coli or typh. A certain amount of organic pollution, but not of recent date.
12. Marabastad Stream (where collected not indicated).	15th Jan., 1903 ..	35·4	7·8	23·2	6·2	2·1	·004	·019	·021	Trace	..	·04	..	Organic pollution.

Plan A.

SECTION OF WELL No. III, NEAR STERKLOOP STREAM, PIETERSBURG.



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ROUGH SANITARY SKETCH PLAN OF PIETERSBURG – TRANSVAAL.

REPORT ON HARRISMITH AS A CANTONMENT FOR BRITISH TROOPS.

PHYSICAL FEATURES OF THE LOCALITY.

Harrismith is situated at an elevation of 5,200 feet above sea level, at the western limit of a belt of broken hilly country that is formed by the foot hills of the western slopes of the Drakensburg, and the northern slopes of the Basutoland mountains.

The foothills are of peculiar formation, being cut away by denudation into fantastic shapes, leaving isolated masses which stand out here and there, and rise some 2,000 feet above the surrounding country.

The town of Harrismith lies in a basin at the foot of one of these isolated mountains, the Plaatberg, which is about 4 miles long from south-east to north-west, and about a mile wide; it rises to 7,500 feet above sea level. The town valley is enclosed by this mountain on the north-east and east, and by lower terraces of the Berg on the north, east, and south-east. Along its southern and south-west boundary there is another terraced hill, while on the west the valley opens out to the undulating plains of the Orange River Colony, that are co-extensive with the Vrede and Bethlehem uplands.

These lower terraces have local names, the northern terraces being named Reitz Hill and Vrede Hill, the north-east and eastern the Underberg, the south-east terraces Natal Hill East and Natal Hill West (now called King's and Queen's Hills). The southern terrace is called the Basuto Hill, and is about 2 miles long from south-east to north-west.

The Wilge River cuts into the basin between Natal Hill West and the south-east extremity of Basuto Hill, and flows in a north-westerly direction through the basin to a point opposite the lower end of the town, where it turns westwards and passes into the plains beyond.

A spur of land or hog's back runs from the foot of King's Hill down the centre of the basin to the Wilge River. It is on the central portion of this spur that the town of Harrismith is situated. In consequence of its hog's back formation it slopes on the west to the river and on the east and north to a spruit called the North Spruit, which intercepts the mountain channels running down from the Plaatberg. This spruit is the boundary of the town area on the north-east and north and joins the Wilge River below the town. In fact, the spur on which the town is built is the tongue of land between this spruit and the river. The town itself is on this spur, and the houses do not extend down the slopes farther than within 200 or 300 yards either of the spruit or of the river.

The basin is about 4 miles across from the Plaatberg to the Basuto Hill, *i.e.*, from the north-east to south-west. From south-east to north-west, that is to say, from Natal Hill West to Reitz Hill, it is somewhat under 3 miles wide.

The greater portion of this basin is much cut up by dongas and dry water-courses. For example, there is a somewhat deep valley between the Underberg and King's Hill, and a lesser valley between King's Hill and Queen's Hill, which are intersected by dongas, the donga from the former running into the North Spruit, and the donga from the latter forming a deep cutting, which enters the Wilge River about half-a-mile above the town, and which receives minor dongas from the south-west slopes of the upper part of the town spur.

Similar minor dongas enter the North Spruit from the slopes of the Underberg, Vrede and Reitz Hills, but scarcely any from the north-west slopes of the town spur. The slopes from Basuto Hill to the river, *i.e.*, the left bank of the river, are free from this donga formation.

The precipitous slopes of the Plaatberg facing the town basin is scarred with krantzes and watercourses which run in a south-west direction through the Underberg to the North Spruit. Several watercourses also run westward, from the spur connecting the Natal Hills with the Plaatberg, towards the North Spruit.

The railway line from Ladysmith to Harrismith and its continuation from Harrismith to Bethlehem runs through this basin more or less parallel to the right bank of the Wilge River, but with a belt of land some 300 or 400 yards between it and the river.

The town is on the side of the railway line farthest from the river, and is consequently about a ¼ mile distant from its banks. It is also about 100 to 300 feet above the bed of the river. The terrace hills surrounding the basin rise to about 300 to 500 feet above the river. The Underberg slopes upwards to the foot of the Plaatberg cliffs for some 1,000 feet, and the more precipitous slope and cliffs of the Plaatberg are another 1,000 feet in height.

The top of the Plaatberg is an undulating grassy upland forming in places deep basins with steep slopes. At other places it is rocky and forms rocky peaks or hills, which rise 300 or 400 feet higher than the top of the cliffs.

The slopes from the cliffs to the Underberg are more or less broken by water-courses and boulders, but there are also extensive grassy stretches on them.

The tops of the other hills are usually formed of sandstone rock covered with a thin layer of grass-covered surface loam. The slopes below these lesser hills are also grass covered, where they have not been cut into by dongas, or made bare by camps, and the soil as a rule is a deep alluvial loam. The surface soil of the slopes on the left bank of the river is a lighter and more sandy loam than the soil of the slopes on the right bank and Plaatberg. Near the banks of the North Spruit and Wilge River there are several swampy areas or pans. The swampy areas are most noticeable along the North Spruit opposite the town, and on the left bank of the river, especially where the valley opens out to the west.

The geological formation of the Plaatberg and of similar isolated masses in the neighbourhood is well marked. The cliff is formed of a cap of basalt, some 100 feet thick, the columnar formation of the basalt forming a precipice all along the top of the mountain. The basalt rests on what appears to be cave sandstone.

Massive outcrops of this sandstone are seen immediately below the basalt cliffs. A grey sandstone forms outcrops on the face of the lower terraces and also on the banks of the river.

Boulders from the basaltic columns at the top of the Berg have been thrown down the slopes, and the whole of the surface soil over the underlying sandstone is formed of a mixture of disintegrated basalt and sand. There is some shale formation amongst the sandstones of the lower slopes; and the soil along the lower portions of the basin and the slopes of the town spur is more stiff and argillaceous than on the top of the terraces.

A well-marked dyke of intrusive rock runs across the root of the town spur from the Underberg to Natal Hill West, and there is other evidence of dyke formation in the lower slopes.

The lower sandstones are probably of the same formation as the Stormberg beds and they are said to contain coal.

The basin described is occupied by habitations over the town area, which covers about 350 acres, and by a native location of about 100 houses. The latter is situated between the railway and the river, about ½ mile above the town.

During the past year camps have occupied all the terraces surrounding the basin, all the slopes from these terraces to the Wilge River or North Spruit, all the available portions of the town spur, and portions of the top of the Plaatberg itself.

The site of the new cantonments is on King's Hill (Natal Hill East) and on the root of the town spur, which commences from below this hill. Above and below the basin there are farms, and there is also an inhabited farm (Lucas's Farm) just below King's Hill.

Water Supply.

The water supply of the district is from upland surface springs and mountain streams. The Wilge River does not form any part of the supply of people inhabiting the town valley, although it may be used in farms above or below it. There are practically no wells. Although one exists in the Market Square it is not used. There are no deep borings, except such as have been made in the neighbourhood in prospecting for coal. Rainwater was previously a common source of water supply in the town, but it is not much used now, and practically the whole of the town, native location and camps, obtain water from one source only, namely, the laid-on water supply of the town.

*Town Water Supply.**

The main source is springs and upland surface water collected in the upland basins on the south-east end of the Plaatberg. The water from these falls down the cliff through a deep krantz and forms a clear mountain stream which flows through bush and over basalt boulders to the steep slopes leading to the Underberg and North Spruit; it is known as the "main stream." It is impounded in a reservoir at the bottom of a ravine running into a valley between King's Hill and the Underberg. The reservoir, No. 2, into which it flows is the middle of three reservoirs which form the town waterworks at this spot.

The upper reservoir or reservoir No. 1 is close to it, and about 20 feet higher up. It is formed by impounding a large stream, which drains the uplands between King's Hill and the Berg. This stream receives near the point where it is impounded a stream which flows from the cliffs of the south-east end of the Plaatberg, and which is fed by surface springs at the foot of the cliffs and by three or four water-courses running into it from the neck connecting the Berg with King's Hill.

A third watercourse from the top of the Berg runs parallel to the main stream further north, and forms one of the chief tributaries of the North Spruit, if one regards the "main stream" as the source of the spruit. It is known as Halle's Stream, and is said to have a stronger and more permanent flow than the main stream. This third watercourse does not enter any of the reservoirs direct, but has been connected with them by means of a surface channel and partially by a pipe, which enters the main stream just before the latter enters the reservoir. Another artificial connection in the waterworks scheme is made by a similar surface channel from the main stream to No. 1 reservoir.

No. 3 reservoir is a service reservoir situated below No. 2 reservoir and fed from it only by means of a pipe connection. There is a pipe connection between No. 1 and No. 2, but No. 1 is only used as a reserve supply. At present the water in the streams feeding No. 1 reservoir, with the exception of the diversion to it from the main stream, is cut off by dams, and led into a bye-wash. There is also an overflow from No. 1 into this bye-wash. The bye-wash becomes an irrigating channel leading to Lucas's Farm. Until the present waterworks were constructed 11 years ago, No. 1 reservoir alone existed, and this irrigating channel formed a furrow leading to the town, the water in the furrow being the town supply then. There is also an overflow from No. 2 reservoir into the North Spruit.

No. 1 reservoir has a black-earth bottom and sides, No. 2 reservoir has its sides lined with loose stones, No. 3 reservoir is an open masonry reservoir.

The total capacity of the impounding reservoirs is 12,000,000 gallons, No. 1 holding about 5,000,000 gallons, and No. 2 about 7,000,000 gallons. The Service reservoir is 100 by 80 by 12 feet in dimensions, with a capacity of 500,000 gallons. The water is led to the town from the service reservoir in a 7-inch cast-iron main with lead socket joints, and is laid on to houses and standpipes in galvanized-iron screw joint pipes.

The water is also carried to standpipes as near camps as possible. For the camps on the Basuto Hill slopes, it is carried across the river to a standpipe on the left bank opposite the town.

It is also laid on to the native location, and practically to wherever a water supply is required on the town lands.

There is a series of barbed-wire fences round the reservoir area. The largest area is fenced off by a barbed-wire fence from the terrace above the reservoir to the Plaatberg cliff, fencing off the collecting area of Halle's Stream, and by a similar fence on the south-east side of the area, running parallel to, and inclosing the stream from the Berg, which joins the stream entering No. 1 reservoir. A triangular area of 2 or 3 square miles is thus enclosed, the base of the triangle being the foot of the cliffs, and the apex just below the reservoirs. The collecting areas of the water-courses from the neck between the Berg and King's Hill, which enter No. 1 reservoir streams, are outside this enclosure but, as already stated, these streams have been diverted into a bye-wash. Within this enclosed area there are two lesser enclosures, one enclosing the reservoirs and an area above them, to a point about ½-mile up the main stream. This enclosure was apparently made to fence off the diversion of the main stream to No. 1 reservoir. The second enclosure is within this one again, and consists of a barbed-wire fence round the reservoirs only. The

* *See* Plan C.

springs and upland basins on the top of the Berg are not fenced off, and cattle graze over this area.

During the war there were a blockhouse and a regimental camp on the collecting area on the top of the Berg, and many cattle are said to have been placed on it. The quality of the water was then impugned; especially as a serious epidemic of enteric fever occurred amongst the troops and town population at the time.

Analyses were made locally and by the Government bacteriologist at Pietermaritzburg.

The latter obtained under 300 colonies in the cc., and declared the water to be pure and free from pathogenic organisms in March, 1901, during the height of the epidemic. The local analysis also declares the water to have been of the highest degree of purity. None of the analyses on the records have been very full or conducted over an extended period.

At present the water is turbid. In March, 1901, Colonel Notter of the Dysentery Commission, ascribed this turbidity to the fact that the diversion of the main stream to No. 1 reservoir is cut through clay at one place along its course; but, as a matter of fact, there are numerous places in the main stream and Halle's stream, as well as in the diverting channels from these, which are formed of black earth and mud.

River Water.

The river flows in a deep channel through the district. The banks are muddy, with sandstone outcrops here and there, and the water is turbid. There are no habitations on its left bank or near its left bank during its course through the Harrismith Basin, but above and below the basin the banks are farmed and cultivated.

The right bank, just above the native location, has been selected for the town and camp nightsoil trenches and refuse dumping ground.

Soldiers have been seen bathing in the river at this point just below the dumping ground.

The water from a camp swimming bath passes directly into the river from the left bank opposite the town. A remount camp reaches to the banks on the right bank at the same point. The scourings of dongas passing beside camps and by the native location enter the river above the town. The North Spruit, with the scourings of other dongas in the neighbourhood of camps, enters it below the town. Except for bathing, the river water does not appear to be used, and no washing of clothes was seen going on in it. For this purpose a pond on the banks, and practically in the night soil dumping ground, is being used by the washerwomen in the native location. This will be referred to later on.

Deep Borings, &c.

A deep boring for coal is said to have been made to the south-east of Natal Hill East, and just below it. A sulphur or mineral spring is said to have been tapped, but I have had no opportunity of verifying the facts, as the spring is said to have ceased flowing. There are many watercourses from the top of the Plaatberg, similar to those supplying the town reservoir, but they are not permanent streams. The strongest of these flows from the south end of the Berg away from the town basin. There are also some surface springs along the base of the cliffs.

Condition of Surface Soil.

Practically the whole of the area described as the town basin, and the terraces surrounding it, have been occupied by camps, men, and animals during the past 3 years. Harrismith was the advance depôt for columns operating in the Orange River Colony, and numerous camps were formed. In addition to these there were large Burgher and native refugee camps, and columns came and went continuously during the latter stages of the war. The result of this is that there is scarcely any extent of surface, which can be called a clean and unpolluted surface, within the area. Evidence of this is everywhere visible, in rank vegetation, growing over the sites of old refuse and other trenches, in tent markings, and in the bare patches of old horse lines.

The surface soil too of the town itself must be largely polluted around habitations from the absence of surface or other drainage, and the presence of animals, &c., within the yards. Fortunately a pail system of sewage disposal has been in use for many years, and cesspits, although not prohibited as yet, are few and far between.

The top of the Berg has not been free from pollution, and, at the present moment, many places are readily detected where carcases have been buried on the collecting area of the main stream of the town water supply, and close to its banks below the cliffs.

Existing camping grounds, Cavalry and transport lines, are also a continuous source of soil pollution, although refuse is collected in bins and removed to the town dumping ground. Most of the latrines have concrete bases and this prevents some soil pollution, although these bases are scoured into earth instead of concrete sumps in some camps. Surface pollution from ablution places is partially avoided in some camps by concrete bases and channels leading to gardens.

As regards the new cantonment site, the following is evidence* of old or recent soil pollution :—

(1.) A terrace below the hospital which is intended for Field Officer's quarters has markings of bell tents and rank vegetation of old refuse depositing ground over a part of the area. The sanitary records in the hospital refer frequently to refuse having been deposited there. It is stated locally that at first the hospital native labourers, and afterwards regimental details were encamped on this site.

(2.) The area enclosed for the house of the General Officer Commanding has been an old camping ground for regimental details.

(3.) The site of the Royal Artillery hutments on King's Hill has markings of tents and rank vegetation and other evidence of refuse pits. The siting of some of the huts is directly over one of these.

(4.) Along the eastern edge of King's Hill there are several patches of rank vegetation and refuse pit formation, and for about 100 yards upwards from the north-east corner of the Cavalry lines, and skirting the site of the Cavalry Field Officer's quarters, there is a considerable surface deposit of refuse.

The whole of the town and camp night soil, slops, and refuse is deposited about three-quarters of a mile above the town close to the river, and just above the native location. The surface area here is a mass of putrefying matter. The foul water from the hospital laundry runs on to the surface soil between the hospital and the town.

Civil Sanitary Surroundings.

The sanitary administration is in the hands of a Town Council of seven members elected by three wards. There are a town clerk, a waterworks manager, and a sanitary inspector, with six native labourers for waterworks, and 20 for street cleaning and other scavengering work.

The disposal of night soil and slops is in the hands of a contractor.

There is no Medical Officer of Health, or expert sanitary adviser.

The population is estimated at 1,000 white people in about 400 houses, and 2,000 coloured, living in the premises of their employers in the town as servants or store assistants, or living in the native location

No Public Health Acts are in force, nor have any municipal regulations been promulgated as yet. Regulations have, however, been submitted to Government for promulgation.

Houses are constructed usually of sunburnt brick covered with plaster, but many of the better class and more recent houses are built of the local sandstone. There are also numerous corrugated-iron buildings.

The house plots are large, 180 by 280 feet. There are, at present, 378 such erven. Many of these have water rights.

There are no house drains or other form of drainage.

The streets have footpaths protected by kerbs ; the roadways are much broken

* *See* Plan B.

up and have the appearance of having been metalled long ago, but without having been repaired for some years.

The water supply has already been described. The consumption in the town varies from day to day and from season to season, but at present it is about 250,000 gallons. The supply main is not sufficiently large to maintain pressure in houses in the higher levels, when the taps of the houses below are running.

The water rates vary from 4*s.* monthly to 21*s.* for householders, and 15*s.* to 2*l.* 10*s.* annually for houses with water rights.

The arrangements for night soil are on the dual-pail system. Pails of the Maritzburg pattern are used. These are 5-gallon pails without handles. Removal of pails is bi-weekly, tri-weekly or daily, according to the wish of the tenant at 4*s.*, 5*s.*, or 14*s.* monthly rates respectively. The pail is removed with its contents, a clean tarred pail being left in its place. Pails are not specially numbered, but are returned indiscriminately to houses. The form of cart is an ordinary buck wagon, with a 450-gallon iron tank, into which the contents of the pails are emptied, on the forepart. The empty pails are carried on the back part. Slops and urine are removed bi-weekly in tumbril carts at a rate of 4*s.* monthly. Dry refuse is removed weekly free of charge.

For the native location there is a free water supply laid on to standpipes from the town main. Several of the native houses have pail latrines, a charge of 2*s.* monthly being made for bi-weekly removal. For natives without private latrines there are 12 small latrines round the town and three outside the native location. The number of public pails in these latrines in 60.

Nightsoil and slops are deposited in pits 60 by 6 by 6 feet, and refuse on the ground or in dongas in the neighbourhood. The dumping ground is on the river bank about ¾ mile above the town and about 200 yards above the native location. Numerous pigs inhabit the dumping ground, and immediately below it is a large pond where the latrine pails are washed, and where the native washerwomen wash clothes. The contractor has "poudrette" works at the dumping ground.

The whole of the conservancy work, except the removal of dry refuse, is carried out by a contractor. He removes 500 pails nightly from the camps, (according to his own account), and there are also 500 pails in the town to be removed nightly, bi-weekly, or tri-weekly. There are four nightsoil carts for the camps and one for the town. For slops, five tumbril carts are used in the camps and four in the town. The pails are tarred twice monthly.

There is no notification of infectious disease, nor proper means of disinfecting clothes and houses. There is a small space set apart for isolating smallpox cases, and some tin huts, formerly used by the Cold Storage Company, have been used as a hospital for natives living in the town.

There is a public slaughterhouse. It is a corrugated-iron shed with three compartments. The floors are concreted and channelled to a concrete sump, which receives the offal and blood. There are three enclosures for cattle, one for each slaughtering compartment. The enclosures are paved with sandstone slabs and they drain into the surface soil. They are about 30 by 45 feet in dimension. Water is laid on to the slaughtering sheds from the town-water supply. The surroundings are clean. There are no pigs near the slaughterhouse. It is situated about 100 yards distant from the hospital laundry.

There are no public laundries except near the native location, where the Municipal Council have constructed a good laundry with good concrete floors and channel leading to a donga near it. Water is laid on from the town mains.

This washhouse has not the appearance of a washhouse in frequent use, and it is understood that the native washerwomen have ceased to use it because they say that clothes are stolen from it. They continue, therefore, to use the dumping ground pond already referred to.

For the washing from the military hospital a special laundry has been constructed. The site is between the hospital and the town, near the slaughterhouses. Water is laid on from the town mains and the waste water runs in earth channels to the North Spruit or surrounding surface.

There are three aerated water factories. All use town water, supplied direct from the main. All have Berkefeld filters on the supply pipe. One has a three-candle filter, one a seven-candle filter, and the third two seven-candle filters. The manufacturers state that sometimes the bougies have to be cleansed every 10 minutes. This has been verified by observation.

The bottles are washed by spray washers in one factory only, and by hand in the two others. One of the latter has well-constructed iron troughs with more or less running water for washing bottles; the other has the usual wooden trough arrangement.

The floors and surroundings of two of the factories are much broken and sloppy; the third is fairly clean.

There is no regulation of milk supplies. Cows graze on the town lands during the day and are confined in kraals in the town during the night. Milk is sold in bottles.

The cattle kraals are gradually being removed from the middle of the town to the outskirts. The largest contains about 24 cows. The milk from this kraal is collected and filled into bottles in an unventilated and dark corrugated-iron hut, with wooden floors, and with wooden benches and shelves for the cans and bottles. It has a foul sour smell.

New Cantonments.

The site selected is the plateau on the top of Natal Hill East or King's Hill. The acreage acquired is 760 acres, but it is understood that this will probably have to be increased to 1,100 acres.

The accommodation planned on this site is for—

1. A company Royal Engineers.
2. A battery Royal Field Artillery.
3. Combined Officers' mess and quarters for Royal Engineers and Royal Artillery.
4. One Infantry battalion.
5. One regiment of Cavalry.
6. Married quarters for these units.
7. Officers' quarters and Officers' married quarters.

Sites for the hospital, Army Service Corps, and detached quarters are provided for on the slope below the hill and at the root of the town spur. It is intended to leave the hospital on its present site.

The soil of the sites on the hill is a thin stratum of loam, overlying sandstone. The sandstone is on the surface in many places. Below the hill, where the hospital is situated, the soil is a deep alluvial soil with much clay, and is very muddy in wet weather.

The plan appended, Plan B, shows the general plan of siting. The barracks look north or north-east, with verandahs on these aspects.

The areas marked off for each unit are approximately as follows :—

1. Cavalry, 25 acres (exclusive of married quarters and parade).
2. Infantry, 24 acres (exclusive of married quarters and parade).
3. Royal Engineers and Royal Field Artillery, 23 acres (including one parade).
4. Hospital, 30 acres (including the enclosure of the old stationary hospital).

The polluted condition of the surface soil in some places has already been noted. The general construction is practically the same as that already reported upon at Pietersburg.

The water consumption is estimated at 90,000 gallons daily for all purposes, for a population of 2,210 troops, 610 natives, and 1,421 animals. It is intended to pump this supply from the town reservoirs to two Service tanks of 180,000-gallon combined capacity, and lay it on to the cantonments by gravitation.

The latrines are at present being built as earth latrines with concrete bases, but the floors have no definite channelling to concrete sumps or drains.

The ablution rooms and kitchens are also being constructed with concrete floors. They are, at present, channelled to corrugated iron tanks, from which the foul water is pumped and carried away in carts. There are bathrooms in the kitchen block as well as bread and meat stores. The distance between lines of huts is 50 feet, and between ends of huts 45 feet.

The line of latrines, ablution, and kitchens runs parallel to, and within the line of huts, at a distance of 50 feet from them. Stables are being sited behind the lines of huts on the same parallel lines, and at a distance of 60 feet from the nearest line of huts. It is understood that no provision has been made for concreting under and around huts, or for paving, concreting, or channelling stables.

A complete system of foul-water drainage is being planned, with the intention of having a water-carriage system of sewage disposal. The outfall of this system was intended to be into septic tanks and filter beds, in a hollow close to the slaughter-house.

Alternative plans have also been proposed, but nothing definite has been decided upon as yet. At present the construction of the barracks has barely commenced. Only a head-quarter office and a foremen of works quarters, and two or three huts, kitchen, ablution room and latrine in the Royal Engineer lines, have been put up The remainder of the barracks has been pegged out, and construction is about to commence. The Royal Engineer huts are occupied by the Royal Engineer construction party.

Existing Camps.

In addition to the hospital, which is mainly constructed of corrugated-iron huts, there are the following camps at Harrismith :—

1. A Cavalry regiment.
2. A battery, Royal Field Artillery, and pompom section.
3. Two Infantry battalions.
4. Army Service Corps, supply and transport, Royal Engineers, and Royal Army Medical Corps camps.

The Cavalry are camped on the slope beneath and against Vrede Hill; the Artillery on the slope beneath Reitz Hill; and the two Infantry battalions on the slopes below Basuto Hill. The remaining camps are on the town spur above the town.

They are all supplied with water from the town. Standpipes are placed as near the camps as possible, and watercarts are filled there. Some camps have arrangements for boiling, or for boiling and filtering, others have none.

There are ablution sheds. Some have concreted and channelled floors; others are on the surface soil. As a rule the water is run on to garden plots. There are swimming-bath arrangements for the camps below Reitz and Vrede Hills on the banks of the North Spruit, and for the Basuto Hill camps on the banks of the Wilge River. They are large pits dug in the soil and lined with sailcloth. The water is laid on from the town in pipes. There are no prepared places for standing on.

Latrines have concrete channelled bases in some camps. In others, the pails are placed direct on the soil or on wooden floors.

Improved corrugated-iron refuse receptacles have been placed in all camps, and receptacles are also provided for wet refuse. The troops are in bell tents, the number in each tent being six to eight. The arrangements for removing night soil, &c., are in the hands of the town contractor, who informs me that he has 500 pails to remove daily from the camps. The arrangements are on the dual-pail system.

During the war a special sanitary corps was appointed for keeping the town and camps clean. It was placed under the command of a combatant Officer. The personnel and equipment of the corps are shown in Appendix (Table III.).

At present there is no special Sanitary Officer, and camps are inspected weekly by three different Officers doing duty at the hospital.

Health Statistics.

(a.) *Civil Population.*

Death registration did not exist until August, 1902; the first entry in the death register is dated 10th September, 1902. The following deaths have been recorded since then :—

September	.. ..	4
October ..	.. ..	1
November	.. ..	3
December	.. ..	3
January ..	.. ..	3
February	.. ..	Nil.

One death was returned as due to enteric fever, one to fever, one to dysentery, one to enteritis, one to gastritis, and one to peritonitis; none of the others come within the category of zymotic diseases. Assuming that the entries for February have not yet been made, the above figures give 14 deaths in 5 months. They are all deaths amongst the white population, and if the estimate of this population is correct, namely, 1,000, these 14 deaths are equivalent to an annual death rate of 33·6 per 1,000; and the zymotic deaths (omitting gastritis, peritonitis) to 9·6 per 1,000.

There was a widespread and serious epidemic of enteric fever amongst the civil population in 1900–01. One of the leading medical practitioners tells me that he had 174 cases then. This practitioner (Dr. Wilson) has been in practice in Harrismith since 1885, and he considers that enteric fever has occurred in the town regularly every season ever since he has been there. The cases are mild as a rule, but they were very fatal during the war.

Diphtheria, according to Dr. Wilson, is also a common disease. Scarlet fever is rare. Smallpox is frequent. There is no systematic or compulsory vaccination. Measles is common. There is no notification of infectious diseases or records of these.

(b.) *Military Population.*

The tables appended show the incidence of the principal diseases amongst the troops, and also the prevalence of enteric fever during the past three seasons. As regards enteric fever, Table I. shows clearly that the period of greatest prevalence is the earlier months of the year.

The features indicated in the second table are—

1. A high incidence of enteric fever and other fevers as compared with sanitary towns in England and with garrisons in most other commands.
2. A low incidence of dysentery and diarrhœal diseases as compared with South African stations.
3. A moderately high incidence of throat affections.
4. An extremely low incidence of primary venereal affections, not only for South Africa, but also as compared with all other stations at home or abroad.

Meteorological Records.

None have been kept in the locality, but the elevation above sea level, the surrounding and underlying sandstones, and other physical features indicate a dry climate, with great diurnal and seasonal variations of temperature. Records were kept for 5 years by Doctor Wilson, but he has lost them. He states that the highest shade temperature which he recorded was 90 degrees, and the lowest 17 degrees. The prevailing wind, or wind of greatest velocity, blows up the valley from the north-west or down it from the south-east. Dust storms are frequent in winter.

Conclusions.

(1.) The climate is a good climate for British troops.

(2.) The water supply of the locality is ample for the existing population, both military and civil, and is capable of being increased, should the population grow.

(3.) The quality of the water supply is good, so far as can be ascertained, but it is open to some forms of pollution and admits of improvement.

(4.) The arrangements for distribution of water are insufficient, owing to the small size of the main.

(5.) The arrangements for disposing of refuse and nightsoil are insanitary, and the general sanitary administration of the town is inadequate for the maintenance of a high standard of health.

(6.) The siting of the new cantonment is good, but in some places the dangers of placing huts over polluted soil will have to be considered.

(7.) The chief sanitary problem, in connection with the new cantonment, is the question of sewage disposal. It is difficult to obtain a suitable spot entirely free from objection anywhere within reasonable distance.

(8.) The relative position of latrines and stables to barrack huts renders it necessary to construct them in such a way that soil pollution is prevented, and that foul matters are removed immediately.

(9.) The existing camps have been fairly well organized as regards sanitary matters, but there is need of systematic organization, so as to bring them all up to the same standard.

(10.) The health statistics, so far as they go, do not indicate a specially high standard of health amongst the civil population, as compared with sanitary towns in England. Both civil and military statistics compare favourably, in some respects, with those of other stations in South Africa.

(11.) The existing hospital site will have to be considerably improved as regards roadways and prevention of soil pollution in and around huts, if it is to remain as at present.

Recommendations.

(a.) *New Cantonments.*

It is essential that all old refuse should be cleared from the sites. Ground, where there is evidence of old refuse or filth pits, should be ploughed up and, if practicable, planted with trees.

As regards siting of huts over such ground, plans must either be altered so as to avoid the ground which has evidence of old pollution; or the space under and around the huts must be covered with concrete, and the huts themselves raised for 1½ to 2 feet above the ground. At present, huts are being erected with scarcely any space between the surface soil and the floors, and without any protection of the soil from pollution.

As regards latrines, it is far better to place them well away from the lines of huts than to bring them into alignment. For night urinals slabs should be placed outside and near the huts. These slabs should be fairly large, have a coping, and be channelled to surface or other drains. The latrine bases should be similarly channelled, and, in fact, the general principle of preventing pollution of soil in the neighbourhood of huts, by preparing and channelling the ground to drains with impervious material should be enforced.

In hut constructions it is better not to have bathrooms in the kitchen huts, especially if meat and bread stores are also placed in the same hut. In any case, it is strongly recommended that windows and doors of these kitchens and stores be covered with gauze wire netting.

As regards ablution rooms, the addition of shower baths, as recommended in connection with the ablution rooms at Bloemfontein, is recommended. The Commanding Royal Engineer, Bloemfontein, has the plans.

As regards stables, it is strongly recommended that they be sited further from the barrack huts. A distance of at least 120 feet should be maintained, and, even then, the flooring and surroundings should be so constructed as to prevent manure, &c., polluting the ground, and ensure the removal of stable refuse to properly constructed and covered manure pits. The immediate removal of all foul water from the stable to drains is also essential when stables are sited so near habitations.

So far as can be judged the provision for this is not sufficiently adequate, and expenditure will have to be incurred in making Cavalry and Artillery horse-lines sanitary. This is all the more necessary because of the fact that the arrangements for siting the Cavalry lines place the troop stables on the upper part of the site, and soakage into the soil from them would be towards the huts.

As regards a general scheme of drainage, two distinct schemes have been considered :—

1. A drainage scheme to include a water-carriage system of sewage disposal.

2. A drainage scheme for slop water only, with American trough or earth latrines.

With regard to a complete water-carriage system, it has been found very difficult to select suitable ground for the reception of the sewage at the outfall. Septic tanks and filter beds are contemplated, but they should dominate a certain area of suitable ground for irrigation and cultivation. The proposed site of the outfall near the slaughterhouse is inadmissible so long as the slaughterhouse remains there. It is also inadmissible because it does not dominate a sufficient or suitable area of irrigation ground.

The best but most expensive scheme would be to carry the sewer to a gentle slope immediately below the railway and racecourse, where there is a large area of arable land, and I strongly recommend this being adopted.*

Another somewhat suitable plot is nearer barracks on the slope below the Natal Hill West. This slope reaches to the donga, opposite the Army Service Corps Transport Camp.

A third site is in the valley below the waterworks and cantonments, where there is a strip of about 10 acres of ground between a donga and the North Spruit. Provided the septic tank and filter beds work satisfactorily, there is no objection to this last site being selected, but it should be enclosed with a plantation of eucalyptus trees now, and the ground should be prepared by ploughing and trenching for systematic irrigation. It is essential that such ground should be properly cultivated.

A point to be noted is that a certain amount of screening must be carried out before the crude sewage enters the septic tank. It is the screened material that is always likely to create a nuisance, and provision should be made for incinerating it on the spot.

All these alternative sites are above the level for hospital drainage. As the present hospital night soil is incinerated, it seems unnecessary to make any arrangement, at any rate at present, for disposing of it otherwise.

As regards disposal of slop water only by means of drains, *i.e.*, leaving the removal of nightsoil to be carried out either by the present pail system or by the American trough system, plans have been prepared showing separate tank and filter bed installation for Infantry and Cavalry, for Royal Engineers and Royal Field Artillery, and for the hospital. It is unlikely that septic tanks and filter beds will be of much use, or indeed be required for slop water alone, and the amount of stable urine and washings mixed with it is likely to interfere with any biological action that may be set up. It is better, therefore, to deal with such a form of sewage by land irrigation and cultivation without the intervention of septic tanks, and the cost of constructing these may be avoided in this case. The filter bed at the hospital, as constructed at present for this purpose, is useless.

What is wanted most is intelligent preparation of the ground for irrigation and continued cultivation either by growing crops or by the formation of osier beds, or plantations of trees which have the power of rapidly absorbing ground water.

With regard to water supply there is little to be said; the quality and quantity depend on the action taken by the Town Council. It is advisable to fence in the collecting area on the top of the Plaatberg, and, if practicable, to introduce a pipe supply by gravitation to the service reservoirs, instead of by pumping from the town reservoirs.

Filter beds have been recommended, and in view of the frequent turbidity of the water and of the fact that many animals are buried on the collecting area and near the streams, filter beds would be advantageous from a sanitary point of view. They would also have some economic value as it would not be necessary with properly constructed and properly managed filter beds to enclose the large area of grazing land which is enclosed at present, if the streams themselves were fenced to

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* *See* Plan A.

prevent cattle dying in them, and a far larger quantity of water, such as the whole of Halle's Stream and the streams entering No. 1 reservoir could be conserved.

The existing hospital seems to have had a good record, and the general plan is good, but if it is to remain on its present site, as a permanent hospital, it is strongly recommended that the huts should be raised for $1\frac{1}{2}$ to 2 feet above the ground, and the soil underneath, and for 3 feet around each hut covered with concrete and channelled to surface drains. The ground, too, is muddy in wet weather, and the construction of metalled roads and cinder paths is necessary.

The plots between these roads and paths should be made into grass plots or gardens. There is already a fairly good system of underground drainage in the hospital for removal of slop water, and there is no objection to this being disposed of as at present by irrigation on a cultivated plot. The drains, however, should be carried down to the plot, and fresh ground taken into cultivation from time to time.

It is under contemplation to have the new cantonments occupied in September next. Occupation of huts before the drainage and water supply systems are completed, and before measures have been taken for the prevention of soil pollution from the first, is strongly deprecated. It is better from a sanitary point of view to put the men into unfinished huts, with finished kitchens, ablution rooms and latrines, than to put them into finished huts with these accessories incomplete.

(b.) *Existing Camps.*

The chief requirements in camps at Harrismith seem to be, first, reduction of the number of men in bell tents to four; second, sanitary organization to bring water supply arrangements, ablution rooms, &c., in all camps up to the same standard which exists in the best of them, *i.e.*, the 1st Bn. South Staffordshire Regiment. Otherwise the sanitary condition of the Harrismith camps compares favourably with that of camps elsewhere in South Africa.

The swimming bath arrangements are, however, unsatisfactory. The water is extremely muddy, and the earth around the baths becomes sloppy.

It is recommended that the construction of a garrison swimming bath should be commenced early, and the troops under canvas allowed to use it before the occupation of the barracks. The site of such a swimming bath need not necessarily be on the barrack site.

(c.) *Civil Population.*

The Town Council seem to be taking a somewhat active interest in sanitary matters. They are handicapped by having no expert adviser. Under the circumstances, I was asked to meet the Council and to explain to them the present health problems of the town and make suggestions as to dealing with them. The recommendation which was most strongly urged was to do away entirely with the present method of disposing of nightsoil, slops, and refuse, and to establish a farm, worked on model lines, for trenching and cultivating these. The details were explained and sites were suggested. The recommendation is practical, and there should be no delay in carrying some such scheme into effect. A plot of 5 acres is calculated to be sufficient for 1 year's nightsoil on the basis that 100 cubic feet have to be disposed of daily in trenches $1\frac{1}{2}$ feet deep and 1 foot wide and filled in for 6 inches only. Four 5-acre plots are recommended to be taken up, one for each year, and each put under crops in rotation. The plots should be enclosed by fences and by belts of trees. A properly constructed place for washing and disinfecting pails and parking the sanitary carts should be an essential part of the farm, and details for these were also put before the Council.

The bi-weekly service of night soil removal is also objectionable and insanitary. Nothing short of a daily removal can be regarded as sufficient in this system of pail latrines.

Dry refuse should be disposed of to farmers or incinerated.

The question of water supply was also considered by the Council. Fencing of the collecting area on the top of the Berg, the construction of filter beds, and of a covered clear water tank, were recommended, as well as improvements in the main pipe to avoid intermittency of supply from insufficient pressure at the higher levels.

The nightsoil carts are not of good construction, nor are pails without handles a satisfactory form of pail. Spilling is inevitable under the present system.

Other sanitary requirements in the town are—

1. Provision for notification, isolation, and disinfection in infectious diseases.

2. Establishment of properly constructed dairies.

3. Drainage of habitations and streets.

Indeed, until there are better facilities for prevention of soil pollution in and around habitations the town is likely to continue to be an endemic area of enteric fever.

W. G. MACPHERSON, *Major,*
R.A.M.C.

9th March, 1903.

TABLE I.—STATEMENT of cases of Enteric Fever admitted to Hospital at Harrismith during three successive Seasons (1900–01, 1901–02, 1902–03).

Month.	Season 1900–01.			Season 1901–02.			Season 1902–03.		Camps in which disease originated.							
	Number of cases.	Local origin.	Cases, N.Y.D. sent down country.	Number of cases.	Local origin.	Cases, N.Y.D. sent down country.	Number of cases.	Local origin.	3rd Dragoon Guards.	1st Mounted Infantry.	81st Battery, Royal Field Artillery.	12th Company, Royal Engineers.	1st Bn. South Staffordshire Regt.	4th Bn. King's Royal Rifles.	2nd Bn. East Yorkshire Regt.	Royal Army Medical Corps.
August	5	..	..	8	..	..	..	..	..	..	..	..	..	..	..	..
September	9	1	..	25	2	..	6	6	2	..	..	..	2	1	1	..
October	8	..	..	20	5	..	..	..	..	..	..	..	..	..	..	..
November	64	2	1	25	4	..	6	5	1	1	..	..	1	2	..	..
December	110	..	9	30	..	..	13	13	2	2	..	2	1	6	..	..
January	85	2	50	155	16	1	13	13	5	1	1	1	1	3	..	1
February	106	1	32	375	9	4	11	11	3	1	..	..	2	5	..	..
March	163	132	1	222	5	37	..	..	..	..	..	..	..	..	..	..
April	113	112	..	138	13	..	..	..	..	..	..	..	..	..	..	..
May	126	123	..	80	27	..	..	..	..	..	..	..	..	..	..	..
June	72	34	..	42	1	..	..	..	..	..	..	..	..	..	..	..
July	18	12	..	13	1	..	..	..	..	..	..	..	..	..	..	..
Total	879	419	93	1,133	83	42	49	48	13	5	1	3	7	17	1	1

AVERAGE Monthly Strengths for Season 1902–03.

Month.	3rd Dragoon Guards.	1st Mounted Infantry.	81st Battery, Royal Field Artillery.	12th Company, Royal Engineers.	1st Bn. East Surrey Regt.	4th Bn. King's Royal Rifles.	2nd Bn. East Yorkshire Regt.	Royal Army Medical Corps.	Remarks.
August	574	365	131	115	360	578	809	86	1st Mounted Infantry disbanded 18th February, 1903. 116 men joined 4th Bn. King's Royal Rifles for duty.
September	526	474	128	135	291	537	737	87	
October	522	419	132	161	266	474	818	87	
November	664	457	145	160	210	409	771	88	4th Bn. King's Royal Rifles increased by new drafts, but no admissions for enteric fever among them.
December	650	409	138	154	358	831	..	89	
January	654	245	124	146	332	778	..	107	
February	654	..	124	146	439	112	..	109	
Average	606	339	131	145	322	631	783	93	
Percentage of enteric fever cases to average strength	2·1	1·4	0·7	2·0	2·1	2·6	?	1·0	

TABLE II.—PRINCIPAL Health Statistics of British Troops at Harrismith, Orange River Colony, since the conclusion of the war.

Week ending	Average strength.	Sick remaining.	Percentage sick remaining to average strength.	Admissions for: Enteric.	S.C. fever.	Dysentery.	Diarrhœa, &c.	Sore throat.	Tonsilitis.	Primary syphilis.	Soft chancre.	Gonorrhœa.	Total principal diseases.
1902.													
6th June	2,069	37	1·30	4	..	..	..	2	2	..	1	1	10
13th „	2,121	70	3·30	3	..	2	..	..	3	1	..	1	10
20th „	2,606	109	4·10	4	..	..	..	..	3	1	..	..	8
27th „	5,066	159	3·13	2	..	..	..	..	2	..	..	1	5
4th July	5,132	160	3·11	1	..	1	..	..	..	..	..	..	2
11th „	5,270	181	3·43	1	..	1	..	..	6	1	..	..	9
18th „	5,839	197	3·34	1	..	3	..	..	3	..	..	1	8
25th „	5,658	202	3·57	..	..	2	..	..	7	..	..	2	11
1st August	5,736	199	3·46	2	..	..	..	1	3	..	..	..	6
8th „	5,602	203	3·62	3	..	..	..	1	2	..	..	2	8
15th „	5,772	171	2·96	..	..	1	..	..	5	..	..	..	6
22nd „	6,455	206	3·19	1	1	..	1	..	8	..	..	..	11
29th „	5,725	222	3·87	5	..	..	2	..	6	..	..	1	14
5th September	5,742	244	4·24	..	..	..	..	..	9	..	..	1	10
12th „	5,813	248	4·26	2	..	..	3	..	5	..	..	..	10
19th „	5,499	226	4·03	1	..	..	2	1	7	..	..	..	11
26th „	3,820	231	6·04	1	..	..	2	1	4	..	..	2	10
3rd October	3,121	254	8·11	3	..	4	1	..	2	..	..	..	10
10th „	3,147	255	8·10	..	..	..	..	2	3	..	..	..	5
17th „	3,147	267	8·16	..	1	..	2	..	4	..	..	..	7
24th „	3,149	215	6·82	..	..	1	2	..	5	..	..	1	9
31st „	3,140	220	7·00	..	..	..	3	..	..	..	..	..	3
7th November	3,022	231	7·64	..	..	..	2	..	1	..	..	..	3
14th „	3,016	225	7·46	2	..	4	..	..	1	..	..	1	8
21st „	3,137	217	6·93	1	..	1	1	..	1	..	..	..	4
28th „	2,786	202	7·25	2	2	1	6	1	1	..	..	..	13
5th December	2,790	214	7·67	2	1	4	2	..	1	..	..	3	13
12th „	2,786	219	7·50	1	3	2	12	1	4	1	..	1	25
19th „	2,792	164	5·86	2	..	..	2	2	2	2	..	2	12
26th „	2,796	161	5·75	6	1	1	..	1	..	1	..	1	11
1903.													
2nd January	2,796	168	6·00	11	1	..	2	10	8	..	..	1	33
9th „	2,530	169	6·76	1	1	1	7	3	2	..	..	..	15
16th „	2,536	180	7·09	2	2	..	2	1	1	..	..	..	8
23rd „	2,399	170	7·08	4	2	..	2	..	..	..	..	..	8
30th „	2,320	160	6·92	..	..	..	5	..	2	1	..	..	8
6th February	2,337	154	6·58	4	1	..	..	..	3	1	..	2	11
13th „	2,476	163	6·62	10	..	1	..	..	1	..	1	2	15
20th „	2,619	166	6·33	1	..	..	..	..	..	..	..	..	1
27th „	2,679	153	5·71	6	1	..	..	..	2	1	..	2	12
Total	145,446	7,392	5·08	89	17	30	61	27	119	10	2	28	383
Average strength	3,729	Annual admission rate per 1,000 of average strength ..		48·2		32·4		52·0		14·2			

TABLE III.—PERSONNEL and Equipment of Sanitary Corps for Harrismith.

	1901.	1902.
Overseer of natives	1	1
Non-commissioned officers	3	3
Privates	2	4
Conductors	..	1
Native labourers	29	100
Wagons, with drivers	4	10
Scotch carts, with drivers	..	2
Drag teams	2	4
Wheelbarrows	..	20
Picks	50	50
Shovels	50	50
Spades	20	20
Crowbars	10	10

HAR. Nº 56

PLAN. A.

SKETCH OF
HARRISMITH AND PLATBERG

To accompany Major Macpherson's Report on Harrismith. (9.3.03)

N.B. Sites of Camps are approximate only

SITES FOR DISPOSAL OF SEWAGE.

(a) – Proposed site for Septic Tanks of New Cantonments.
(b) – Existing site of disposal of Hospital waste water (ablution rooms, &c.)
C – Third alternative site for Septic Tanks of New Cantonments.
D – Second Alternative site for Septic Tanks of New Cantonments.
E – First and best alternative site for Septic Tanks of New Cantonments.
F – Sites for Sewage Farm for town night soil and slops (as recommended to Town Council).

Contours 40' V.I. (below 600 Contour, 20' V.I.)

Scale – 3" to 1 Mile.

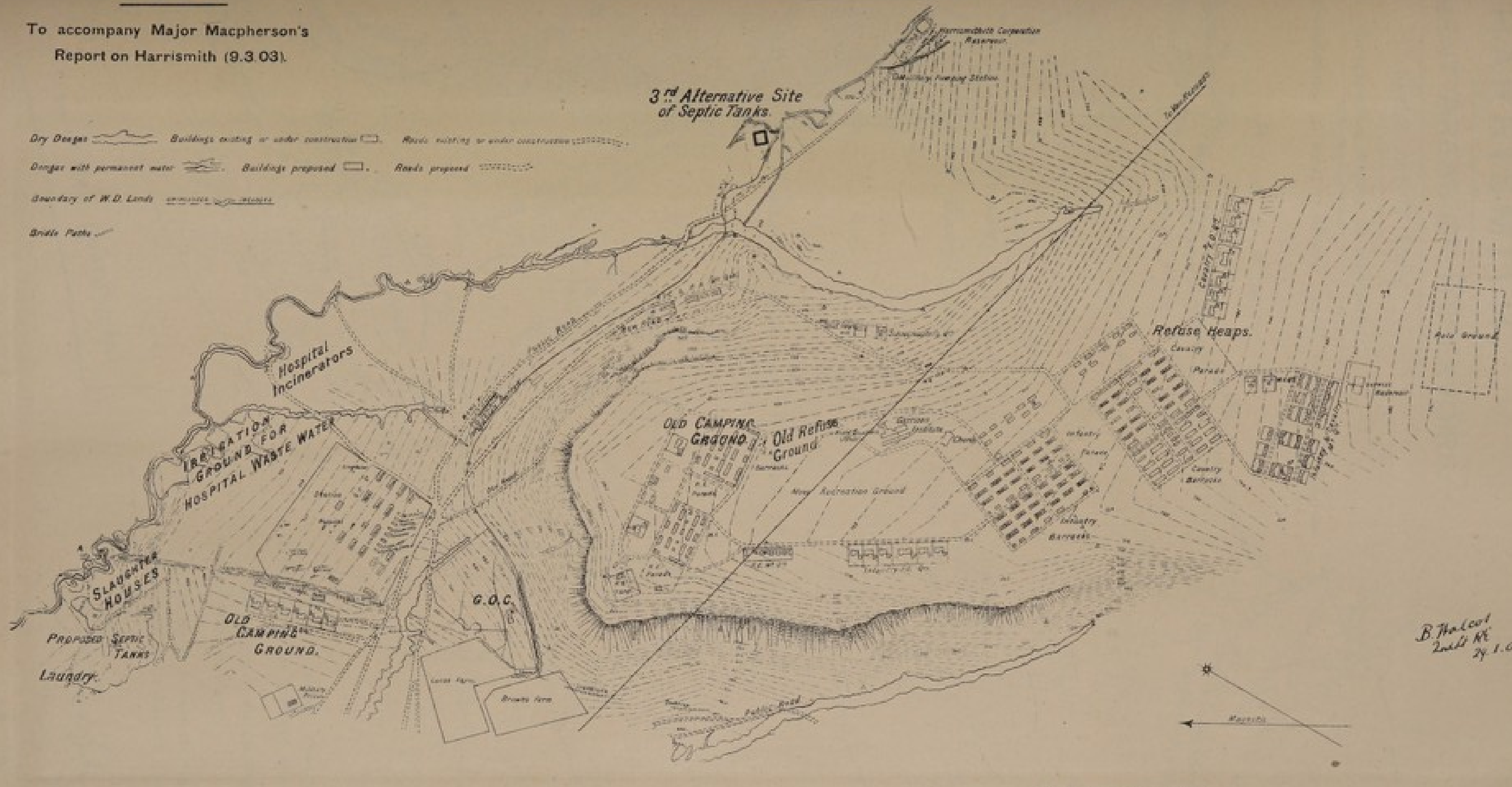
yards 100 0 100 500 1000 1500 2000 *yards*

Maj. R.E.
C.R.E. Harrismith
-1-03.

From Surveys by Lt. J. J. H. Nation, and 2nd Lt. B. Walcot, R.E.

PLAN B.

To accompany Major Macpherson's
Report on Harrismith (9.3.03).



Date on which Printed, 23. 2. 03.

Reduced Photographically from Scale $\frac{1}{3600}$.

Scale, 1200 Feet = 1 inch. (14400)

Datum Level, 5000 Feet above Mean Sea Level at Durban, Natal.

(200. 12/03. 1150) (232. 7b &c.

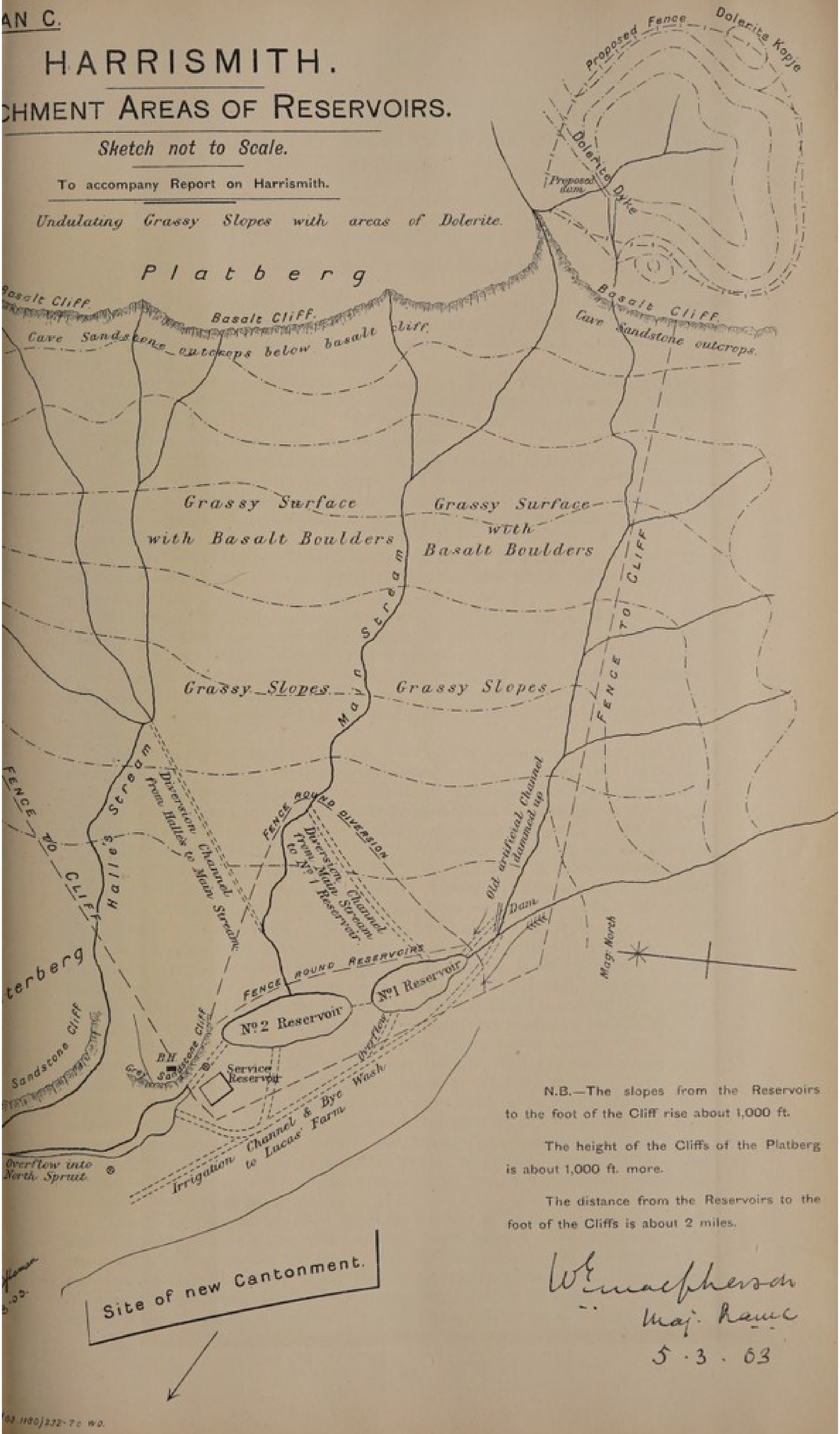
AN C.

HARRISMITH.

CHMENT AREAS OF RESERVOIRS.

Sketch not to Scale.

To accompany Report on Harrismith.



N.B.—The slopes from the Reservoirs to the foot of the Cliff rise about 1,000 ft.

The height of the Cliffs of the Platberg is about 1,000 ft. more.

The distance from the Reservoirs to the foot of the Cliffs is about 2 miles.

W. E. Macpherson
Maj. R.A.M.C.
5 . 3 . 03

REPORT ON BARBERTON AS A CANTONMENT FOR BRITISH TROOPS.

PHYSICAL FEATURES OF THE LOCALITY.

The district in the neighbourhood of Barberton is known as the De Kaap Valley.

This is a huge amphitheatre-like valley, about 20 miles in diameter, surrounded by mountains which rise round it to a height of 2,000 to 3,000 feet or more. The mountains are precipitous, and numerous narrow creeks and ravines run into them from the upper slopes of the valley.

Three rivers of considerable size, namely, the North Kaap, the South Kaap, and the Queen's River run through the valley, the general trend of drainage through the basin being from west to east. The last-named river runs from south-west to north-east and is the more southernly of the three.

The North Kaap is the largest, and all three converge at the north-east corner of the basin, where they form one stream, the Kaap River which escapes into a narrow winding valley extending for some 30 miles or more to join the valley of the Crocodile River at Kaapmuiden, on the line of railway between Pretoria and Komati Poort.

The bed of the Queen's River is about 600 to 800 feet below the base of the mountains surrounding the valley, and the conformation of the surface from the mountains to the river valley is a series of "talus" slopes.

A series of basalt dykes form small ridges or kopjes of 50 to 100 feet in height, which extend across the valley, parallel to one another, south-east to north-west, thus cutting the line of rivers more or less at right angles. This feature gives a characteristic appearance to the Kaap basin; miniature hills, ridges, and valleys, with the deeper depressions of the river valleys cutting through them, being presented in a bird's-eye view from the slopes at the base of the mountains overlooking the valley.

Barberton is situated at the highest point of the basin, close under the high, precipitous mountains on the south-east corner. In fact, one or two houses are built up the mountains and creeks. The town practically overlooks the whole of the vast amphitheatre and appears to be perched like a Swiss village on the side of the mountains. It is about 6 miles distant from the nearest point of the Queen's River and about 600 feet above it. The mountains behind it rise in a series of peaks with intervening creeks for about 3,000 feet more, the height of the town above sea level being 2,877 feet at the railway station. The town sites are formed of the base of the mountains and three or four spurs running from it into the valley for a distance of about 1 mile. The eastern and highest spur is known as Scot's Hill; it is a ridge about 200 feet higher than the town level and has a slope on its west or town side suitable for building. A shorter and lower spur runs parallel to it from the centre of the town; it is known as Gospel Hill. A third spur, known as Hospital Hill from the fact that the Civil Hospital is situated on it, runs from the western extremity of the town; and a less pronounced slope extends into the valley west of Hospital Hill. The general configuration is somewhat like a crescent, Scot's Hill being the eastern and Hospital Hill the western arm, and Gospel Hill a short tongue jutting out from the centre of the crescent. There is a low kopje at the end of both Hospital and Gospel Hills, while Scot's Hill is a high ridge throughout its whole length. Hospital Hill contains the Civil Hospital near its extremity, and the railway station and railway premises between it and the town. Gospel Hill has a church and some residential houses. Scot's Hill has the Military Hospital hutments on its western slope and a number of residential houses on the slopes at its root.

The business part of the town lies along the base of the mountains or centre of the crescent from which the spurs extend. The barrack hutments are on the continuation of the town at the root of the Hospital Hill arm of the crescent, or rather of the slope to the west of it. Residential houses extend to the Barrack and Military Hospital sites. Generally speaking, the barracks form one extremity of the town and the Military Hospital the other; the distance between them by road being about 2 miles. The residential sites near the barracks are known as Belgravia and the sites near the Military Hospital as Berea.

Two native locations, one Kaffir and the other Indian, are in the shallow valley between Gospel Hill and Hospital Hill. The valley between Scot's Hill and Gospel Hill is occupied at its upper end only. Deep dongas run down to the rivers from the town between Hospital Hill, Gospel Hill, and Scot's Hill, as well as down the valleys to the west of the slope from the barrack site; they form narrow cuttings through the surface soil, 30 to 40 feet deep in places, and for the most part are thickly covered in with bush and other vegetation. Several deep ravines or creeks run from the back of the town into the mountains; they are narrow and tortuous, with high precipitous sides, and are covered with dense creepers and sub-tropical bush and vegetation of great variety. The longest of these creeks is probably only about 2 miles. The creeks commence in krantzes at the summit of the mountains or at the foot of steep precipices. They are the beds of mountain streams. These streams are usually dry, except in rains. Their course is over rock and boulders and through dense bush which it is difficult to penetrate.

The geological formation of the mountains is auriferous quartz and schists, quartz conglomerates and quartzite, the latter being found at the top of the mountains. The underlying rock of the slopes, leading from the mountains to the foot of the valley, is granite. The Queen's River flows over granite beds, and a grey granite is the outcrop seen everywhere on the town and barrack sites at the base of the mountains, and along the slopes of Scot's Hill.

There are numerous dykes of basalt running through these formations. The bottom of the principal creek appears to be almost entirely a bed of basalt boulders. The schist is of varying character, but well marked outcrops of chloritic schist are seen on the lower peaks and levels. The laminations of the schistic rock dip at an angle of 45 degrees to 60 degrees. At the higher levels the dip appears to be southwards away from the valley towards the Lomati Valley, but on the lower levels and near the town there is a distinct dip and strike towards the Kaap basin. In many places there are great contortions in the laminae.

The surface soil over the town area, and generally over the slopes down to the Queen's River, is a disintegrated granite and basalt, forming a gravelly soil intermingled with red earth. Along the slopes from the basalt dykes and ridges the surface is stony, and in many other places, especially on the town slopes, the soil is thin with granite outcrops. The slopes, generally, are covered at present with long rank grass and short mimosa scrub.

There are several farms in the Kaap basin, but only a small portion appears to be under cultivation.

There are one or two mining villages high up the mountains above the town, where mines are being worked. The nearest is about 4 miles distant from the town.

Water Supply.

At present the only source of water is from the ravines behind the town. The water from two of these has been partially conserved in waterworks and led to a storage reservoir, from which it is distributed to the town and military sites. These two ravines are known as "Rimer's Creek" and "Rose's Creek."

(1.) *Rimer's Creek Water Supply.*

The source is a mountain burn running over a bed of basalt boulders, for the most part, from the summit of the mountain, some 2,000 feet above the town. The creek through which it runs is narrow, with precipitous sides, and is covered with dense bush. Except at its entrance above the town, it is uninhabited, and is, in fact, in most places inaccessible. A line of telegraph wires and a footpath run to the top of the mountain. The path has been closed by a fence at the top of the creek, and is now much overgrown with bush and creepers, and difficult to trace.

For water supply purposes the stream is dammed at two places. The upper dam is about ½ mile up the creek, and about 400 feet higher than the upper part of the town. It is formed by a concrete wall 2 feet thick, and about 20 feet across; it is 1 to 2 feet deep, and makes thus a small pool in the bed of the stream. A 3-inch pipe is led from the bottom of the pool down the creek to the lower dam, which is situated about ¼ mile down stream, and at a level about 170 feet lower.

The lower dam is similar to the upper dam in construction, but it has an overflow weir at one side and is a foot deeper. There is a screened masonry outlet at the centre of the dam, from which a 4-inch pipe leads down the creek to the town level, and rises from there to the reservoir, the reservoir being placed about 100 feet above the highest portion of the town, on the slope at the commencement of the Scot's Hill spur.

The 3-inch pipe from the upper to the lower dam was running full, and the dam itself was overflowing, when I saw them on the 14th March, in dry weather, but a couple of days after some heavy rains. The overflow from this dam was calculated to be yielding at the rate of 20,000 to 30,000 gallons in 24 hours, and the pipe to be discharging at the rate of 240,000 gallons in 24 hours. The lower dam was also overflowing, but no gauging was made. The 4-inch exit pipe from the dam was running full, but the head of fall between the inlet and the reservoir is only some 50 feet, and the length of pipe about 1 mile.

In winter and dry weather the yield from Rimer's Creek is said to be less than 50,000 gallons, and it is also stated that it is the only ravine near the town with anything like a permanent supply. The yield is said to be diminishing year by year.

The bush up this creek is inhabited by monkeys and other wild animals, but otherwise the water is collected on and passes through an unpolluted and inaccessible area. Just above the upper dam, however, there is a spot by the side of the stream that is frequently visited by picnic parties, and one or two small upland basins on the top of the mountains form collecting areas, which are used as grazing grounds, and drain towards the creek. The water from the creek is at all times clear and sparkling.

(2.) *Rose's Creek.*

This is a short creek running into the mountains at the east end of the town, the entrance to the creek being about 400 yards below the reservoir, and between it and Rimer's Creek.

The creek forms a watercourse flowing over a bed of compact schist with veins and leads of quartz, the lines of laminations of the schist running across the bed. The precipitous mountains forming the sides of the creek are of the same formation. As in Rimer's Creek, there is dense bush along the creek.

The water is collected from two artificial basins, an upper and a lower, the former being at the head of the creek about 250 yards up stream from the latter, which is about 300 yards from the mouth of the creek and 700 from the reservoir. The upper dam is a small semicircular concrete basin at the foot of a wall of schist or quartz, rising almost perpendicularly for some hundreds of feet to the top of the mountain. The basin is only some 3 feet wide and a few inches deep; a 3-inch pipe leads from it to the lower dam. It is practically the base of a waterfall from the mountain top. It is, however, perfectly dry, except in rains. It was seen in somewhat heavy rain, and the water trickled down the fall in a thin stream only. The basin at the foot was practically empty, the 3-inch pipe carrying off all the water that came down the fall while running barely ¾-inch full.

The lower dam is also a shallow basin formed by a dam about 1 inch deep and some 30 feet wide across the bed of the stream. The outlet is into a concrete catchpit from which a 4-inch pipe leads along the east side of the creek to the reservoir. The pipe from the upper basin discharges into this catchpit, and the basin, when seen during rain was quite dry, the only water reaching it being that conveyed by the 3-inch pipe from the upper basin.

There are no habitations or other sources of pollution of the ground in this creek, and the catchment area is practically inaccessible.

The water is clear, but it is evident that in dry weather no water at all enters the pipes leading to the reservoir. In this respect the supply seems different from that of Rimer's Creek, which appears to be fed by more or less permanent springs from catchment areas on the top of the mountain.

(3.) There is a third source of water supply from a small spring at the base of the east side of Rose's Creek, about 150 yards below the lower dam. A concrete catchpit has been built over this spring, 6 feet by 2½ feet by 1¼ feet deep. The bottom of the pit is boggy ground through which the spring issues. The pit is covered with some broken gauze netting only. A 3-inch pipe leads from it down the creek to the town. It is said to have been conserved as a water supply for the railway station, but this has been abandoned, and the yield, which is comparatively insignificant, is apparently led into three 400-gallon iron tanks placed by the side of the road leading from the town to the Berea. The 3-inch pipe passes through a rubbish dumping ground from an hotel at the mouth of the creek. The water from the tanks is said to be used for watering horses only; it does not enter the town reservoir. There is no positive information, however, about this pipe in the office of the Town Clerk, except that it does not go to the reservoir.

The reservoir, which receives the water from Rimer's and the Rose's Creeks only, has a capacity of 250,000 gallons, but this has been diminished recently by the building of an inner wall to prevent leakage. It is well constructed, arched over with concrete covered with earth, and ventilated. There is an overflow to a swimming bath at the mouth of Rose's Creek. At present the overflow is considerable.

Water is distributed to the town in a 6-inch main, passing into 4-inch branch mains. It is laid on to houses, public standpipes, military buildings and practically to all occupied places except the Kaffir location, the inhabitants of which draw water from standpipes in the Indian location. The pipes are partly galvanized iron with screw joints, and partly cast-iron with lead socket joints.

The supply is constant during the rainy weather; it is extremely limited during the dry weather, the water being allowed to run for an hour or two only each day.

There is no record, either locally or in the Military Laboratory, Pretoria, of analysis showing the quality of the water; but no suspicion as to the purity has arisen, and unless there are bad jointings in underground pipes, there are practically no sources of pollution at source and during collection, conveyance, storage or distribution.

As regards other sources of water supply, rain collected on roofs does not appear to have been considered. There are one or two private surface wells, but they are used for gardens only. There are no deep borings, but in view of the numerous lines of basalt dykes across the valley and the directions of the laminations of the schist, water is probably carried underground towards the centre of the valley.

The rivers in the valley yield large supplies, but they are far from the town and receive a certain amount of washings, &c., from mines and mining villages in the mountains above.

There are practically no springs, unless the surface percolation which no doubt feeds the Rimer's Creek water supply, and is the dry weather yield, may be considered as such.

Conditions of Surface Soil.

For many years there has been no pollution of surface soil over the town or cantonment areas by cesspits, and the area has generally had the advantage of a sanitary administration which caused refuse, &c., to be removed regularly from the neighbourhood of the habitations.

The dumping ground for refuse, carcases, and nightsoil is well beyond the town area, about ½ to 2 miles below it, down the slope. There is, however, a very large amount of rank vegetation and scrub, and a general appearance of want of cleanliness and tidiness, from rubbish lying about the yards of business premises and amongst the rank vegetation in the town. Dirty water gets thrown out on the soil around habitations. With the exception of some rubbish under one or two of the huts, there is no appearance of surface soil pollution over the military areas; they have an underground drainage system for the immediate removal of kitchen sink and ablution water. The only extensive form of soil pollution near barracks is from the stable, where the manure is accumulated on the surface, and where the drainage goes into an open pit in the neighbourhood.

From the sanitary point of view, the absence of surface or underground drains in connection with town habitations must also necessarily affect the condition of the surface soil in the town area.

The soil is generally a quartz and granite gravel, and there is an immediate slope down to the valley from all the houses. There is thus little or no retention of ground water near habitations, and there appeared to be an absence of surface pools or puddles, except here and there in the dongas and at some distance from the town, even after heavy rain. Storm water from town houses and barrack huts, &c., is carried direct on to the surface, and it is the exception to find channels for its removal. Lines of intercepting earth channels, however, run above and through the military hospital area, but no pools seem to be left in them even after heavy rain.

The only evidence of encampments is over an area between the new barracks and railway station, where there was a Burgher camp from December, 1900, to December, 1902, with a maximum population at one time of 3,000. The British occupation took place in September, 1900, but no extensive encampments were formed, and the traces of any, that were, have disappeared. The troops were as a rule housed in the town.

Civil Sanitary Surroundings.

The Sanitary Administration is at present carried out by a Health Board, of which the Resident Magistrate is Chairman, under Proclamation 28 of 1901.

Formerly, after Barberton had become a large mining camp, with a population in 1885-86 of 6,000 to 8,000, it was found necessary to form a sanitary board. Good sanitary regulations were proclaimed by the late Government, and remained in force until the late war. The Sanitary Board consisted of the Mining Commissioner as Chairman, and six members elected by stand or license holders. Their latest regulations were published in 1895, and provided for construction of latrines, prohibition of cesspools, provision of pails and receptacles for night soil, wet and dry refuse, prevention of dirty water being thrown out on the surface soil, removal of rubbish and rank vegetation, burying of carcases, prevention of water pollution, and provision for dealing with epidemics by notification, isolation, and vaccination. These regulations also provided for registration of deaths and births, and levying of rates. At present they are in abeyance, although many of their features remain under the Proclamation of 1901.

The Executive Officers of the existing Health Board consist of a secretary, sanitary inspector, water bailiff, and a labour staff of three natives for waterworks, and 29 for sanitary services. The district surgeon acts as health officer.

The water supply has already been described; its chief feature is its scantiness during dry weather. It is thought that to some extent this may be due to the mains having become silted up with gravel, leaves, &c., carried into the pipes from the mountains. It was ascertained by the Officer, Royal Engineers, stationed at Barberton that this had actually taken place in one instance. The water is laid on to houses, and a charge from 7*s*. 6*d*. to 10*s*. 6*d*. made monthly. There are no water erven.

The removal of night soil, slops, refuse, &c., is carried out by the Health Board and not by a contractor. A dual pail system for night soil removal is in force. The wagons used are buck wagons carrying wooden casks, into which the contents of the pails are emptied. The pails are removed at the same time and washed in a donga pool near the dumping ground; they are tarred once every 10 or 14 days. Removal is tri-weekly, at a charge of 6*s*. monthly per pail. From hotels and large establishments the removal is nightly. Two wagons are used for town and garrison.

The soil is deposited in pits measuring about 18 feet long by 12 feet broad and 10 feet deep. There is a long line of these pits running up the right bank of a donga 1½ to 2 miles below the town; they are only partially covered in. The soil in which they are sunk is a red disintegrated basalt alluvium.

Slops are removed in tank carts of about 300 gallons capacity. One cart is stated to be sufficient for the town and garrison for a daily removal, but there is an extra cart held in reserve.

Dry refuse is removed to a spot about 2 miles up the valley to the west of the town; two wagons and two carts are employed for this purpose. The charges for these services are included in the charges for night soil removal. The native locations come under similar rules regarding removal of waste matters, construction of latrines, and provision of pails.

The population is estimated at about 1,500 white persons. The population of the Indian location is about 100, and of the Kaffir location about 50. Most of the Indians and Kaffirs live, however, in the houses of their employers, and the total native and Asiatic population is estimated at about 1,000.

No census has been taken, but in August, 1902, there were 265 householders, (including the locations), with 315 latrine pails in the town, 14 in the Indian location, seven in the Kaffir location, and 42 in public latrines. Allowing what is a fair estimate in South African pail systems, of one pail per seven of population, this would give a population of 2,646 whites and others, a number that corresponds closely with the estimate of population.

Only a small portion of the town area is occupied. In an area of some 3,000 "stands," each stand measuring 100 feet by 150 feet, there were only 233 occupied premises in August, 1902. The large population of 1886, which covered much of the Berea and Hospital Hill sites, is said to have left for the Rand, taking its houses with it. No trace of this large population remains.

With regard to laundries, milkshops, cowsheds, bakeries, slaughter houses, and aerated water factories, no municipal regulations are enforced beyond that of sanitary inspection and removal of nuisances. A high state of sanitation does not exist in them. The aerated water factories are three in number. They use town water, but the cleansing arrangements are the usual tub and hand-washing arrangement. The premises are not particularly clean or tidy. In one factory ice is manufactured, with an ammonia and brine apparatus.

Neither in the Health Board Office nor in the Resident Magistrate's Office were notifications of infectious disease being received.

Cantonments.

Two separate areas are occupied about 2 miles distant from one another by road; they are known as the Belgravia site and the Scot's Hill site. They are on a somewhat lower level than the centre of the town, which extends from one site to the other on the slope between the 2,800 feet and 2,900 feet contour line.

Belgravia Site.

This contains accommodation for ½ battalion Infantry and for the Supply and Transport Depôts. The area taken up represents about 200 town stands. The extent of the site is about 30 acres, exclusive of the site enclosed for Officers' quarters, but including an area suitable for future extension, married quarters and parade grounds.

The accommodation on this site is in huts, the Army Service Corps portion of which is under construction, for 20 serjeants (including 2 Army Service Corps) and 396 other ranks (including 12 Army Service Corps). On the Officers' mess site there is accommodation for 21 Officers and 10 servants.

The intervals between lines of huts are 75 feet and between ends of huts 50 feet. There are, however, only four huts in line end to end and there is a space of 200 feet down the centre of this line; so that the end to end interval of 50 feet applies to pairs of huts only.

There is a line of wash-house, latrine and urinal on each flank at a distance of 100 feet from the lines of huts.

The cook-house is by itself above the huts facing the 200 feet space. It is 110 feet from the nearest huts.

The type of men's hut is the A pattern hut. The aspect is N.N.W. Verandahs have been constructed on the southern as well as on the northern aspect. The roofs are whitewashed.

Officers' huts are B pattern huts with verandahs all round. The aspect is north-east.

The accessory huts (canteen, recreation room, serjeants' mess, guard room, medical inspection room, &c.) are special huts of local construction. They are lofty with a high louvred ridge for ventilation.

The huts are raised on wooden piles 4 inches to 4 feet above the surface according to the slope of the ground. There is no preparation of soil under or around huts, or surface drainage.

Cook-houses, ablution rooms, latrines and urinals have good cemented floors channelled to catch-pits. A complete system of stoneware cylindrical drains is connected with these. From the head of the drains to the point just outside the barracks the drain is 4 inches in diameter and is about 750 yards long. From this point to the outfall it is a 6-inch drain and runs for about 300 yards. All the branch drains are of the same dimensions and all enter the 4-inch main, except the drain from the Officers' mess and quarters, which enters the 6-inch main. There are manholes at each bend and junction. They are open cement pits covered with 1½-inch grating. There are no traps.

The outfall is on the bank of a donga that runs into the valley on the west of the Officers' quarters site. The discharge is into a small uncovered cement sump, discharging over two 1-ft. wide sluices to biological filter tanks. There are two tanks 20 feet by 9 feet by 4½ feet each. They are said to be filled with 18 inches of large stone at the bottom, 12 inches of spalls above these, and 18 inches of broken stone passing ¾ inch mesh on top. The stone on the top is, however, a larger stone than would pass even a 2-inch or 3-inch mesh. The stone used is grey granite. The foul water discharges on to the filter beds at the sluice opening only. There are no distribution channels. The effluent from the beds is carried by pipe to the neighbouring donga and discharges there. The soil over which it discharges has a foul, black, slimy appearance, and the pools formed in the donga below the discharge are pools of dirty water.

A native looks after the filter beds and works the sluices. The cycle is as follows: At 4 p.m. the inlet sluice of "A" bed is open, and of "B" bed closed. "A" bed remains open for 24 hours; it is then closed and "B" sluice is opened. At 5 a.m. the next morning the outlet of "A" bed is opened. At 4 p.m. it is closed and the inlet sluice opened, the inlet of "B" being then closed. Each tank is therefore kept filling for 24 hours continuously, is kept closed for 13 hours, and is allowed to empty and aerate for 11 hours.

No urine either from latrines, urinals or stable enters this system of drainage, so that the foul water consists simply of ablution water and kitchen washings; or, in other words, of greasy soapy water, which forms a scum on the corner of the filter beds near the sluices.

The filter beds have been working for 4 months. The affluent and effluent were examined. The filtered effluent was more turbid and had a more marked smell than the unfiltered affluent, but contained slightly less oxidizable matter.

The only stable constructed at present on the barrack site is the Officers' stable. It has a wide verandah, and the floor of the verandah and stable is paved and channelled, as in well-constructed stables in England. The channels discharge into a catch-pit gulley, from which a pipe leads to an earth sump about 30 yards distant. A corrugated-iron tank is placed in the sump. It is supposed to be emptied and the contents removed in a tank cart, but at present the stable urine and scourings are soaking into the soil. There is no manure pit.

The water supply is laid on from the town mains. Two 10,000-gallon octagonal iron tanks placed above ground are kept as reserve service tanks.

Scot's Hill Site.

This site contains the Royal Engineer yard and quarters, hospital huts and accessories, Royal Army Medical Corps Officers' quarters and mess, and sisters' quarters. There is also an enclosure where it is proposed to place married quarters and where there are at present a hospital, laundry and stable.

The area of the hospital, including Officers' and sisters' quarters, is about 20 acres. It has four wards of 20 beds each. The ward huts are in two lines of two huts each, with 75 feet between the lines, and 160 feet between the ends of the wards. The Royal Army Medical Corps barrack huts are on one flank of the ward huts at a distance of 95 feet, and the sick Officers' hut on the opposite flank at a distance of 115 feet. The latrines are 80 feet from the wards, and, generally speaking, there is not only much open space, but the lines of huts are one above the other on a considerable slope.

With the exception of the Royal Army Medical Corps barrack huts, which are of the "A" pattern, the huts on the hospital site are all of local construction. The special features are—

(1.) Loftiness, 10 to 12 feet to the eaves, and 18 to 23 feet to the ridge.

(2.) Ventilation by a raised louvred ridge, and louvres in the gables.

(3.) Verandahs on all sides.

(4.) Gauze-covered windows and doors.

(5.) Bow windows at ends of wards, giving brightness to the ward, as well as space for a table for sitting-up patients.

The huts are of corrugated iron, with whitewashed roofs, and they have a pleasing, artistic appearance. They are raised on wood piles according to slope of ground, 4 inches to 4 feet above the surface. The slope is cut away for 2 or 3 feet at the back, to avoid higher elevation in front, in some cases.

The arrangements for water supply are the same as on the barrack site, except that the town supply is laid on to a 10,000-gallon service tank, and from it to the hospital; in other words, the hospital taps are not supplied direct from the town main. Hot-water pipes are also laid on from the kitchen to the ward huts.

The drainage system is also similar, both in construction and outfall, to that of the barracks, only ablution and kitchen waste water and scourings of latrine and urinal floors and mortuary being removed in the drains.

The length of the hospital drainage is about 1,000 yards of 4-inch pipes to the point where the branch drain from the laundry enters it, and then about 400 yards of 6-inch pipes to the outfall. The outfall is on the right bank of the donga running between Scot's and Gospel Hill, but is placed some 200 or 300 yards below the extremity of the latter. There is a system of biological filters similar to that connected with the barracks outfall, and with similar results.

The area adjoining the hospital site occupied by the Royal Engineers is about 3½ acres, and the site containing the laundry and stables about 14 acres. The stables are similar in construction to those of the Infantry barracks; they are about 70 yards from the site of the proposed married quarters and 300 from the sisters' quarters, which is the nearest building in the hospital site. The laundry is at the extreme limit of the site; it is well constructed, and has a model arrangement of tanks for washing blankets connected with it.

The soil under and around the hospital is not prepared or channelled to surface drains. There is a considerable amount of rank grass and vegetation over the area, and on a large outcrop of granite about 20 yards from the administrative hut there are several small rain pools in which mosquitoes are breeding.

The mortuary is a corrugated-iron hut on a concrete base without windows or other light apertures. Adjoining it there is a similar hut, where infected clothing is stored and disinfected. There is a portable Thresh disinfector placed in the open near it.

The removal of night soil and those slops which do not go into the drains is carried out by the civil authorities at a charge of 10*s.* 6*d.* monthly per pail. The latrines are earth latrines. The form of pail is the Ordnance pattern latrine bucket. The seats are made to fit close down on the pail. The system is a dual pail system.

Camps.

Although there are practically no camps for troops transport lines are still maintained, and there are also small camps for native followers.

A portion of the old transport lines and Burgher camping ground is being ploughed up and potatoes are being grown on the ground thus prepared.

Health Statistics.

(a.) *Civil Population.*

None of the death registers under the old Sanitary Board regulations were obtainable. After the British occupation death registers have been kept since September, 1900, the first entry being 15th September, 1900.

The following deaths have been entered amongst those of the civil population who died, so far as can be determined, in the town of Barberton, since then:—

1900 (from 15th September)	34
1901	222
1902	24
1903 (to 12th March)	9

The large number of deaths in 1901 was due to deaths in the Burgher camp. During that year there were 67 deaths from measles, 13 from pneumonia, 19 from diarrhœa, and 35 from bronchitis.

In 1900 no deaths from enteric fever and only one from dysentery were recorded. In 1901 there were six enteric fever and four dysentery deaths, and in 1902 one enteric and two dysentery deaths.

The records of the Burgher camp population are so mixed up with those of the town that it is impossible to form any approximate estimate of death rates of the the normal civil population.

Malarial fevers have been considered the chief diseases peculiar to the district, though not necessarily contracted in the town. So far as the records go only two deaths from this cause are recorded in 1900, 11 in 1901, (of which seven are returned as remittent fever), and two in 1902. The Kaap Valley below the town is said to be a locality where malarial fever is contracted, and cases of blackwater fever are said to be common.

Records of the Civil Hospital from 1889 to 1896 show a preponderance of admissions for malarial fevers, both amongst Europeans and natives, but the cases are said to have come mostly from the district and not from the town. Enteric fever and dysentery cases are also recorded amongst the admissions, both European and native.

There is a history of severe and fatal fevers in the town, when the large mining settlement was first formed in 1884 to 1886, but no figures can be obtained.

(b.) *Military Population.*

The table appended gives the principal statistics since the end of the war. The chief features are—

(1.) The entire absence of enteric fever.

(2.) The comparatively moderate incidence of dysentery and diarrhœal diseases, throat affections and venereal diseases, as compared with other garrisons in South Africa.

(3.) The high admission rate for malarial fevers.

(4.) The exceptionally small percentage of sick remaining in hospital each week to average strength during what are regarded as the most unhealthy months in South Africa, viz., January, February and March, and the high percentage in previous months.

The latter fact is accounted for by the admissions for malarial fever amongst men who were stationed at Komati Poort, a notoriously malarial station, at the end of the war.

A common cause of admission, peculiar to the district and station, is a form of acute fever, accompanied by swelling of glands and much malaise. The fever lasts for a few days and necessitates men being kept in hospital for 10 days or a fortnight. A peculiar form of small necrotic ulcer, the size of a split pea, is found associated with the swelling of glands, generally between the toes or on the leg or in the axilla. This is attributed to the bite or sting of an insect, but no one has discovered the insect in question. Between June and December there were 27 admissions from this cause and none since then. This is equivalent to an annual admission ratio of 85·6 per 1,000 of average strength.

The district is notoriously unhealthy for all forms of domestic animal, and the rank vegetation and scrub, especially in the creeks and dongas, are full of ticks and other insects.

A peculiarity of the locality is its comparative immunity from flies. I have certainly seen fewer flies here than elsewhere, and it is the common experience of those who have lived here all the year round.

Meteorological Records.

None have been obtained. Records are said to have been kept for many years in one of the neighbouring mining villages, but I have been unable to obtain them.

In thermometers kept in the verandah of the Royal Army Medical Corps Officers' mess during the past hot weather the highest temperature recorded was 97 degrees Fah. The heat is relaxing, and less easily borne than similar temperatures at higher altitudes.

There is considerable freedom from dust storms.

Conclusions.

(1.) The sites of the new cantonment and hospital and the general siting and construction of the huts meet sanitary requirements.

(2.) The construction of the locally-designed huts is especially good and well adapted for the climate.

(3.) The drainage system for the removal of foul water admits of improvements, and the installation of biological tanks in connection with the outfall is of little use.

(4.) The removal of night soil and urine present no special sanitary features beyond those which are common to a pail system of conservancy, but the type of wagon used for night soil is insanitary.

(5.) Better arrangements are required for the disposal of stable drainage and manure.

(6.) The absence of surface drains for storm water and of arrangements for keeping the surface under and around huts free from pollution is likely to cause trouble in the future.

(7.) The water supply is excellent as regards quality, but it is likely to cause serious trouble as regards quantity in times of drought should the population increase.

(8.) It depends almost entirely on rain collecting on the sides of narrow ravines, and there will be difficulty in impounding any large basin in order to increase storage.

(9.) Water is likely to be obtained in considerable quantities from underground sources in the valley below the town, but the quality is doubtful.

(10.) The quality of the river water is also doubtful.

(11.) The general sanitary administration presents no features different from that of other towns in the Transvaal, but to some extent the town has had the advantage of sanitary administration under good regulations for several years.

(12.) The chief sanitary defect is in the large areas of rank vegetation and scrub, over unoccupied portions of the town-lands, and in the general construction of the houses.

(13.) The arrangement for ploughing and planting crops over old horse lines and camps is an excellent sanitary measure.

(14.) The health statistics for recent months compare favourably with those of other garrisons in South Africa.

(15.) The entire absence of enteric fever is remarkable, and this may be due to several causes, such as excellence of water supply, comparative absence of dust and flies, immediate removal of a large proportion of foul water, such as would otherwise pollute the soil, in a system of drains, the hutting of troops, and the sanitary construction of latrines, urinals, ablution rooms, &c.

(16.) The malarial fever of the locality is probably contracted in the lower valley or at notoriously malarial places in the district and not in the town area.

Recommendations.

No recommendations need be made as regards sites or siting of the new cantonments except that rank vegetation requires to be kept down more than at present, especially over the area occupied by the hospital. One advantage of this will be the reduction of the number of insects, and especially of the ticks that appear to inhabit this vegetation.

Some steps should also be taken to get rid of the small rain pools in the granite outcrops in the hospital site, or otherwise prevent mosquitoes breeding in them.

Until a more constant water supply can be ensured than is at present likely to be provided in dry weather, it would be useless to introduce any water carriage system of sewage disposal, and the present arrangements meet the requirements of this small garrison. It is recommended, however, that an incinerator be constructed for the incineration of as much of the hospital and ward refuse as possible.*

The town wagons for the removal of night soil require to be of a better pattern. The present wagons with wooden barrels are of an insanitary type.

Although the underground drains are in some respects imperfect, few alterations can be suggested at present, but it is recommended that they should be flushed out from time to time, from the heads of branches, as the flow in some of the 4-inch branches is neither constant enough nor of sufficient volume to be self-cleansing.

The biological tanks, although their construction is not likely to be of much use in causing a non-putrescent effluent to be obtained, need not be abolished, as they help to break up the grease and soapy scum. Some better results might be obtained by adding distributing channels over the beds and altering the cycle of filling, resting and aeration ; but this would involve some additional expense, and it is not recommended that any expense should be incurred in constructing biological tanks for foul water from ablution rooms and kitchen sinks at this particular site. It is better to pass such water over suitable cultivated ground direct, as a rule, but in Barberton a direct outfall into the donga, after passing these filter tanks, is sufficient.

As regards stable drainage, it is recommended that, instead of the present arrangement, it should be run into the drains. It is likely to prevent biological action in the outfall tanks, but as little, if any, action is taking place, this will not matter much, and the tanks into which the effluent discharges are well removed from, and below, all habitations, so that no nuisance or danger to public health will arise.

It is not advisable that the drainage from the mortuary and infected-clothing hut should discharge direct into this drainage system. It would be better to collect such drainage in special sumps or receptacles, and destroy the contents by burning.

As regards construction, the type of hut used for hospital wards, although possibly more expensive than the War Office type, is far better adapted for the climate and locality. The double verandah or verandah all round and the louvred ridge ventilation make the hut superior to the "A" type of barrack hut in every respect.

Although there is no indication at present of bad results from the absence of surface drainage and the omission to prepare and channel the surface under and around huts, these measures of sanitation must be considered essential for all constructions of this kind in more or less permanent garrisons. It is especially necessary in districts where malarial fevers are prevalent.

As regards water supply the questions involved are entirely questions of quantity, depending upon the supplies provided by the town waterworks. As regards quality, there is nothing to indicate the necessity of either boiling or filtering this water. It is collected on areas practically inaccessible to men or animals.

As regards quantity, much could be done to increase this water supply by storing rain water from the roofs for use during the time when the supply is deficient, or by adopting a system of reserve storage tanks for private houses. Such tanks should be made mosquito-proof in this district.

But, if any larger scheme of water supply becomes necessary, it would be well to look for some wide basin amongst the neighbouring hills, where a large reservoir could be impounded, even though it be some distance from the town.

Underground water supplies and river water should only be considered as a last resource, as they are not likely to be so pure in this locality as the supplies collected in the mountains. A large supply could, of course, be obtained by pumping from the river, but it would require purification, and it is better to do with less water from a pure source than introduce a suspicious water supply into the town.

As regards immediate requirements, advantage should be taken of the present rainy season, to have the mains to and from the reservoir examined and scoured. An alleged decrease in supply may be due to silting up of the pipes with grit.

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* I understand that an incinerator does exist, or rather a form of boiler.

As regards town sanitation, there is little that is likely to be effected by military representation, but the chief sanitary requirements seem to be—

1. Cleaning the unoccupied areas of rank vegetation and scrub.

2. Better construction of houses.

3. Daily instead of tri-weekly removal of night-soil and slops. It should be noted, however, that if a sufficient quantity of water is obtainable, the situation of the town is extremely favourable for a water-carriage system.

4. Improved night soil-wagons.

5. Better construction of butchers' shops, sanitary control of milk supplies and aerated water factories. As regards the last, the introduction of spray washers should be enforced.

W. G. MACPHERSON, *Major*,
R.A.M.C.

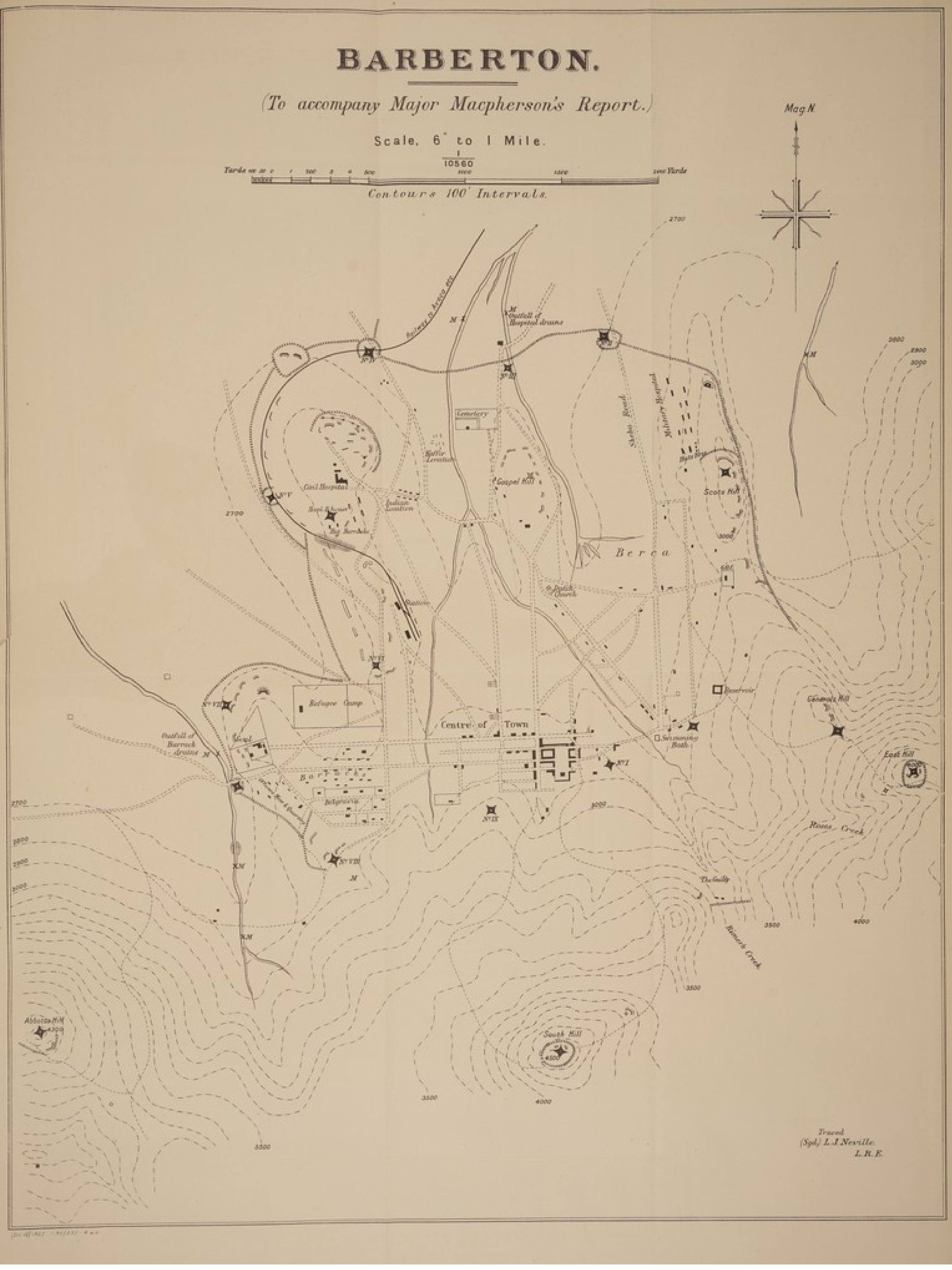
BARBERTON,
18*th March*, 1903.

APPENDIX.

TABLE of Principal Health Statistics of British Troops at Barberton.

Week ending	Average strength.	Sick remaining.	Percentage to strength.	Admissions.* Malarial fever.	Dysentery.	Diarrhœal diseases.	Tonsilitis.	Primary syphilis.	Gonorrhœa.	Soft chancre.	All causes.
1902.											
6th June	665	52	7·8	6	..	..	..	..	..	..	15
13th "	505	53	10·4	7	..	..	..	1	..	..	18
20th "	657	69	10·5	45	..	..	..	..	..	..	49
27th "	681	44	6 4	12	..	..	..	..	..	..	15
4th July	847	35	4·1	8	..	..	1	..	..	..	15
11th "	743	27	3·4	5	..	..	..	..	..	..	12
18th "	681	29	4·2	8	..	..	1	..	..	..	13
25th "	683	30	4·3	4	..	..	3	..	..	..	10
1st August	569	30	5·2	1	..	..	4	..	..	..	10
8th "	565	32	5·6	2	..	..	1	..	..	..	6
15th "	483	32	6·6	1	..	..	..	..	..	..	7
22nd "	483	35	7·4	3	..	..	..	..	..	..	11
29th "	403	35	8·6	1	..	..	..	..	..	..	8
5th September	397	32	8·0	2	..	1	..	..	..	..	5
12th "	338	28	8·2	..		..	..	..	..	..	3
19th "	353	32	9·0	..	1	..	2		..	1	7
26th "	367	38	10·3	1	..	..	..	..	..	..	8
3rd October	356	35	9·8	1	..	..	..	..	..	..	6
10th "	356	37	10·3	2	..	1	..	..	..	1	9
17th "	359	33	9·2	..	..	..	..	..	..	..	5
24th "	382	35	9·1	1	..	..	..	..	1	..	4
31st "	357	23	6·4	1	..	..	..	..	..	..	6
7th November	353	17	4·8	..	..	1	..	..	1	..	3
14th "	331	20	6·0	2	1	..	..	..	..	..	8
21st "	327	19	5·8	2	..	..	..	..	..	..	4
28th "	297	18	6·0	..	..	2	..	..	1	..	4
5th December	273	16	5·8	2	..	..	..	..	..	..	8
12th "	247	13	5·2	1	..	..	..	..	..	..	3
19th "	240	15	6·2	2	..	..	..	..	..	1	6
26th "	246	11	4·4	..	..	..	..	..	..	..	1
1903.											
2nd January	254	10	3·9	..	..	..	..	..	..	..	..
9th "	249	8	3·2	..	..	..	..	..	..	..	5
16th "	251	6	2·3	1	..	..	..	..	..	..	2
23rd "	251	4	1·5	..	..	.	..	..	..	..	..
30th "	259	4	1·5	..	..	1	..	..	..	..	2
6th February	252	4	1·5	22	..	..	..	..	..	..	2
13th "	251	5	1·9	1	..	1	..	..	..	..	3
20th "	247	5	2·0	..	..	..	..	..	..	..	2
27th "	245	6	2·4	3	..	1	..	..	..	..	5
6th March..	245	10	4·0	1	..	..	..	..	..	..	5
13th "	245	9	3·6	..	..	..	..	..	1	..	4
Average strength per annum.	16,293	996	236·8	130	2	8	12	1	4	3	311
				Admission ratio per 1,000 of average strength per annum.							
	..	389	Aver. 6·1	424·1	33·4		41·7	25 7		..	1012·8

* Admissions for enteric and S.C. fever, *nil.*


BARBERTON.
(To accompany Major Macpherson's Report.)
Scale, 6" to 1 Mile.
1/10560
Yards
Yards
Contours 100' Intervals.
Mag. N.
Railway to Avoca
Outfall of Hospital drains
Cemetery
Kaffir Location
Gospel Hill
Civil Hospital
Indian Location
Military Hospital
Sheba Road
Scots Hill
Berea
Station
Dutch Church
Refugee Camp
Reservoir
General's Hill
Centre of Town
Swimming Bath
East Hill
Outfall of Barrack drains
Belgravia
Roses Creek
The Gully
Rimer's Creek
Abbotts Hill
South Hill
2700
3000
3500
4000
Traced
(Sgd.) L. J. Neville
L. R. E.

REPORT ON MIDDELBURG, TRANSVAAL, AS A CANTONMENT FOR BRITISH TROOPS.

Physical Features of the Locality.

The district, generally, is the area in which the Great Oliphant's River and its upper tributaries rise. The watershed between this river and the Vaal River forms a semi-circle, east, south and west of Middelburg, at a distance of 40 to 50 miles from the town. Middelburg is thus practically the centre of a circle, of which this watershed forms the southern half. The area enclosed by this semi-circle, between the watershed and the town, is an undulating high veldt, extensively dotted with surface pans or small lakes, surface springs and marshes, which feed the Great Oliphant's and the Klein Oliphant's Rivers from its centre, the Kerom and Selos Rivers from its eastern, and the Wilgen River from its western boundary. These rivers converge some 12 to 15 miles below Middelburg, and the country slopes from their watershed towards the town. All this country from the watershed to the town is known as high veldt. Below and north of the town it becomes more broken and terraced, and is called the terraced or "bank veldt," while beyond this, below the junction of the Great Oliphant's River with the main tributaries, it is considered low veldt.

The chief feature of the high veldt is the large number of surface pan or small lake formations, springs and marshes, which it contains. Shallow, gently sloping grassy valleys lead from these springs or marshes to one or other of the river channels. Generally, strong running streams of clear water flow down these valleys. The terraced veldt is characterised mainly by its stony hills, and the ravines through which the river and its tributaries wind. There are also numerous springs along the banks of the river in this area.

The main area of the town of Middelburg is a slope between the Klein Oliphant's River and a strong stream, (the Merriefontein stream), rising in springs in one of the shallow valleys of the high veldt, (the Merriefontein or Uitkyk valley), south-west of the town. The area may be described as a triangle, of which the southern side or base is the railway line, the western side the Merriefontein stream, and the eastern the Klein Oliphant's River; the apex of the triangle being the junction of the two streams. The Merriefontein valley extends only some 3 miles up from the Klein Oliphant.

The occupied portion of the town covers the central or main part of the triangle. The new cantonment site is the western or south-western angle, and the native location and some scattered houses are on the eastern or south-eastern angle.

There are valleys similar to the Merriefontein valley, with their own system of springs and streams opening to the Klein Oliphant's River, on all sides of the town area, both north and south of the river.

The railway line from Pretoria to Delagoa Bay runs along the southern boundary or higher part of the town slope. In the neighbourhood of the station, the town houses extend south of the railway, and the railway station is thus within the town area. The height of the station above sea-level is 5,090 feet. It is about 100 feet above the lower part of the town or bed of the Klein Oliphant's River; and the slope rises beyond the railway for about 200 feet or more. This rise is known as Carcase Hill. At one time the burgher camp and several military camps were placed on it.

On the west of the town, *i.e.*, on the further side of the Merriefontein stream and Klein Oliphant, the hills are more pronounced and stony, forming a ridge with a somewhat steep escarpment at the point where the stream joins the river below the town.

This ridge is known as the Western Kopjes. A number of military camps were placed on the slopes of these kopjes facing the town.

The town lands on the north side of the river are extensive grassy slopes with more stony ground near the river banks. The main rise opposite the town is known as Gun Hill. A large burgher camp was situated on its slope facing the town.

The area is generally free from donga formation, but irrigation furrows pass into and through the town; and, as already stated, streams or spruits are found in all the valleys, the soil through which they run being usually somewhat marshy.

There is a considerable amount of bush in the terraced veldt north of the town and in the river ravines, but the high veldt is free from bush. The occupied portion of the town contains many eucalyptus, mimosa, and other trees, which have been planted by erf owners.

The geological formation is somewhat difficult to grasp. From the red alluvial and argillaceous character of the surface and subsoil, one expects to find a considerable extent of basalt or dolerite in the neighbourhood; but the kopje-like ridges and stony hills of the ravines below the town show very little of this formation. Its place seems to have been taken by a hard compact and heavy ferruginous or purple-coloured sandstone, which forms lines of dykes and columnar-like outcrops and boulders similar to the basalt and dolerite outcrops and intrusions elsewhere. This stone is called "oud klip"* or "old rock" by the inhabitants, and is a good building stone. It is being quarried in several places close to the town for building and road metalling.

Another characteristic formation which appears to form the chief underlying rock for miles of the undulating country south of the town and which has outcrops in the Merriefontein valley is a white quartzose sandstone. The weathered outcrops at the head of the valley have a hard surface of almost pure quartz, the upper layers crumble readily into a clean white quartz gravel, composed entirely of small rounded quartz crystals of millet-seed size, with scarcely any binding material. The deeper layers are more compact, but they are of the same composition. The compact layers of this stone are also used for building purposes, and are being quarried.*

Beneath this quartzose stone there is said to be a bed of fire clay, and, beneath the clay, extensive coal measures. The depth of surface soil over the quartzose sandstone is said not to exceed 25 feet in its deeper parts. At places it is only an inch or two thick and the stone forms outcrops here and there. The quartzose rock itself is said to be 25 feet thick and the stratum of fire clay underneath, 6 to 10 feet. The coal bed is said to be 17 feet.

In places the surface soil is more sandy or gravelly than in others. In the neighbourhood of the springs and marshes it is usually a black bog soil. Over the town area and elsewhere there is a considerable amount of iron conglomerate, similar to that found over the surface at Newcastle in Natal. The bed of the river is generally stony and rocky and is formed of the ferruginous sandstone already described.

The slopes in the immediate neighbourhood of and south of the town are unoccupied except by camps. They are also uncultivated except over a very small area.

In the broken stony country north of the town, near the river, there are several Kaffir kraals and a large native Christian settlement, Botzibilo.

There are coal mines on the high veldt to the south-west, the nearest (Uitkyk) being about 4 miles distant.

Water Supply.

There are several sources of water supply—

(1.) Springs.
(2.) Spruits and furrows.
(3.) River.
(4.) Wells.
(5.) Rain.

All these are being used by the inhabitants as water for drinking or other purposes.

* The nature of the geological formation as explained by the Government geologists at Pretoria is shown diagrammatically in Appendix B. Geologically the hard, red sandstone is the Waterberg sandstone.

(1.) *Springs.*

The principal spring supply is from the Merriefontein valley south-west of the town. There are 9 or 10 springs of considerable strength, mainly on the west slope of the valley and at its upper part. There is, however, one good spring on the east slope high up the valley, close to the military quarry, while over the town area there are several "vlei" or swampy formations, where small surface springs are being formed.

The upper springs are the feeders of the Merriefontein stream. Several estimates have been made of their total yield. Colonel Rice, Commanding Royal Engineers, estimated it at 1,250,000 gallons daily. Dr. Arnold, the Medical Officer of Health for the District, estimates the yield at 426,450 by gauging nine springs separately, or the spruits leading from groups of them. My own estimate, about 350,000 gallons, corresponds more closely with Dr. Arnold's. It was made by gauging partly the pipes from springs and partly the spruits and furrows from unpiped springs.

The lowest five springs, numbered 1, 2, 3, 4, 5, have been opened up by cuttings. The cuttings are of considerable extent, 10 to 100 feet into the side of the valley. They are covered in temporarily with corrugated-iron sheets, and pipes are laid from them to two large temporary reservoirs dug out in the surface soil near the bottom of the valley below them. A 4-inch pipe is led from these reservoirs to standpipes for the camps, town, and across the river to Gun Hill for the use of the burgher camp.

These works were erected by the Royal Engineers after the British occupation in July, 1900. Previous to that time the stream fed by these springs was led to the town in an open irrigation channel. This furrow still exists and takes the flow of the springs higher up the valley. These are strong springs, as yet unopened, oozing out in marshy ground. The highest is known as the Uitkyk spring. It is also the strongest, yielding about 80,000 to 90,000 gallons daily. The other unopened springs are known as the Reitfontein springs; they are between the Uitkyk and the piped springs. Dr. Arnold estimates their combined yield at 216,000 gallons. The combined yield of the springs opened up and piped is estimated at 58,610 gallons. 350,000 gallons may be regarded, therefore, as the approximate yield of the Merriefontein valley springs, at any rate, at present.

Although they are surface springs, with apparently a comparatively small collecting area dominating them, they are said to be strongest in dry weather and not after heavy rains. This requires confirmation. There is a statement on the files of the Water Supply Commission to the effect that they nearly ran dry in 1895–97.

The quality of the water, according to chemical analyses made both in the military and in the civil laboratories at Pretoria, is remarkably pure. There is no record of extended biological analyses.

According to the Government analyst's report the water is destitute of lime and metals and contains only three or four parts dissolved solids in 100,000 parts water. It is always very clear, even when in contact with the black bog earth into which it oozes, and it flows clear and sparkling in the furrows.

The origin of these springs and the cause of their remarkable purity have not been determined yet. The absence of iron and lime indicates that the water has not percolated through the ferruginous sandstone in the neighbourhood nor through any extent of the red surface soil of which the collecting area is apparently composed. It is probable, therefore, that the water has percolated through the clean white quartzose sandstone which is seen at the higher elevations of the veldt to the clay bed below, or it may be derived from underground pans, formed on this clay, similar to the numerous surface pans of the high veldt forming the watershed.

Springs in adjoining valleys, the water of which has been analysed, also show this characteristic deficiency in lime (*see* Table 3, Appexdix).

(2.) *Furrow Water.*

There are two artificial irrigation furrows leading to the town. The first is from the Merriefontein stream, the intake being about 1½ miles above the town, and just below the upper half of the cantonment area. It is an open furrow and feeds irrigation channels leading to the western plots of the town.

The second furrow leads from a dam which stretches across a wide shallow valley about 2 miles south of the town. The dam is 200 to 300 yards wide, and at its highest point some 30 feet deep. It is said to be capable of holding back 22½ million gallons. It is called the Town Reservoir, and was completed just before the British occupation. It has recently been under repair and the water supplying it is at present diverted into a furrow passing to the side of the dam and entering the old furrow below it. The water is obtained from springs up the valley, similar to the Merriefontein springs. The valley is, in fact, the next valley to the east of the Merriefontein valley on the high veldt. The head of the valley has been occupied by camps during the war. The analysis of the water in the dam contrasts very unfavourably with that of the Merriefontein springs. It contained nitrates, oxidizable matter, albuminoid ammonia and organic solids in excess. It was declared totally unfit for drinking purposes. The furrow leading from it feeds irrigation channels leading to the eastern and southern plots of the town. The water in the furrow has also been analysed and declared totally unfit for drinking purposes.

The water runs clear in the furrow. The furrow is an open channel and exposed to pollution.

The spruit or stream water in the neighbourhood of the town is the overflow from these furrows flowing down the line of the valleys. The water lies, as a rule, in these spruits in pools or pockets along their natural watercourses and the pools are dirty and turbid.

A strong stream, with a yield estimated at 380,000 gallons, runs in the next valley of the high veldt, east of the Town Reservoir valley. It is known as the Vaalbank Spruit, and a furrow was constructed from it to the Town Reservoir furrow. It is not, however, used and is at present dry. It is called "Du Toit's" furrow.

(3.) *Well Water.*

Wells are sunk all over the town by owners of plots. They are all surface wells. Dr. Arnold has examined 103. The average depth of water level was 6 feet from the surface. In the deepest the water was 50 feet and in the shallowest 1 foot from the surface. 52·84 per cent. were defectively covered, 64·15 per cent. were unlined, 71·7 per cent. had the water drawn by rope and bucket, and 22·4 per cent. were receiving surface drainage from fowl yards, stables, bathrooms, &c. I find a record of only one analysis of the water in these wells (No. V. of Table 3). But analysis No. 2 of Table 3 is also said to be a well water. There are no public wells.

(4.) *Rainwater.*

Several of the townspeople, (12·59 per cent. of the householders according to Dr. Arnold's investigations), depend upon rainwater collected from their roofs, as their drinking water supply.

(5.) *River Water.*

The Klein Oliphant's River runs from south-east to north-west on the northern boundary of the town area, and does not affect the other town water supplies in any way. It runs, however, beside the present native location, which is situated upstream from the town area; and there was a large native refugee camp on the opposite bank. It is the source of water supply for the native location, the inhabitants drawing their water from it by hand. Above the location it receives the water from the Vaalbank and town reservoir valley streams. Below the location to its junction with the Merriefontein Stream below the town, the river is used by the washerwomen. Below the town it takes a winding course through rocky ravines, and receives water from the valley in which the town and camp nightsoil is deposited. It then flows through the rifle range and close to the musketry camp. For some miles below the camp there are several native kraals, and the German Mission native settlement (Botzibilo) on the banks. Neither the musketry camp nor native villages are dependent, however, on the river for water supply, as there are numerous clear springs all along the banks.

Condition of Surface Soil.

Organic pollution of the surface soil has been extensive. The occupied area of the town had no sanitary system until the British occupation in 1900. Open cesspits existed then, and although a pail system of conservancy was introduced afterwards and cesspits abolished, a considerable quantity of kitchen and other slops continues to be thrown out on the soil around habitations. The tank and refuse carts were insufficient for the needs of the place during the war, the camps were without sanitary organization, and the railway station was specially noticeable for the foulness of its surroundings. At any rate, this is what one gathers from a perusal of the sanitary records during the war. In August, 1901, for example, Colonel Notter, R.A.M.C., reported that "the ground surrounding the town has been camped on in all directions, and latrines dug without any approach to a sanitary system." Cesspits appear to have continued well on into 1902. At present, the evidence of old camp occupation is well marked over the slopes of the western kopjes facing the town; over the south part of the town adjoining the railway line, and extending beyond the railway up Carcase Hill and the Town Reservoir valley; over the ground to the east of the town as far as the native location, and to the south, across the river, up the slopes of Gun Hill. Apparently the new cantonment site has remained clean, as well as the grass veldt above the springs in the Merriefontein valley. There are, however, signs of old refuse and filth pits along the base of the western kopjes, almost as far as the lower springs. The Town Reservoir valley has a large number of refuse dumping grounds and filth pits over it, especially on its eastern slopes, as well as an old burgher camp cemetery. Refuse is seen over these slopes to a point well above the reservoir itself. The largest area of foul ground is on the slopes beyond the burgher camp on Gun Hill, about $1\frac{1}{2}$ miles south of the town. There, a whole valley has been converted into dumping grounds, carcase and nightsoil pits, extending right into the musketry camp at the rifle ranges.

The valley on the far side of the western kopjes is also being converted into a similar area, as it is the present dumping ground for the town and camps. Infantry and Mounted Infantry camps are placed at present at the head of this valley, and a new native location is being constructed at its lower end. It is also the site of the slaughterhouse and isolation hospital for natives.

A considerable effort was made, so far as the records show, to clean up all these areas and reduce the previous irregular methods to some general system for the town and camps, but it may be accepted as a fact, that till within a year ago, constant and serious pollution of soil had been going on in all directions in and around the town.

A special bacteriological investigation of the state of the soil was made by Major Beveridge, R.A.M.C., in December, 1901, and he was able to isolate the enteric bacillus from the soil of one of the native latrines. The camps were then without any sanitary organization, at any rate they were declared to be in a highly insanitary condition. Old camping grounds were being used by columns, and the old Boer refugee camp was camped over. The evidence of excessive soil pollution at that time is irresistible.

At present no special pollution of soil is taking place over the new cantonment area. The huts that have been erected are kept free from occupation by contractors' men or others. The Royal Engineers, the contractors' men and native labourers are in camp a few hundred yards from the sites.

Civil Sanitary Surroundings.

Middelburg has been a township under its present name since 1875. Previously, from 1866 onwards, it appears to have been a Dutch church settlement under the name of "Nazareth." There appears to have been no sanitary system of administration in the town previous to the British occupation, which took place in July, 1900.

Civil sanitary administration is now carried on by a Health Board with the Resident Magistrate as Chairman, under Proclamation 28 of 1901. No other sanitary regulations or bye-laws are in force. The Assistant Engineer of the Public Works Department advises on sanitary engineering questions. The Medical Officer of Health for the Eastern Transvaal, (Dr. Arnold), has Middelburg as his head-quarters, and is making a special study of the local sanitation. The remainder of the executive staff consists of a sanitary inspector and assistant, a water bailiff and 20 native labourers.

The town is laid out over an irregularly shaped area, and has about 38,000 acres of town lands extending mainly to the north on the far side of the river. The number of erven is 869, of which 415 are old water erven measuring 100 by 50 yards each. The remainder measure 80 by 80 yards. 115 of the water erven are irrigated by the Merriefontein furrow, and 200 by the Town Reservoir furrow. About 200 of the erven extend to the south of the railway line up the Town Reservoir valley. The majority of the erven have not been built upon, the present number of houses being estimated at 306 only. The population is reckoned to be 2,500 whites and 1,000 natives. The number of houses in the Kaffir location is 69.

The water supply has already been detailed. The consumption of pipe water for the town, camps and railway has been estimated by Dr. Arnold to be less than 2,442 gallons per hour during the forenoon. There has been no estimate of consumption at other times. The quantity supplied from the springs feeding the reservoir is 58,610 gallons in 24 hours. The railway takes a considerable quantity, but the pipe supply appears to be sufficient at present for town and camp. Only a small supply is given to the town (namely by four standpipes). A water supply commission considered the question of water supply in January last and has submitted a report, urging the purchase of Uitkyk and Reitfontein farms so as to secure the strong springs higher up the Merriefontein valley, and thus increase the pipe supply. There are no water rates at present, the pipe supply having been laid on by the military authorities.

The disposal of nightsoil is by the pail system. It is carried out departmentally. The number of pails dealt with is 550, including 69 in the Kaffir location. Removal is tri-weekly. As far as possible pails are washed and tarred weekly, but the number is insufficient to maintain a dual system of pails. The contents are removed in tumbril carts. Three carts, each capable of taking the contents of 100 buckets are employed. Clean buckets are taken to the latrines in ordinary Scotch carts when the number permits. The contents are deposited in deep pits on the far side of the western kopjes about a mile from the town, about a mile below the military camps, about 200 yards from the town slaughterhouse, and ½ mile above the site of the new native location. The pails are cleansed in the spruit running down the valley near the slaughterhouse.

According to Dr. Arnold's investigations only 14 houses had more than one pail closet, chiefly hotels and boarding houses, and 14 had only five between them. Four residential houses and 22 business premises had none at all. Of 189 houses employing Kaffir servants only 50 provided special closets for them

The rates charged for nightsoil removal are 7*s.* per pail per month, natives being charged the same as the white population. There are no public latrines.

Slops are removed in the same carts as the nightsoil; the carts working during the night for the latter and during the day for the former. Only a portion of the slop water is removed in this way, the equipment and staff being inadequate to meet the whole requirements of the town. The rates charged for removal of slops are 1*l.* monthly.

Refuse is removed in Scotch carts only when required, or when it is creating a nuisance, at a charge of 3*s.* per load.

Slaughterhouses are private. Formerly they were situated between the native location and the railway. They have now been removed to a spot near the nightsoil trenching ground. Only one exists. It is an open shed on the veldt without water supply, drainage, or other preparation of surface. Offal is buried in the ground close to the shed. It is little more than a kraal.

There is no public laundry. The principal washing stand is on the river bank below the burgher camp.

There is no sanitary control over milk at present. 44 persons keep cows in the town. 24 of these offer milk for sale and three others bring milk into the town from outside. The milk is sold in empty whiskey or wine bottles. The bottles are cleansed anyhow.

There are four aerated water factories; they all use the piped spring water, which is laid on to the premises, except in one case, where water is conveyed in a barrel from one of the town taps. One factory uses a charcoal "syphon cleansing" filter in a slate tank, another uses a 3-candle Berkefeld filter on the delivery pipe, and a third two 7-candle Berkefeld filters on the delivery pipe, but lets the water run afterwards into a slate tank inadequately covered and containing a charcoal "syphon-cleansing" filter; the fourth uses a cloth filter. Bottles are washed by hand in a trough in the first factory; they are steamed in tanks in the second; in the third they are washed by machine washer and spray; and in the last by hand, in water drawn by rope and bucket from an unlined unprotected surface well. In all factories the premises are untidy and littered with rubbish.

New Cantonments.

The site is the eastern slope of the Merriefontein valley, between the railway and the town furrow. It lies higher up the valley than the town, and extends to a point almost opposite the lower springs.

An area is also taken up opposite this site on the western slope of the valley, below the Western Kopjes, for transport and supply depôts and quarters for married soldiers. The centre of the valley between these sites is apt to be swampy, otherwise the slopes are good and dry. The soil is a red earth with a considerable amount of quartz gravel or sand; it works into a stiff mud in wet weather. The swampy area is black "vlei" soil. The site drains naturally into the Merriefontein stream past the lower portion of the town, and thence into the Klein Oliphant's River. It does not dominate any large area for land treatment of sewage, and the only areas available for this purpose are an area between the eastern cantonment site and the town, and an area between the western cantonment area and the cemetery, unless the sewage is conveyed into another valley by pumping or by other means.

The site selected for buildings is planned to accommodate the following units, beginning at the town end and going up the valley:—

(1.) One company Royal Engineers.
(2.) One battery Royal Field Artillery.
(3.) One battalion Mounted Infantry.
(4.) One battalion Infantry.
(5.) A hospital of 140 beds (approximately).

The site is also planned for married quarters for Officers and other ranks, residence of General Officer Commanding, Officers' club, cricket ground, &c.

The areas covered are approximately as follows:—

(1.) Royal Engineers, 18 acres (exclusive of Officers' quarters and married quarters).
(2.) Royal Field Artillery, 12 acres (ditto).
(3.) Mounted Infantry, 33 acres (ditto).
(4.) Infantry, 26 acres (ditto).
(5.) Hospital, 32 acres (including Officers' and nursing sisters' quarters, space for isolation, Officers' and natives' wards, and Royal Army Medical Corps detachment barracks and accessories).

The whole available site, that is to say, all of it that is suitable for building, is practically taken up, and there are no open spaces for parade grounds between units or between lines. The units are, however, placed more or less in echelon up the valley, and want of space between them is not a marked feature except on plans.

The intervals between units are 33 yards from site to site, and 80 to 100 yards from building to building.

The intervals between huts are 40 feet 8 inches end to end, and 70 feet between lines. The stables are below the huts on the same alignment. The interval between stable and hut lines is 100 feet; the stables are 47 feet from one another end to end, and 60 feet line to line.

The distance from the nearest latrines to the huts is 80 feet. The latrines are on the flanks and not in alignment with the huts, as in the Pietersburg and Harrismith plans.

The barrack huts are the War Office "A" pattern. Accessory huts, such as

Officers' mess, quarters, recreation room, &c., are of local design, with verandahs all round or on both sides, and similar in construction to the Barberton local designs. They are more picturesque and comfortable than the War Office patterns.

Cookhouses, ablution rooms, and latrines have properly cemented floors. The type of latrine has not, however, been determined, whether earth closet, American trough, or water carriage.

The huts are raised on piles 4 inches to 3 or 4 feet, according to the formation of the ground. The soil under and around is not prepared or channelled for drainage.

An old roadway runs diagonally under the huts of the Mounted Infantry lines, and forms a watercourse in heavy rains.

No provision is apparently being made for paving and draining the stables.

The construction of the hospital wards is similar to that of the wards at Barberton. They are bright and airy wards, but instead of single ward pavilions as at Barberton, the pavilions are double wards of 20 beds each, with nursing sisters' room and other accessories in the centre. There are four such pavilions, at intervals of 100 feet between one another. The kitchen is 80 feet from the wards, and the latrines 85 feet.

The aspect of the huts is N.N.W. on the southern site, except on the hospital site, where it is north-west. On the northern site (*i.e.*, Army Service Corps and married quarters) the aspect is S.S.E.

The arrangements for water supply and drainage have not yet been definitely planned. The amount of water required is estimated at 80,000 gallons daily, including supply for married families and animals.

Existing Camps.

On the town area there are camps of Royal Engineers, Royal Field Artillery, Royal Army Medical Corps with military hospital, and Army Veterinary Department with veterinary hospital. The sites are in the immediate neighbourhood of town habitations. The hospital, for example, is on one of the church grounds; the Royal Field Artillery partly on one side and partly on the other side of the railway on the town side of the station; the Royal Engineers on the south-east of the town near the Merriefontein Spruit; and the Army Veterinary Department on the north side near the river. They all use the pipe water, but the horses of the Royal Field Artillery are watered from the south-east furrow, which passes close to the camp. They have all a pail system of latrines. Ablution arrangements vary in character. Except in the hospital, there is no preparation of surface; merely wooden stands for basins. Most of the men are under bell tents, four to six in a tent.

On the eastern slope close to the cantonment site there is an Army Service Corps supply camp, and on the western slope an Army Service Corps transport depôt. They use the pipe water.

An Infantry camp and a Mounted Infantry camp are pitched on uplands about 2 miles from the town, south-west of the western kopjes, at the head of the valley in which the town filth trenches are placed. The men are in bell tents, six to eight in a tent. They obtain water from a spring below the camps. It is an open spring, containing a 50-gallon corrugated-iron tank, from which the water is pumped to watercarts. It is enclosed with a double fence of rabbit netting and barbed wire. The end of the hose lies on the ground when not in use. These camps have open ablution stands or sheds. In the Royal Irish camp the surface is being prepared to prevent it becoming sloppy. The surface soil of latrines and urinals is becoming foul. A pail system is in force.

The Cavalry camp is on an upland farm (Rockdale) about 5 miles south-east of the town. The men are in bell tents, six in a tent, and the horse lines are outside the line of tents. The latrines are trench latrines, and slops are emptied into soakage pits near the latrines. There are ablution stands near the tents. The foul water runs into earth channels and disappears in the soil a few yards distant. It is not used for garden plots. The water is obtained from a spring in an outcrop of quartzose sandstone, similar to the sandstone on the Merriefontein area.* It is enclosed in corrugated iron, covered and locked. Water is pumped from it to watercarts. The hose of the pump lies on the ground when not in use. The water is clear but has a considerable amount of green vegetation floating on the top.

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* Analyses XVII. and XXII., Table III., Appendix.

A road passes immediately above the spring and there is also a small quarry immediately above the spring at a distance of about 20 yards from it. The quarry at present contains refuse and excreta and there is considerable risk of these being washed into fissures in the rock in the next rain and thence into the spring. A diagrammatic section in the appendix illustrates the condition. The water is boiled and stored for cooling and distribution in corrugated-iron tanks under regimental arrangements, two men being kept employed solely for this purpose.

In addition to the military camps there is a camp for the South African Constabulary on a hill (Carcase Hill) south of the railway line and above the new cantonment area.

There is also a large repatriation camp between the native location and the town.

A musketry camp has been formed at the rifle range. The old refuse dumping ground and burying ground for carcases extend near to it. The latrines are trench latrines placed on the slope above the camp. The water is drawn from an open spring issuing from a ferruginous sandstone cliff close to the river bank It is led in a small iron pipe to a corrugated-iron tank, and drawn from the tank by hand. There are no special arrangements for ablution or disposal of refuse and slops. The spring is on a lower level than the camp, though the slope of the camp is not towards it.* Another spring connected with the rifle range is by the side of the road leading to the camp, and on the opposite side of the river near the butts.† The water is clear, but runs in a bog and is collected by a small pipe in the bog into a corrugated-iron tank, from which it is drawn by hand. A road to Kaffir kraals passes above this spring.

The town camps and the Infantry and Mounted Infantry camps have their latrine contents removed by a contractor to trenches near the town trenches.

Health Statistics.

(a.) *Civil Population.*

No records have been obtained throwing light on the health of the locality previous to the British occupation.

The table appended shows the number of deaths recorded from all causes and from the principal zymotic diseases since the British occupation. In examining the register, deaths amongst the military, burgher, and Kaffir refugee camps have been eliminated as far as possible.

The figures are, however, of no value in estimating death rates. All that can be said is that out of the 380 deaths noted from all causes, 53·4 per cent. were from the principal zymotic diseases, in the following order:—

	per cent.
Dysentery and diarrhœal diseases	33·9
Measles	11·1
Enteric fever	4·8
Whooping cough	1·8
Malarial fevers	1·3
Diphtheria	·5

In the 6 months, September, 1902, to February, 1903, the number of deaths recorded in Middelburg town was 32. In a population of 3,000 whites and natives, this indicates a somewhat low annual death rate, viz., 21·3 per 1,000.

The medical officer of health receives weekly lists of notified infectious diseases from the district surgeon. In December, January and February last, the notifications from civil populations were 16 enteric fever, 62 malarial fever, and 10 dysentery, as compared with 18 enteric fever, 1 malarial fever, 7 dysentery, and 1 small-pox case from military populations. All the malarial cases amongst the civil population are reported by one practitioner. This practitioner has reported no cases of enteric fever.

(b.) *Military Population.*

The table appended gives the statistics of the principal diseases amongst the troops at Middelburg since the declaration of peace. As compared with other garrisons in South Africa, the figures show—

* Analysis XXV., Table III., Appendix. † Analysis XXVI., Table III., Appendix.

(1.) A moderate amount of enteric fever, (but excessive as compared with garrisons outside South Africa).

(2.) A high incidence of dysentery and diarrhœal diseases.

(3.) A moderate incidence of throat affections.

(4.) An extremely low incidence of primary venereal affections, both for South Africa and elsewhere.

The high incidence of dysentery and diarrhœal diseases is attributable to an outbreak of these diseases in the Cavalry camp at Rockdale farm in September and October.

Meteorological Records.

None have been obtained for reference. The general impression is that Middelburg, although its elevation is over 5,000 feet above sea level, is comparatively relaxing in the hot weather, on account of the amount of water in the neighbourhood. 21 degrees of frost are said to have been recorded here in the winter. Thunderstorms are severe, and cases of death from lightning stroke are comparatively frequent. Dust storms are not a marked feature of the locality. The prevalence of flies is considerable.

Conclusions.

(1.) As regards climate there is nothing unfavourable to health.

(2.) The chief characteristic of the physical features of the locality is the number and comparative purity of the springs, notwithstanding their contact with bogs and marshy surface soil at their point of exit.

(3.) Another characteristic is the frequency of swampy and boggy ground around springs and along the spruits leading from them.

(4.) The site selected for the new cantonment is somewhat cramped on account of proximity of town, railway, swampy ground, and spring collecting areas.

(5.) Its chief defect is that it does not dominate an area suitable for a satisfactory water-carriage system of sewage disposal.

(6.) The arrangement of buildings on the site is the best possible under the circumstances. If more space were available it would have been better to make the intervals between units and between barracks and stables greater.

(7.) There are possibilities of an exceptionally pure water supply, but the minimum quantity has yet to be determined.

(8.) The quantity, however, is likely to prove ample for the requirements of the present civil and military population.

(9.) Considerable improvement is capable of being made in the local method of sewage and refuse disposal.

(10.) The town systems of sanitation are being ably watched and improvements urged, as far as finances admit, by the Health Board and the Medical Officer of Health for the Eastern Transvaal.

(11.) In this respect, *i.e.*, in respect to sound sanitary supervision and advice, Middelburg is in a much more favourable position than many other garrison towns in South Africa.

(12.) The statistics show a large amount of zymotic disease, but not in excess of other towns in South Africa.

(13.) Malarial diseases are probably prevalent, but there have not, apparently, been complete scientific investigations on this point.

(14.) As compared with other garrisons in South Africa, Middelburg does not present specially unfavourable conditions of health, so far as can be determined by statistics and other considerations.

Recommendations.

(a.) *New Cantonments.*

As regards water supply, the springs up the valley are the only good sources available. It is intended to have them opened up and masonry and cement-covered sumps built round them, at the point where they flow from the rock; that is to say, if they are found to flow from rock. Springs, so conserved, would be collected by pipes into storage and Service reservoirs.

These proposals meet sanitary requirements. It is indeed essential that the water should be preserved from contact, as far as possible, with surface soil. The present arrangements can only be regarded as of a temporary and primitive character, the water being liable to pollution at any moment.

In notes, placed at my disposal, in connection with the recent Water Supply Commission, a suggestion is made to the effect that Uitkyk Farm could be cultivated, and coal mines started on it. It would be most inadvisable, from a sanitary point of view, to cultivate or start coal mines on the slope leading to any of the springs conserved for the water supply of the cantonments; and the area dominating the springs should be fenced off, and the surface kept a clean upland service, as at present.

With regard to the removal and disposal of waste products, several problems are presented. It is better, if possible, to introduce a water-carriage system at once, but the following points have to be considered:—

(1.) The doubt as to the minimum quantity of water flowing from the springs.

(2.) The difficulty of finding a suitable plot of land for the outfall.

In the meantime, therefore, it is recommended that the triangular plot of land, between the town furrow the spruit and the town boundary below the cantonments, be set apart as an irrigation ground for the foul water from kitchens, ablution rooms, and stables. A portion of this plot, equal to 10 acres in extent, should be selected as far from the cantonments and town as possible, planted round with a double belt of trees, ploughed up, under-drained to a depth of 4 or 5 feet, and prepared as ground for systematic irrigation and cultivation of crops. It is only by careful attention to such details that causes of complaint will be avoided. In time, and as the working of biological methods have had longer experimental trial in South Africa, the construction of biological tanks and connection of a water-carriage system of latrines with the foul-water drains, should be contemplated. But if these were started at once, taking the whole sewage of the cantonments, it is feared that the proximity of the tanks and irrigation ground to the town, would lead to constant complaints on the part of the local sanitary authority. It can, however, be asserted with confidence, that 10 acres of ground properly drained, prepared, and cultivated, and surrounded by a belt of trees, as recommended above, will be sufficient for the disposal of the foul water without being prejudicial to the health of the town, even although the irrigation area is near it; and that the effluent from such an area may, with safety, be passed into the spruit below. The spruit is already the natural drainage of a portion of the town, and can never be regarded as a source of potable water.

As regards the construction of drains, it is understood that these will be laid in accordance with the "Drainage Manual" requirements; but it is intended to lay larger drains than are absolutely necessary with a view to their being able subsequently to take the whole sewage of the cantonments. Under these circumstances it is essential that arrangements be made for automatic or hose flushing of the drains.

An alternative plot of ground, less open to objection from the town point of view, is the ground on the opposite side of the spruit between the transport lines and the cemetery. The ground would require a considerable amount of preparation, but it would be well away from the town and cantonments; and, if well managed, planted round with trees and cultivated, an installation of biological tank and filter beds for the whole sewage of the cantonments could be started there without fear of any reasonable objections being raised.

A point to be noted in connection with septic tanks is that bulky matter, such as pieces of cloth, should be prevented from entering the tank, and the screenings should be incinerated on the spot in a suitable incinerator. One of small size would be sufficient, similar to the incinerators used in connection with military hospitals in South Africa.

As regards site, considerable improvement can be effected by clearing the spruit between the eastern and western sites of obstructions to the flow of water, by subsequently keeping the channel clear, and by planting eucalyptus trees down the valley on either side so as to dry up the swampy ground. In time, as the Uitkyk and Reitfontein springs are conserved and brought into the water supply scheme, it should be possible to make the whole of the valley between the western and eastern cantonment sites into parade grounds and gardens.

No definite arrangements appear to have been made for surface drainage and removal of storm water. It is essential that provision should be made for this and for well-constructed roads and paths, if the site is to remain sanitary. I would recommend that storm water be removed in brick or cement intercepting surface channels discharging into the spruit.

As regards plans and construction of buildings, it would be necessary to find another site, than that proposed on the eastern slopes, for the married quarters, as these occupy a portion of the only plot of ground suitable for disposal of foul water, unless the plot on the opposite side of the spruit is taken up for this purpose as suggested above.

Otherwise there is no new feature in construction of hutments, stables, and barrack accessories, different from the cantonments already reported upon. The want of any provision for properly paving, cementing and draining stables, and preparing and channelling the ground under and around huts is the chief defect. In Middelburg this defect is likely to be felt because of the proximity to swampy and spring bearing ground; and another object of considerable importance in concreting surfaces under and around huts is the necessity of keeping down insect life as far as possible. Mosquitoes, ticks, and similar insects are extremely likely to have their breeding ground amongst the rank vegetation that springs up under the huts; and, although the subject requires more accurate and scientific investigation than appears to have been given to it hitherto, there is some indication of malarial fever being contracted in the lower portions of the town from the swamps in the valley leading to the cantonments.

As regards minor details of construction, the following recommendations have been made locally :—

(1.) Provision of windows and doors to the ablution room.

(2.) Complete disconnection of the floor channel in the larder from the floor channel in the wash-up rooms in the kitchens. The larder should be constructed so as to remain and be kept perfectly dry, cool, and well ventilated.

(3.) Increase of ventilation in the latrines. Louvred panels in the sides, as in the latrines constructed on Naval Hill, Bloemfontein, seem best suited to effect this.

(4.) Construction of a disconnecting passage between the bathrooms, bed-pan room, commode or earth closets and the hospital wards.

(5.) An operating room hut separate from the wards.

The Commanding Royal Engineer has altered his designs to give effect to these recommendations. In other respects the hospital wards are admirable in design and construction. They are double pavilions with the two wards similar to the ward of the single pavilions at Barberton.

As regards disposal of dry refuse, it is recommended that a simple form of destructor be constructed. Such a destructor has been constructed in connection with the Cavalry and Artillery camps now at Mooi River, and seems to be able to deal with the dry refuse satisfactorily.

The Town Health Board are employing a simple method of disposing of carcases by incineration. After vultures have fed on them they are tarred and burnt. About 2 gallons of tar are sufficient to reduce 30 carcases to a condition of calcined bones in about 3 hours. This method might be developed into some kind of system in connection with carcase disposal.

(b.) *Civil Surroundings.*

The sanitation of civil surroundings may well be left in the hands of Dr. Arnold. He is fully conscious of all the defects, and is studying the problem of how they can best be remedied. Want of municipal funds is, however, likely to be prejudicial to any immediate improvement. The improvements which are most needed are—

(1.) A complete system of water supply laid on in pipes.

(2.) Increase in the number of pails and conservancy carts to enable the whole of the nightsoil and slops to be removed. A nightly service and a dual-pail system should be aimed at.

(3.) Disposal of nightsoil and slops on areas carefully planned, farmed, and enclosed by belts of trees, as recommended at Harrismith.

(4.) Cultivating the old disused dumping ground and filth pit areas in the neighbourhood, or planting them with trees. Extensive areas require some treatment of this kind. Colonel Notter made a similar recommendation in 1901.

(5.) Construction of a public slaughterhouse on a sanitary site, with good clean water laid on, and disposal of offal by cremation instead of by burial in the neighbourhood.

(6.) Construction of public latrines.

(7.) Sanitary control of milk supplies, aerated water factories, butchers' shops and bakeries, both as regards construction of premises and supervision over storage, preparation and sale of supplies.

(c.) *Existing Camps.*

The date on which units can occupy the cantonments is uncertain; but, without going to much expense in connection with camps, considerable improvement is desirable in the following directions:—

(1.) Using up ablution water in garden plots.

(2.) Better construction of and channelling of floors of latrines, urinals, and ablution places. The surface soil in the urinals in one camp is becoming dangerously polluted already.

(3.) Reduction of number of men in bell tents to four.

(4.) Arranging trestles for hose from pumps to watercarts, so as to prevent the mouth of the hose lying on the ground.

(5.) Thorough cleansing of the quarry above the water supply at Rockdale Camp, and fencing round the quarry so as to prevent its again being used as a latrine and dumping ground.

(6.) Removal of labour camp from neighbourhood of the quarry on the cantonment area. This camp is close to a good spring, and its trench latrine has been dug above the spring.

(7.) The effect of the musketry camp on the health of the men should be watched. It is an unsatisfactory camp, both as regards site, surroundings and sanitary arrangements, and it is strongly recommended that a properly laid out standing camp for musketry be provided with well-constructed latrines, cookhouses, ablution room, &c., and provision for maintaining purity of water supply. It is a camp that is apt to be neglected from a sanitary point of view, and disease may be contracted in it that is being attributed to other causes.

I am aware that the so-called unhealthy season is drawing to a close, and that the cantonment may be ready for occupation before the next unhealthy season commences, but there is need of more systematic sanitary organization in camps.

Unfortunately some of the camps are at considerable distances from one another and from the town, and it is all the more difficult, therefore, without a special sanitary officer being appointed to obtain a uniform and high standard of sanitation in them. However, as compared with some other camps in South Africa at present, there is much evidence of attempts to maintain regimentally high standards of sanitation.

As regards position, the sites of the camps of the Royal Engineers and Royal Field Artillery are not good selections, the former being low down amongst rank vegetation and on the edge of swampy ground, the latter on a confined area with the railway line and sidings running through it.

The Royal Army Medical Corps Camp is also on an unsatisfactory site in the town. This camp gave the worst health statistics during the last 6 months; the Royal Field Artillery Camp coming next amongst town camps, but better than the Rockdale Camp, which has the worst record of camps outside the town.

W. G. MACPHERSON, *Lieut.-Colonel,*
R.A.M.C.

PRETORIA,
30th March, 1903.

TABLE I.—PRINCIPAL Health Statistics of British Troops at Middelburg, Transvaal.

Week ending	Average strength.	Sick remaining.	Percentage to strength.	Admissions for									
				Enteric fever.	Malarial fever.	S.C. fever.	Dysentery.	Diarrhœal diseases.	Sore throat.	Tonsillitis.	Primary syphilis.	Soft chancre.	Gonorrhœa.
1902.													
6th June	2,054	24	1·16	..	6	..	..	1	1	..	..	..	..
13th „	1,980	45	2·27	1	6	..	4	..	1	1	..	..	..
20th „	2,889	54	1·86	1	9	..	2	1	2	3	..	2	..
27th „	2,757	76	2·75	..	7	..	2	..	1	3	..	..	..
4th July	4,584	105	2·27	..	9	..	2	1	2	1	..	..	.
11th „	4,480	81	1·80	1	2	..	2	..	..	2	..	..	1
18th „	4,558	76	1·66	..	5	..	..	..	1	3	..	..	1
25th „	4,609	76	1·64	..	..	..	..	..	..	6	..	..	..
1st August ..	4,419	65	1·47	..	4	..	1	..	..	2	..	..	..
8th „	4,419	68	1·53	..	6	..	..	..	1	4	..	..	..
15th „	2,595	67	2·58	..	3	..	7	..	..	..	..	..	..
22nd „	2,488	56	2·25	..	..	..	3	1	..	5	..	..	1
29th „	2,936	58	1·86	..	1	..	2	..	..	5	..	..	..
5th September ..	2,622	57	2·17	..	..	..	13	..	..	2	..	..	..
12th „ ..	1,435	66	4·59	..	1	..	4	1	3	3	..	..	1
19th „	1,840	74	4·02	1	1	..	1	..	..	..	..	..	..
26th „ ..	1,801	78	4·33	3	2	..	..	1	1	3	2	..	..
3rd October ..	1,774	88	4·96	5	..	..	1	1	..	1	..	..	..
10th „ ..	1,738	81	4·66	..	2	..	5	..	4	..	..	..	..
17th „ ..	1,754	82	4·67	1	6	..	3	1	..	2	..	..	..
24th „ ..	1,761	77	4·37	3	1	..	4	1	3	..	..	..	..
31st „ ..	1,634	77	4·77	1	1	..	3	2	..	1	..	..	..
7th November ..	1,639	82	5·00	3	7	..	1	1	..	2	..	..	..
14th „ ..	1,735	87	5·01	1	2	..	3	3	..	2	..	..	2
21st „ ..	1,768	103	5·26	8	1	..	2	16	..	4	..	..	..
28th „ ..	1,759	116	9·43	2	2	..	4	9	..	3	..	1	..
5th December ..	1,759	111	6·19	1	2	..	2	3	..	..	..	..	1
12th „ ..	1,896	106	5·69	..	1	..	..	5	..	2	..	..	1
19th „ ..	1,728	101	5·84	4	2	..	..	5	..	1	..	..	1
26th „ ..	1,715	91	5·30	3	4	..	2	1	..	..	..	..	..
1903.													
2nd January ..	1,710	101	5·80	3	6	2	2	2	..	2	..	..	1
9th „	2,246	107	4·76	..	13	1	1	2	..	..	1	..	1
16th „ ..	2,208	108	4·89	2	7	..	1	5	..	2	1	..	..
23rd „ ..	2,228	114	5·16	1	9	4	2	1	..	1	1	..	..
30th „ ..	2,241	141	5·84	..	12	3	1	2	..	1	1	..	..
6th February ..	2,156	133	6·16	3	10	1	1	6	..	1	..	..	..
13th „ ..	2,378	118	3·49	1	8	..	2	3	..	1	..	..	..
20th „ ..	2,392	133	4·72	2	12	..	2	5	1	..	..	..	..
27th „ ..	2,031	149	7·33	1	3	..	1	3	2	..	..	..	..
6th March	2,510	157	6·25	2	5	..	..	1	1	..	..	..	..
13th „	2,641	164	6·20	2	8	..	1	2	..	2	1	2	1
20th „	2,673	141	5·27	..	3	..	..	1	1	2	..	..	..
Totals	102,180	3,994	177·27	56	189	11	87	87	25	73	7	5	12
				Annual admission ratios per 1,000 of average strength.									
Average strength ..	2,432		Average 3·8*	28·3	96·2	†	88·4		49·7		11·9		

* This percentage is obtained from the figures forming the totals of the first two columns.
† For comparison with ratios given in tables appended to other reports, the ratio for simple continued fever and enteric fever combined is 34·1 per 1,000.

TABLE II.—DEATHS from Zymotic Disease recorded amongst the Civil Population of Middelburg, Transvaal.

Month and year.	All causes.	Dysentery.	Diarrhœal diseases.	Diphtheria and croup.	Measles.	Whooping cough.	Malarial fever.	Enteric fever.
1900.								
October	8	1	2	..	..	..	..	..
November.. ..	5	..	3	..	..	..	..	..
December	7	1	3	..	..	..	..	..
1901.								
January	5	2	..	..	..	..	..	..
February	3	..	..	1	..	..	1	..
March	5	..	1	..	..	..	1	2
April	14	3	..	..	..	..	..	2
May	13	..	2	..	1	..	..	..
June	10	4	1	..	..	..	1	1
July	29	..	3	..	13	..	..	..
August	30	..	5	..	17	2	..	..
September ..	22	2	5	..	8	..	..	..
October	23	..	9	..	3	..	..	..
November ..	36	1	13	..	..	1	..	..
December	38	5	12	..	..	1	..	..
1902.								
January	53	30	9	..	..	1	..	..
February	13	..	3	1	..	1	1	2
March	12	..	..	..	..	..	1	1
April	8	..	1	..	..	..	..	..
May	2	..	..	..	..	..	..	..
June	1	..	..	..	..	..	..	..
July	5	..	2	..	..	..	..	..
August	3	..	..	..	..	..	..	..
September ..	4	..	..	..	..	..	..	..
October	7	..	..	..	..	1	..	..
November.. ..	5	..	3	..	..	..	..	1
December	9	1	..	..	..	..	..	3
1903.								
January	6	..	2	..	..	..	..	2
February	1	..	..	..	..	..	..	1
March	3	..	..	..	..	..	..	2
Total.. ..	380	50	79	2	42	7	5	18

TABLE III.—STATEMENT of Records of Water Analyses made in connection with the Occupation of Middelburg, Transvaal.

N.B.—Analyses 1 to 26 inclusive were made by Major Beveridge in the Military Laboratory Pretoria, 27 to 32 by Dr. Pakes in the Government Analyst's Laboratory, Pretoria.

		1.	2.	3.	4.	5.	6.	7.	8.
Source.		Standpipe near engine-house of railway station supplying water to blockhouses.	Soda water factory before filtration.	Stream through camp.	Standpipe of main water supply.	Well water from 60-ft. well with water rising 30 ft. from surface.	Stream at G.P.O.	Main standpipe, No. 17 Stationary Hospital.	No. 1 spring supplying pipe water.
Date ..		17.11.01	21.11.01	15.12.01	16.12.01	8.1.02	27.5.02	29.5.02	4.6.02
Physical characters ..		Turbid	Turbid	Grey	Clear	Cloudy	Turbid	Clear	Clear.
Parts per 100,000. Solids	Total ..	5·0	15·0	3·5	..	15·0	6·5	3·5	3·0
	Volatile ..	2·5	5·0	1·0	..	4·0	4·0	3·0	2·0
Chlorine	..	0·3	1·6	0·1	0·5	0·6	0·2	0·4	0·4
Hardness	Total ..	4·0	9·2	1·5	1·6	6·5	3·3	0·9	0·9
	Fixed ..	4·0	5·7	..	..	3·5	3·3	..	..
NH_3.	Saline ..	0·023	0·011	Traces	Traces	0·007	0·014	0·010	0·017
	Organic ..	0·043	0·012	0·07	0·02	0·15	0·040	0·014	0·025
Nitrates	..	0·800	0·095	..	..	..	0·800	Heavy traces	Traces.
Nitrites	..	Traces	..	..	..	..	Nil	Traces	Nil.
Oxygen	15 minutes ..	0·06	0·083	0·16	0·08	0·04	..	..	Nil.
	4 hours ..	..	..	..	..	..	0·33	..	..
Remarks by analyst ..		Unfitted for drinking.	Organic impurity unsuitable for drinking.	Doubtful.	No remarks.	Of good quality, and if efficiently filtered, quite suitable for drinking or domestic purposes.	Not suited for drinking purposes.	Organic contamination, unfit for drinking.	..

TABLE III.—*continued.*

Source.		9. No. 2 spring supplying pipe water.	10. No. 3 spring supplying pipe water.	11. No. 4 spring supplying pipe water.	12. Main standpipe of town.	13. River water at Gun Hill.	14. Pump supply from river at Gun Hill.	15. Spring east of Uitkyk.	16. Spring west of Uitkyk.
Date		5.6.02	5.6.02	5.6.02	5.6.02	24.6.02	24.6.02	30.6.02	30.6.02
Physical characters		Slightly turbid	Clear	Clear	Clear	Milky	Dirty grey	Clear	Clear.
Parts per 100,000. Solids	Total	3·0	4·0	3·0	3·0	19·8	..	..	4·0
	Volatile	1·0	3·0	1·0	1·0	3·6	..	..	1·8
Chlorine		0·4	0·4	0·4	0·2	0·10	0·60	0·20	0·09
Hardness	Total	0·7	0·9	0·8	0·8	9·6	4·9	0·4	1·2
	Fixed	..	..	..	..	1·2	..	..	..
$N.H._3$	Saline	0·012	0·005	0·012	0·007	0·014	0·014	..	Traces.
	Organic	0·015	0·012	0·012	0·012	0·013	0·016	..	Traces.
Nitrates		Traces	Traces	Traces	Traces	Nil	Nil	Nil	Nil.
Nitrites		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Traces.
Oxygen	15 minutes	Nil	Nil	Nil	Nil	0·015	0·010	Nil	Nil.
	4 hours	..	..	..	..	..	..	..	..
Remarks by analyst		Suitable for drinking, but requires filtering.	Suitable for drinking, but requires filtering.	Suitable for drinking	Very pure and suitable for all purposes.	Suspicious.	Suspicious.	Pure water.	Very pure.

TABLE III.—*continued.*

Source.		17. Rockdale Spring.	18. Tap at hospital kitchen.	19. Main standpipe.	20. Rockdale Spring.	21. Water tanks, Rockdale.	22. Rockdale Spring.	23. Watercart. Camps at Rockdale.	24. Spring near site of temporary camp.
Date		30. 6.02.	30.6.02.	30.6.02.	15.8.02.	15.8.02.	22.11.02.	21.11.02.	8.1.03.
Physical characters		Clear	Clear	Clear	Clear	Clear	Clear	Clear	..
Parts per 100,000. Solids	Total	8·4	4·0	4·8	2·00	3·1	2·5	19·9	4·3
	Volatile ..	1·0	2·4	3·6	0·40	0·8	..	14·4	1·0
Chlorine		0·4	0·4	0·4	0·2	0·3	0·4	Nil	0·4
Hardness	Total	0·4	2·20	0·2	2·9	3·3	1·2	11·4	1·20
	Fixed	..	..	..	..	..	0·6	..	..
$N.H_3$.	Saline	0·004	0·006	0·002	0·002	Traces	0·002	0·003	0·004
	Organic ..	0·010	0·004	0·004	0·005	0·01	0·007	0·005	0·013
Nitrates		Nil	Nil	Nil	Nil	Traces	0·021	0·02	0·021
Nitrites		Traces	Traces	Faint traces	Traces	Nil	Nil	Nil	Nil.
Oxygen	15 minutes .	Traces	0·002	Nil	..	..	..	..	..
	4 hours.. ..	..	..	..	(2 hours) 0·024	0·048	0·002	0·004	Nil.
Remarks by analyst		Suitable for drinking.	Suitable for drinking.	Suitable for drinking.	A pure water, and suitable for drinking.	..	Pure water. Biological analysis. Bac. Fluor. Prot. subtilis.	Suitable for drinking. Biological analysis. Bac. Fluor. Prot. subtilis.	Fit for drinking.

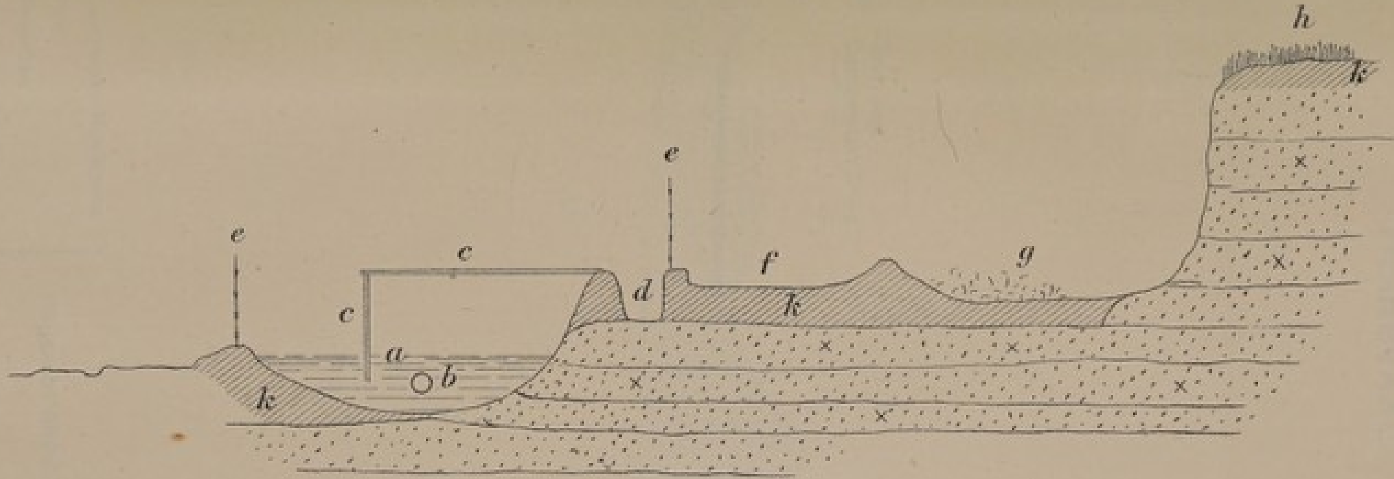
TABLE III.—*continued*.

Source.		25.	26.	27.	28.	29.	30.	31.	32.
		Spring north end of rifle range.	Spring south end of rifle range.	Water from military reservoir (pipe water).	Tap at extremity of pipe system.	Stream from Reitfontein Springs.	Uitkyk Spring.	Town reservoir, water above dam.	South-east furrow, from town dam.
Date		2. 2. 03	2. 2. 03	11. 1. 03	11. 1. 03	11. 1. 03	11. 1. 03	11. 1. 03	11. 1. 03
Physical characters		Clear	Slightly turbid	..	..	..	..	..	..
Parts per 100,000. Solids	Total ..	6·2	10·2	3·0	2·85	3·35	3·35	14·90	11·55
	Volatile ..	1·8	2·4	0·8	Nil	Nil	Nil	3·75	1·45
Chlorine		0·5	0·7	0·4	0·4	0·4	0·5	0·4	0·4
Hardness	Total	1·00	1·2	Nil	Nil	Nil	Nil	2·0	1·2
	Fixed	1·00	0·4	..	..	..	..	0·9	0·6
$N.H._3$	Saline	0·002	0·003	Traces	Nil	Nil	Nil	Nil	Nil.
	Organic ..	0·016	0·017	Traces	Nil	Nil	Nil	0·84	0·040
Nitrates		0·021	0·021	Nil	Nil	Nil	Nil	0·279	Nil.
Nitrites		..	..	Nil	Nil	Nil	Nil	Nil	Nil.
Oxygen	15 minutes ..	..	..	..	..	..	..	..	..
	4 hours ..	0·032	..	Nil	Nil	0·004	Nil	0·209	0·171
Remarks by analyst		Suitable for drinking.	Good quality; suitable for drinking.	Quite satisfactory in present condition.				Heavily contaminated with organic matter, and totally unfit for consumption.	

MIDDELBURG, TRANSVAAL.

(SHOWING DANGER OF POLLUTION BY HUMAN EXCREMENT.)

N.B.—DISTANCE FROM (a) TO (g) = ABOUT 100 FEET.



a = Spring.

b = Hose from Spring to Pump.

c = Corrugated iron cover of spring.

d = Surface trench to cut off surface water from Spring.

e = Barbed wire fence.

f = Road above Spring.

g = Rubbish and excrement in quarry above Spring.

h = Grassy veldt above quarry.

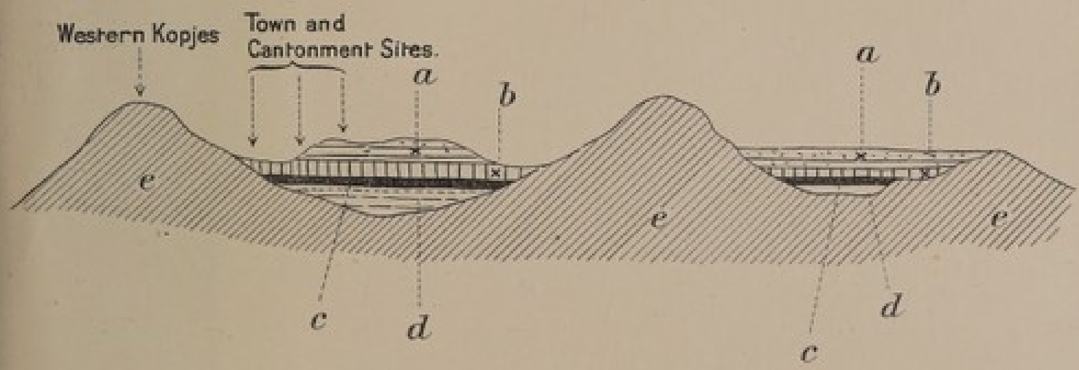
k = Surface alluvium.

× × × Underlying quartzose sandstone, porous

(200. 12/1903 1160) 232 - H a w e

PLAN . B.

DIAGRAMMATIC SECTION, ILLUSTRATING GEOLOGICAL FORMATION IN VICINITY OF MIDDELBURG, TRANSVAAL.

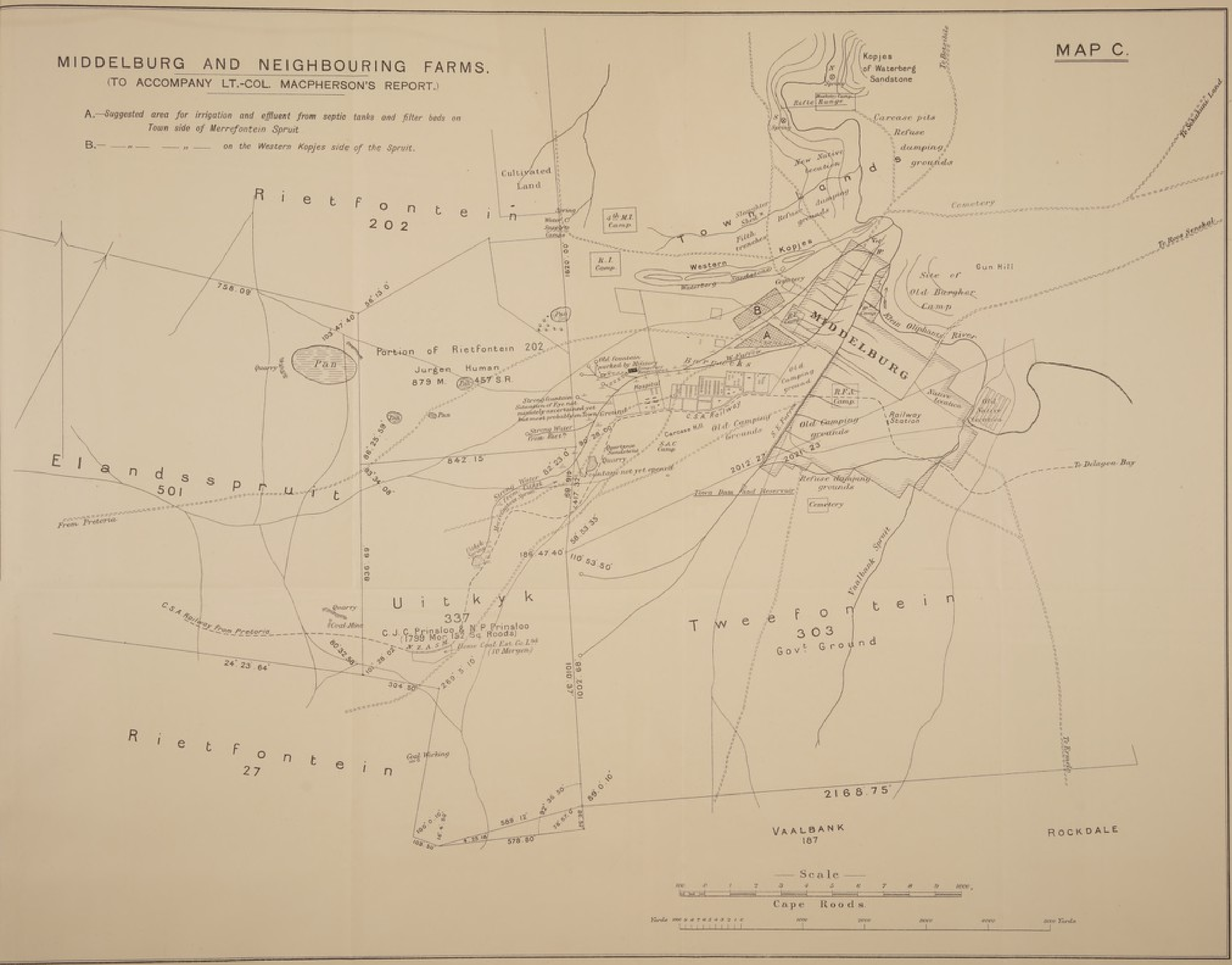


(a) = White quartzose Sandstone
(b) = Fire Clay
(c) = Coal Measures
(d) = Shales and Sandstone

} Horizontal Strata lying unconformably on (e).

(e) = Waterberg Sandstone with dip of 60° approx.

(1180) 232 11b w.o



MIDDELBURG AND NEIGHBOURING FARMS.
(TO ACCOMPANY LT.-COL. MACPHERSON'S REPORT.)
MAP C.
A.—Suggested area for irrigation and effluent from septic tanks and filter beds on Town side of Merrefontein Spruit
B.— „ „ on the Western Kopjes side of the Spruit.
Rietfontein 202
Portion of Rietfontein 202
Jurgen Human
879 M. 457 S.R.
Elandsspruit 501
From Pretoria
Uitkyk 337
C.J.C. Prinsloo & N.P. Prinsloo
(1799 Mor 132 Sq. Rooda)
C.S.A. Railway from Pretoria
Rietfontein 27
Tweefontein 303
Govt Ground
VAALBANK 187
ROCKDALE
MIDDELBURG
Town Lands
Western Kopjes
Kopjes of Waterberg Sandstone
Rifle Range
Carcase pits
Refuse dumping grounds
New Native location
Cemetery
Gun Hill
Site of Old Burgher Camp
Klein Olifants River
Native Location
Railway Station
R.F.A. Camp
Old Camping grounds
Carcase Hill
S.A.C. Camp
Town Dam and Reservoir
Vaalbank Spruit
Cultivated Land
Pan
Quarry
Coal Mine
Coal Working
To Delagoa Bay
To Roos Senekal
To Belfast
To Ermelo
2168.75
Scale
Cape Roods
Yards

REPORT ON POTCHEFSTROOM AS A CANTONMENT FOR BRITISH TROOPS.

PHYSICAL FEATURES OF THE LOCALITY.

The district around Potchefstroom is a wide shallow basin surrounded by low ridges and kopjes. The diameter of the basin is about 8 miles. The Mooi River intersects it from north to south. The town of Potchefstroom is in the centre of the basin, on the right or western bank of the river. The slopes from the surrounding kopjes to the river valley are gentle slopes, becoming almost flat for a considerable area on either side of the river. The river itself runs through the area as a narrow winding meadowland stream, with low marshy banks. The lips of the basin are formed of low stony ridges and hills.

The cantonment is situated on the slope from one of the hills near the north-west corner of the basin. Its central point is about 3 miles from the centre of the town, and about 2 miles from the nearest point on the river. The highest point of the site is about 150 feet above the level of the river. The site itself slopes generally in a southernly direction towards a shallow valley, which drains towards the river above the town. A dry watercourse runs through this valley.

Below the town the basin opens out towards the Vaal River, and the general flatness of the country renders it somewhat swampy in this direction. There is a marked absence of donga formation.

The height of the basin above sea level is about 4,500 feet. Geologically, it seems to be the southern limit of the dolomite formation which commences at Pretoria. At any rate there is a well-marked dolomite outcrop in a valley about 1 mile north of the cantonments, running to the bed of the river about 3 miles up stream from the town. No further dolomite formation was detected below this point. The ridges and kopjes in the neighbourhood are formed of outcrops of white quartz-like rock or quartzite, in many places resembling the chert formation over the dolomite near Pretoria. Lower down the valley there are outcrops of sandstone and quartzite, the former dipping west to east at an angle of about 45 degrees, and there are also intrusive dykes of basalt. The chert or quartz outcrops, which are a marked feature of the area west and north of the cantonment, seem to run north-east to south-west; and the basalt dykes east to west. The main basalt dyke runs across the cantonment area. It does not, however, form any marked ridge or outcrop above ground.

The general surface of the area near the kopjes and ridges is stony, and covered with a growth of low thorny mimosa bush. The more depressed portions of the basin and entering valleys have a black surface soil. Otherwise, the soil is generally a red sandy soil mixed with clay and gravel. A borehole is being sunk on the cantonment site about 300 yards below the hospital, and about the same distance above the watercourse of the shallow valley. The section of the borehole, shown in the Appendix, indicates generally the nature of the soil in this valley.

The chief centre of population is the town, which covers an area about 2 miles long and 1 mile wide. The town lands extend to the west and south-west towards the Vaal River, which is about 12 miles distant, and appear to be unpopulated, except for a large native location immediately below the town. They do not extend beyond the river on the east. Up stream, and within 2 or 3 miles of the town, there are several farms on the river banks, and the Potchefstroom basin east of the river has been taken up for land settlement purposes, and is now occupied by a large population, living in tents on the plots assigned to them. There is also a large native location, Elandshoevel, on the east bank, opposite the town. A land settlement population is also being formed down stream, on the west bank of the river, and south of the town.

The railway line from Johannesburg to Klerksdorp crosses the river from east to west about 2 miles above the town, and then runs in a south-westerly direction more or less parallel with, and about 1 mile west of the river, the town lying between the railway line and the river, and the railway line between the town and the cantonment.

From a point about ½ mile above the place where the railway line crosses the river, an irrigation canal commences and is fed from the river. It runs parallel to the river for some distance, then passes under the railway at the bridge and runs for a few hundred yards to the east of the line. It then passes under the railway again to the west of the line, and flows between the line and the cantonment site to a point above the railway station, where it turns eastwards under the railway and passes to the river below the town. Subsidiary furrows and irrigation channels are given off from it to irrigate the whole of the town land between the railway and the river. It is known as the town or main furrow.

Two new irrigation canals are being constructed. One is on the east of the river. It is about 8 miles along, and irrigates the lands of the farm settlements there. The other is on the west side, practically running parallel to the main furrow of the town, but on a line further west and nearer the cantonment site. It is being made for the purpose of irrigating the farm settlements below the town. The former has its intake from the river immediately above the main furrow. The latter has its intake from the main furrow just below the railway bridge.

From the cantonment site to the town, therefore, the road passes (1) the new irrigation canal on the west side, (2) the old canal or main furrow of the town, (3) the railway line, (4) subsidiary furrows from the main furrow.

The dry watercourse in the shallow valley, into which the slopes of the cantonment site drain, is intercepted by the town furrow at present. Later on it will be intercepted by the new furrow.

Over the town area there is luxuriant vegetation in irrigated gardens and building plots. Plots not yet taken up above the town between the railway and the river are covered with thick grass. Below the town there is considerable mealie patch cultivation. Elsewhere along the stony slopes, and where there is no irrigation, there is dry bare veldt with low mimosa scrub.

Water Supply.

The only sources of water supply at present are—

(1.) The water from the river and irrigation canals.

(2.) Surface wells.

(3.) Rain collected on roofs.

(1.) *River Water.*

Water from the Mooi River is the main source of supply both to the town and cantonments. The river rises in the southern slopes of the Witwaters Rand, south of Pretoria, and is also fed by a tributary, the Wonderfontein Loop, which rises in dolomite caves about 30 miles north-east of Potchefstroom, and in an underground river and springs (Oog Mooi) at Frederickstad, about 15 miles from Potchefstroom. The water is essentially a clear limestone water, and it loses very little of this character in its course to the Vaal, remaining almost invariably clear and sparkling, even after flowing through marsh and meadow. For a river water it is a hard water, due to the amount of lime and magnesia in it, derived from the dolomite. It is naturally somewhat softer after heavy rain.

As already indicated, it is largely used for irrigation purposes, and the town supply is derived entirely from river water conveyed in open irrigation channels. There is no pipe supply. The channels are open surface earth channels running through camps, streets, and gardens. The course of the main furrow, or old furrow, from which the new furrow and subsidiary furrows are given off, has already been described. The intake is about 3 miles above the town, in somewhat marshy ground. Above the intake there are several farms right up to Frederickstad, those nearest to the intake being on the eastern bank. Cultivated lands, mealie patches, potato fields, &c., extend to the river bank, and clothes are being washed in the stream about ½ to 1 mile above the intake. On the western bank about a mile above the intake there is a farmhouse close to the river bank, with domestic refuse thrown on the banks, and household washing is being carried on in the stream. In fact all phases of domestic rural life are being enacted there, and pigs, poultry, and cattle help to pollute the river. A few hundred yards higher up, the same kind of pollution is going on, from a hut occupied by natives, and still further up stream the Native Sub-Commission and Compensation Claims Board have taken up their quarters near a large plot of irrigated gardens, the effluent from which flows to the river. From the intake to the town, the furrow is used (1) as a proposed intake for the cantonment water supply, about ¼ mile below the intake at the river; (2) for watering horses just above the railway bridge; (3) for watering horses about 1½ miles below the railway bridge; (4) for brickfields about 30 yards below (3); (5) for watering horses about 50 yards below (4); (6) for filling watercarts for the present supply to cantonments about 50 yards below (5); (7) as a pumping station intake for the present pipe supply to cantonments about 10 yards below (6); (8) for watering horses about 50 yards below (7). Below this to the town the stream is exposed to pollution from camps, traffic and houses in every direction. A diagrammatic sketch in the appendix shows these features.

The water is distributed to the cantonments and camps without purification. It is generally clear and clarification is not considered necessary. The increase in organic pollution from intake of furrow to a point opposite the town is shown in the analyses (Table VIII.) appended. Its general character is that of a water from dolomite formations, the chief organic constituents being carbonates of magnesia and lime.

(2.) *Wells.*

The wells in the town are shallow surface wells. The table in the appendix (Table IX.) best indicates the fact; the average depth of water from the surface being about 6 feet. They are unprotected wells in most instances. The analyses shown in Table VIII. indicates a limestone origin; and as there is no lime or dolomite rock in their neighbourhood the inference is that the water is practically the furrow water percolating through the surface soil into the wells.

(3.) *Rainwater.*

In several houses rainwater is collected from the roofs and stored in tanks for drinking purposes.

There are no springs in the neighbourhood, and the country generally is considered a district devoid of water except from the river. There is, however, an area of marsh water at a narrow cutting through a well-marked quartzite ridge about 3 miles north of the cantonment site and ½ mile west of the Ventersdorp Road. The marsh is probably fed from a surface spring, but it was impossible to determine its origin on account of heavy rains making it difficult to examine the marsh.

The quantity of water available, therefore, in the locality, other than rainwater, must be taken as the yield of the river. The estimated yield at the proposed intake for cantonments is 100,000,000 gallons daily. After considerable rainfall, I estimated the yield in the main furrow at the proposed intake as 7,000,000 gallons per diem, but the gauging was very roughly made. I have been unable to obtain maximum or minimum gaugings, and it is said that the river runs low during the winter.

A borehole has been sunk below the hospital site; it is below a line of intrusive basalt, and at 62 feet no water has been found. A section of this borehole is shown in the appendix.

Condition of Surface Soil.

The whole of the surface soil between the river and the railway line may be regarded as generally polluted—

(1.) By the town and native location habitations, in many of which open cesspits are still in use, with an absence of arrangements for removal of slops, and no drainage system.

(2.) By scattered domestic encampments of repatriated families, &c., over the open ground north-west of the town, right up to the main furrow, without any arrangements for removal of nightsoil, &c.

(3.) By old military and burgher camps, which occupied nearly the whole of the open area between the town and the railway.

(4.) By existing repatriation and transport camps, which are full of animals.

(5.) By constant ox-wagon traffic, which makes the surface of the roads and streets not unlike the surface soil of a farmyard in places.

West of the railway station there have been old encampments, mainly on the slope between the cantonment site and the furrow, and on the slope south of the cantonment site to beyond the railway station. Markings of these camps remain, but there is comparatively little evidence of refuse, &c., being dumped down anywhere over these areas.

Refuse dumping grounds for the cantonment are placed about 1½ miles north of the site in an adjoining valley and close to the Ventersdorp Road. Nightsoil trenches for town and cantonments, and a dumping ground for town refuse are placed in a valley west of the town and south-west of the cantonment, about 2½ miles distant from each.

Over the cantonment area and existing military camps considerable fouling of the surface soil is going on, mainly by animals, soakage pits and ablution water. Cavalry and artillery horses are picketed out over the area or occupy unfinished stables, and there is an absence of proper manure or refuse pits. Camps for workmen, Europeans, Boers and natives are formed in the cantonment area, with improvised bucket latrines; and the occupied hutments are also supplied with these, with one or two exceptions, where the new latrines are being used. Ablution water is passing into soakage pits in the Mounted Infantry camp, and in the Cavalry camp on the cantonment site ablution water is thrown out on the soil.

Civil Sanitary Surroundings.

The town of Potchefstroom is about 2½ miles from the cantonments, but there are signs of its extending shortly to within ½ mile of the nearest buildings.

The population is estimated at between 5,000 and 6,000 whites, and 3,000 or 4,000 natives. The number of houses in the town is 760, but there is a considerable population living in tents and improvised shelters.

The sanitary administration is carried on by a Health Board, with the Resident Magistrate as Chairman, under Proclamation 28 of 1901. Complete bye-laws have not yet been promulgated, but a bye-law regulating the construction of buildings was proclaimed in the Government Gazette of 25th March, 1903.

The area covered by the town buildings is about 2 miles square, and it is estimated that it contains 23 miles of streets, and 50 miles of irrigation furrows.

The executive sanitary work is carried out by a Secretary to the Health Board, two sanitary inspectors, a water bailiff and 19 native labourers, with the aid of convict labour. The work of removal of nightsoil, &c., is carried out by a contractor.

The Medical Officer of Health for the Western Transvaal (Dr. Walker), resides in the town and exercises special supervision over sanitary matters there.

The water supply has already been described. The surface wells are in many cases near cesspits.

A system of open cesspits still exists, although the majority of houses use pail latrines. Removal from this is carried out on the dual-pail system bi-weekly by contract.

A new contract has been entered into from the 1st April, and bye-laws are proposed abolishing cesspits and making pail latrines compulsory. A rate of 6*s.* monthly is charged for each bucket.

The soil is removed in tank carts, the empty buckets being carried in a space provided for them on the cart.

It is being trenched in deep pits about 2½ miles from the town in a valley west of the town.

No arrangements have yet been made for removal of slops and urine; they are thrown on the soil near habitations or used in gardens.

Dry refuse is removed in Scotch carts at a charge of 1*s.* per load to a dumping ground near the filth trenches. Carcases are removed at a charge of 10*s.* each.

There are no regulations for, or sanitary supervision over, the sale of milk or other articles of food and drink, with the exception of a regulation that cattle are to be slaughtered at slaughter poles placed in an enclosed fence, south of the town near the native location and river.

Milk is sold in bottles, and bottles are cleaned in any kind of water.

There are five aerated water factories. In all, well-water, drawn from wells on the premises, is used. The wells are all shallow surface wells, unprotected and unlined. Pumps are used. In one factory there is an elaborate arrangement for boiling the water. In all, except in one case where there is no purification, the water is passed through a Berkefeld or other form of candle filter.

Bottles are washed by hand in all except two factories, where revolving brush and spray washers are used. The water used is unpurified well-water, except in the factory where the water is boiled. In this factory the boiled water is laid on to the spray washer, but the pipe is also connected with the unboiled water tank, and either the purified or unpurified water can be used at will. The premises generally are littered with rubbish, and within 50 yards of one of the wells a cesspit is known to exist.

Notification of infectious diseases is in force, and an isolation hospital, with a Thresh's portable disinfecting apparatus, has been established on the east side of the river on the site of an old burgher camp.

There are no industries, except one brewery in the centre of the town. The water used in it is from surface wells, which are steined to the level of the water.

The streets are fairly well made on gravelly soil, but there is no general drainage of the town except into the water furrows and irrigation channels.

Houses are built generally of sun-dried or kiln-dried brick, with thatch or corrugated-iron roofs. There is also a number of corrugated-iron erections. Only some of the better class houses are raised above the ground.

The native location is without sanitary arrangements. The water supply is from irrigation furrows after they have passed the town, or from surface wells, or from the river, which is close to its eastern boundary.

All the houses are of sun-dried brick, with thatched roofs, and they are placed, as a rule, in well-cultivated and neat gardens, containing a variety of fruit and other trees.

Most of the laundry work is done in the native location. A steam laundry is about to be erected in the town.

The people living in tents and temporary shelters are without any sanitary arrangements. Many of them are close to the main furrow before it enters the town, and clothes are being washed on the bank of the furrow.

The native location (Elandshoevel) on the east of the river is outside the town lands, and does not come under the town sanitary administration.

New Cantonments.

The new cantonment area is an irregular polygon of 700 acres, approximately, situated mainly on the southern slopes of a long low hill, somewhat triangular in shape. The base of the triangle may be taken as commencing at a small kopje, known as Derby Hill, at the south-east corner of the cantonment site, and running south-east to north-west to the south-west corner. The length of this base is about $1\frac{1}{2}$ miles, and it is on the slope forming it that the cantonment buildings have been erected. The hill extends from this slope in a north-easterly direction, narrowing towards the apex in an outcrop of chert or quartz. This outcrop commences at the south-west corner and forms a more or less prominent ridge running from south-west to north-east at the back of the cantonment site, and dividing the western slope from the southern and eastern slopes.

The middle or most prominent portion of this ridge is known as Telegraph Hill, its north-east extremity as Reservoir Hill, and its south-west extremity as Hospital Hill. A basalt dyke, as already noted, runs diagonally across the cantonment slope from west to east, but does not form a marked outcrop above the surface.

The cantonments are divided into two sections, the North Camp and South Camp.

The North Camp occupies the southern slope from Hospital Hill to near Derby Hill, and contains from west to east the following units :—

(1.) Hospital.
(2.) Mounted Infantry.
(3.) Cavalry.
(4.) Royal Field Artillery.
(5.) Infantry.

The South Camp occupies the area around Derby Hill, and contains—

(1.) Head-quarter offices.
(2.) Royal Engineers lines.
(3.) Army Service Corps supply depôt.
(4.) Army Service Corps transport lines.

In addition to these areas a considerable amount of land has been mapped out on the eastern slopes as a brigade parade ground, and the whole valley overlooked by the North Camp and the slope beyond is taken up as recreation grounds, an area of some 5,000 or 6,000 acres being utilized for purposes connected with the cantonments.

The natural drainage of the cantonments is towards the watercourse running down this valley, and already described as being intercepted by the main furrow of the town; or more correctly speaking, by the new Government furrow, which is being constructed to the west of the town furrow.

The soil is, as a rule, a gravel soil mixed with clay, but there are several patches of black or bog earth notably along the watercourse in the valley below.

The areas occupied by the buildings of each unit are approximately as follows:—

	Acres.
(1.) Military Hospital, 300 beds	12
(2.) Mounted Infantry battalion	22
(3.) Cavalry regiment	22
(4.) Royal Field Artillery, 1 battery	10
(5.) Infantry battalion	20

These areas are exclusive of parade grounds, Officers' and married quarters; the total area mapped out for each unit being approximately—

	Acres.
(1.) Hospital	32
(2.) Mounted Infantry lines	36
(3.) Cavalry lines	36
(4.) Royal Field Artillery lines	42
(5.) Infantry lines	50
(6.) Royal Engineers and Army Service Corps lines ..	18

It is proposed to place quarters for married Officers on the north-east corner of the Infantry lines, and for married soldiers between the Royal Field Artillery lines and South Camp.

The intervals between the units are—

	Feet.
(1.) From hospital buildings to Mounted Infantry ..	250
(2.) From Mounted Infantry to Cavalry	200
(3.) From Cavalry to Royal Field Artillery	300
(4.) From Royal Field Artillery to Infantry	600
(5.) From Infantry to South Camp	1,600

The intervals between the huts are—

(1.) Mounted Infantry and Cavalry, end to end, 35 feet; lines, 50 feet.
(2.) Royal Field Artillery and Infantry, both end to end and lines, 50 feet.
(3.) Hospital wards, end to end, 35 feet; lines, 60 feet.

The stables of the mounted branches are in alignment with the huts and on the lower portion of the slope. The distance between the stable lines from the barrack lines is 90 feet in the Royal Field Artillery lines, and 80 feet in the Mounted Infantry and Cavalry lines.

The stables are 41 feet from one another end to end, and 50 feet line to line, in the Royal Field Artillery lines; in the Cavalry and Mounted Infantry the distances are 24 feet end to end, and 50 feet line to line.

In the hospital, Mounted Infantry, and Cavalry lines, the ablution rooms and latrines are in alignment with huts and cookhouses, and in a line down the centre of the huts; the latrines being 60 feet from the cookhouses, and 60 feet to 68 feet from the nearest huts.

The huts are of the "A" type, with single verandah; the aspect in the North Camp being N.N.E. (up hill), and S.S.W. (down hill), the verandah being on the N.N.E. aspect. In the South Camp the aspect is N.N.W. and S.S.E.

The Officers' mess and quarters in the Infantry lines, and in the South Camp, have an east and west aspect. The hospital huts have verandahs on both aspects.

None of the huts are raised more than a few inches to 1 foot above the ground; the slope of the site generally being only about 1 foot in 60. The ground underneath and around is not prepared or channelled. The verandahs are floored with wood boards in the hospital, Officers' quarters and messes, and some of the huts. Other huts have at present earth verandahs, the earth being banked up against the space between the surface soil and the floors of huts.

The stables are constructed with side and floor flaps for ventilation in place of windows, and they have also good ridge ventilation. The flooring and drain channels are of ant-heap earth beaten down. Watering troughs are between stable lines on unprepared ground. At present they overflow on to the surface soil.

Ablution rooms, latrines, and kitchens have cement floors channelled to sumps. The latrines are at present constructed as earth latrines. There are no special huts for dining-rooms. The barrack-rooms or verandahs are intended to be used as such.

A water-carriage system of sewage disposal is proposed, with an outfall into septic tanks and primary filter beds on the Exeter system. The septic tank site selected is at the foot of the slope west of Derby Hill and south of the North Camp. It is about 1,800 feet from the Infantry barracks, and about 1,000 feet from the Army Service Corps supply depôt, the former being the nearest point in the North Camp, and the latter the nearest point in South Camp. It is being planned to deal with a maximum flow of 100,000 gallons from a population of 2,600 men and 1,500 animals.

At present it is arranged to dominate an irrigation area of about 5 acres, resting on the north bank of the watercourse, about 2,400 feet above the new Government furrow.

Roads are being made throughout the cantonments, and trees have been planted. No provision is being made for removal of storm water by surface or other drains, other than by earth channels.

The water supply intake has already been indicated. It is on the town furrow about ¼ mile below its intake from the river. At the intake, strainers and a small settling tank are being constructed. The water will be pumped to eight 20,000 gallon reservoirs on Reservoir Hill.

From Reservoir Hill it will be led by gravitation to the cantonment site, where it is proposed to construct subsidiary tanks for each set of barracks, capable of storing 100,000 gallons in the aggregate. A borehole is being sunk about 300 yards below the hospital, but no water has been reached (*see* Appendix).

A destructor for dry refuse is being constructed about 2 miles south of the cantonment, and about the same distance west of the town.

Arrangements are being made for warming a small proportion of the huts, such as recreation rooms.

An incinerator, boilers for infected linen and steam disinfector are being erected in the hospital lines. There is a well-built operating room of brick. The floor is however without channelling, and the angle between floor and walls is not rounded.

Existing Camps and Temporary Arrangements for the Garrison.

All the garrison, with the exception of the Mounted Infantry and Army Service Corps Transport Company, are in cantonments.

A temporary water supply is being pumped from an intake on the town furrow, east of Derby Hill, to corrugated-iron tanks in the Infantry lines. It is laid on by pipes to the Infantry and Royal Field Artillery lines, and a special boiling arrrangement has been built between the lines of huts for sterilizing the water. Water has also to be brought in watercarts. They are filled from the furrow near the existing pumping station. The hose from the pump lies on the ground when not in use.

Half the Cavalry are encamped on their own lines above the huts. The other half is in more or less unfinished hutments, and the horses in unfinished stables of the Cavalry and Mounted Infantry lines. The cookhouses, ablution rooms, and latrines of these lines are unfinished and not used.

The hospital huts are also occupied, but a proportion of the beds are in E.P. tents in the lines.

Regimental and hospital transport animals are picketed in kraals in their own lines.

The Infantry and hospital are using the ablution room, cookhouses, and latrines of their lines.

The other units have temporary earth latrines.

The Cavalry have practically no ablution arrangements, and are using field kitchens.

There is a camp for married natives on the upper part of the slope above the Cavalry lines. It has a population of 60 adult males and several women and children. Two 3-pail latrines are provided for them, and their refuse is being deposited in the neighbourhood of the camp.

Just below the Cavalry and Artillery lines there are two large camps of about 120 bell tents, with 2 to 3 men in each, occupied by British and Boer workmen.

Near the Army Service Corps lines there is a small camp of native labourers. All these are provided with pail latrines, with pails placed direct on the surface, and have a water supply similar to that of the rest of the garrison.

Refuse is being removed in open buck wagons without sides. The refuse receptacles are cement structures, uncovered, and enclosed on three sides only.

In the Cavalry and Mounted Infantry camps men are specially told off to boil water for drinking, and to keep the drinking water tanks supplied with boiled water.

A Medical Officer is specially told off for sanitary duties.

Health Statistics.

(A.) *Civil Population.*

There was no death registration until the beginning of 1901.

Since then a number of deaths has been entered, but in such a way that, for the first year at any rate, it is practically impossible to eliminate deaths in the temporary burgher camp from those in the town.

The principal figures obtained from examination of the register are given in Table VI., Appendix.

The chief feature is the high percentage of deaths from the principal zymotic diseases, and this percentage is apparently uninfluenced by the statistics of the burgher camps, for it has remained higher after the burgher camps ceased to exist.

Notification returns are imperfect. They commenced in January, and since then the following diseases have been notified :—

January.—Dysentery, 1 ; enteric, 1.
February.—Nil.
March.—Dysentery, 4 ; enteric, 7.

Eleven cases of enteric fever and one of dysentery have also been notified in March from the South African Constabulary Camp. This is situated north-east of the cantonment on the slope leading from the cantonment to the railway bridge.

The medical officer of health informed me that he had reason to believe that there are many unnotified cases of enteric fever in the town.

There appears to be little, if any, malarial fever.

(b.) *Military Population.*

The principal/health statistics since the close of the war are given in the Appendix, Table I. Tables are also given showing the distribution of these diseases amongst the corps at present forming the garrison.

As compared with similar statistics already submitted in connection with reports on other garrisons, the chief features in the health of the Potchefstroom garrison are—

(1.) An excessive incidence of enteric and S.C. fevers. No other garrison shows so great an incidence.

(2.) A fairly high incidence of dysentery and diarrhœa.

(3.) A moderate incidence of throat affections and primary venereal affections.

The Royal Engineers, who have been in the hutments longest, show the highest incidence of enteric fever. The Cavalry show the next highest incidence, the Royal Army Medical Corps the least. If the S.C. fever figures are combined with those of enteric fever the order of incidence is—

(1.) Cavalry.
(2.) Royal Engineers.
(3.) Mounted Infantry.
(4.) Infantry.
(5.) Royal Army Medical Corps.
(6.) Army Service Corps, and
(7.) Royal Field Artillery.

The Cavalry received a draft of 192 young soldiers on the 5th December, 1902, but the incidence of enteric fever amongst them and the deaths are practically the same as amongst the old soldiers, of whom there are 420. The figures are 10 admissions and four deaths amongst the young draft and 26 admissions and eight deaths amongst the old soldiers. 5·2 per cent. of young soldiers and 6·1 per cent. of old soldiers were accordingly attacked during the present epidemic, with a mortality of 2 per cent. amongst the former and 1·9 amongst the latter.

Meteorological Records, &c.

Table VII. appended gives a record of temperatures kept during 1902. There are no rainfall gaugings. Dust storms are said to be severe. Thunderstorms are also severe, and deaths from lightning have occurred.

Flies are troublesome, especially in the Cavalry lines. Mosquitoes are said to swarm in the lower lying parts of the town, but do not appear to be present in the cantonment area.

Conclusions.

(1.) The general siting of the cantonment is good as regards slope and soil.

(2.) The general character of construction, intervals between units, huts, latrines, cookhouses, ablution rooms, &c., do not present features different from those of other South African cantonments at present in course of construction, with this exception, that Cavalry and Mounted Infantry lines are placed nearer the hospital than in other cantonments.

(3.) The chief sanitary defect in construction, as in all other South African cantonments, is the want of provision for preventing pollution of soil under and around the hutments, the absence of proper stable flooring and drainage, and want of preparation of ground around watering troughs. The occupied stables are already becoming foul, and their proximity to barrack huts makes this fouling of the ground a serious sanitary defect.

(4.) The latrines in the Cavalry lines and hospitals are not well placed.

(5.) The proposed arrangements for a water-carriage system of sewage disposal with biological treatment will probably work satisfactorily in time, but, in the meantime, it is essential that a sufficient area of ground for irrigation and cultivation be marked off, and provision made for systematic and methodical cultivation and drainage of that area.

(6.) This has apparently not been fully contemplated, but unless it is done an offensive bog is likely to be formed near occupied cantonment areas, and the health of any community using the new Government furrow as their water supply is likely to be seriously affected by an insufficiently purified effluent from the cantonment finding its way into it.

(7.) The water supply generally, both for cantonments and town, is liable at any time to serious and specific pollution, and, so long as it exists under present conditions, epidemics of water-borne disease may be expected.

(8.) The sanitary conditions of the town and civil population generally are bad, especially as regards water supply and soil pollution, and radical changes are required to place them on a sound basis.

(9.) The general health conditions of the troops, as indicated by the admissions to hospital, are the conditions which may be expected from the nature of the water supply and, as regards water-borne disease, they are markedly worse than other garrisons in South Africa.

(10.) The health statistics of the civil population are complicated by the health statistics of burgher camps, but they do not indicate a high standard of health.

Recommendations.

(a.) *New Cantonments.*

As regards occupation of these cantonments, before they have been completed, a distinct sanitary error has been committed. This is apparent everywhere, both in stables and in huts, especially in the former. Under the circumstances, it is most strongly recommended that surface drainage schemes should be prepared without delay, and cookhouses, ablution rooms, and latrines completed.

The camping of horses, transport lines and natives, on the cantonment site, does not help to maintain a high standard of health amongst the troops, and the occupation of unfinished stables has led to objectionable sanitary conditions. The undue prevalence of flies alone is an insanitary condition that might have been avoided by attention to stable sanitation. This is specially important, in consequence of proximity of these stables to the hospital wards. Flies breeding in the stable lines may readily migrate to wards, and become carriers of infection.

As regards permanent occupation, it is recommended that, sooner or later, huts be raised, concreted underneath and around and channelled to surface drains; stables properly paved and drained, roads constructed and intervening spaces fenced in or planted with trees. Until this is done it will be impossible to prevent pollution of soil, or obtain healthy conditions in these cantonments. The proximity of huts and units to one another renders this measure of sanitation essential.

As regards water supply, the sanitary aspect of the existing state of affairs could not be very much worse, and it is recommended that one or other of the following schemes be adopted :—

(1.) A combined water supply scheme for town and garrison. The valley of the Mooi River has been examined for several miles up stream to the springs near Frederickstad, and it is apparent that it is liable to serious pollution from a considerable population and from agricultural land. At the springs known as "Oog Mooi," near Frederickstad, the water issues in a strong stream from dolomite rock. The quantity is said to be more or less permanent at all seasons of the year. When examined the yield was at least 5,000,000 gallons in 24 hours. It is strongly recommended that a waterwork scheme on broad lines be adopted by enclosing, cleaning, concreting and damming this source and laying it on by pipes to the town and garrison. There is a fall of about 100 feet in 15 to 18 miles to the highest point of the garrison site. At present the source is liable to pollution by picnic parties, animals, &c., at the springs themselves, and should such a scheme be adopted it would be necessary to enclose the head of the springs in such a way that pollution of this kind would be impossible. The water as it issues from the rock is crystal clear, and similar to the dolomite water supply of Pretoria. A scheme of this kind would alter the whole complexion of Potchefstroom as regards water-borne disease.

(2.) Failing the construction of a good waterwork scheme, as suggested, the next best scheme would be to form complete filter works, sufficient for town and garrison, at an intake as near the distribution area as may be convenient.

(3.) Failing any combined scheme such as suggested in (1) and (2), the garrison will have to protect itself by—

(*a.*) Filter beds of its own, or

(*b.*) By installation of sterilizing apparatus.

The water, being clear, is well adapted for filtration through candle filters, and an installation of filters similar to that in use in French barracks is recommended.

Whatever is done, purification of the water supply is essential under the circumstances, and as the water is almost invariably clear and free from suspended matter, sterilization by candle filters would present no difficulties.

Purification, however, must be complete for all purposes. A system of water supply, partly pure and partly impure, especially where the impure water is clear and sparkling, and accordingly deceptive, is as liable to be unsafe as a water supply without any purification at all.

The combined scheme of water supply for both town and garrison by conservation of the Oog Mooi springs at their source is therefore most strongly recommended; although, at first, it is likely to be the most costly scheme.

As regards temporary water supply arrangements, the means of purification by boiling are good, but the intake is not satisfactory, and in any case the hose should be kept off the ground on trestles.

As regards foul drainage, it is recommended—

(1.) That the septic tank and filter beds should dominate an irrigation area of at least 10 acres. At present the area mapped out is likely to prove inadequate for a time. Such an area could readily be obtained by extending the present area down the side of the watercourse; or, if practicable, a better area would be found on the south side of the dry watercourse (*see* map).

(2.) That this irrigation area be enclosed and the boundary planted with eucalyptus trees, in a double or treble row along the side of the watercourse and along its lower boundary. No provision at present has been made for this.

(3.) That the area be carefully prepared for crops by ploughing and under drainage, and that the effluent be discharged over it by broad irrigation or intermittent filtration, and cultivated under some definite management and supervision.

As regards polluted ground in the neighbourhood of or on cantonment sites, it is recommended that these be ploughed and cropped as soon as possible. There are several areas fouled by horses and refuse that require treatment in this way.

As regards the defect in siting latrines near huts and cookhouses, it is recommended that the cookhouses should be supplied with wire gauze-covered windows and doors, and the latrines very carefully cemented and channelled to covered sumps. When a water-carriage system is introduced the sanitary defect of proximity of latrines to cookhouses will be lessened, but in an earth system of latrines it is, from a sanitary point of view, a prominent defect to place the latrines near the cookhouses.

The lighting and warming of huts in the cantonment are not at present well arranged. No doubt this is fully considered and proper arrangements contemplated. As regards warming, it is obvious from Table VII. in the Appendix, that proper provision should be made for the cold weather. It is understood that provision has been made for this to a certain extent, and it may be left to experience to decide what further provision is necessary.

An accessory, which has been omitted in the plans of these cantonments, is a dining hut for each company or half company. The provision of such an accessory will help greatly to prevent fouling of barrack huts and verandahs. They are being fouled at present by men dining and washing their mess utensils there. Clothes, too, are being washed on verandahs, and provision of proper wash places is an urgent matter.

As regards special hospital constructions, the following are recommended:—

(1.) Provision of wire gauze windows and doors to hospital wards, especially to the enteric wards.

(2.) Channelling floor of operating theatre, and rounding re-entering angles.

(b.) *Civil Surroundings.*

The chief requirements as regards civil surroundings are the introduction of model bye-laws and their enforcement with reference to—

(1.) Milkshops.
(2.) Slaughterhouses.
(3.) Cesspits.
(4.) Water supply.

With regard to water supply, the abolition of surface wells and irrigation channel supplies and the introduction of piped water supply from a safe source are essential to sanitary reform in the civil surroundings. A good water supply scheme for the town seems to be the main public health problem which should be faced.

Next to that, the abolition of cesspits and the provision of public latrines for natives and others are essential measures of sanitation.

The existing methods of disposal of sewage in the town by a pail system requires careful revision; and the establishment of a model farm, such as has been recommended in my report on Harrismith, is specially recommended, and is specially suitable for a town like Potchefstroom. Sanitary arrangements for the population extending towards the cantonment site are also essential.

Existing Camps.

These camps are likely to be occupied now for a short time only. As the season of enteric fever prevalence is coming to a close, and, as proper precautions are being taken for sterilizing water, there is little to be said. The fact must, however, be recognized that the want of properly constructed cookhouses, latrines, and ablution places is a serious sanitary defect in any standing camp, and it is strongly recommended that in future, should the necessity arise of establishing temporary camps, no site should be occupied until these accessories are properly constructed; the essential features of proper construction being cemented floors channelled to sumps, which can be disinfected and emptied as required, and which will prevent the fouling of soil on the camp areas.

Unless there are strong reasons for keeping the Cavalry in hutments, or camping them at present on their cantonment lines, it is recommended that they should be removed from the site until their stables, hutments, and accessories are completed, and placed in a camp with full and proper provision for cooking, ablution, latrines, and water purification.

W. G. MACPHERSON, *Lieut.-Colonel,*
R.A.M.C.

Pretoria,
11*th April*, 1903.

TABLE I.—PRINCIPAL Health Statistics of Regular Troops at Potchefstroom since the close of the War.

Week ending	Average strength.	Number of sick remaining.	Percentage of sick remaining to average strength.	Admissions for: Enteric fever.	S.C. fever.	Malarial fevers.	Dysentery.	Diarrhoeal diseases, enteritis, &c.	Sore throat.	Tonsilitis.	Primary syphilis.	Soft chancre.	Gonorrhœa.	All causes.
1902.														
6th June	450	2	0·4	..	..	..	..	..	..	..	..	..	1	2
13th ,, ...	839	7	0·8	..	1	..	..	..	..	..	..	..	..	6
20th ,, ...	812	9	1·1	..	..	..	..	..	..	1	..	..	1	5
27th ,, ...	927	22	2·3	..	2	..	..	..	1	1	..	..	..	19
4th July	1,187	29	2·4	..	3	..	..	1	..	1	..	..	..	16
11th ,, ...	2,533	30	1·2	..	4	..	..	..	..	..	..	..	1	24
18th ,, ...	2,723	35	1·3	..	..	..	..	..	..	2	..	..	1	14
25th ,, ...	2,723	40	1·5	1	..	..	..	..	..	4	..	..	1	21
1st August	2,891	50	1·7	..	1	..	2	..	..	3	..	..	..	29
8th ,, ...	2,713	46	1·7	1	4	..	..	1	..	1	..	..	..	18
15th ,, ...	2,717	46	1·7	..	2	..	..	1	..	2	..	..	1	15
22nd ,, ...	2,854	48	1·7	..	2	..	1	..	..	2	..	..	1	26
29th ,, ...	2,178	41	1·9	1	1	..	..	..	..	1	..	..	..	11
5th September ..	1,846	37	2·0	..	3	..	..	..	..	1	1	..	..	15
12th ,, ..	1,284	29	2·3	..	1	..	..	..	..	1	..	..	1	7
19th ,, ..	1,774	35	2·0	..	..	..	..	..	..	4	1	..	3	22
26th ,, ..	2,158	80	3·7	..	..	1	1	1	..	2	..	..	2	25
3rd October ..	2,199	96	4·4	..	..	..	..	..	..	4	..	1	1	30
10th ,, ...	2,241	99	4·9	..	2	..	1	..	..	6	1	..	2	37
17th ,, ...	2,298	108	4·7	..	1	1	1	..	..	5	2	1	1	30
24th ,, ...	2,274	128	5·6	..	..	2	..	1	..	3	..	2	2	48
31st ,, ...	2,260	138	6·1	..	..	1	4	3	..	3	1	2	2	36
7th November ..	2,731	131	4·8	..	2	..	..	2	1	1	..	..	7	33
14th ,, ...	2,754	150	5·5	..	3	..	1	5	2	6	..	..	2	53
21st ,, ...	2,692	144	5·3	..	4	..	1	3	..	3	..	1	1	43
28th ,, ...	2,679	153	5·7	2	2	..	..	3	..	3	1	..	1	47
5th December ..	2,602	150	5·8	1	9	..	1	4	..	1	1	..	3	66
12th ,, ...	2,753	147	5·3	..	5	..	..	5	..	1	1	1	1	41
19th ,, ...	2,796	136	4·9	..	1	..	..	6	..	1	2	..	2	33
26th ,, ...	2,768	156	5·6	..	4	..	3	2	..	..	..	..	..	41
1903.														
2nd January ..	2,758	163	5·9	5	3	..	..	5	..	2	1	..	1	60
9th ,, ...	2,331	161	6·9	3	9	1	2	8	1	..	1	1	4	59
16th ,, ...	2,290	178	7·8	8	7	..	..	2	..	2	..	..	2	63
23rd ,, ...	2,251	170	7·6	6	4	..	..	..	..	1	..	..	2	38
30th ,, ...	2,288	178	7·8	12	4	1	3	..	..	3	..	..	5	63
6th February ..	2,283	195	8·5	12	10	..	5	..	..	3	..	..	1	56
13th ,, ...	2,267	195	8·6	14	6	..	6	1	..	5	..	..	2	62
20th ,, ...	2,260	205	9·1	6	13	2	2	..	..	2	..	..	..	67
27th ,, ...	2,307	196	8·5	9	7	1	5	3	..	1	1	..	1	54
6th March	2,278	206	9·0	8	7	1	1	1	..	1	..	..	1	57
13th ,, ...	2,293	203	8·9	4	7	1	3	3	..	2	..	..	..	54
20th ,, ...	2,286	191	8·4	10	6	2	2	1	..	1	..	..	2	44
27th ,, ...	2,205	179	8·1	5	6	..	1	1	1	2	..	..	1	41
Totals ..	95,753	4,742	..	108	146	14	46	63	6	88	14	9	60	1,526
Average strength ..	2,227	Average percentage remaining to strength 4·9	Annual admission ratio per 1,000 of average strength.	137·8		..	59·2		49·5		44·9			828·4

TABLE II.—ADMISSIONS for Enteric Fever and S.C. Fever amongst the Troops at Potchefstroom according to Corps.

Week ending	King's Dragoon Guards.			8th Mounted Infantry.			Royal Field Artillery.			Royal Engineers.			2nd Bn. Somersetshire L.I.			Royal Army Medical Corps.			Army Service Corps.		
	Enteric.	S.C. fever.	Total.	Enteric.	S.C. fever.	Total.	Enteric.	S.C. fever.	Total.	Enteric.	S.C. fever.	Total.	Enteric.	S.C. fever.	Total.	Enteric.	S.C. fever.	Total.	Enteric.	S.C. fever.	Total.
1902.																					
7th November	..	2	2	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..
14th "	..	..	..	..	1	1	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..
21st "	..	..	..	1	2	3	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..
28th "	..	1	1	..	1	1	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..
5th December	..	2	2	..	1	1	..	..	..	..	..	..	..	..	..	..	2	2	..	..	..
12th "	..	2	2	..	..	..	..	..	..	..	..	..	..	2	2	..	..	..	..	..	..
19th "	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..
26th "	3	1	4	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1903.																					
2nd January	2	1	3	..	2	2	..	..	..	1	..	1	1	..	1	..	..	..	..	1	1
9th "	2	3	5	..	1	1	..	..	..	..	..	..	..	2	2	..	1	1	..	1	1
16th "	3	2	5	2	3	5	..	..	..	2	1	3	1	1	2	..	..	..	..	..	..
23rd "	..	2	2	1	1	2	..	..	..	2	..	2	2	1	3	..	..	..	1	..	1
30th "	7	2	9	..	..	..	..	..	..	..	..	..	3	2	5	..	..	..	..	..	..
6th February	5	4	9	1	4	5	..	..	..	1	..	1	3	2	5	..	..	..	1	..	1
13th "	5	2	7	2	4	6	1	..	1	3	..	3	2	..	2	..	..	..	..	..	..
20th "	3	3	6	1	7	8	..	..	..	1	..	1	1	1	2	..	1	1	..	..	..
27th "	4	3	7	2	3	5	..	..	..	1	..	1	1	1	2	1	..	1	..	..	..
6th March..	3	3	6	2	3	5	..	..	..	1	..	1	2	..	2	..	1	1	..	..	..
13th "	2	4	6	..	1	1	..	1	1	..	..	..	2	1	3	..	..	..	..	..	..
20th "	3	2	5	2	2	4	1	..	1	..	1	1	4	1	5	..	..	..	..	..	..
27th "	1	3	4	1	1	2	1	..	1	1	..	1	1	1	2	..	..	..	..	..	..
Totals	43	43	86	15	38	53	3	1	4	13	3	16	23	17	40	1	7	8	2	2	4

TABLE III.—ADMISSIONS for Dysentery, Diarrhœal Diseases, and Throat Affections amongst Troops at Potchefstroom, according to Corps.

Week ending	King's Dragoon Guards.		8th Mounted Infantry.		Royal Field Artillery.		Royal Engineers.		Somersetshire L.I.		Royal Army Medical Corps.		Army Service Corps.	
	Dysentery and diarrhœa.	Throat affections.	Dysentery and diarrhœa.	Throat affections.	Dysentery and diarrhœa.	Throat affections.	Dysentery and diarrhœa.	Throat affections.	Dysentery and diarrhœa.	Throat affections.	Dysentery and diarrhœa.	Throat affections.	Dysentery and diarrhœa.	Throat affections.
1902.														
7th November	1	..	..	..	..	..	..	..	..	1	..	..	..	..
14th "	..	..	2	2	..	2	..	1	..	3	1	1	..	..
21st "	1	..	..	..	..	..	..	..	1	..	1	1	..	..
28th "	..	..	2	1	..	..	..	..	..	1	..	1	..	..
5th December	1	..	2	..	..	..	..	..	1	..	..	..	..	..
12th "	5	..	..	..	2	..	..	..	..	..	..	..	..	..
19th "	1	..	..	1	..	..	1	..	..	..	..	..	..	..
26th "	4	..	1	..	..	..	..	..	..	..	..	..	..	..
1903.														
2nd January	2	..	..	1	..	..	..	1	2	..	..	..	..	..
9th "	4	1	1	..	..	..	..	1	4	..	..	..	..	..
16th "	..	..	1	..	..	..	..	..	1	2	..	..	..	..
23rd "	..	..	1	..	..	..	..	..	..	1	..	..	..	..
30th "	1	1	..	..	..	..	..	..	1	2	..	..	..	..
6th February	2	1	1	..	..	1	..	..	1	..	..	..	..	..
13th "	..	..	2	4	..	..	1	..	..	1	1	..	..	..
20th "	1	1	4	..	..	1	1	..	..	..	..	..	..	..
27th "	3	1	..	..	2	..	..	..	1	..	..	..	..	..
6th March	1	..	2	1	..	..	..	..	..	..	..	..	..	..
13th "	3	..	..	..	..	1	..	..	..	1	..	..	..	..
20th "	..	..	3	1	1	..	..	..	..	..	..	..	..	..
27th "	1	..	2	..	1	..	..	..	1	4	..	..	..	..
Totals	31	5	24	11	6	5	3	3	13	16	3	3	..	..

TABLE IV.—COMPARATIVE Statement of Admissions for Enteric and S.C. Fever, Dysentery and Diarrhoeal Diseases, and Throat Affections amongst the Corps stationed at Potchefstroom, from November, 1902, to March, 1903 (inclusive).

Corps.	Average strength for period.	Total admissions for: Enteric fever.	S.C. fever.	Total enteric and S.C. fever.	Dysentery and diarrhoeal diseases.	Throat affections.	Total enteric, S.C. fever, dysentery and diarrhoeal diseases, and throat affections.	Percentage of admissions to average strength: Enteric fever.	S.C. fever.	Total enteric and S.C. fever.	Dysentery and diarrhoeal diseases.	Throat affections.	Total.	Remarks.
1st King's Dragoon Guards ..	607	43	43	86	31	5	122	7·0	7·1	14·1	5·1	0·8	20·1	1st King's Dragoon Guards.—Average strength: November, 524; December, 648; January, 641; February, 623; March, 600. Under canvas till 7th February, 1903; then half in tents, other half in huts in cantonments.
8th Mounted Infantry ..	539	15	38	53	21	11	88	2·7	7·1	9·8	4·5	2·0	16·3	8th Mounted Infantry.—Average strength: November, 535; December, 551; January, 547; February, 557; March, 504. Under canvas during whole period.
Royal Field Artillery.. ..	150	3	1	4	6	5	15	2·0	0·6	2·6	4·0	3·4	10·0	Royal Field Artillery.—Average strength: November, 152; December, 149; January, 157; February, 149; March, 141. Under canvas till 17th January, 1903; then in huts.
Royal Engineers	120	13	3	16	3	3	22	10·8	2·5	13·3	2·5	2·5	18·3	Royal Engineers.—Average strength: November, 50; December, 102; January, 140; February, 143; March, 164. In huts during whole period.
2nd Bn. Somersetshire L.I. ..	566	23	17	40	13	16	69	4·2	3·0	7·2	2·3	2·9	12·4	2nd Bn. Somersetshire L.I.—Average strength: November, 524; December, 534; January, 550; February, 583; March, 640. In hutments from end of December.
Army Service Corps	64	2	2	4	..	..	4	3·1	3·1	6·2	..	..	6·2	Army Service Corps.—Average strength: November, 61; December, 57; January, 73; February, 73; March, 56. Partly under canvas during whole period.
Royal Army Medical Corps..	116	1	7	8	3	3	14	0·8	6·0	6·8	2·6	2·6	12·0	Royal Army Medical Corps.—Average strength: November, 121; December, 120; January, 117; February, 114; March, 107. In hutments from latter half of December.

TABLE V.—STATEMENT of incidence of Enteric and S.C. Fevers, Dysentery and Diarrhœal Diseases, Throat Affections and Primary Venereal Affections in various Garrisons in South Africa, as compared with Potchefstroom, commencing 6th June, 1902.

Name of garrison.	Number of weeks during which statistics were collected.	Annual admission ratio per 1,000 of average strength.				Remarks.
		Enteric and S.C. fevers.	Dysentery and diarrhœal diseases.	Throat affections.	Primary venereal affections.	
Naauwpoort, Cape Colony	31	8·8	39·2	170·0	106·2	Good water supply. Crowded camps.
Ladybrand	34	42·5	21·2	18·6	69·2	Fair water supply. Trench latrines.
Bloemfontein	35	48·3	58·2	68·5	54·5	Doubtful water. Camps.
Kroonstad	35	80·6	118·1	91·7	35·4	Doubtful water. Camps.
Pietersburg	35	64·4	47·5	36·8	36·8	Water liable to pollution. Camps.
Pretoria	35	32·1	56·0	44·8	32·8	Water good at source furrows. Camps.
Harrismith	39	48·2	32·4	52·0	14·2	Water good at source. Camps.
Barberton	41	0·0	33·4	41·7	25·7	Water supply pure and from inaccessible source. Hutments.
Middelburg, Transvaal..	42	34·1	88·4	49·8	17·9	Water pure at source. Camps.
Potchefstroom	43	137·8	59·2	49·5	44·9	Water pure at source, liable to pollution. Hutments and camps.

TABLE VI.—DEATHS from the Principal Zymotic Diseases at Potchefstroom amongst the Civil Population.

Month in year.	Total deaths.	Total zymotic diseases.	Percentage total zymotic diseases to total deaths.	Deaths from: Enteric and undefined fevers.	Dysentery and diarrhœal diseases.	Diphtheria and croup.	Measles.	Whooping cough.	Remarks.
1901.*									
January	1	1	100	..	..	..	..	1	These figures include deaths in the burgher camp.
February	11	3	27·3	..	2	1	..	..	
March	15	14	93·3	1	9	3	1	..	
April	26	6	23·0	1	4	1	..	..	
May	60	41	68·3	13	14	2	12	..	
June	243	195	80·2	25	19	2	149	..	
July	147	94	63·9	19	10	1	64	..	
August ..	73	45	61·6	14	10	3	18	..	
September ..	172	74	48·8	16	12	1	45	..	
October ..	87	60	68·9	6	7	1	46	..	
November ..	83	51	61·4	14	17	1	19	..	
December ..	91	63	69·3	31	20	..	12	..	
Total ..	1,009	647	64·1	140	124	16	366	1	
1902.									
January ..	71	35	49·3	8	20	1	3	3	These figures include deaths in the burgher camp.
February ..	55	25	45·4	5	11	..	..	9	
March	26	14	53·8	2	9	1	2	..	
April	33	21	63·6	5	12	2	..	2	
May	46	16	34·8	3	2	1	..	10	
June	37	17	45·9	4	9	..	..	4	
July	37	8	21·6	2	2	1	2	1	
August ..	33	9	27·2	1	7	..	1	..	
September ..	37	7	18·9	2	5	..	..	..	
October ..	45	16	35·7	5	9	..	..	2	
November ..	49	21	42·8	4	13	1	3	..	
December ..	40	17	42·5	1	16	..	..	..	
Total ..	509	206	40·4	42	115	7	11	31	
1903.									
January ..	29	13	44·8	1	12	..	..	..	
February ..	23	9	39·1	..	9	..	..	..	
March	14	7	50·0	1	5	1	..	..	

* Death registration commenced at the beginning of 1901.

TABLE VII.—RECORDS of Temperature at Potchefstroom during 1902. (From observations kept by Dr. Walker (M.O.H.)—Fahrenheit Scale.)

Month.	Mean of shade maxima.	Mean of shade minima.	Absolute maximum in shade.	Absolute minimum in shade.	No. of days rain. No rain gauge records were kept.
	degs.	degs.	degs.	degs.	
January	84·1	59·6	..	47	11
February..	85	59·8	94	46	13
March	79·9	56·6	89	44	7
April	76·1	46·6	85	35·5	10
May	75	45·3	77	34	4
June	58·3	31·9	70	24	2
July	65·7	33·8	74	28	1
August	68·5	40·1	79	32	1
September	76·5	46·7	88	35	4
October	80·8	48	89	39	4
November	85	55·1	97	42	6
December	90·8	56	104	45	7

TABLE VIII.—RECORDS of Water Analysis at Potchefstroom.

Analysis I. and II. were made by Major Beveridge, R.A.M.C., in the Military Laboratory, Pretoria, remainder by Dr. Pakes, in the Government Laboratory, Pretoria.

Source.		I. Spruit branch of Mooi River, (main furrow of town near the town).	II. Intake for new cantonments (main furrow of town near its intake from river).	III. Well of magistrate's house (surface well).	IV. Main furrow of town at its lower end.	V. Surface well.	VI. Irrigation furrow in Lombard Street.	VII. Main furrow a short distance below the intake from river (same as II.).	VIII. Main furrow near railway station.
Date		10.2.03	15.8.02	3.3.02	3.3.02	3.3.02	3.3.02	20.1.03	20.1.03
Physical character		Clear	Clear	..	..	..	..	..	..
Solids ..	Total	8·6	26·2	35·65	31·65	44·7	27·05	38·85	30·35
	Volatile	2·4	5·7	10·30	10·90	12·8	8·1	8·1	8·1
Chlorine		0·8	0·4	1·96	2·20	1·96	0·3	1·6	0·5
Ammonia	Saline	0·003	0·002	0·017	0·003	0·013	0·014	Nil.	Nil.
	Organic	0·021	0·006	0·030	0·019	0·028	0·019	0·002	0·007
Nitrites as N...		0·021	Traces	Traces	Traces	Traces	Traces	0·02	Nil.
Nitrates		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil.
Hardness	Total	11·2	14·0	24·4	22·8	30·8	20·2	12·7	14·8
	Fixed	10·0	..	5·7	7·7	10·4	8·2	3·0	4·4
Oxygen consumed in 4 hours ..		0·16	0·048	0·13	0·12	0·066	0·11	0·097	0·108
Remarks by analyst		Fairly satisfactory, safe for drinking when carefully boiled. Biologically contained staphlococci fluor liq. subtilis flav. liq. proteus.	A good water and suitable for drinking purposes.	..	..	..	..	Not too good, but is not bad enough to say it is unfit for drinking purposes.	Heavily polluted, therefore not fit for human consumption.

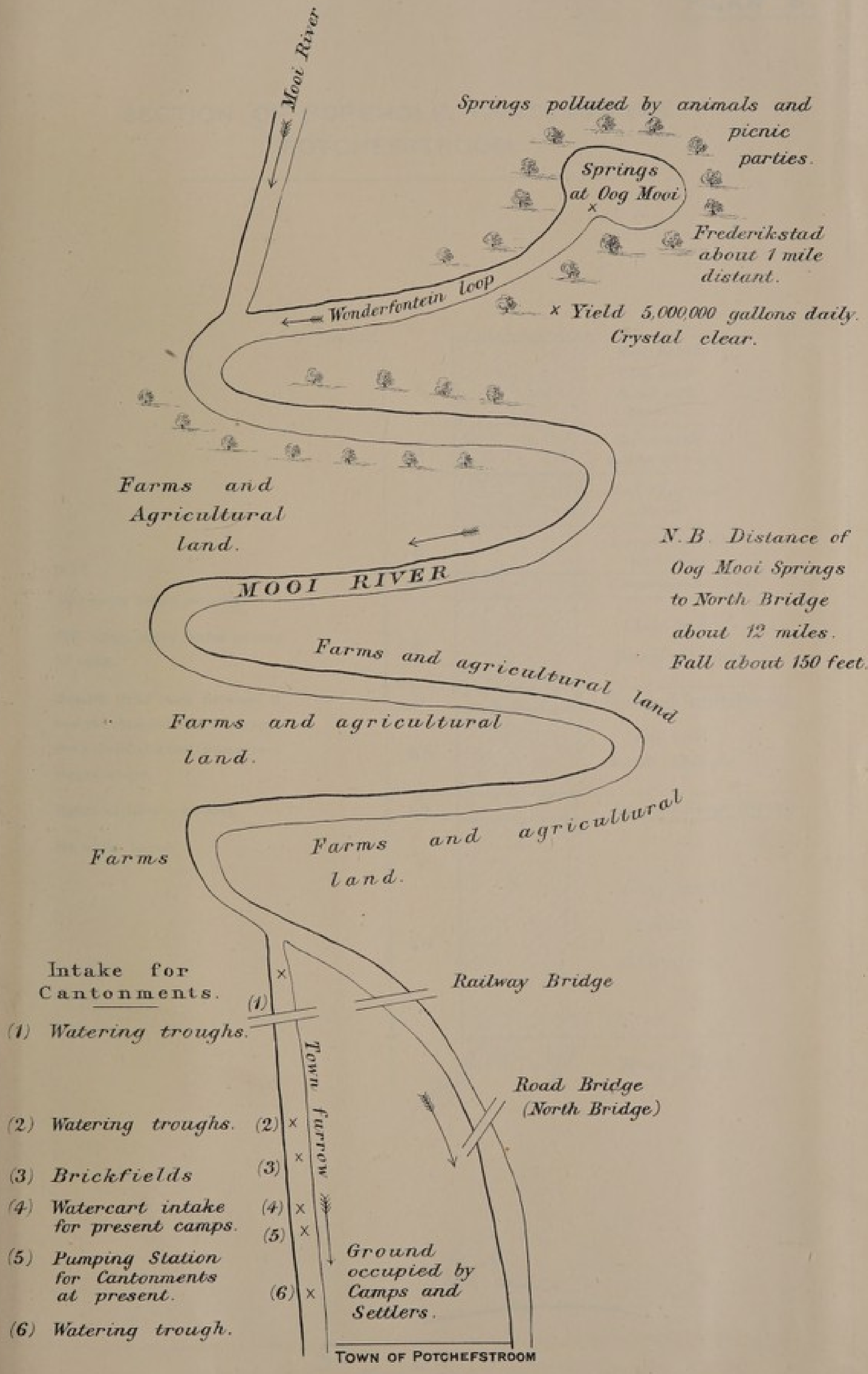
TABLE IX.—RECORDS of wells in main street, Potchefstroom (from notes made by Dr. Walker, Medical Officer of Health).

West side of street.			East side of street.		
Index numbers.	Depth of well in feet.	Depth of water in feet.	Depth of well in feet.	Depth of water in feet.	Index numbers.
1*	15	3½	9	½	1‡
2	9	2½	8	2	2
3	9½	2½	9½	¾	3
4	11½	5	7½	¼	4
5	7	1½	9	2	5
6	11	3	7	1	6
7*	?	?	6	1	7
8	8	1	6	1	8
9	7½	1½	12	?	9§
10†	7	1	8	2	10
11	9	3	8	3	11
12	7	1	8	1	12
13	10	?	8½	1½	13
14	7½	1½	8	2	14
15	12	?	8	2	15§
16	6½	½	9¾	1	16
17	8	2	9	1	17
18*	10	3	7	1	18

* Mineral water factory. † Empty house. ‡ Restaurant. § Hotel.

Plan A.

DIAGRAMMATIC SKETCH OF MOOI RIVER FROM MAIN SOURCE AT OOG MOOI TO POTCHEFSTROOM.



PLAN . B.

SECTION OF BOREHOLE, CANTONMENTS, POTCHEFSTROOM.

SITE.

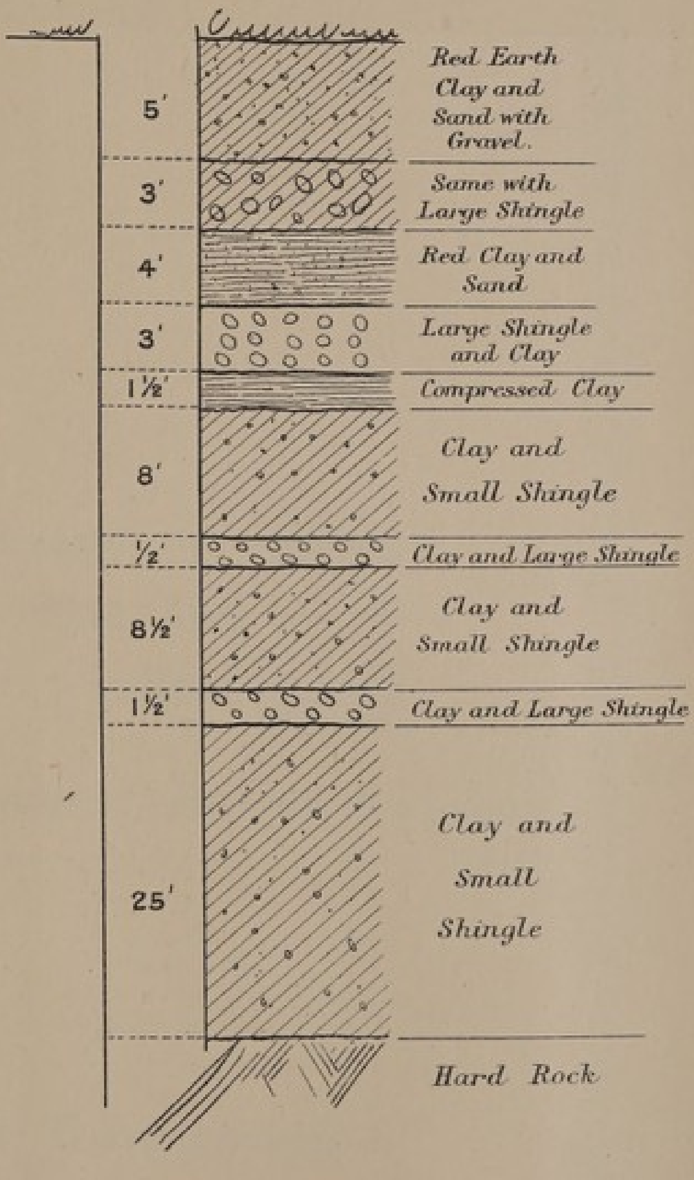
300 yards below Hospital.

300 yards above water course of valley.

Basalt dyke runs between it and the Hospital, and intercepts the ground and deep water from slopes above.

Depth of bore = 62 feet.

No water found.



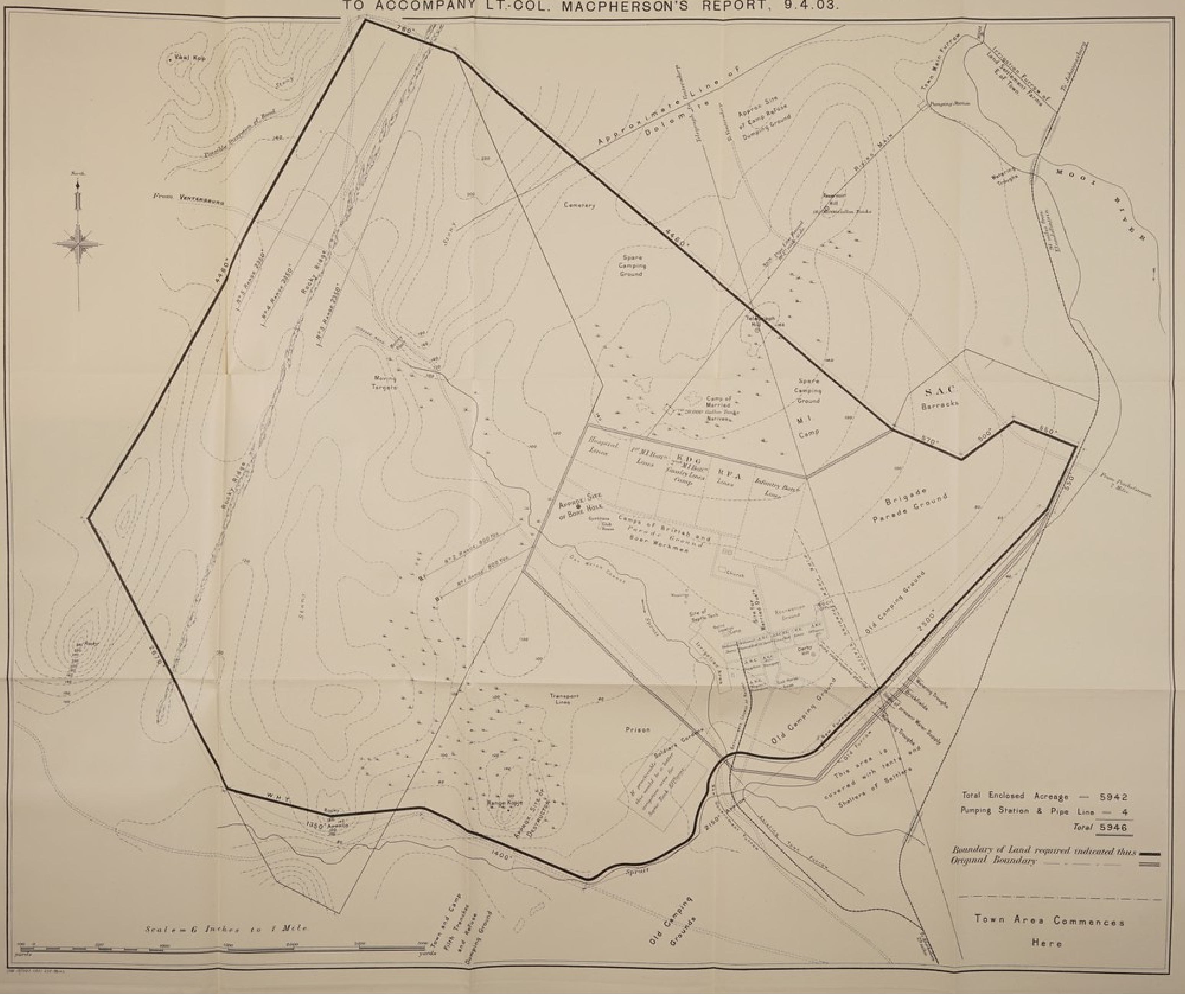
W.

5-3-03

2(1903 1180) 232 · 16 W.O.

PLAN OF POTCHEFSTROOM CANTONMENTS AND VICINITY.

TO ACCOMPANY LT.-COL. MACPHERSON'S REPORT, 9.4.03.



PRETORIA & ENVIRONS.

TO ACCOMPANY SANITARY REPORT OF LT.-COL. MACPHERSON.

Scale: 2 Inches = 1 Mile (1:31680)

REFERENCES.

Railway Line.
Telegraph Line.
Roads (Main).
Roads (Minor).
Wind Pump, W.P.—Level Crossing, L.C.
Signal Post.
Heights computed from ZASM. Level for pret. of 4593–4510.
Form Lines by Aneroid and Clinometer at 25 ft. approximate VI.

REPORT ON PRETORIA AS A CANTONMENT FOR BRITISH TROOPS.

Physical Features.

Pretoria is situated in a valley about 2½ to 3 miles in width, running west and east between two lines of hills, namely, the Das Poort Rand on the north, and the Quagga, Schanskop, and Klapperkop ridges on the south.

The Magaliesberg range runs in a line north of and parallel to the Das Poort Rand, with a valley similar to and about the same width as the Pretoria valley between it and the Das Poort range.

South of the Quagga, Schanskop, and Klapperkop line of hills, there is a mass of hills more or less continuous with them, called the Blauwrand, enclosing minor valleys at a higher elevation than the Pretoria valley.

There are three main lines of drainage for the town valley—

(1.) The Aapies River, which rises 3 miles south-east of the town in Groenkloof, a somewhat deep and narrow ravine from the northern slopes of the Blauwrand, and which runs northwards, intersecting the town and escaping from the town valley at Das Poort, a narrow cutting through the Das Poort range, about 2 miles north-west of the centre of the town.

(2.) Skinner's Spruit, which rises in the west of the town valley and southern slopes of the Das Poort Rand and joins the Aapies at Das Poort.

(3.) A small spruit which rises in the Waterkloof or southern slopes of the eastern end of the town valley, and which runs westward down the centre of the valley to join the Aapies at the line of junction between the main portion of the town and its eastern suburbs.

The Aapies divides the town into two portions, the western being the main business part, and the eastern the residential suburbs. The latter are again divided into two portions by the spruit from Waterkloof, the northern being known as Arcadia and the southern as Sunnyside.

Skinner's Spruit may be regarded as separating the town from the Leper Asylum and sewage farm, but otherwise it does not enter into direct association with the town drainage.

Irrigation channels run from the Aapies as it enters the town throughout the area between the river and Skinner's Spruit.

The new cantonment area is at the head of one of the minor valleys of the Blauwrand, on the southern slopes of the Quagga and Schanskop ridges, which cut it off from the town valley. This area has also three lines of drainage—

(1.) The main portion of the area drains westwards to Quagga's Poort and so into the town valley near the sources of Skinner's Spruit.

(2.) The remaining portion of the area on which buildings have been placed drains southwards toward a valley known as the Zwartkop, and from there towards a strong stream, the Six-Mile Spruit, which runs westwards to the Crocodile River.

(3.) A small and unoccupied portion drains towards the north-east into Groenkloof ravine and Aapies River, above the town.

Another line of drainage connected with the district lies to the extreme east of the town valley, where a strong stream, the Hartebeest Spruit, rising in the hills east of the Waterkloof, runs northwards to join the Pienaars River north of the Magaliesberg.

The railway line from Johannesburg enters the town valley from the south by the Aapies valley. The railway station is at the south of the town. The line to

Pietersburg runs westwards and then turns northwards to the Das Poort, skirting the western limits of the town. The Delagoa Bay line skirts the southern boundary of the town and Sunnyside and a portion of its eastern limits.

Military camps are placed on the eastern limits, near the railway line to Delagoa Bay, on the southern limits in the neighbourhood of the railway station, on the western limits on the southern slopes of the Das Poort Rand, west of the Poort, and at the western head of the town valley below the Quagga Poort.

The geological formation of the town valley and bounding hills is the series of sandstone, shales and slate known as the Pretoria beds. These dip from south to north, and lie conformably on a dolomite formation, which commences in the Blauwrand south of the town. The Pretoria valley and hills are also intersected by well marked dykes of intrusive basalt and dolerite. The line between the Pretoria beds and the dolomite runs down the centre of the cantonment site, the line of demarkation being marked on the surface by outcrops of chert on the top of the dolomite, and of slate over the Pretoria beds. Between the chert and the slate there is a large area of alluvial soil, formed by the wastage of the dolomite and shales. This forms the central line of the cantonments and the line of its main drainage towards Quagga Poort. There are brick earth and brickfields down the valley from the cantonment site to the town.

Water Supply.

The water supply is from—

(1.) The Aapies River.
(2.) Wells.
(3.) Springs.

(1.) *The Aapies River Supply.*

The river rises in springs issuing from the dolomite a few hundred yards above an hotel in the Groenkloof known as the Fountains Hotel. One set of the numerous clear springs at the main source, called the upper springs, is cemented round and a piped main is run from it to the town. The overflow runs in a strong stream, and is diverted into furrows and irrigation channels throughout the town. The water is clear and sparkling, and the various analyses made by the Government Analyst and bacteriologist indicate purity of source.

The irrigation furrows are open channels running along the sides of streets and frequently overflowing on to the street. They are exposed to every form of pollution from street traffic and habitations, and household slops drain or are thrown into them.

The quantity of water has been gauged at 2,500,000 gallons daily at the main source. It is very considerably increased by springs lower down; one set of springs below the source, called the lower springs, yielding, for example, 3,000,000 gallons. These springs are said not to vary during seasons, but the yield is supposed to have diminished during the last 2 or 3 years, the upper springs being gauged now at 1,500,000 gallons only, and the lower at 2,750,000 gallons.

(2.) *Wells.*

The wells are mainly surface wells, and are found all over the town, chiefly in the residential suburbs. Dr. Pakes, the Government analyst and bacteriologist, has shown me results of analyses of 17 wells in the town. Only one gave a satisfactory water, and the majority were heavily contaminated with organic impurities.

Outside the town area wells have been used or sunk for military purposes. Analyses of these were made in the Military Laboratory. They show the usual characters of liability to continuous or intermittent contamination.

(3.) *Springs.*

Several minor springs exist in the town valley, but most of them are on private property, and there was no opportunity of ascertaining their significance from the point of view of water supply. The dip of the slate, shale, and sandstone indicates, however, a tendency to spring formation along the southern base of the town valley.

(4.) *Deep Bores.*

Deep borings have been made on the cantonment site, but no water has been found at reasonable depths. A deep bore, 260 feet, exists in connection with one of the mineral water factories in the lower part of the town. The water in it rises to within 6 feet of the surface.

The storage of rainwater for domestic or other supplies is not a feature of the locality.

Condition of Surface Soil.

The cantonment area has been kept free from pollution, so far as previous encampments are concerned. Owing to its distance from the town several huts have been occupied by construction parties, and a large native labour encampment has been formed on the area. Temporary pail latrines have been provided for these, but the removal and deposit of nightsoil, wet and dry refuse, &c., do not appear to have been thoroughly supervised or systematically carried out, and, although the pollution from these sources is not great at present, it is cumulative.

As regards the town area, the chief source of pollution is from animals, slops, and other domestic refuse, for the removal of which there is no definite system. Outside the town and in neighbouring camps, the same form of soil pollution which exists in other camps in South Africa has been taking place. In some of the camps latrines are paved with the local slate, but well constructed ablution places do not exist. Large quantities of refuse have been deposited near the town, mainly along the slopes of Skinner's Spruit.

Civil Sanitary Surroundings.

In the immediate neighbourhood of the cantonment area there are no civil habitations or dumping grounds for nightsoil or refuse.

The populated area is about 4 miles distant, but down the valley along which the main road from the cantonment to the town runs there is a number of brick-fields, with labourers and overseers living in tents or tin shanties on the ground, and practically without any sanitary systems.

The town sanitation is under the administration of a Sanitary Committee elected by the Town Council, a body nominated by the Government. They act under bye-laws published in 1902.

The Assistant Medical Officer of Health for the Transvaal acts as Sanitary Adviser. There are one chief and six subordinate sanitary inspectors.

The population, according to a census taken in 1902, was 13,108 whites, and 9,863 coloured people. The number of erven is over 4,000 in the town and suburbs, and about 1,000 in the Kaffir locations.

The source of the water supply has already been indicated. The present daily supply from the Groenkloof springs is said to be 1,500,000 gallons. It is distributed by gravitation to public taps and private houses throughout the main portion of the town, and from pumping stations to supply the Infantry and hospital camps on the higher levels of Arcadia and Sunnyside.

The quality of the water is as a rule remarkably pure. The supply is, however, intermittent, owing apparently to the main being of insufficient size; that is to say, no water is running in the upper levels of the town when the taps are running in the lower levels. The use of private house tanks, which are filled whenever the opportunity occurs, is practically universal in the houses on these levels, and many houses in Sunnyside are supplied with water from watercarts, although the piped water is laid on. These suburbs also depend on private wells for their water supply.

The effect of intermittency or defective jointing of pipes is shown by Dr. Pakes in some biological analyses recently made, where marked variation in the number of bacterial colonies occurred in one of the mains as compared with others. Bacilli of the colon group were found by him at the same time in connection with this variation, the results indicating intermittent biological contamination in the piped supply.

Nightsoil is dealt with on the pail system. Removal is bi-weekly or tri-weekly for private houses, nightly for hotels and similar public establishments. Ten tank carts, with a capacity of about 500 gallons each are employed. 40 empty buckets can also be carried on the carts, so that although each cart carries away nightly the contents of about 100 pails, only one-quarter is replaced by clean pails. With a bi-weekly removal this is equivalent to a cleansing of pails about every 10 days.

The contents of the carts are deposited on a sewage farm about 2 miles west of the town, on the north bank of Skinner's Spruit. The farm covers an area of 400 acres or more. Much of the soil is heavy black soil, but the upper portions are a more gravelly red earth. The system of farming is a 4 years' rotation of crops. The nightsoil is not trenched, but it is spread on the surface, dried, and picked of tins, sacks, &c., and then harrowed or ploughed. The crops grown are mealies or hay. A plot of 13 acres of new and somewhat light soil took the nightsoil of 75 days, or 375,000 gallons. The experience of the farm is that heavier soils take less nightsoil, and that trenching had to be abandoned for surface spreading because the tins and clothes that come to the farm in the pails got buried and interfered with subsequent ploughing. There are plantations of black wattle and eucalyptus on the farm in addition to crops. The farm staff consists of a manager with one European assistant, one European foreman, and 12 to 25 natives.

The nightsoil carts are parked on the farm, and the pails are cleansed there. Each nightsoil wagon has a staff of 1 European and 10 natives. They cleanse the pails by filling them with dry hay, setting the hay on fire, and afterwards tarring.

The whole of this system has been in existence for some years. It was worked formerly by a contractor, but is at present carried out departmentally.

Slops and urine are not removed from habitations; they find their way into irrigation channels or surface drains, or are thrown on the surface soil. Dry refuse is removed and is being deposited in several directions, mainly for the purpose of filling up dongas, old brick pits, &c., in the neighbourhood of the town.

Dead animals are buried in pits or left to lie on the surface near the sewage farm on the opposite side of Skinner's Spruit.

There are no slaughterhouses, laundries, cowsheds or milkshops constructed or managed under sanitary supervision. Those that exist are similar in character to what has been already described in other towns.

Infectious diseases are notified, but there is no isolation hospital for general infectious diseases. There is a smallpox lazaretto at Das Poort, and a leper asylum beyond the sewage farm.

There is no public disinfecting establishment, but a steam disinfecting apparatus exists at the civil hospital.

Five aerated water factories were examined. They all used water from the town mains laid on to the aerating machines through a three, five, seven, or nine-candle Berkefeld filter, with the exception of one large factory, where no direct filtration of town water takes place. The washing of bottles was by revolving brush, running water troughs, or spray washers in three of the factories. In two only, including the large factory mentioned above, were tubs and hand-washing methods used. In the smaller factory the surroundings were not very satisfactory. In the others both interior and exterior were well paved or concreted, free from lumber and rubbish, and clean. Generally speaking these factories are in advance of factories seen elsewhere, so far as sanitary considerations go.

The regulations and rates charged for the removal of nightsoil and rubbish are given in the Appendix. The system of water rates is complicated, and is undergoing revision, as arrangements are being made for the transfer of the waterworks to the municipality.

New Cantonments.

The site has already been noted. It is about 4 miles south-west of the town.

The elevation above sea level is 4,600 feet (approximately). It overlooks more or less open country southwards as far as Johannesburg. On the north it is shut off from the Pretoria valley by the Quagga and Schanskop ridges. On the east and west there are low hills running parallel to these ridges. Between these western hills and the Quagga ridge a shallow valley is enclosed, down which the cantonment site drains to Quagga Poort; and between the eastern hills and the Schanskop ridge a somewhat deeper and narrower valley is enclosed, which drains from the cantonment site to the Groenkloof.

The site is more or less the neck between these east and west valleys, and the main portions selected for building are the upper slopes of the western of the two valleys, and the upper portion of the southern slope of the neck.

The surface of this latter portion is stony with outcrops of chert. The centre, forming the line of valley to Quagga Poort, is deep alluvial soil, the wastage of dolomite and shale, and the northern slopes of the site have shale and slate near the surface.

The accommodation that is being provided is for—

(1.) Two Infantry battalions.
(2.) Two Cavalry regiments.
(3.) A brigade division of Artillery.
(4.) Two companies of Royal Engineers.
(5.) A general hospital of 520 beds.
(6.) Army Service Corps depôts.
(7.) Ordnance depôts.

A branch railway line is taken to the site from the Johannesburg line at Droogegrond station, about 6 miles south of Pretoria.

The Royal Field Artillery and one Infantry battalion are on the Quagga ridge slopes with an open space of about 400 yards between them.

The second Infantry battalion and the two Cavalry regiments are on the northern slope of the neck between the east and west hills, and have open spaces of about 800 yards between the Infantry and Cavalry, and about 200 yards between the two Cavalry lines.

The space between the Royal Field Artillery and Cavalry lines is from 350 to 500 yards.

The Royal Engineers' lines and hospital are on the southern slope of the neck.

There is an open space about 350 yards wide between them, the Royal Engineers' lines being about 300 yards south of the second Infantry lines, and the hospital about 500 yards from the south-east corner of the nearest Cavalry lines.

The space between the first and second Infantry lines is being set apart as recreation grounds, with a large garrison institute, built of sandstone, in the centre.

The area covered by each unit, exclusive of parade grounds and married quarters, is approximately—

	acres.
(1.) Infantry regiments, each	17
(2.) Cavalry regiments, each	18
(3.) Royal Field Artillery	20
(4.) Royal Engineers	8
(5.) Hospital	22

The intervals between huts are—

(1.) Cavalry, Infantry and Royal Engineers, 35 feet end to end; 50 feet line to line.
(2.) Hospital, 50 feet end to end; 70 feet line to line.

The stables of the mounted branches are in alignment with the huts as in the cantonments elsewhere. They are sited on the lower portion of the slope in the Cavalry lines, on the upper portion in the Infantry lines. The nearest line of stables is 70 feet from the nearest line of huts in the Cavalry lines.

The stables are 50 feet distant from one another, line to line, and 63 feet, end to end. The latrines are placed on the outer lines in alignment with the huts, in all lines except the hospital, where both latrines and ablution rooms are on the flanks, and in the Royal Field Artillery lines, where they are in the centre. They are 50 feet from the nearest huts, in all lines, and do not adjoin the cookhouses.

The aspect of the huts is north and south. Their construction is similar to that of other cantonments. They are raised 4 inches to 4½ feet, according to slope, above the surface. The surface under and around the huts, is not prepared or channelled to surface drains. Good surface drains of brick are, however, being constructed over the area. The stables are intended to have a flooring of beaten earth. At present, however, no stables of mounted units have been constructed.

Latrines are intended to be Jennings' trough latrines for a water-carriage system of sewage disposal. At present none have been constructed. The sewage system, consisting of 4, 6, 9, and 12-inch stoneware pipes, is being planned to take the drainage of the Infantry, Royal Field Artillery, and Cavalry lines, to the foot of the valley above Quagga Poort. Septic tanks, with a series of single-contact filter beds on the Exeter system, are being constructed there. The tanks are double, with a capacity of 50,000 gallons each. The filter beds are in two sets of four beds of 3,000-gallon capacity each, with central actuating bucket gear chambers for automatic distribution of the effluent over the beds. It is intended to fill the beds with ¾-inch mesh cinder from the railway. The samples seen were somewhat friable.

The filter beds do not dominate any well-defined area of irrigation, but discharge on to a line of drainage leading through Quagga Poort into the town valley, where there are some wide slopes suitable for irrigation purposes. There are no habitations near the tanks, nor any spruits or rivers into which the effluent can find its way direct.

The installation is designed for a population of 3,000, at 100,000 gallons daily with an 8-hour cycle for six filters, while the two remaining beds are resting. A second line of drains and biological banks is being planned to take the Royal Engineer lines and hospital sewage to the Zwartkop valley; and a third installation will be made for the house of the General Officer Commanding, and probably for transport lines. The gradients, &c., for the drains and sewers, have not yet been worked out; but it is expected that in some portions they will be too flat to be self cleansing with a normal flow of sewage.

The water supply for the cantonments is being derived from clear springs, (called the "lower springs"), at the junction between the dolomite and Pretoria shales in the Groenkloof, a few hundred yards below the town supply springs, and about 200 yards above the Fountains Hotel.

The springs are at present open unprotected springs by the side of the road. The edges are surrounded by marshy ground and decaying vegetable and other refuse. They are strong springs bubbling up through a loam and sandy bottom, and yielding about 2,750,000 gallons daily. The undertaking with the civil authorities is that 200,000 gallons shall be given daily from these springs to the cantonments.

The proposal is to sink an open corrugated-iron cylinder, as a pumping sump, round one of the springs in the centre of the pool. A large pumping station is being erected a few yards distant to pump through 9-inch steel tubes, with lead socket joints, to a covered reservoir of 600,000 gallons on the top of the eastern hills overlooking the cantonment.

Distribution of the water from the storage tanks will be by 8-inch steel tube mains to 6 and 4-inch branch mains, feeding subsidiary corrugated-iron tanks for the several units.

The surface of the cantonment area is at present covered with high veldt grass except where there are chert outcrops. There it is stony and bare.

Existing Camps.

The details of temporary camps in and around Pretoria have not been fully examined; those that have possess the same inadequate arrangements for the prevention of soil pollution as elsewhere, and an examination of the records on sanitary matters shows that much difficulty has been experienced on the part of the medical officers to prevent a serious state of pollution, especially in the camps near the railway sidings and barracks on the south of the town. With regard to some of these camps, the reports written as recently as February last state that "properly cemented kitchens, bathhouses, washhouses, and latrines do not exist."

The "Staats Artillerie" barracks are occupied by a battalion of Infantry and by the Head-quarter Staff offices, the former being quartered in the lofts above the stables and in the gunsheds and outhouses, and the latter in the barrack building.

These barracks are two-storied, and solidly built of brick and masonry, much in the style of continental barracks, with small square rooms opening on to corridors, surrounding paved yards.

A system of underground untrapped drains exists. Drains from the old bath rooms and latrines, which have now been removed, appear to have been led to ventilated cesspits about 30 feet from the end of the barracks. Other drains, including stable drains, appear to have discharged into a donga outside the barrack enclosure.

A complete system of drainage, in accordance with the drainage manual, has been planned to replace this old system. These drains will connect with a sewer from the civil hospital and railway establishments and discharge into a septic tank installation, constructed for the civil authorities, on the western side of the town between the cemetery and native location. No irrigation area is dominated, and the effluent will discharge direct into a spruit leading past the location to the Aapies River below the town.

The troops at present occupying these barracks use temporary pail latrines and ablution stands placed outside the barrack enclosure, or within the squares of the gunsheds.

The Head-quarter Staff establishment occupy corrugated-iron huts in the barrack enclosure. Latrines and ablution rooms have been erected for them near the huts.

There is a street of 15 well-built villas for Staats Artillerie Officers outside the barrack enclosure; they are occupied by various Officers at present, and are well adapted for use as Officers' quarters.

The existing water supply for camps connected with the new cantonments is from the open spruit below the Fonteinen Hotel. The hose of the pumps lies on the ground when not in use. Other camps use the town water supply.

Health Statistics.

(a.) *Civil Population.*

Owing to the difficulty of obtaining access to the Government and Municipal Offices during the Easter holidays, the statistics of the civil population have not yet been fully ascertained, but it seemed inadvisable to delay submission of this report until this could be done.

A newspaper note of a report of the Medical Officer of Health for 1902 appeared on the 8th April, 1903; but it was ascertained that the report was not a printed or published report, but had been given in typed form to the correspondent. The report states that the population was 13,108 Europeans and 9,863 natives, or a total of 22,971. The deaths were 279 amongst Europeans, and 207 amongst the coloured population. There were five deaths from diphtheria, 29 from enteric fever, 51 from dysentery, 10 from other "miasmatic" diseases. If these are taken as representing the zymotic diseases of the locality, the following conclusions may be made as regards the vital statistics:—

(1.) General death rate, Europeans, 21·2 per 1,000.

(2.) General death rate, coloured population, 20·9 per 1,000.

(3.) General death rate, total population, 21·1 per 1,000.

(4.) Zymotic death rate, total population, 3·9 per 1,000.

(5.) Percentage zymotic to total deaths, 18·5 per 1000.

These figures indicate a satisfactory condition as regards general mortality, but a somewhat high incidence of the class of diseases which are regarded as preventible by good sanitation.

(b.) *Military Population.*

The table appended gives the principal health statistics of the troops since the declaration of peace. As compared with other garrisons in South Africa, the chief features are:—

(1.) A moderate incidence of enteric and continued fevers.

(2.) A fairly high incidence of dysentery and diarrhœal diseases.

(3.) A moderate incidence of throat affections.

(4.) A moderate incidence of primary venereal affections.

As compared with garrisons elsewhere than in South Africa, the enteric incidence is very high, and the venereal incidence very low. The large number of cases of malarial fever are attributable to the troops coming from the low veldt; and, as they do not indicate any local origin, no comparisons on this point have been made.

Meteorological Records.

Records do not appear to have been kept for any length of time, and the only records which I have obtained are the tables shown in the Appendix. They are taken from the Report of the Medical Officer of Health for the year 1902.

Conclusions.

(1.) The site of the new cantonments is well selected from a sanitary point of view, and affords good prospects of sound methods of disposing of foul matters.

(2.) In this respect it is more favourably situated than most other cantonments in South Africa.

(3.) The chief considerations in connection with drainage will be the flatness of some of the drains, and the maturing of the contact beds. During the process, however, no complaints need be expected, on account of the beds being placed well away from habitations.

(4.) Complaints may be expected in connection with the septic tanks, to which it is intended to carry the Staats Artillerie barrack drainage, during maturing of the beds.

(5.) The arrangements for water supply for the cantonments are good and ample. The chief consideration is adequate protection of the water at its source.

(6.) The siting of units on the cantonment area is good; the wide open spaces between units being a marked feature in the plans.

(7.) In other respects, the general arrangement of hutments, stables, latrines, and other accessories, does not differ from cantonments already reported on; and the sanitary defects of insufficient protection of soil, in and around hutments, from pollution are likely to become prominent questions sooner or later.

(8.) The general sanitary arrangements of the town as regards water supply, removal of waste products, control and supervision over articles of food and drink, house construction, drainage, and arrangements for dealing with infectious disease, fall short of the sanitary requirements of a town of the dimensions of Pretoria. In scarcely any respect are they better than in smaller towns in South Africa.

(9.) The health statistics of the troops show a considerable incidence of preventible disease.

(10.) The health statistics of the civil population indicate a standard of health somewhat higher than in most other South African towns.

(11.) The climate is not so bracing as the climate of other Transvaal stations, but there is nothing in it unfavourable to the maintenance of a high standard of health.

Recommendations.

As regards siting, construction of buildings, stables and accessories of the permanent cantonments, there is little to note beyond the fact that as time goes on the want of measures to protect the soil under and around huts will become an acute sanitary question. Some of the huts too are placed low down on the ground and it will be difficult to ascertain the state of cleanliness or otherwise underneath, and one can only recommend that the raising and concreting under and around huts should be contemplated as a necessary sanitary measure within a year or two, if not done now.

As regards stables the same sanitary question of soil pollution will arise so long as the "dagga" floor system prevails. This form of flooring may be satisfactory in India where stables are placed some distance from barracks and not enclosed as they are here, but with stables in alignment with and in close proximity to barrack huts it is not a sound sanitary system of construction.

As regards proximity of latrines to huts, and placing them as in the Artillery lines in the centre, the conditions would not be satisfactory with an earth or pail system of latrines. It is understood, however, that none of the latrines will be used until a water carriage system is in full working order, and in this case the sanitary objection of proximity of latrines to barracks is not so great.

As regards ablution rooms, an installation of shower baths, as recommended in the report of Bloemfontein, is suggested as being well adapted for the kind of ablution-room construction adopted here. The continental and American systems of shower bath ablution are economical in water, space and time, while they enable men to have a general bath in the most cleanly and sanitary manner; that is to say, in a continuously running stream of clean water.

As regards cookhouses it is recommended that there be wire gauze windows and doors. The prevalence of flies and proximity of stables are the reason for this recommendation.

As regards water supply it is strongly urged that the source should be well protected. The mere sinking of a corrugated-iron cylinder round the spring, in order to form a sump for the pump, is not sufficient. A road with a considerable amount of traffic runs along the edge of the spring, and there is a hotel about 200 yards distant. The sump should be sunk deep down into the earth through which the spring wells, if possible, as far as the rock; but in any case for 6 or 8 feet; and it should be covered with a dust-proof cover.

Apparently no analyses have been made of the water taken direct from this spring. It is recommended that samples should be analysed periodically to ascertain whether the character of the water remains constant, both now and after it has been laid on to the cantonments. No measures of purification are contemplated. They probably are not required, but it is only by periodical analyses that the necessity or otherwise of purification in the barracks or further protection at the source can be determined.

As regards drainage there is nothing special to recommend provided the principles of construction as laid down in the drainage manual are adhered to; but the manual is not much in favour of automatic flushing tanks, because they get out of order.

On this point much improvement has taken place in the type of flushing tanks, and with trough latrines and occasional flat gradients it is strongly recommended that a certain number of these tanks be erected in connection with the drainage system.

As regards disposal of crude sewage by biological treatment, an opportunity is afforded of carefully watching the action of the filter beds on a mixed stable and domestic sewage, under South African atmospheric conditions; and it is strongly recommended that the following points in connection with the maturing and working of the beds be ascertained and recorded:—

(1.) Whether the material used is suitable or not? The cinder, which I saw, was friable and it was only by careful washing that cinder of anything like uniform hardness seemed capable of being obtained.

(2.) The length of time which the filter beds take to mature; that is to say the period that elapses between the first working of the beds and

(*a*.) The commencement of distinct increase in the nitrates and reduction of the oxygen consumed;

(*b*.) The securing of a fully oxidized non-putrescent effluent.

For ascertaining this, the effluent should be analysed at least once a week, and the quantity of ammonia, nitrates, and oxygen consumed, as well as the physical characters noted. When the nitrates show distinct increase and oxygen consumed decreases it may be inferred that the bacteria concerned have begun to act and that maturation will then take place rapidly.

(3.) The reaction of the crude sewage and septic tank effluent should be ascertained.

(4.) The progressive rates of reduction in capacity of the filter beds, and the number of days or weeks from first working or resting till the capacity has been reduced to the minimum working requirements.

In England these filter beds seldom mature in less than 6 weeks with ordinary domestic sewage; sometimes a much longer time is required; but the following points may serve as a guide to those supervising the maturing and working of the biological treatment. (*See* also Appendix A.) :—

(1.) When the sewage is run to the beds for the first time, it is well to give a longer contact and work them with fewer fillings. This should be kept up till signs of bacterial action begin to appear from the chemical analyses.

(2.) If the material appears to crumble away and become too fine, steps should be taken to replace it with hard stone. The hard slate of the locality or possibly basalt rock may be found suitable. The smaller the stone the more rapid and complete will the action of the bacterial beds be, and anything that satisfies the conditions of hardness and smallness so as to give sufficient surface for the adhesion of the bacterial slime will suit.

(3.) It should be recognized that as the capacity of the beds decreases the efficiency of the bacterial action increases. The use of vertical ventilating pipes in the beds will, however, increase efficiency with a smaller decrease in capacity and, if maturing seems to be delayed, it would be well to introduce these pipes.

(4.) A large proportion of stable sewage is apt to affect the development of the bacteria. The sewage should be neutral or slightly alkaline, and it may be found necessary, if maturing of the beds fails to take place within a reasonable time, to lime the sewage. In fact, liming may become a necessary requirement for complete nitrification, and can be effected by a regulated addition of lime water to the sewage as it enters the septic tank, or by mixing a proportion of limestone with the material of the filter beds.

(5.) When the capacity of a bed becomes so reduced as to require attention, the original capacity can be greatly restored by resting the bed for a few days. This should be done systematically once a month, and the arrangement of four beds with 8 hour cycles is intended to admit of one bed resting weekly in rotation. A longer resting period is apt to cause the bed to dry up and the bacterial slime to become inactive.

As regards domination of land for further treatment of the effluent, this is not an important matter in connection with the main tanks near Quagga's Poort; but in the minor systems for the hospital and Royal Engineers' lines, and for the General Officer Commanding's quarters, land should be dominated, irrigated, and cultivated, unless sites sufficiently far from habitations and from streams into which the effluent might discharge, are obtained.

The drainage from transport lines should, if practicable, be passed into the main drainage, otherwise it is likely to be too much of a concentrated animal sewage to admit of proper maturing of the filter beds. If it is found necessary, therefore, to give the drainage from these lines a separate outfall, it would prove more satisfactory to use it for irrigating an area of forage crops, instead of passing it through septic tank and filter beds.

As regards the occupation of the Staats Artillerie barracks, it is recommended that all the internal pipes of the old bathrooms, &c., be removed, and old underground drains, except those for storm water, and cesspits cut off entirely from any possible communication with the buildings.

As regards surroundings, the question of refuse disposal on a suitable site requires decision. It is strongly urged that it should be disposed of in a destructor, unless arrangements can be made for its removal by farmers to farm grounds. In any case, a small destructor should be provided at the septic tanks for incineration of the screenings of the crude sewage.

As regards town sanitation, no recommendations are made which can properly be represented by military authorities; but until water supply, disposal of sewage of all kinds, and general reform in sanitary arrangements for the supply of food and drink are made, soldiers frequenting the town are more likely to contract disease there than in the new cantonments. It must be regarded as an endemic area of enteric fever. In connection with this it should be noted that many prospective improvements and changes are being worked out by the municipal authorities.

As regards the water at present being supplied to construction parties in the new cantonments, it is being pumped into watercarts from a source liable to pollution, and the pumping arrangements are insanitary. This water should not be used for drinking unless it is boiled or otherwise sterilized.

W. G. MACPHERSON, *Lieut.-Colonel*,
R.A.M.C.

PRETORIA,
14*th April*, 1903.

TABLE I.—Principal Health Statistics of the British Troops at Pretoria since the declaration of peace.

Week ending	Average strength.	Sick remaining.	Percentage of sick to average strength.	Admissions for: Enteric fever.	S.C. fever.	Malarial fever.	Dysentery.	Diarrhœa and enteritis.	Sore throat.	Tonsilitis.	Primary syphilis.	Gonorrhœa.	Soft chancre.	Remarks.
1902.														
6th June ..	7499	..	..	..	..	..	..	..	..	..	..	..	..	This does not include the whole of the admissions, as No. 2 and No. 22 General Hospitals were open at Pretoria during these weeks.
13th „ ..	7499	7	0·09	..	..	..	..	..	..	2	..	..	..	
20th „ ..	7499	11	0·14	1	..	..	..	..	..	1	..	..	1	
27th „ ..	7499	53	0·70	..	..	14	..	1	..	1	..	6	1	
4th July ..	5049	157	3·11	1	..	26	1	3	..	3	..	1	..	
11th „ ..	5306	200	3·76	4	..	29	1	..	..	7	..	3	1	
18th „ ..	5999	232	3·86	1	..	33	1	1	..	5	..	..	1	
25th „ ..	5994	231	3·85	2	..	22	..	2	..	6	..	2	..	
1st August ..	5994	255	4·25	..	..	23	..	1	2	9	..	2	..	
8th „ ..	6002	261	4·36	..	..	22	..	1	1	7	..	1	..	
15th „ ..	6011	247	4·11	2	..	15	2	..	..	8	..	3	..	
22nd „ ..	7241	344	4·75	2	..	13	3	2	..	5	..	5	3	
29th „ ..	7812	372	4·76	1	1	8	4	..	..	5	..	8	4	
5th September	8317	348	4·18	..	..	13	4	..	3	12	..	4	3	
12th „ ..	6755	302	4·47	4	1	15	3	3	1	9	1	1	2	
19th „ ..	5715	277	4·84	1	2	4	2	2	..	3	2	4	..	
26th „ ..	6213	292	4·86	3	2	8	5	1	1	7	1	5	2	
3rd October ..	6007	275	4·59	4	3	2	5	3	3	3	1	..	..	
10th „ ..	4554	290	6·36	..	5	3	2	6	1	4	..	2	1	
17th „ ..	4382	285	6·50	2	2	2	1	12	..	12	..	3	..	
24th „ ..	4155	262	6·30	2	2	6	2	8	..	2	..	6	..	
31st „ ..	4103	251	6·11	4	2	6	8	5	..	2	..	3	..	
7th November	4125	280	6·78	5	..	1	4	3	..	5	..	1	..	
14th „ ..	4211	275	6·53	3	..	3	4	6	..	2	..	3	..	
21st „ .	4203	273	6·50	4	..	1	3	4	..	6	..	6	..	
28th „ ..	4076	288	7·06	2	..	3	3	5	..	6	2	5	..	
5th December	4017	352	8·76	3	.	1	5	5	..	1	..	4	1	
12th „ ..	3803	243	6·39	6	..	2	2	5	..	5	2	3	..	
19th „ ..	3632	255	7·02	9	..	4	2	7	..	4	..	8	1	
26th „ ..	4215	248	5·88	1	..	3	..	6	..	2	1	1	1	
1903.														
2nd January ..	4215	278	6·59	6	..	1	..	5	..	..	2	2	..	
9th „ ..	4141	279	6·73	4	..	1	3	6	..	..	..	1	..	
16th „ ..	4186	270	6·45	3	.	4	4	7	..	1	..	3	1	
23rd „ ..	3467	263	7·58	9	..	..	3	5	..	2	..	2	1	
30th „ ..	3453	290	8·39	7	..	..	5	4	1	2	..	3	2	
6th February .	3473	306	8·81	5	..	1	5	4	..	..	..	..	1	
13th „ ..	3599	327	9·36	8	..	..	2	..	1	..	..	5	1	
20th „ ..	3609	348	9·66	2	..	..	..	..	..	1	..	1	..	
27th „	3636	351	9·65	9	..	..	3	1	..	..	..	2	..	
6th March ..	3410	291	8·53	7	..	2	3	3	..	7	..	3	2	
13th „ ..	3377	304	9·00	4	..	..	3	..	..	3	..	..	1	
20th „ ..	3373	293	8·70	7	..	..	2	..	..	2	..	..	2	
27th „ ..	3354	295	8·79	5	..	..	2	..	..	3	..	..	2	
Total ..	215,180	11,061	..	143	20	291	103	127	14	164	14	112	35	
Average strength	5,000	..	Annual admission ratio per 1,000 of average strength.	39·4		..	55·6		43·20		39·0			

TABLE II.—PRETORIA.

Notifications of Infectious Disease for 1902 (from report of Medical Officer of Health).

Disease.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Enteric fever	62	27	28	17	10	2	4	5	5	21	20	43	244
Dysentery	10	4	2	6	8	5	1	1	3	19	13	14	86
Malaria	5	1	2	..	1	..	1	1	1	1	1	2	16
Scarlet fever	..	..	1	3	..	1	2	4	4	6	5	1	27
Puerperal fever	..	..	1	1	..	..	1	1	..	..	..	..	4
Diphtheria	2	5	..	2	5	3	1	3	1	1	2	3	28
Smallpox	..	..	..	..	..	..	..	1	..	..	1	..	2
Chickenpox	1	..	..	1	1	3	7	11	18	11	8	1	62
Erysipelas	..	..	..	..	..	..	..	..	3	1	1	2	7
Leprosy	..	1	..	..	..	..	..	..	..	..	..	..	1
Total	80	38	34	31	25	14	17	27	35	60	51	66	477

TABLE III.—PRETORIA.

Rainfall registered at Government Buildings in 1902, and average rainfall for 10 years from 1892-1901 inclusive (from report of Medical Officer of Health).

Month.	Year 1902.		Average for 10 years.	
	Inches.	Days.	Inches.	Days.
January	4·22	14	6·77	15
February	4·18	14	3·69	10
March	2·25	9	3·11	12
April	1·70	5	0·91	6
May	0·27	2	0·56	3
June	0·01	1	0·19	1
July	0·03	1	0·07	1
August	0·02	1	0·19	2
September	0·33	2	0·18	4
October	2·65	7	1·93	8
November	2·80	12	3·99	12
December	5·78	18	4·35	15
Total	24·24	86	26·94	89

Maximum and Minimum Temperature of Pretoria for the year 1902.

Month.	Maximum.	M. maximum.	Minimum.	M. minimum.	Mean.
January	98·0	85·42	54·0	61·95	73·69
February	97·0	86·96	55·5	59·95	73·45
March	89·0	82·73	33·0	58·65	70·69
April	89·5	80·98	45·0	52·53	66·76
May	84·5	76·85	37·0	44·27	60·56
June	77·0	70·93	29·5	37·82	54·38
July	79·5	73·31	34·0	39·18	56·24
August	83·5	76·10	37·0	43·84	59·97
September	94·0	78·90	39·5	51·07	64·98
October	95·0	82·48	40·0	54·02	68·25
November	95·0	83·33	47·0	58·43	71·88
December..	100·0	85·18	53·5	60·44	72·81

APPENDIX A.

CONDITIONS OF SUCCESSFUL WORKING OF CONTACT BEDS.

(From "Report of Rivers Department, City of Manchester, Treatment of Manchester Sewage." 1902.)

1. The bed should be worked very slowly at first in order to allow it to settle down and the bacterial growths to form. In this way there will be less danger of suspended matter finding its way into the body of the bed, while the material is still loose and open.

2. The burden should not be increased till analysis reveals the presence of surplus oxygen, either dissolved or in the form of nitrates in the effluent.

3. Analyses of the air in the bed may usefully be made from time to time during resting periods.

4. The variations in capacity should be carefully recorded. If the capacity is found to be rapidly decreasing a period of rest should be allowed.

5. Long periods of rest should be avoided during winter as when deprived of the heat of the sewage the activity of the organisms decreases. If necessary the burden on the bed should then be decreased by reducing the number of fillings per day rather that by giving a long rest at one time.

6. The insoluble matter should be retained on the surface by covering, at any rate, a portion of the latter with a layer of finer material not more than 3 inches in depth. The suspended matter thus arrested should not be raked into the bed, but when its amount becomes excessive it should be scraped off. This should be done, if possible, in dry, warm weather after the bed has rested some days. By placing the inlet and outlet penstocks as close together as possible, the suspended matter will tend to concentrate in their vicinity and its removal will be facilitated.

APPENDIX B.

GOVERNMENT NOTICE No. 593 OF 1902.

It is hereby notified that the following regulations for regulating the removal of stable litter, filth and refuse from private houses and for fixing the charges for such removal in the town of Pretoria have been approved by His Excellency the Lieutenant-Governor and are published for general information.

W. H. MOOR,
Assistant Colonial Secretary.

Colonial Secretary's Office, Pretoria,
11*th November*, 1902.

Regulations.

1. The owner or occupier of any dwelling-house, store, shop, workshop or other premises within the Municipality of Pretoria, shall provide or cause to be provided sufficient portable galvanized-iron dust bins of circular shape, provided with lid and handles, or such other suitable receptacles as may be approved of by the Medical Officer of Health or Sanitary Inspector, the cubical capacity of which shall be not more than 5 cubic feet, in which household refuse only shall be deposited. Any owner or occupier neglecting or refusing to provide such portable dust bins or other suitable receptacles as aforesaid within 7 days of receipt of notice from the Chief Sanitary Inspector to that effect shall be deemed to have contravened these regulations and shall be liable to the penalty hereinafter provided.

2. The owner or occupier of any dwelling-house, store, shop, workshop or other premises within the Municipality of Pretoria shall have the household refuse removed therefrom not less than one in every week on a day to be appointed by the Council. Such household refuse shall be placed in the portable dust bins or other suitable receptacles as aforesaid. It shall be kept in the back premises, but as near to the street as possible, and shall only be removed by the servants of the Municipality of Pretoria, and any person other than such servants of the Municipality of Pretoria who shall remove or cause to be removed household refuse from any dwelling-house, store, shop, workshop or other premises as aforesaid, whether such person be the owner or occupier, or person requested or authorized by such owner or occupied to do so, shall be liable on conviction to the penalty hereinafter provided, and it shall be in the option of the Chief Sanitary Inspector of the Municipality of Pretoria to prosecute either such owner or occupier or any person actually removing such household refuse, or any one or all of them for the contravention of these regulations.

Household refuse is hereby defined as cinders, ashes, potato peelings and other vegetable refuse, and kitchen refuse generally; but nothing in these regulations contained shall be constructed to compel any householder to have cinders and ashes removed weekly, or to prevent his accumulating or utilizing cinders and ashes for garden, sanitary, or other purposes.

Stable litter, garden, trade and manufacturing refuse are excluded from the definition of household refuse, and shall not be placed in the household bins to be removed as such.

3. The owner or occupier of any dwelling-house, store, shop, workshop or other premises within the Municipality of Pretoria who shall keep or allow to be kept on his premises horses or cattle of any description shall provide a suitable fixed receptacle of sufficient size for the storage of the stable litter. Such receptacles shall be constructed to the satisfaction of the Medical Officer of Health or Chief Sanitary Inspector. Any owner or occupier neglecting or refusing to provide such receptacle for the storage of stable litter within 14 days of receipt of notice from the Medical Officer of Health or the Chief Sanitary Inspector to that effect shall be deemed to have contravened these regulations or shall be liable to the penality hereinafter provided.

4. The owner or occupier of any dwelling-house, store, shop, workshop or other premises within the Municipality of Pretoria shall have all stable litter, garden, trade and manufacturing refuse removed therefrom as often as may, in the opinion of the Chief Sanitary Inspector, be necessary. Stable litter may, however, with the consent of the Chief Sanitary Inspector and when required for the purpose of manure on the premises, be kept thereon, provided that it shall be kept so as not to be an offence or nuisance to the neighbours or the public.

Every owner or occupier who shall refuse or neglect to have such stable litter, trade, or garden refuse removed within 24 hours after the receipt of written notice to that effect from the Chief Sanitary Inspector shall be deemed to have contravened these regulations and shall be liable to the penalty hereinafter provided.

5. The servants of the Sanitary Department of the Municipality of Pretoria are hereby empowered to enter upon any premises, whether private or public, for the purpose of the removal of household refuse, stable litter, garden, trade and manufacturing refuse therefrom and for the inspection of such premises.

Any person obstructing or hindering such servant of the Sanitary Department in the carrying out or performance of his duties as aforesaid, whether personally or by means of any servant in his employ, or by any dog kept at large or secured in such a manner upon the premises owned or occupied by him as to prevent the carrying out and performance of such duties, or by any other means whatever, shall be liable to the penalty hereinafter provided.

6. The charges to be paid to the Town Council of Pretoria for the removal of such household refuse, stable litter, garden, trade and manufacturing refuse shall be as follows:—

	Per month.			Per quarter.		
	£	*s.*	*d.*	£	*s.*	*d.*
For each portable bin of household refuse removed weekly ..	0	2	0	0	6	0
" " " twice weekly	0	4	0	0	12	0
Daily, except Sundays	0	12	0	1	16	0
Stable litter, trade and garden refuse, per Scotch cart load, weekly	0	10	0	1	10	0
Per Scotch cart load, twice weekly	1	0	0	3	0	0
Daily, except Sundays	3	0	0	9	0	0
Per wagon load, weekly..	2	0	0	6	0	0
" " twice weekly	2	0	0	12	0	0
" " daily, except Sundays	12	0	0	36	0	0

Odd loads of rubbish, 2*s.* 6*d.* per Scotch cart load, 10*s.* per wagon load. Such charges shall be paid monthly in advance at the offices of the Town Council during the ordinary business hours by the occupier of the premises; and in the event of the occupier neglecting or failing to pay such charges, the Town Council are hereby empowered to proceed against the owner or occupier of the premises, or both in one and the same action for recovery of the amount due; the owner, however, being hereby empowered to recover from the occupier any sum due by such occupier which such owner may have been called upon to pay, and the occupier in like manner being empowered to recover from the owner any amount owing prior to his occupation of the premises which such occupier may have been called upon to pay.

7. All persons who shall themselves elect to remove their own garden, trade or manufacturing refuse shall only deposit such refuse at such sites as may from time to time be appointed by the Council, the whereabouts of which may be ascertained on application to the Chief Sanitary Inspector.

Any person found depositing or throwing rubbish of any kind in any public street or place, or at any spot not authorized by the Council, shall be deemed to have contravened these regulations, and shall be liable to the penalty hereinafter provided.

8. Every person found guilty of the contravention of any of the foregoing regulations shall be liable for each offence to a penalty not exceeding 10*l.*, and in default of payment thereof to a term of imprisonment not exceeding 1 month.

9. These regulations shall take the place of and supersede Section 64 of the Bye-Laws or Regulations for the Municipality of Pretoria, approved by His Excellency the Administrator of the Transvaal, and published under Government Notice No. 296 of 1902, with the exception of that portion of the said section relative to the removal of the carcases of dead animals.

SANITARY COMPLAINTS.

Complaints regarding non-removal of rubbish or nightsoil should be addressed in writing to the Chief Sanitary Inspector, and in the case of the latter should be made before 4 o'clock p.m. to ensure attention the same night.

DEAD ANIMALS.

The charges for the removal and burial of carcases are as follows:—

Carcases of a horse, mule, bullock or cow, 10*s*. each.
„ of a sheep, goat, calf or dog, 5*s*. each.
„ of any smaller animal, 2*s*. each.

On Sundays reports of carcases requiring removal should be made in writing, giving name and address in full, to the Sanitary Inspector, Sanitary Stables, Bloed Street.

APPENDIX C.

GOVERNMENT NOTICE No. 349 OF 1902.

(Published in No. 141 of the "Government Gazette," on the 1st of August, 1902.)

Bye-laws or Regulations.

For regulating the removal of nightsoil from private premises and public places, and for fixing charges for such removal.

Prepared in accordance with Section 19, Sub-section 14 and Section 37 of Proclamation Transvaal, No. 7 of 1902.

1. The owner or occupier of any dwelling house, store, shop, workshop, or other premises within the Municipality of Pretoria, shall have the nightsoil removed therefrom not less than twice weekly during the winter months (April to September inclusive), and not less than three times weekly during the summer months (October to March inclusive).

Such nightsoil shall only be removed by the Municipality of Pretoria, and any person other than such servants of the Municipality of Pretoria who shall remove, or cause to be removed, nightsoil from any dwelling house, store, shop, workshop or other premises as aforesaid, whether such person be the owner or occupier, or person requested or authorized by such owner or occupier to do so, shall be liable on conviction to the penalty hereinafter provided, and it shall be in the option of the Chief Sanitary Inspector of the Municipality of Pretoria to prosecute either such owner or occupier, or any person actually removing such nightsoil, or any one or all of them for the contravention of these regulations.

2. The servants of the Sanitary Department of the Municipality of Pretoria are hereby empowered to enter upon any premises, whether private or public, for the purposes of the removal of nightsoil therefrom, and for the inspection of such premises.

Any person obstructing or hindering such servant of the Sanitary Department in the carrying out or performance of his duties as aforesaid, whether personally, or by means of any servant in his employ, or by any dog kept at large, or secured in such a manner upon the premises owned or occupied by him as to prevent the carrying out and performance of such duties, or by any other means whatever, shall be deemed to have contravened those regulations, and shall be liable to the penalty hereinafter provided.

3. The charges to be paid to the Town Council of Pretoria for the removal of such nightsoil shall not exceed the following:—

	Per month.	Per quarter.
	£ s. d.	£ s. d.
For each pail removed by ordinary service (bi-weekly in winter, tri-weekly in summer).	0 7 6	1 2 6
For each pail removed by special service (daily)	0 17 6	2 12 6

Such charges shall be paid monthly or quarterly in advance at the offices of the Town Council during the ordinary business hours by the occupier of the premises, and in the event of the occupier neglecting or failing to pay such charges, the Town Council are hereby empowered to proceed against the owner or occupier of the premises, or both, in one and the same action for recovery of the amount due; the owner, however, being hereby empowered to recover from the occupier any sum due by such occupier which such owner may have been called upon to pay, and the occupier in like manner being hereby empowered to recover from the owner any amount owing prior to his occupation of the premises which such occupier may have been called upon to pay.

4. Notwithstanding that he may have paid the charges for an ordinary service as laid down in the last preceding section, the occupier of any dwelling house, shop, store or workshop, or other premises within the Municipality of Pretoria, or failing him, the owner thereof, shall, whenever the Chief Sanitary Inspector or authorized official is of opinion that the contents of the sanitary pail of his premises are such as to require immediate removal, and after written notice to that effect, take out a special service ticket at the Town Treasurer's office before 4 p.m., of the day on which the notice is served, for the removal of the pail in question by special service that night, and shall pay for such special service the sum of 2*s*. 6*d*. And if such occupier, or failing him, the owner as aforesaid, shall refuse or neglect to take out such special service ticket, he shall be deemed to have contravened these regulations and shall be liable to the penalty hereinafter provided.

5. Every person found guilty of the contravention of any of the foregoing regulations shall be liable for each offence to a penalty not exceeding 10*l*., and in default of payment thereof, to a term of imprisonment not exceeding 1 month.

6. These regulations shall be read as part of the bye-laws or regulations for the Municipality of Pretoria, approved of by His Excellency the Administrator of the Transvaal and published under Government Notice No. 296 of 1902.

REPORT ON PROPOSED CANTONMENTS AT MIDDELBURG, CAPE COLONY.

It is understood that the construction of the cantonment is to be on a basis of 5 years' occupation, and that, as far as possible, the material for hutments is to be obtained from old hut encampments in the Cape Peninsula and Deelfontein. It is also understood that the strength will be about 5,400 troops and about 3,000 animals. With the addition of families, native followers, &c., the population on the site is likely to be between 6,000 and 7,000.

In my previous report on Middelburg, the general features of the locality, as affecting the probable health of a cantonment there, were noted. They need not be repeated now, and this report is accordingly confined to the main sanitary considerations of the present cantonment proposals. But I would again draw attention to the necessity of sanitary reform amongst the neighbouring civil population.

I.—Water Supply.

A quantity, not less than 200,000 gallons daily, must be secured. Each of the bore-holes already sunk in the valley above Grootfontein Poort yields apparently 40,000 gallons daily. The water is obtained from a gravel formation. From the character of the strata it is evident that the formation is that of a large river or lake bed running down the valley to the poort. The strata on this area above the gravel are apparently of recent formation, and merely silt and thin deposits of sandstone and lime. The formation of the banks on either side are marked by distinct strata of underlying sandstone similar to outcrops on neighbouring kopjes. A good and abundant water supply can undoubtedly be obtained from the gravel formation, but the recent deposits overlying it cannot be depended on to purify water soaking into it so much as the solid sandstone, which is the old formation on either side, and which no doubt will also be found below the gravel.

The recommendations, therefore, are:—

(1.) That no encampments or other habitations should be allowed on or near this water-bearing area. It is unfortunate that an Artillery encampment has been formed near it. A warning on this point was given in my original report, and it would be advisable to prepare the permanent Artillery cantonment first, in order that early removal from this site may be facilitated.

(2.) That the water from the bore-holes should be periodically analysed to determine whether it is organically pure, and whether it is liable to variation indicating intermittent or other contamination. In other words, the water-bearing area should be safeguarded in every possible way until more is known about it by means of these periodical analyses.

As regards extension of bore-holes to obtain the required quantity of water, it is recommended that they be sunk as far away as possible from the lines of roads and traffic, preferably to the east, and that they should all be in the valley above the Grootfontein Poort and not in the area below it, where it is proposed to place the cantonments.

A consideration in connection with a water supply from bores above the Grootfontein Poort is the possible effect that the pumping of 200,000 gallons daily will have on the existing springs and on contemplated irrigation arrangements. Should the springs diminish and irrigation be interfered with, it is recommended that water be obtained from bore-holes sunk, not in the gravel and old river bed, but into the solid sandstone formations, well to the east or south-east of the spring-bearing areas.

It is stated that the water in some of the bores contains sulphuretted hydrogen. This will rapidly disappear on exposure to air, and need not interfere with the use of the water subsequently.

2.—Siting and Drainage.

The points to be considered in determining the siting of cantonments are:—

(1.) Placing the units on slopes with sufficient fall to give self-cleansing gradients for the immediate removal of foul water, and for a possible future water-carriage system of sewage disposal.

(2.) The necessity of placing them on or near ground which can be irrigated and cultivated with a view to diminishing dust.

The proposed siting of the Infantry units between the site of the present hospital and Royal Engineers camp meets both these requirements, although the water for irrigation will have to be obtained from the pumped supply.

The drainage from this site should be carried to the ground occupied at present by the Mounted Infantry or 16th Lancers, or, better still, across the road to the neighbourhood of the present Artillery or transport lines, where there is a good soil for efficient irrigation and cultivation with subsequent drainage into the donga, which is the natural drain of the area.

The proposed site of the mounted units, and married quarters, while admirably meeting the second requirement, seems too flat, and does not appear well adapted for rapid removal of sewage by means of a water-carriage system.

It would be a great mistake to adopt a site in which this cannot be readily carried out in the event of a more prolonged occupation of the cantonment than that contemplated at present. It may be that the site is not so flat as it appears, and that sufficient slope can be obtained to meet the requirements of the "Drainage Manual"; but, if there is any doubt on this point, it is strongly recommended that the proposed siting be altered and the units carried further up the natural slope of the ground. An installation of septic tank and single-contact filter beds should be contemplated as an outfall of any system of foul drainage containing sewage, with subsequent irrigation of the effluent over cultivated land. The tanks and land need not be placed more than 300 yards from the nearest unit, if they are properly managed, and they should dominate about 10 acres of irrigation land for both Infantry and mounted branches sites.

3.—The Prevention of Soil Pollution.

This is a matter just as important as the prevention of water pollution. In a way it is of more importance, because a polluted water can be purified, a polluted soil cannot, or at any rate not so readily. It may also be taken as an axiom that the amount of risk to health from soil pollution is in direct proportion to the number of inhabitants on the site, and the length of time the site is occupied, unless recognized principles of town sanitation are adhered to.

We have here a contemplated population greater than that of most towns in South Africa, with a comparatively long period of occupation, and on a soil readily carried about as dust.

The sanitary indications, therefore, distinctly point to the necessity of making careful provision for immediate removal of waste products, and for the maintenance of cleanliness of surface under and around the hutments.

The following recommendations are consequently made:—

(1.) The height between floors of occupied huts should be such as to enable all parts of the surface underneath to be readily examined and readily accessible.

(2.) The surface underneath should be prepared and channelled to surface drains. Concrete is the best material for this purpose, and money is well spent in concreting the surface under and around the huts. But if other material is available which will enable the surface to be kept clean and free from moisture and rank vegetation, there is no objection to its being used, in view of the fact that the contemplated occupation is for 5 years only. If the hutments are to be occupied longer, concreting alone is recommended.

(3.) All surfaces likely to be directly polluted with foul matter, such as floors of latrines, ablution rooms, and kitchens should be prepared as smooth concrete floors, channelled to concrete drains or sumps. The floors of stables should be similarly constructed, or, at any rate, so prepared that constant soakage of organic matter into the soil is avoided.

4.—Prevention of Dust.

The area is extremely dusty and liable to constant dust storms. To avoid the inconvenience of these as much as possible it is recommended that :—

(1.) Roadways should be made and covered with good hard ballast. There is a quarry of disintegrated basalt at Naauwpoort Station. This is the best road material to use, as it does not crumble into dust so readily as the sandstone and shale of the locality. No doubt a similar ballast can be found near the site of the cantonment.

(2.) As much of the area as possible surrounding and between units and between roadways should be irrigated and planted with trees or cultivated. The necessity of this is very great at Middelburg. For this reason, one might be prepared to sacrifice something in the way of better slope in order to obtain better irrigation and cultivation.

5.—Construction and Siting of Huts, &c.

The proposed area of each unit is about 50 acres. This is ample. The proposed distance between units is from 100 to 200 yards. This is also ample, and if necessary could be lessened, but it is advantageous to keep a belt of this width between units, provided it can be kept cultivated, otherwise it is better to have only the distance given by a good broad roadway in order to avoid the dust that would arise from a belt of uncultivated ground, constantly traversed by men and animals.

The proposed distance between huts is from 75 to 100 feet. This, too, is ample, and better than that given in cantonments elsewhere, where the average distance is about 35 feet end to end, and 50 feet line to line. If necessary the huts might be placed with these shorter distances between them in order to avoid an unnecessary length of drainage, but the shorter distances quoted should be regarded as a minimum.

The proposed distance of stables from men's huts is about 100 yards. In other cantonments the distance is from 20 to 40 yards. The 100 yards distance is far preferable, and will admit of less elaborate pavement and construction of stables.

The proposed latrines are placed well outside the line of hutments. This is their correct place, especially where there is a cart-removal system of latrine contents. The object in such a case should be to place the latrines in positions which are accessible to filth carts without their going through or near the hutment lines, and which are far enough from cookhouses to prevent latrine flies migrating from one to the other. A distance of 100 feet from the nearest hut is a suitable minimum, although in other cantonments they are placed as near as 60 feet.

The aspect of the huts should be north to north-east, with verandahs on both sides, for the hospital at any rate. Single verandahs should be placed on the north to north-east aspect, and verandahs ought to be lined with match-boarding to prevent over-heating of the air entering the barrackroom.

With regard to the proposal to utilize old huts from Green Point and Deelfontein, the following sanitary considerations should be attended to :—

(1.) The huts should be lined with new match-boarding. The old match-boarding of hospital huts and Boer prisoners' huts are likely to be full of organic matter.

(2.) The flooring should be caulked if practicable. Otherwise, judging by the flooring seen in Deelfontein huts erected at the present hospital, it seems impossible to prevent scourings from the huts accumulating on the surface beneath, unless the surface is well concreted and channelled.

(3.) So far as the plans go the old huts are in need of proper ventilation apertures. Ridge ventilation, which is the best for these corrugated-iron huts, as well as other ventilating apertures, have been objected to because they admit dust. With proper roadways, plantations and cultivated ground around, this objection should be reduced to a minimum, and for barrackroom huts, ridge ventilation cannot well be abandoned, otherwise the air in them is apt to become very foul during the night, especially in the cold weather when the men shut the windows. It was suggested that ventilation would take place through the flooring. This is wholly inadmissible for two reasons :—

(*a.*) The floors should not be so open as to admit air in any quantity, and for the very reasons that suggest their being caulked.

(*b.*) The floor apertures cannot be regarded as outlets for foul air.

(4.) The number of huts should be sufficient to allow the men separate dining huts.

(5.) The hospital should be constructed for 7 per cent. of strength, with sufficient area to allow of expansion by tents to 10 per cent. Provision should be made for hospital treatment of Officers, women and children, for native followers and for isolation of infectious diseases. There is ample space for this on or near the proposed hospital site.

(6.) As regards old hospital huts, plans exist of huts with an ablution room opening direct into the ward. This form of construction must be avoided.

It is impossible without detailed plans and levels to indicate more precisely the sanitary requirements of these cantonments, but the recommendations, in light of the existing plans and proposals, may be summarized as follows :—

1. A water supply of 200,000 gallons daily from bores in the valley north and north-east of Grootfontein Poort.

2. Periodical analyses of the water from bores in the gravel of the lower portion of this basin.

3. Abandonment of water supply from bores in the cantonment area itself.

4. Watching effect of this supply on springs supplying water for irrigation purposes.

5. Subsequent borings at spots not likely to effect these springs, should they fail to give a sufficient supply for trees and cultivation of the soil around the units.

6. Siting of huts on slopes that will admit either now or subsequently of a water-carriage system of sewage disposal—

(*a.*) By self-cleansing pipes, as laid down in the Drainage Manual.

(*b.*) By an outfall into septic tanks and filter-beds at a distance of not less than 300 yards from the nearest hutments.

(*c.*) By irrigating with the filter-bed effluent, an arable area of land equal to 10 acres for the mounted units, and 10 for the Infantry units.

7. Prevention of soil pollution :—

(*a.*) By surface drains.

(*b.*) By concreting and channelling floors and surroundings of all surfaces liable to pollution with foul matter such as latrines, ablution rooms and cookhouses.

(*c.*) By keeping the ground under and around huts clean and free from accumulation of moisture and organic matter.

(*d.*) By preparing, channelling and draining floors in and around stables and water troughs, so as to prevent soakage of stable urine, &c., into the soil.

8. Minimizing dust :—

(*a.*) By roadways covered with a ballast of hard material such as disintegrated basalt.

(*b.*) By planting trees and cultivating spaces between units and other suitable spaces within or around the unit areas.

9. Siting of huts with a north or north-east aspect, and maintenance of the proposed distance between barrack hut and barrack hut, between huts and stables, and between latrines and huts.

10. Provision of ridge ventilation and matchboard lining for the barrack huts, and caulking of barrack hut floors, or, at any rate, of hospital hut floors. (Covering the floors with linoleum may take the place of caulking.)

11. Provision of verandah on both sides of hospital huts, and on the north-east or north aspect of soldiers' huts.

12. Provision of dining huts.

13. Provision of hospital accommodation for Officers, women and children, and for native followers.

Finally it is strongly urged that the first works undertaken and completed should be those required to lay on a pure water supply to the sites, to remove foul matter and to prevent pollution of soil. The completion of the soldiers' huts should follow, not precede, these, otherwise there is a great temptation to occupy huts before the cantonment is sanitarily ready to receive troops. Hitherto the completion of the barrack hut seems to have had priority.

It is also strongly urged that no fresh troops be brought to this area until the cantonments are ready for them. It is better to occupy camps at Naauwpoort for example than to add to the accumulation of encampments in the neighbourhood of the proposed cantonment.

As the preparation of plans and the construction of cantonments progress, the Officer Commanding Royal Engineers and the Senior Medical Officer should keep in close touch with one another to avoid want of attention to sanitary details, as good work may be spoiled by omission of some small but important sanitary point that can be readily rectified in course of construction.

No special recommendations have been made regarding accommodation for native labourers, servants, or followers in or near the cantonments, because the same strict sanitary measures as regards latrines, and prevention of soil pollution are as necessary (in a sense even more necessary) in connection with a Kaffir location as in connection with the hutment of British troops. Overcrowding in these locations is a point which requires to be specially considered. The air space should be at least 400 cubic feet per head in the native huts.

Other recommendations such as the destruction of refuse in a destructor have also been omitted. Such recommendations will be more properly raised as general questions, which it is proposed to submit later in the form of a summary of the sanitary requirements of garrisons in South Africa.

W. G. MACPHERSON, *Lieut.-Colonel,*
R.A.M.C.

MIDDELBURG, CAPE COLONY,
27th April, 1903.

REPORT ON MILITARY CAMPS AT STELLENBOSCH.

These camps were visited on the 1st May, 1903, at the request of the Principal Medical Officer, Cape Colony District, in order to determine the necessity or otherwise of evacuating the locality from a sanitary point of view. The average strength of troops in these camps since the close of the war to the present date is 1,678, and the admissions for enteric fever during the period 144, all of which have occurred since November, 1902. This represents an annual admission ratio per thousand of strength of 92·9. This is the highest admission ratio, with the exception of Potchefstroom, in any garrison in South Africa since the close of the war. The evidence of the past sanitary condition of the camps shows that the essential requirements of all standing camps have not been adhered to, to the extent necessary for the prevention of diseases of this kind so far as removal of waste products, sanitary organization generally, and prevention of water and soil pollution are concerned.

Under such circumstances the outbreak of enteric fever was inevitable, and the state of soil pollution is now so great that it is difficult to select on the farms rented by Government any ideal spot for encampments. It is, therefore, strongly recommended that the locality be evacuated as early as possible. At the same time it is equally strongly recommended that the units there be not sent to camps elsewhere until the camps are sanitarily ready to receive them, that is to say, until latrines, cookhouses and ablution rooms are prepared in such a way as to avoid polluting the ground with foul matter and refuse, and until proper arrangements are made for laying on a pure water supply or for purifying a supply of doubtful quality, and for the removal, according to sanitary methods, of all waste products. Should it be necessary on account of military or other considerations to retain troops even temporarily on these sites it is recommended that the following sanitary points be attended to:—

1.—Water Supply.

(1.) The water from the bore holes only should be used for drinking, cooking and ablution. The spruit water is liable to pollution at its intake and above its intake, as well as in the storage reservoir, which is open on all sides to pollution by dust from large deposits of manure, horse kraals and isolation horse kraals in its immediate neighbourhood. The "vlei" water is liable to pollution from the drainage of foul ground whenever the rains come on.

(2.) Examination of the pipes conveying the water to distribution tanks is necessary. Many of the joints above ground are leaking and the underground pipes pass in some sections below camps and old trench latrines.

(3.) Analysis of the water at its source and at the points of distribution is necessary in order to obtain some precise information as to the sources of contamination between these points. The analyses made so far are of no value practically in this respect.

(4.) Precise information is necessary regarding the strata through which the bore holes are sunk and the depth of each. Otherwise it is impossible to interpret accurately the results of analyses of water at its source.

(5.) Purification of water by boiling or sterilizing filters in sufficient quantity to give each man about 1 gallon of water daily under regimental organization. At present this is not being done, in the camp of the 2nd Dragoons at any rate.

(6.) Purification of watercarts by boiling water instead of by Condy's fluid. The latter will not destroy specific germs of enteric fever.

2.—REMOVAL OF WASTE PRODUCTS.

(1.) All waste products should be burnt on the spot or removed to a distance from the camps; at present only the contents of latrine pails and urine pails are systematically removed. Stable litter is removed regimentally to a short distance from camps, and kitchen refuse is thrown into pits close to the kitchen. Ablution water is discharged on to the ground or into earth channels.

(2.) The method of removal of waste products requires to be of a higher standard. Urine is removed in wooden barrels and latrine pails with their contents in open carts. The contractor should be obliged to supply for this purpose properly constructed sanitary carts, such as the tank and tumbril cart.

3.—PREVENTION OF SOIL POLLUTION.

(1.) The surface soil forming the floors of latrines, ablution rooms and cookhouses should be cemented and channelled to sumps, or at any rate formed of some hard material which can be kept clean and which will admit of little or no soakage of organic matter from these places into the soil.

(2.) The foul water from ablution rooms, &c., should be conveyed to definitely marked-off irrigation areas, preferably areas where there are trees or cultivation.

(3.) Slabs should be arranged for night urine pails along the lines of tents.

4.—SITING AND ARRANGEMENT OF CAMPS.

(1.) The sites have been so generally fouled that it is difficult to suggest better ground than that occupied unless it be the ground covered by scrub on the slopes above both the Infantry and Cavalry camps. As regards the latter, however, there are old latrine pits, one or two of which are still open, about ½ mile up the slope. These will have to be avoided so that during the rains the contents of the pits are not washed down to the camp site.

(2.) The bell tents should not contain more than four men each in a standing camp in time of peace, and they should be spread out as much as the available ground permits. Otherwise the men are very liable to considerable sickness from sore throats and the spread of contagious or infectious diseases, such as enteric fever, is greatly increased. At any rate, this is the experience of camps elsewhere.

(3.) Dining tents should be provided for the men. At present they have only their bell tents or open air for dining in.

In conclusion it may be remarked that a definite and intelligent sanitary organization is essential to the maintenance of health of troops in these or any other camps, and the want of this in the past at Stellenbosch has made it impossible to predict any higher standard of health there in the future without going to great expense.

W. G. MACPHERSON, *Lieut.-Colonel,*
R.A.M.C.

CAPE TOWN,
4th May, 1903.

From Lieut.-Colonel W. G. Macpherson, R.A.M.C., to the Principal Medical Officer, South Africa.

Cape Town,
4th May, 1903.

ir,

I have the honour to report that I visited the Tuberculosis Sanatorium at Abram's Kraal, Thaba N'chu, in accordance with your instructions, on the 23rd and 24th April, 1903.

The site of the sanatorium is on an open treeless farm about 4 miles distant from Thaba N'chu Railway Station by a fair carriage road, the main road from Thaba N'chu to Winburg.

It is at an altitude of about 5,000 feet above sea level, and for a considerable portion of the year, especially during the dry winter season, the climatic conditions are, to some extent, those of Davos Platz, *i.e.*, constant sunshine, high altitudes and great dryness of atmosphere. It is not likely, however, to have such great stillness of air, or freedom from dust.

On the days, however, on which I visited the farm, the climatic conditions were perfect for the treatment of tubercular disease, and superior to those of Bloemfontein where the altitude is not so great, the population more dense, and the dust more constant.

As regards the general arrangements, the patients, 10 in number, were accommodated in six E.P. tents and fairly comfortable. The sanitary arrangements for so small a population were sufficient, but would be inadequate for any larger sanatorium than that contemplated.

The water supply is also adequate in so far that its purification for this number of patients can be thoroughly supervised and carried out to a sufficiently large extent by means of the Berkefeld Field Service Filter, but for any larger population it would be necessary to sink bore holes in the sandstone formation, and pump to proper storage and distribution tanks.

One favourable feature in the treatment of the patients is the fact that all the milk used by them is obtained direct from cows kept on the farm, and milked under strict sanitary conditions.

The patients appeared to be doing well, and the conditions of rest, mental and physical, as well as the constant sunshine and dryness, are likely to be beneficial.

The chief consideration at present seems the likelihood of life becoming extremely monotonous, and a proper supply of books and games is much needed.

In the event of a large number of patients being kept at this sanatorium, proper contracts should be entered into for the removal of waste products, proper latrines and ablution rooms should be constructed, and a destructor should be provided for the incineration of ward and kitchen refuse. Otherwise the surroundings of the sanatorium are likely to become foul in the course of time.

W. G. MACPHERSON, *Lieut.-Colonel,*
R.A.M.C.