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REPORT

P. 7712

ON THE PREVALENCE OF

fever

ENTERIC FEVER

IN THE

G. L. Barracks

ROYAL BARRACKS, DUBLIN.

Presented to both Houses of Parliament by Command of Her Majesty.



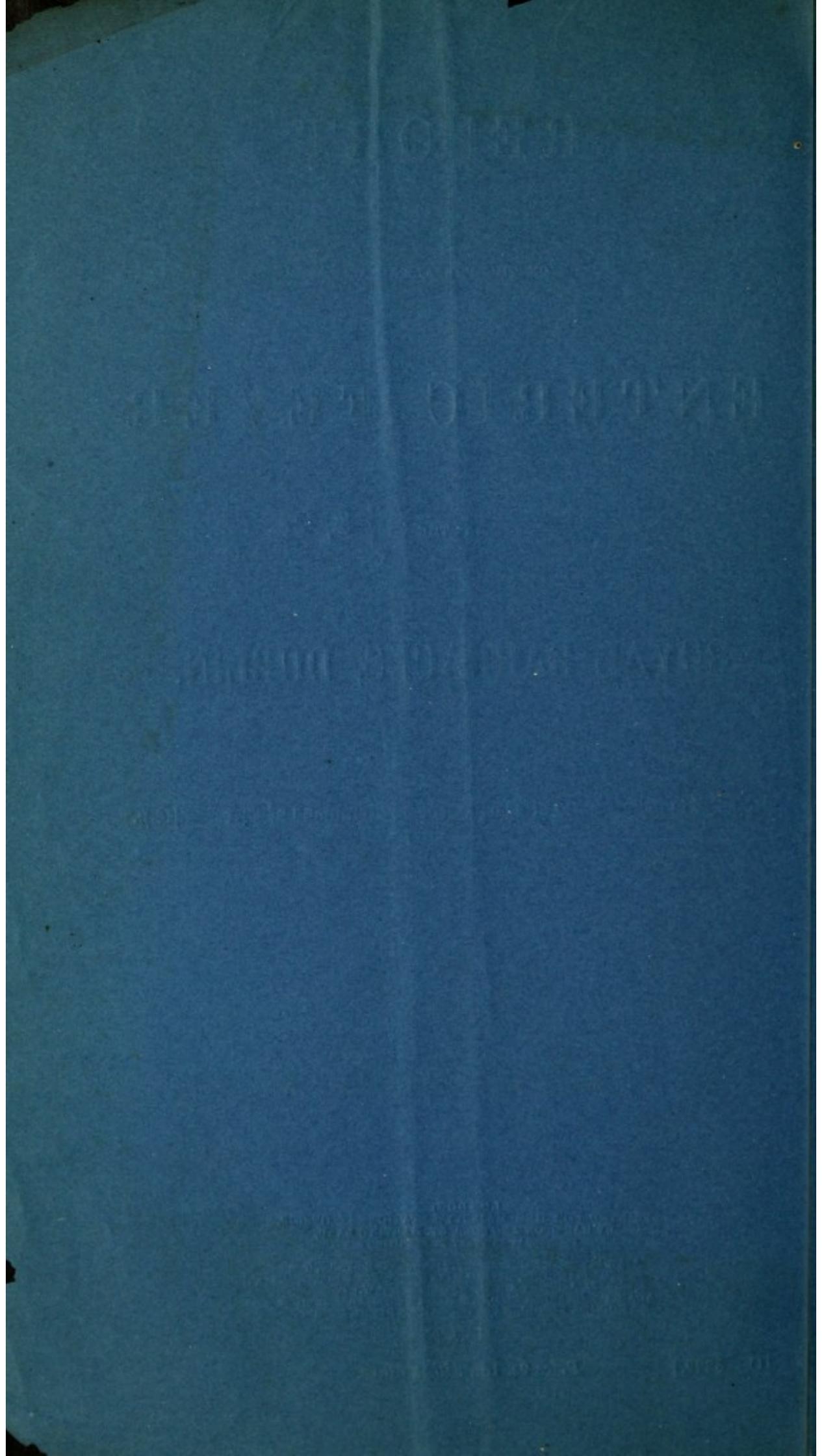
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REPORT

OF THE

ROYAL COMMISSION

ROYAL BARRACKS, DUBLIN

Dublin 16. (Wt. 22942 1625 2 | 88-H & S 1210.)
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Printed by the Government Printer, Dublin, 1888.



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Report on the Prevalence of Enteric Fever in the Royal Barracks, Dublin.

Dublin, 23rd November, 1887.

Sir,

In accordance with your letter of 26th May, 1887, enclosing a communication from Lieut.-General Sir Lothian Nicholson, K.C.B., of the War Office, dated 16th May, 1887, we beg to report, for the information of the Secretary of State for War, that we have carefully considered the circumstances connected with the prevalence of enteric fever in the Royal Barracks, from January 1879, to October 1887, so far as can be now ascertained.

During the inquiry we have paid frequent visits to the Royal Barracks, and have obtained every assistance, not only from yourself, but also from Colonel Slacke, R.E., the Royal Engineer in charge of the Dublin District; Colonel Frazer, R.E., C.M.G., in charge of the Royal Barracks; Surgeon-General Hassard, the Principal Medical Officer in Ireland; Deputy Surgeon-General Webb, and Dr. Large, Surgeon in charge of the barracks.

We have had before us various correspondence upon the question of the prevalence of enteric fever in the Royal and other Barracks in Dublin, and the general sanitary condition of the Royal Barracks, and plans of the drains and buildings of the barracks and adjoining premises in Arbour Hill.

It is necessary here to consider the question of the prevalence of enteric fever, not only from the special point as to the probable cause of the particular cases of fever brought under our notice, but also with reference to the many predisposing and originating causes of enteric fever which may exist in buildings so situated and so constructed as the Royal Barracks are.

It is necessary to include the adjoining premises in Arbour Hill as portions of the buildings to be considered.

I.—SITE OF BARRACKS.

1. Looking at the barracks and its adjoining premises in Arbour Hill from a general point of view, it is favourably situated, being built on a site sloping towards the south, well exposed to air and sun. These advantages, however, have not been availed of to their fullest extent, as the buildings have been badly distributed, especially in the Royal Barracks proper—a question to be considered in detail further on. Barracks rather favourably situated.

2. The geological structure of the site upon which the barracks stand possesses some peculiarities which are of considerable importance when discussing questions connected with the health of the occupants of the buildings. Geological structure.

The valley in which Dublin stands has some geological features likely to affect the health of its inhabitants. The Dublin district generally stands on the "boulder clay" of the "glacial drift," which is one impervious stratum. There is, however, in the centre of the city of Dublin, extending along the valley of the Liffey, a gravel bed formed by an old raised sea-beach: this gravel lies on the "boulder clay" before mentioned—the latter clay being an impervious stratum, the gravel a very pervious one. Gravel bed along valley of Liffey.

As the ground rises on each side of the Liffey, the gravel is found at the bottom and the clay on the higher sides of the valley. The result is that the drainage on the higher levels of the valley tends to run off the clay and accumulate in the gravel bed at the lower level. It necessarily follows that

the gravel receives not only the sewage and drainage proper to its own area, but also that of the clay above

Influence of gravel bed on drainage.

It so happens that the Royal Barracks are partly situated on the clay and partly on the gravel, and therefore all drainage not carried off by proper sewers and drains for that part situated on the clay tends to flow down towards the south and accumulate in the gravel.

In terracing the ground to accommodate the buildings of the barracks, retaining walls had to be constructed; the dampness of these walls shows that a considerable amount of water is always passing from the higher to the lower ground, and thus must ultimately find its way into the gravel bed below.

Thus, while the aspect of the barracks is good, its site, from a geological point of view, is defective, and therefore the drainage arrangements require special attention to make the site a healthy one.

Surroundings of barracks.

The surroundings of the barracks are on the whole not unsatisfactory. On the north it is bounded by the Arbour Hill premises, which are a sort of off-shoot of the barracks, and beyond them to the north lie open fields. On the south there is the Esplanade, and beyond it the quays and the river Liffey.

Boundaries.

This large open space in front, were it not for the effluvia from the Liffey (which cannot be considered advantageous), certainly is conducive to healthiness. A small portion of the eastern side abuts on a crowded neighbourhood, a portion of Barrack Street, containing tenement houses; the remainder is bounded by the open grounds of the King's Hospital (Bluecoat School) and a disused iron works. On the west a small portion is bounded by tenement houses of a rather inferior description, situated in Temple Street West, the rears of which abut on the boundary wall of the barracks.

We visited and carefully examined these houses, and could not find any conditions calculated to affect the health of the inmates of the barracks; in fact, these houses had, within the last twelve months, been carefully looked after by the sanitary authority of the city, and, although old and dilapidated, were in a better sanitary condition than such houses are usually found.

It is right here to state that cases of enteric fever took place in these houses, and that a death occurred in the person of an inmate of No. 7, Temple Street West, which is adjacent to the cavalry mess-room and the latrines used by the cavalry officers, their mess servants, and the women and children of the cavalry quarters.

The remainder of the western side of the barracks is bounded by the public streets, and has not any tenement houses adjoining it.

II.—THE PLAN AND STRUCTURE OF THE BUILDINGS.

Distribution of buildings.

The distribution of the buildings of the Royal Barracks over the site is somewhat peculiar, and by no means conducive to the health of the inmates.

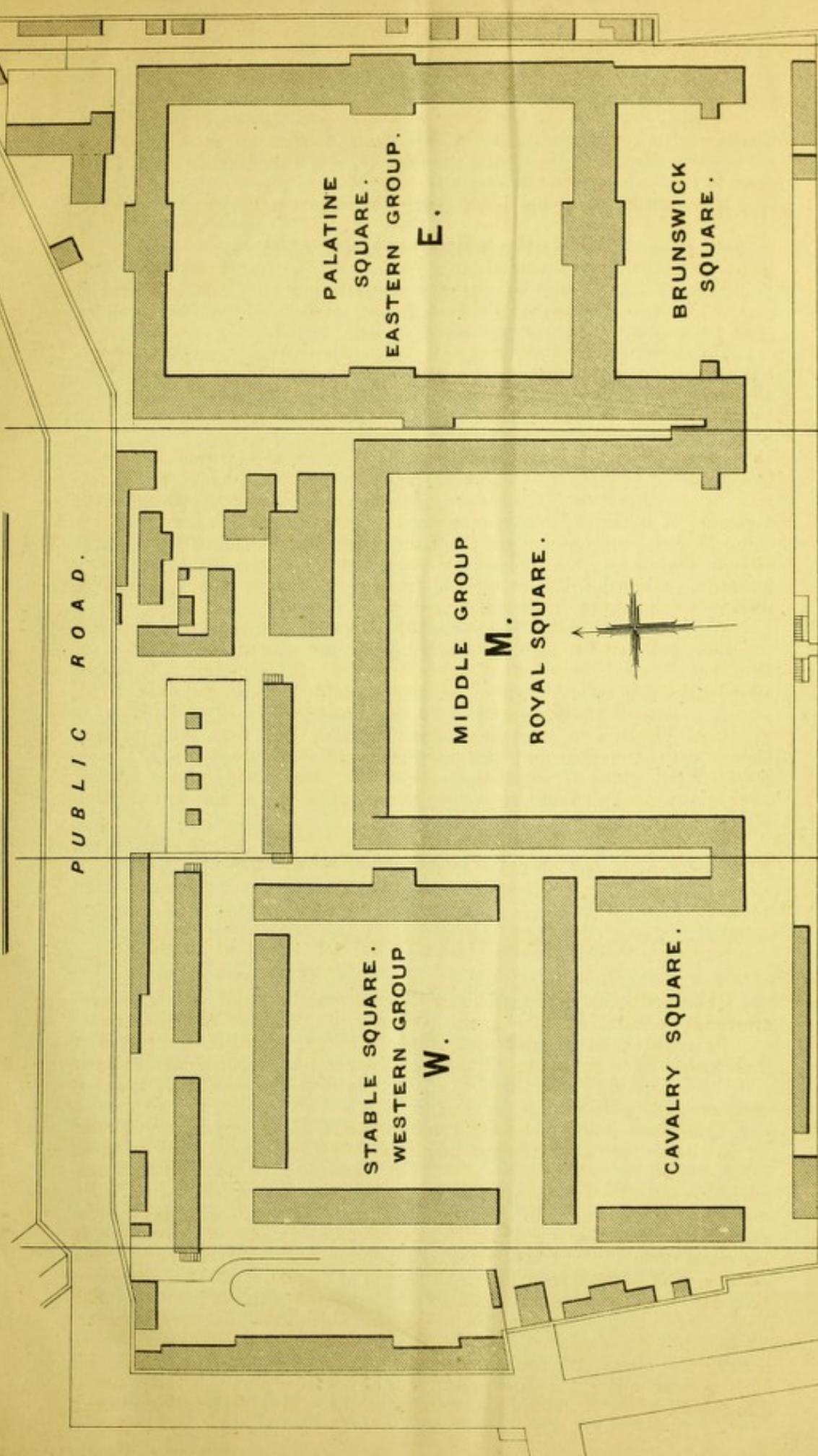
In considering the distribution of the buildings, it will be convenient to deal with them as consisting of three groups, eastern, middle, and western, and as intersected by four lanes, which for convenience may be called Lanes 1, 2, 3, and 4 (*see plan* No. I.).

Eastern group.

The eastern group consists of Palatine Square, a large open space bounded by handsome and solidly-constructed four-storey buildings, closed in at all sides, entered by archways, one of which is situated in the centre of each side of the square. To the south of this square is situate Brunswick Square, which has buildings on three sides only, the fourth side being open to the south—the north side communicating with Palatine Square—by one of the archways before mentioned. On the north side, and to the rear of Palatine Square, is a terrace rising to the level of the first floor of the buildings. This terrace is supported by a retaining wall, but 10 feet from the windows of the ground floor, terminating at the top in a parapet which runs for a considerable distance in front of the first floor windows. At the eastern end of this terrace, where it is about 130 feet wide, stand a number of buildings which still further intercept the air and light from the windows of the north side of Palatine Square. At the other extremity of the terrace the boundary wall of

ROYAL BARRACKS DUBLIN.

PUBLIC ROAD.



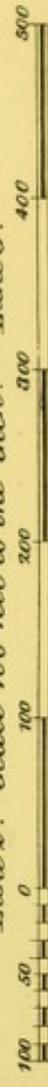
Lane 4

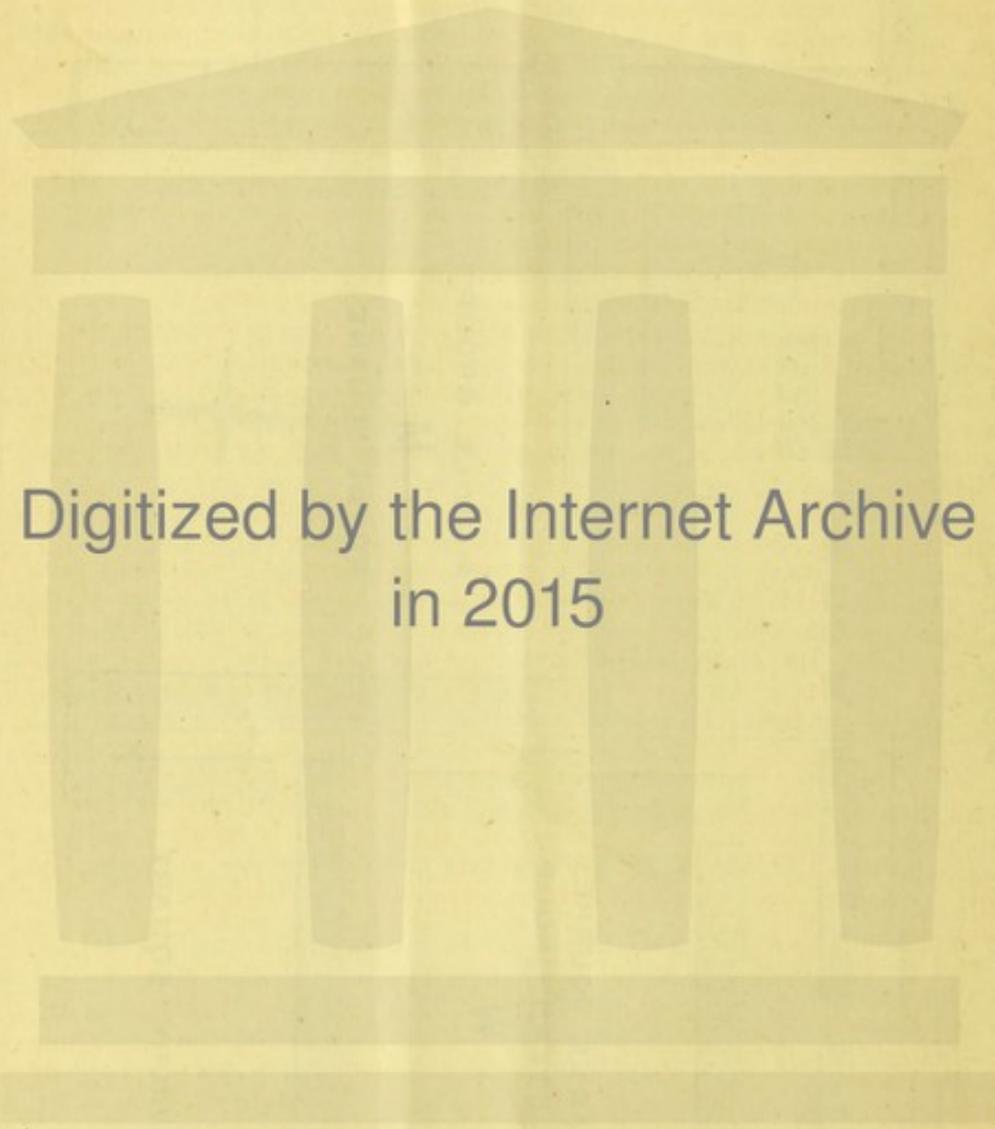
Lane 3.

Lane 2.

Lane 1.

Scale 100 feet to one inch.





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the barrack is so close to the buildings as to produce the same injurious effect. In fact, all the north structures of the square on the lower storeys have their light and air interfered with.

On the eastern side of this eastern group of buildings runs a roadway (Lane No. 4) with some low buildings on the public side. These buildings do not seem in any way to interfere with the light or ventilation of the quarters in Palatine Square, the windows of which on this side overlook the grounds of the King's Hospital.

On the western side of this group of buildings, however, there is a totally different state of things. About half of the western side of Palatine Square, and the whole of the western side of Brunswick Square, have their western windows looking into a narrow lane (Lane No. 3) the opposite side of which is formed of a row of buildings belonging to the middle group already mentioned, the lane is but 20 feet wide; the buildings on the Palatine Square side are four storeys high, and on the other side three storeys; the lane itself contains several small buildings—cook-houses, ablution rooms, wash-houses, &c. The lane is closed at its lower end. That portion of the west side of Palatine Square which is not bounded by the lane proper is closely hemmed in by buildings, including the riding school, and two cook-houses which extend towards the north in a very objectionable though not quite so injurious a way as its narrow and more closed-in portion.

Thus the space between the eastern group of buildings, comprising Palatine and Brunswick Squares, and the middle group, is confined by a narrow lane closed at one end, and partly occupied by small buildings scattered irregularly through it—a state of things found in old and overcrowded towns, but not now to be expected in a barrack. An arrangement more calculated to lower the health of the occupants and to spread disease could scarcely be contrived. The atmosphere of this lane was found on all occasions of our visits close and offensive.

The central group of buildings consists of Royal Square, and a number of buildings at the rear or northern side. Royal Square itself consists of ranges of buildings forming three sides of a square, and is open on the southern side. To the north side of Royal Square are situated a number of buildings, all on a higher level than that side. These comprise the riding-school, the wall of which, facing the north side of Royal Square, is close to the windows of the barrack rooms, shutting out a large amount of light and air from about half the windows at that side.

Two-storey buildings, at a distance of 40 feet, the lower storey being stables, the upper recreation rooms and cavalry soldiers' quarters—this structure does not interfere with the light and air. Again, to the north of these buildings stand the canteen, magazines, some married soldiers' quarters, latrines, and other small buildings, for the most part crowded together in an irregular and injurious manner, partly standing on terraces, the retaining walls of which, and the boundary wall on the north side of the barrack, tend to prevent the free admission of light and circulation of air. The most serious defect, however, connected with this central group of buildings is the position of the east and west sides of Royal Square. The eastern side forms one side of the narrow lane (Lane No. 3) already referred to when considering the distribution of the eastern group of buildings. Similar unhealthy conditions prevail along the western as along the eastern side of this lane. The state of affairs on the western side of Royal Square is almost as bad as on the eastern.

The western side of the square forms the boundary of another lane (Lane No. 2) the western side of which is completed by the western group of buildings, just as the eastern and middle had formed the previously described lane (No. 3). This lane has all or nearly all the unhealthy conditions found in connection with Lane No. 3. The occupants of the buildings cannot ever be expected to be healthy until these unsanitary conditions are mitigated.

The western group of buildings comprises: Cavalry Square, the Horse Square, certain buildings to the north of the Horse Square, consisting of stables with cavalry soldiers' quarters, and recreation rooms over them. To the north of these, again, are walls and terraces similar to those already described, with various small buildings, many of which structures tend somewhat to interfere with the supply of light and air to the cavalry quarters. To the west of this group of edifices runs another lane, but in this case there

are no high buildings; but, on the other hand, there are latrines, cook-houses, stables, and other obstructions. At the north-west portion there is another terrace, with high retaining walls, having many of the objectionable features already referred to in connection with the eastern group.

On the eastern side of the western group there is the long narrow lane (No. 2) already referred to, separating this group from the central group of buildings, with all its unhealthy conditions.

The buildings in Cavalry Square correspond with those of Brunswick Square on the other side of the barracks; those on the eastern side abut on the lane (No. 2) with high buildings on either side; and those on the western side abut on the lane (No. 1) which runs along the western boundary of the barracks, having the cavalry officers' mess and quarters, the end of the cavalry soldiers' married quarters, one side of the Horse Square, and the cavalry recreation rooms on its eastern side; and on its western, the rears of buildings in Temple Street West, latrines, water-closets, ash-bins, a cook-house; and towards its northern end a retaining wall supporting a terrace, upon which are situated stables and married soldiers' quarters. This retaining wall tends to obstruct the free course of light and air to the eastern side of the Horse or Stable Square.

Structure of Buildings.

Age of buildings. While very little appears to have been done towards re-arrangement of the position of the buildings, a great deal has evidently been completed in the way of modernising the old and badly-planned interior. All the buildings are old, many of them very old. The age of the buildings is in itself a source of great difficulty in providing healthy conditions for the inmates.

Old timber. There is a considerable amount of old timber in the floors and elsewhere, which is somewhat detrimental to health.

Practice of washing old floors. We especially noticed the old floors, which are made worse instead of being improved by frequent washings. These old boards, being very pervious in texture, absorb and retain a considerable portion of the water used for washing them, and practically the floors in the barrack-rooms can never dry. This system of washing old and pervious boards is nearly abandoned in well-regulated public institutions; and instead the boards are rendered impervious by some form of waxing, which can be kept perfectly clean by occasional rubbing by damp cloths, followed by hard dry scrubbing with occasional polishing with bees-wax and turpentine or other similar material.

Atmosphere of rooms. We observed a stuffy smell in many of the rooms, especially in those which have windows opening towards the lanes. In the cavalry soldiers' quarters, although those are situated over the stables, the atmosphere was much purer, owing no doubt to the fact that the buildings are only two storeys high, do not look into lanes, and have open roof ceilings with roof ventilation.

It is to be noted that there were but few cases of enteric fever in the quarters occupied by the cavalry soldiers.

Fresh air inlets. We noticed in many places that the inlets for fresh air were too near the ceilings, and therefore nearly on a level with the outlets, and that the window ventilation was altogether under the control of the men, there not being any perforated panes or slips to the windows to prevent complete closure.

III. SEWERS AND DRAINS.

The four main sewers. The sewers and drains in connection with such an extensive and scattered set of buildings as the Royal Barracks and Arbour Hill premises are necessarily also of a complicated and intricate character. The method of dealing with the barracks as consisting of three separate groups of buildings facilitates the consideration of this question also. There are four main sewers, which, so far as the barracks proper are concerned, run down the four lanes already denoted, and may be said in general terms to drain the premises on both sides of each lane in which they are situated. These sewers may be called Drains 1, 2, 3 and 4, as corresponding with the Lanes 1, 2, 3, and 4 respectively.

Although these sewers pass each along its own lane respectively, they are not in other respects similar in their course. No. 1 originates at the Hospital in Arbour Hill, passing along the road from the hospital to the gate of the Arbour Hill premises, under Arbour Hill into the barracks, down lane No. 1, across Barrack Street, the Esplanade, and the quays to the Liffey. The connections of this sewer, and its defects, have been pointed out in the Preliminary Report of 13th of August, 1887, a copy of which is appended.

Sewer No. 1.

No. 2 originates in the Arbour Hill premises, in a stone drain which receives the drainage from the married soldiers' quarters in Arbour Hill, the house of the Governor of the Military Prison, some other portion of the prison premises, and then crosses the road at Arbour Hill, passes down Lane No. 2, and follows a similar course to Drain No. 1, across the Esplanade, to the Liffey. No. 3 receives the sewage and drainage from the main portion of the prison, the chapel, disused cemetery, and other premises connected with the prison and chapel in Arbour Hill, then crosses Arbour Hill to the barracks, where it receives all the sewage from the latrines used by the Infantry soldiers, shortly after it enters the barracks from Arbour Hill, and it then passes down Lane No. 3, across the Esplanade, as in the case of Nos. 1 and 2, and into the Liffey.

Sewer No. 2.

Sewer No. 3.

No. 4 differs in its arrangement from Nos. 1, 2 and 3: it originates within the barrack, and has no connection with Arbour Hill. It originates in surface drains at the upper end of Drain No. 4, next Arbour Hill, receives all the drainage along the course of No. 4, and passes into the street sewer at the entrance gate of the barracks in Barrack Street. It will be observed that the course of this drain is short, and it receives much less sewage and drainage than any of the others.

Sewer No. 4.

Old Drains.—The questions connected with old drains are necessarily very difficult of investigation in such a building as the Royal Barracks. In the many cases in which we had the connection between the main sewers examined, we only met with the remains of a very few old drains, none of which contained any recent sewage matters, and must have been completely disused many years ago.

Very few old drains.

We examined one large and very old sewer running along the terrace in front of the barrack, connecting the two gates in Barrack Street. This sewer was opened for our inspection at several points, and near to the buildings, and several old tributaries to it traced. In no case could we find any connection with or very close to the buildings, and the old sewer itself has been evidently free from sewage for a very long time.

Examination of an old sewer.

We found in it some almost dry deposit, perfectly free from smell. We inquired carefully as to whether any other old drains or sewers had been discovered in connection with the buildings, and were assured that nothing of the sort had been found during the recent excavations.

In connection with the subject of old drains we should mention that in some places these drains still exist, and are in use. Such drains are probably harmless when they only carry clean surface drainage, but under all other circumstances they may become sources of danger, and therefore pipes should be substituted.

We regret to say that there are no plans of the old drains in existence, and therefore we had to depend on careful examination, and the reports of previous excavations made by the Military Authorities.

No plans of old drains.

We are distinctly of the opinion that there are no grounds for believing that the health of the inhabitants of the barracks can be affected by neglected old drains.

Health of troops not affected by old drains.

Before passing from the subject of the sewers, we may remark that very important drainage works have recently been carried out by the officers of the Royal Engineers, and others are in progress. This work has been performed, and cannot fail to have a beneficial influence upon the health of the troops quartered in the Royal Barracks.

Importance of drainage works recently carried out

Closets, Latrines, Urinals, Sinks, &c.—The connections of closets, latrines, &c., in Sewer No. 1 have been dealt with in our preliminary report, and we believe that it is advisable that all similar matters on the other lines of sewers should be similarly dealt with; the connections have been examined since we made the recommendation, and we have no doubt all defects met with have been remedied.

Connections of closets, latrines, &c.

Soldiers' latrines.

We have given special attention to the soldiers' latrines, already referred to, in connection with our description of Sewer No. 3.

In the case of those used by the infantry soldiers, we are not satisfied with the plan or working of the trough system of latrines there in use. There is no flush, properly so called, to the troughs; the removal of the soil depends altogether on the outward current of the water with which the troughs are gradually filled, which is allowed to discharge itself by the periodical removal of a plug. There is no wash-out, and it was quite clear on inspection that portions of the solid matter and papers had remained in the trough, either lying in the bottom or adhering to the sides for a considerable time. It is quite impossible to calculate the risks run by healthy men in using these latrines, had they been previously used by others suffering from enteric fever. It is one of the well-known characteristics of that disease that the affected persons frequently go about and use latrines for some time after they have become centres of contagion. Those latrines must be considered dangerous from this point of view, and are sufficient to account for the spread of disease among the men using the same. The latrines used by the cavalry soldiers are somewhat better arranged, but, nevertheless, are open to similar objections to those used by the infantry. We have remarked on the closets used by the cavalry officers and the mess servants in our preliminary report. We examined many closets in other parts of the barracks, but did not find any out of order; nevertheless, we recommended to the engineer officer in charge that all their connections with the sewer should be examined, and the smoke test applied to each; this suggestion has been acted upon since our visits.

Latrines used by women and children.

The latrines used by the women and children are all of an unsatisfactory pattern, and, although not out of order, were found to be untidy, and in several cases not sufficiently clean. It was incidentally mentioned by the husbands of some of the married women that their wives objected to use the closets on account of their want of privacy; although this complaint does not affect the question of the prevalence of enteric fever, yet we think it is one which should receive attention, and be remedied if possible.

Urine-tubs.

In connection with the question of latrines we think it advisable here to refer to the state of the urine-tubs employed at night in the barrack rooms. We find these are made of wood, which necessarily becomes saturated with urine, so that it is impossible to effectually cleanse them and render them sweet. Galvanized iron vessels would be found superior to wooden tubs.

We found that foul water was emptied into some of the gullies, especially in Lanes Nos. 2 and 3, causing considerable offensive deposits in the pits of the traps; this arrangement is a very unsatisfactory way of disposing of slops.

Surface of squares require repair.

Although the surface of the barrack-squares, &c., was generally good and well drained by surface channels, yet in some cases there were pools of water which, from the peculiar nature of the ground upon which the barracks stand, are likely to be a source of dampness. These should be repaired and concreted as soon as possible.

Ventilating arrangements for sewers.

Ventilation of Sewers and Soil Pipes.—The ventilation of the three main sewers of the barracks is carried out by means of gratings in the ground, opening directly into the sewer, and by iron ventilating shafts placed against the buildings or walls, and when against buildings carried above the eaves or above the ridge of the roof. The arrangements for ventilation on Sewer No. 1, as it passes through the Arbour Hill premises and Royal Barracks, have been described in our preliminary report, in which, however, it is not mentioned that there are ventilators over the course of the sewer as it crosses the Esplanade. The ventilating arrangements on Sewers Nos. 2 and 3 are of a similar character, having shafts against buildings and ventilating gratings in the Esplanade, but none in the Arbour Hill premises.

Sewer No. 4 is also ventilated by shafts, but no gratings in the barrack premises.

There are gratings in the street on the Corporation Sewer, into which the sewer discharges in Barrack Street.

Danger of shaft system.

We have remarked in our preliminary report on the danger attendant on the system of ventilating main sewers by shafts against inhabited buildings, and the danger of ventilating gratings in close proximity to inhabited buildings or much frequented spaces, such as yards and passages. We consider our remarks on the subject in the preliminary report are equally applicable to all similar cases throughout the barracks.

The ventilation of the soil pipes of the water closets seems to be effectually carried out, but we observed in some isolated water closets and latrines that the closet drains were not ventilated and supplied with fresh air inlets. This was the case in the water closets of the cavalry officers and mess servants, and in the latrines for the women and children, all of which should be properly ventilated and supplied with fresh air inlets. Fresh air inlets required.

IV.—WATER SUPPLY, MILK SUPPLY, AND IMPURITIES OF THE AIR.

WATER SUPPLY TO THE BARRACKS.

The barracks are supplied by the pipe water of the city, which is one of very good quality. It is taken from taps attached to the main pipes, and not from cisterns, which might possibly be contaminated with organic matter derived from the atmosphere. Source of water supply.

We are satisfied that the water used in the barracks is a perfectly safe one for all possible purposes.

SUPPLY OF MILK TO THE BARRACKS.

The generally admitted fact that milk may be the vehicle for the distribution of the virus of enteric fever, led us to inquire into the circumstances under which milk is supplied to the Royal Barracks.

For the purpose of comparison we also thought it desirable that the milk in use in the other barracks should be subjected to analysis. Accordingly, on the morning of the 25th August, 1887, specimens of the milk delivered at all the Dublin barracks were, by order of the military authorities, sent to us for examination, and the following are the results of their analyses. Specimens of milk analysed.

Royal Barracks.

The milk supplied to these barracks came from five contractors or vendors.

The specimens analysed proved to be of very bad quality, as will be seen by the following :—

Milk supplied to officers' mess, Lincolnshire Regiment, was adulterated with 19 per cent. of water; that is, to the original pure milk, assumed to be of poor quality, 19 per cent. of its weight of water had been added, making a mixture of 119 parts of milk and water. The milk furnished to the sergeants' mess was adulterated with 26 per cent. of water. Bad quality of milk.

The milk supplied to the sergeants' mess, Second Royal Highlanders, was adulterated with 26 per cent. of water; that supplied to the men's mess, with 21 per cent. of water; while the article supplied to the officers was poor, below the standard of average-quality milk, and was, we have little doubt, slightly adulterated.

The following shows the quality of milk delivered to the Fourth Dragoon Guards :—

Officers' mess, adulterated with 19 per cent. of water.
Sergeants' mess, adulterated with 17 per cent. of water.
Cook houses and men, adulterated with 56 per cent.
Provosts' cells, adulterated with 13 per cent. of water.
Married men's quarters, adulterated with 25 per cent. of water.
Second sample from officers' mess, adulterated with 19 per cent. of water.
A specimen of the milk retailed generally in the barracks was found to have been adulterated with 38 per cent. of added water. Result of analysis.

Richmond Barracks.

Milk supplied to officers' and sergeants' messes, Second Battalion, Royal Welsh Regiment, adulterated with 16 per cent. of water. Ditto.

The milk supplied to the mess of non-commissioned officers and men of this regiment was pretty good.

Milk delivered at sergeants' mess, Second Grenadier Guards, adulterated with 21 per cent. of water. The supply to the non-commissioned officers and privates was rather poor, and was probably slightly watered.

Beggars' Bush Barracks.

Result of analysis. Milk supplied to officers' mess, adulterated perhaps with a small proportion of water.
Sergeants' mess, adulterated with 32 per cent. of water.
Men's mess, rather poor.

Portobello Barracks.

Ditto. Royal Artillery.—The milk from this barracks was of good quality.

Ship Street Barracks.

Ditto. First West York Regiment.—The milk delivered to the officers' mess was pretty good, whilst that furnished to the sergeants' mess and married men's quarters was rather poor.

The men had two distinct supplies, one of which was rather poor; and the other was adulterated with 50 per cent. of water.

Pigeon House Fort.

Ditto. The milk from the fort proved fairly good.

Island Bridge Barracks.

Ditto. 16th Lancers.—Officers' mess.—The milk was adulterated with 15 per cent. of water.

Sergeants' mess.—Milk adulterated with 19 per cent. of water.

Married men's quarters.—Milk adulterated with 24 per cent. of water.

The results of the analyses of milk supplied to the various barracks are most unfavourable; in the case of the Royal Barracks, out of the 12 supplies of milk, 11 were adulterated with from 13 to 56 per cent. of water, and the 12th supply was so much below the standard of average-quality milk, that there is the strongest reason to believe that it was slightly adulterated.

General remarks on analyses of milk. There were 17 supplies of milk to the other barracks, seven of which were adulterated with from 15 to 50 per cent. of water; five were of doubtful purity, and five were fairly or decidedly good.

Dairy yards. We have not been able to ascertain that there were in 1886-7, any cases of typhoid fever amongst the persons engaged in supplying milk to the Royal Barracks. The dairy yards of the contractors were found to be in a fairly good state, though not as perfect as it would be desirable that such places should be. They are all supplied with Vartry (or Dublin) pipe water of the quality of which very favourable opinions have been expressed by high authorities. If Vartry water had been used to adulterate the milk, it is not likely that it could have introduced into it the virus of typhoid fever.

Period of sending out cows to grass. The Dublin dairy cows are usually sent out to grass lands near the city, and are kept there until the end of October. It is rather remarkable that out of the 60 cases of typhoid fever which occurred in the Royal Barracks from the 1st January, 1879, up to the end of October, 1887, and the exact dates of which have been furnished to us, no fewer than 46 occurred during the months that the cows were at grass, and 14 during the other months. There is no reason to doubt that the milk was adulterated during these months, and the question arises what were the sources of the water used to adulterate it. If the

water were obtained from wells, streams or ponds in the country, it might sometimes have been impure and unwholesome, or polluted with dangerous organic matter; indeed, our experience shows that many of the sources of water are highly polluted. This is of course only a conjecture, but the fact of the typhoid fever cases in the barracks increasing so much when the dairy cows were at grass is remarkable.

ORGANISMS IN THE AIR OF BARRACKS.

With the view of forming a comparison between the air of the Palatine Square, and that of the confined space between Royal Square and Palatine Square, the following biological test was employed.

Biological test of purity of air.

The number of micro-organisms falling per minute upon each square foot of the surface of the ground, was ascertained by the method proposed by Dr. Percy Frankland. We found that 74 per minute fell in the central part of the Square, whilst there descended in the space between the two Squares, nearly three times that number, namely 202. The organisms were collected between three and four in the afternoon, but probably had the experiment been made earlier in the day, when the operations of cooking and cleaning were going on, the difference would have been more marked.

V.—THE PREVALENCE OF DISEASE AND MORTALITY.

In order fairly to discuss the prevalence of enteric fever in the Royal Barracks, it is necessary to consider, not only the health of the troops stationed in this particular barrack, but its relation to troops stationed elsewhere, and to the civil population. It is also advisable to consider whether other forms of disease which are known to prevail under similar conditions to enteric fever have also prevailed in the barracks, while many other points necessarily arise in connection with these leading questions.

Health of troops in Royal Barracks compared with that of troops elsewhere.

The following statement shows the prevalence of the principal diseases arising under similar conditions to enteric fever, that is, in connection with sewer exhalations or sewer-gas contamination of the air.

ADMITTED TO HOSPITAL.

Year.	Enteric Fever.		Diarrhœa.	Diphtheria.	Pneumonia.	
	Died.				Died.	
1883	0	1	3	} None {	..	19
1884	0	2	24		1	11
1885	0	4	12		2	32
1886	5	9	10		3	26
1887	0	10	4		..	15
Total ..	5	26	53	0	..	103
Deaths..	5	..	0	0	6	..

Pneumonia is included in the above, owing to the fact it has frequently prevailed in an infectious form in localities the atmosphere of which is polluted by sewage exhalations.

Pneumonia.

Many or all of the cases, however, may not have been of this kind. We regret we were unable to discover the exact places where the persons resided who were attacked by diarrhœa and pneumonia.

During our inquiries we ascertained that diarrhœa had prevailed to a considerable extent among the men, who did not bring the circumstance under the notice of the medical authorities.

Diarrhœa.

In the description of the site of the Royal Barracks in Section I., we have referred to the tendency which certain forms of disease have to prevail on the littoral gravel bed in Dublin.

Cholera.

This has already been shown to be true of cholera, in a paper published by one of the authors of this Report (on the "Relation between the Distribution of Cholera in Dublin during the Epidemic of 1866, and the Geological Stratum of the Dublin District," *Dublin Journal of Medical Science*, April, 1878).

A somewhat similar relation is pointed out by Dr. Mapother in his "Lectures on Public Health," published in 1867.

Method of testing the effect of the littoral gravel bed on the prevalence of enteric fever.

With the view of testing this question with special reference to the prevalence of enteric fever, a street list of the deaths from enteric fever has been prepared at the General Register Office, and then compared with a map, upon which the outcrop of the littoral gravel bed was marked, specially prepared for the purpose at the Office of the Royal Engineers.

In the first instance, the population of that portion of the City of Dublin situated on the gravel bed, was carefully taken out from the Census Returns of 1881, and subtracted from the total population of the city at the same period, the result being that in 1881, out of a population for the whole city of 249,602, there resided on the gravel, 80,759; and in the other portions of the city, situate upon the clay, 168,843.

During the period from 1st January, 1882, to 31st May, 1887, the deaths from enteric fever amounted to 539, or 1 in 463 of the mean population. Of these deaths 221, or 41 per cent. occurred among those residing on the gravel, or at the rate of 1 in 365 of the population; and 318, or 59 per cent. occurred in other portions of the city, being at the rate of 1 in 531 of the population. The ratio for death-rate for enteric fever in the two populations, being 1.5 to 1 on and off the gravel respectively.

DEATHS from Enteric Fever in the Area described as "Post-tertiary, Fluvio-marine Sands, Gravels, and Clays," and in the remainder of the City of Dublin. [1882 to May, 1887.]

	Population, according to the Census of 1881.	Number of deaths from Enteric Fever 1882 to May, 1887.	Ratio to Population.
Area described as "Post-tertiary, Fluvio-marine Sands, Gravel, and Clays"	80,759	221, or 41 per cent.	1 in 365
Remainder of City	168,843	318, or 59 per cent.	1 in 531
Total	249,602	539	1 in 463

A map was carefully marked in the Royal Engineer Office, showing the distribution of deaths from enteric fever during the past 2½ years, the result being 239 marks on the map. During that period 101, or at the rate of one death for 800 of the population occurred on the gravel bed; whereas off the gravel bed the number was 138, or at the rate of one in 1,223, the rates being 1.5 to 1, fully confirming the views entertained as to this question.

Bluecoat School comparatively free from enteric fever.

As a considerable portion of the Royal Barracks stands on this gravel, it is clear that the situation of the barrack is to some extent favourable to the prevalence of enteric fever. It is right here to mention, that in the adjoining premises of the Bluecoat School, there were very few cases of enteric fever.

On inquiry at that Institution, it was ascertained that during the past 12 years there were only 10 cases of enteric fever, and these about five years ago, among the residents in that Establishment. These cases were attributed to the opening up of some old drains in adjoining premises (not the barracks).

The population of this Institution is an average of 130, nearly all young persons, who are at an age predisposing them to contract enteric fever. Nearly the whole of the premises of the Bluecoat School stand on the gravel bed. Cases of enteric fever have from time to time occurred among the civil population in the vicinity of the Royal Barracks, and deaths have been registered as occurring in Barrack Street and Temple Street West, in the latter case, in a house immediately adjoining the barrack wall in the vicinity of

the latrines connected with the cavalry officers' mess. The cases and deaths, however, do not seem to denote any special prevalence of enteric fever in the immediate vicinity of the barracks, as compared with other portions of the city similarly situated.

It is very important that the relative healthiness of the troops in Dublin, as compared with other places, should be carefully considered before discussing the particular question as to whether there has or has not been a comparative excess of prevalence of enteric fever in the Royal Barracks.

With the view of testing this question, tables have been prepared showing the relative mortality of the troops in the United Kingdom, in Ireland, and in Dublin, during the period immediately preceding that which led to the present inquiry, namely, 1881 to 1885 inclusive—the relation between the mortality of the troops and the general population—and, in a similar manner, the relative mortality among the troops from certain zymotic diseases, and from enteric fever especially. Further, other tables have been prepared, showing the relation between the prevalence of zymotic disease and enteric fever, especially among the troops in Dublin, as compared with the troops generally in the United Kingdom, and certain districts and localities.

As the age of men in the Army is limited, it would be manifestly unfair to found any definite conclusion on facts derived from a comparison between the troops and the general population of all ages; therefore, the only ages dealt with in detail are those between 15 and 45, which are the periods adopted in the tables of the Registrars-General most nearly approximating the range of ages among the troops. This is especially important when considering the question of the prevalence of enteric fever, as that disease confines its ravages almost entirely to persons who have not passed middle life; and therefore it is a disease to which soldiers, from their age, may be expected to be liable.

They should not, however, be more liable to the disease than the general population, and, having regard to the many measures taken for the preservation of the health of the troops, a slighter degree of prevalence should be anticipated among them than among the general population. As there is no record of the prevalence of disease among the general population, it is only by comparison between the death rates of the troops and that for the population at large that any conclusion with regard to relative healthiness can be drawn.

As the question of the prevalence of enteric fever in the Royal Barracks is the one especially under consideration, it is well, in the first instance, to ascertain how the troops in Dublin compare with the troops elsewhere, as to the prevalence and fatality of this particular disease.

An abstract made from a table constructed from the reports of the Army Medical Department, between 1881 to 1885, gives the following results:—

ADMISSIONS to Hospital from Enteric Fever occurring among the Troops in the following Districts per 1,000.

	1881.	1882.	1883.	1884.	1885.	Average.
United Kingdom	0·9	2·0	1·3	1·1	1·7	1·4
Ireland	1·9	1·5	2·5	1·7	1·6	1·9
Belfast District	0·3	0·7	1·0	0·4	0·3	0·7
Cork District	3·1	0·8	2·2	1·7	1·3	1·8
Curragh District	Not known	Not known	Not known	1·2	0·3	0·6
Dublin District	1·5	2·2	4·5	2·2	2·8	2·5
Dublin Garrison .. ..	..	..	3·4	3·5	3·5	3·5
Home and Woolwich.. ..	..	5·0	0·5	0·4	4·0	2·5

It will be observed from the above that enteric fever prevailed during the period referred to, more constantly and persistently in the Dublin district than in the other military districts with which it is compared, except the Home and Woolwich districts, which have been taken specially with a view to comparison with the Dublin Garrison. In the Dublin Garrison the rate for the three years 1883–5 was 3·5, as compared with an average rate of 2·5 in the Home and Woolwich districts during the four years 1882–5, showing an excess of 1·0 in the Dublin rate.

If the mortality from enteric fever be treated in a similar manner, we find mortality per 1,000 of strength from enteric fever in the following:—

	1881.	1882.	1883.	1884.	1885.	Average.
United Kingdom	·18	·47	·24	·19	·48	·31
Ireland	·32	·27	·36	·22	·38	·31
Belfast District .. ..	..	..	·35*	..	..	·07
Cork District	·57	·10	0	·37	·24	·25
Curragh District	Notknown	Notknown	0	0	·29	·10
Dublin District	·24	·45	·89	·25	·69	·47
Dublin Garrison	Notknown	..	·85	·41	1·06	·79
Home and Woolwich.. ..	..	·61	·26	·09	·64	·40

* Only one death.

Mortality from enteric fever among troops in Dublin Garrison.

From this it appears that the death-rate per 1,000 strength from enteric fever of the troops in Dublin Garrison* is much higher than that of the average rates for the troops in the United Kingdom, or Ireland, or in the Dublin district, the average rates being respectively 0·79, 0·31, 0·31 and 0·47. Thus the death-rate among the troops in Dublin Garrison from enteric fever was considerably more than double that from the same cause among the troops generally, and this notwithstanding the facts shown in the following statement:—

DEATHS per 1,000 Strength from all Causes.

	1881.	1882.	1883.	1884.	1885.	Average.
United Kingdom	7·45	6·94	6·28	5·33	6·68	6·55
Ireland	6·46	6·65	5·53	5·09	6·26	6·02
Belfast District	8·40	7·33	7·36	5·39	7·77	7·25
Cork District	5·79	5·19	4·69	4·16	5·52	5·07
Curragh District	Notknown	Notknown	3·62	2·06	6·15	3·94
Dublin District	6·43	7·55	6·48	7·20	6·46	6·82
Dublin Garrison .. ..	..	..	6·97	6·36	6·55	6·63
Home and Woolwich.. ..	7·5	6·1	6·7	6·1	6·9	6·7

General death-rate of troops in the Dublin Garrison.

The general death-rate of the troops in the Dublin Garrison is but slightly over the average of the troops in the United Kingdom, and is lower than the army rate in Ireland, and even in the Dublin district itself, and below the death-rate of the troops in the Home and Woolwich district, where the death-rate of the general population is below that of Dublin in the ratio of 20·7 to 28·1 per 1,000 per annum.

Again, we find the admissions per strength from the principal febrile zymotics are more numerous in the Dublin district, namely, 37·8 per 1,000, than the average of the United Kingdom, of Ireland, or of any of the Irish districts, although the rate is not so high as London. In the Dublin Garrison itself for the three years 1883–85 it was 42·5, as shown in the following table:—

ADMISSIONS, Febrile Zymotics per 1,000 of Strength.

	1881.	1882.	1883.	1884.	1885.	Average.
United Kingdom	44·6	38·4	33·8	31·0	30·6	34·5
Ireland	43·8	38·6	33·0	24·3	24·5	33·1
Belfast District	48·5	28·0	29·8	22·3	23·0	30·4
Cork District	61·8	28·9	26·1	20·1	20·4	31·8
Curragh District	Notknown	Notknown	27·6	15·3	15·8	19·2
Dublin District	30·1	47·9	43·6	33·0	32·5	37·8
Dublin Garrison .. ..	..	..	51·1	42·1	35·8	42·5
Home and Woolwich District	50·1	31·3	34·5	42·2	42·1	40·0

Febrile zymotics

The rate of mortality per admissions of febrile zymotics is higher in Dublin than elsewhere, not excepting the Home and Woolwich district, as shown in the following table, thus showing that the forms of disease met with are either more severe or are treated under less favourable circumstances.

* The Dublin Garrison returns for the three years 1883–5

MORTALITY per cent. of Admissions from Febrile Zymotics.

	1881.	1882.	1883.	1884.	1885.	Average.
United Kingdom	1.1	2.0	1.3	1.2	2.1	1.5
Ireland	1.7	2.1	1.8	1.3	2.6	1.9
Belfast District	0.7	1.2	1.2	..	1.4	0.9
Cork District	1.7	1.1	0.9	1.8	3.5	1.7
Curragh District	Not known	Not known	..	1.9	1.9	1.1
Dublin District	2.1	2.7	2.9	1.1	2.5	2.3
Dublin Garrison .. ..	..	..	2.5	1.0	3.0	2.2
Home and Woolwich District	1.4	2.2	1.5	0.8	2.1	1.6

We find, however, that the mortality per cent. of admissions of enteric fever cases among the troops in the Dublin district who are treated in hospital is less than the average of the United Kingdom, although higher than the average of Ireland or of any of the other Irish districts, and higher than the rate among the troops in London. In the Dublin Garrison the rate for the three years 1883-85 is 22.6, being under the average of the United Kingdom in the five years 1881-85, but over the average for any of the other district areas mentioned above. An examination of the rates of mortality from enteric fever per cent. of admissions to the military hospitals gives the following results:—

	1881.	1882.	1883.	1884.	1885.	Average.
United Kingdom	20.3	23.6	20.0	19.1	28.8	23.1
Ireland	17.0	17.9	14.3	12.8	24.3	17.0
Belfast District .. ..	..	..	33.3	..	..	12.5
Cork District	18.5	12.5	..	21.4	18.2	14.1
Curragh District	Not known	Not known	..	..	100.0*	20.0
Dublin District	15.8	20.7	20.0	10.0	25.0	18.9
Dublin Garrison .. ..	..	..	25.0	11.8	30.0	22.6
Home and Woolwich District	Not known	12.3	50.0	20.0	16.0	16.1

* Only one case which proved fatal.

Compared with the mortality at Cork Street Fever Hospital, where civil cases are treated, the death-rate is excessive, the Cork Street Fever Hospital rate for the five years under consideration being, for males of 15 years and upwards, 11.1 per cent., females 14.1 per cent., both sexes 12.4 per cent., as shown in the following table:—

Comparison with mortality at Cork Street Fever Hospital.

TABLE showing for the Ages, 15 Years and upwards, the number of Cases of Enteric Fever admitted into Cork Street Hospital, Dublin, during the Five Years ending 31st March, 1886, with the Number of Fatal Cases and Rate of Mortality per cent. of Admissions.

Period.	Enteric Fever in Persons aged 15 Years and upwards.								
	Males.			Females.			Total.		
	Admissions.	Deaths.	Mortality per cent.	Admissions.	Deaths.	Mortality per cent.	Admissions.	Deaths.	Mortality per cent.
Year ended March 31, 1882..	13	2	15.4	5	1	20.0	18	3	16.7
.. .. 1883..	28	2	7.1	20	1	5.0	48	3	6.3
.. .. 1884..	19	2	10.5	11	3	27.3	30	5	16.7
.. .. 1885..	16	3	18.8	13	3	23.1	29	6	20.7
.. .. 1886..	23	2	8.7	22	2	9.1	45	4	8.9
Average for five years..	19.8	2.2	11.1	14.2	2.0	14.1	34.0	4.2	12.4

It has been already shown that the death-rate among the troops is generally lower than that of the general population at the same ages. The following table shows that the death-rate from the febrile zymotics on an

average is about the same among the troops as among the population of the same ages and sex in the United Kingdom generally, and in Ireland exactly the same. In London and Dublin it is lower.

Average annual mortality amongst troops as compared with population general.

TABLE showing the Average Annual Mortality during the Five Years 1881-5 amongst the Troops* stationed in various parts of the United Kingdom, compared, as far as practicable, with the Average Mortality for the same period amongst Males aged 15 and under 45† Years in the General Population of the same Localities.

Locality, &c.	Number of Living.	Deaths from.					
		All Causes.		Certain Zymotic Diseases.‡		Enteric Fever.	
		Average No. per Annum.	Rate per 1,000 Persons.	Average No. per Annum.	Rate per 1,000 Persons.	Average No. per Annum.	Rate per 1,000 Persons.
United Kingdom:							
All males aged 15 and under 45	7,478,768	62,540	8.36	4,394	0.59	2,119	0.28
Troops	87,674	574	6.55	46	0.52	28	0.31
Ireland:							
All males aged 15 and under 45	1,064,745	8,543	8.02	662	0.62	176	0.17
Troops	23,746	143	6.02	15	0.62	74	0.31
Belfast Military District:							
Troops	2,989	22	7.25	1	0.27	2	0.07
Cork	8,682	44	5.07	5	0.53	2	0.25
Curragh §	3,282	13	3.94	1	0.20	3	0.10
Dublin	10,136	70	6.82	9	0.89	5	0.47
London:							
Registration males 15 and under 45	867,347	8,219	9.48	675	0.78	277||	0.32||
Home and Woolwich Military District:							
Troops	11,654	78	6.69	7	0.60	5	0.46
Dublin Registration District:							
Males 15 and under 45	83,080	1,227	14.77	101	1.22	30	0.36
Dublin Garrison:							
Troops §	5,080	34	6.63	5	0.92	4	0.79
Royal Barracks, Dublin:							
Troops §	1,456	..	..	0.66	0.46	..	..

Special comparison with regard to enteric fever.

In the case of enteric fever, however, the mortality among the troops is higher generally than in the civil population.

Thus, for the United Kingdom, the death-rate from enteric fever among the troops is 0.31 per 1,000 strength, as compared with 0.28 or 0.03 lower per 1,000 among the males in the total population between the ages of 15 and 45 years.

This is not a very great excess, but it represents 3.2 more deaths annually from enteric fever in the army in the United Kingdom than in an equal number of the general population, whereas the number ought to be less. In Ireland the excess is more marked, the rates being 0.17 per 1,000 for the general population, and 0.31 for the military, showing an excess for the military of 0.14.

From the foregoing statement it is evident—

General conclusions.

1. That the general death-rate of the military, as compared with the general population in Dublin, is extremely favourable.
2. That the death-rate from febrile zymotics, also, is lower than that of

* Non-commissioned officers and men.

† According to the census of 1881.

‡ For the troops, diseases of the "Febrile Group" as adopted in the Reports of the Army Medical Department; for the general population, miasmatic diseases as given in the Reports of the Registrar-General; cholera, malarial diseases, erysipelas, pyæmia, and septicæmia.

§ For three years 1883-5.

|| For four years 1882-5.

the population generally, but the difference is not as great as that between the rates for all cases.

3. That the death-rate from enteric fever is much in excess of that of the civil population.

4. That enteric fever is more fatal, and probably more prevalent in the army than in the population generally.

5. That there is an excess of prevalence of enteric fever among the troops in Dublin as compared with the United Kingdom generally, with Ireland, with other Irish districts, and with the London districts.

6. That a similar condition exists regarding febrile zymotics generally.

7. That the forms of febrile zymotics prevalent among the troops in Dublin Garrison and the Dublin military district are more severe, or are treated under less favourable circumstances, than elsewhere in the United Kingdom, as the mortality per 100 admissions is higher.

8. That, measured by the mortality per 100 admissions, enteric fever, as it prevails among the troops in Dublin, is more severe than among the troops in other parts of Ireland or in the London district, but not as severe as the army average for the United Kingdom; also, that fever among the troops seems to be more severe than among the general population in Dublin, the proportion of deaths to cases being very much higher than in the Cork Street Hospital.

These facts are very remarkable; the most remarkable being that enteric fever seems to be more prevalent among soldiers than among the civil population, although, in other respects, the health of the troops is better than that of the civil population.

We think this may be to some extent accounted for by the fact that the army may be looked upon as a distinct community, living under special circumstances.

Enteric fever is a disease which, when once it gets a foothold in a community, is difficult to eradicate. It is slow and uncertain in its progress, and may be conveyed from place to place by the movements of those whom it affects; thus a regiment, or portion of a regiment, is a very suitable medium for retaining and conveying the disease.

Again, enteric fever is a disease peculiarly liable to attach itself to a particular locality, so that when introduced into a barrack it will be difficult to remove.

We have thus two good reasons why soldiers in their migrations through various garrisons should be especially liable to maintain the prevalence of enteric fever in the army. The use of common latrines tends to maintain and multiply the poison of enteric fever in the army to a degree that does not exist in the civil population.

A healthy regiment arrives at an infected barracks, uses the latrines, and becomes infected with enteric fever. An infected regiment arrives at a healthy barracks, poisons the latrines, and leaves them to infect the next arrivals.

We are therefore of opinion that the system incident to the distribution of the troops is liable to spread enteric fever, and requires special precaution to prevent its having this effect. It is not therefore surprising to find enteric fever appearing in any barracks, and it has prevailed from time to time in all the Dublin Barracks.

It therefore seems most desirable, and we strongly recommend, that a thorough cleansing and disinfection of all latrines and sewers connected therewith should take place on the departure of each regiment or detachment from a barracks before it is reoccupied.

It seems, however, lately to have prevailed specially and virulently among the officers, women and children, and troops in the Royal Barracks. We have already pointed out special conditions which favour unhealthiness of the troops in these barracks, and contribute to favour the spread of enteric fever.

We have now to consider the special distribution of the disease in the barracks.

On examination of the carefully prepared chronological list annexed* of the cases which occurred in the Royal Barracks, we find there are 66 cases in all concerning which correct information has been obtained.

Peculiarities of enteric fever.

Reasons why soldiers are especially liable to.

Disinfection of latrines and sewers on departure of troops. Enteric fever considered especially in regard to the Royal Barracks.

These were, as shown in the list, distributed over a period of nine years, and the number of cases in each year was as follows :—

1879	..	..	..	3
1880	..	..	..	4
1881	..	..	..	4
1882	..	..	..	7
1883	..	..	..	5
1884	..	..	..	1
1885	..	..	..	3
1886	..	..	..	11
Up to date in 1887	..	..	..	27

These cases include all of which correct details are obtainable. It will be observed that in 1879 there were but three cases, and in 1880 and 1881 the number was only one more in each; in 1882 the number rose to seven; in 1883 it fell to five, again to fall to one in 1884; in 1885 there were but three cases; in 1886 and 1887 there appears to be a severe epidemic of the disease, which prevails still at the time we write.

Comparing the number of deaths recorded in the Dublin Registration District during the same period with the cases of enteric fever in the Royal Barracks, the result is as follows :—

	Deaths in Dublin.		In Royal Barracks.	
Comparison between enteric fever in Dublin Registration District and Royal Barracks.	1879	.. .. 218	.. .. 3
	1880	.. .. 190	.. .. 4
	1881	.. .. 123	.. .. 4
	1882	.. .. 135	.. .. 7
	1883	.. .. 132	.. .. 5
	1884	.. .. 134	.. .. 1
	1885	.. .. 144	.. .. 3
	1886	.. .. 129	.. .. 11
	First three quarters of 1887	.. .. 90	.. .. 27

It would appear that the prevalence of enteric fever in the Royal Barracks did not correspond with that among the civil population. Thus in 1879-80-81 the cases in the Royal Barracks were at their minimum, whereas in two of those years there was an excessive prevalence of the disease in Dublin, as indicated by the deaths. In 1886 the cases in the Royal Barracks were more numerous than in any of the preceding years, while the mortality was less in the Dublin Registration District than in any of the previous years, with the exception of 1881.

Prevalence of enteric fever in Dublin for the current year (1887).

In the present year, to the middle of October, there has been a larger number of cases of enteric fever than before in the barracks.

At the time of writing this report, there had been already 120 deaths registered from enteric fever in Dublin for the current year 1887, so that it must be admitted that there is a probability, amounting almost to a certainty, that the deaths from enteric fever in Dublin in 1887 will considerably exceed those of last year, although unlikely that it will reach the extremely fatal years of 1879 and 1880, when the deaths were 218 and 190 respectively.

From March, 1884, when the only case in that year occurred, to June, 1885, or for about a year and a quarter, not a single case arose in the barracks.

Special causes existing in Royal Barracks.

From this it is clear that there are causes in existence, in connection with the troops quartered in the Royal Barracks, which tend to maintain the disease there independently of its general prevalence in Dublin.

On looking at the accompanying map,* on which are marked the localities of origin of all the known cases of enteric fever, we find that the cases are grouped in certain localities. The cases of earlier date we find grouped in Cavalry Square, and we have already in our preliminary report pointed out the causes of these cases.

Some cases described.

These cases were among the officers, women, and children of the cavalry, and we find a case occurred of an officer who frequented the cavalry mess, but who lived in Palatine Square, namely, Lieut. Harris of 2nd Dragoons, who was attacked so long ago as 22nd March, 1881; and another case, Lieut. Richmond of 21st Hussars, in 1882. These officers lived on the east side of Palatine Square, and only one other case occurred in that part of the barracks,

* Plan No. 4.

thus showing that the east side of Palatine Square was nearly free from the presence of the disease; and it would appear that, except in the case of Lieut. Thistlethwaite, 60th Rifles, who fell sick in October, 1883, there was no other case on the east side of Palatine Square which could have been said to have originated there, the other cases being fairly attributable to infection received at the cavalry mess-room in Cavalry Square.

We next find there are two other groups of cases—those situated on the west side of Palatine Square and on the west side of Royal Square, the former numbering 18, the latter numbering six. It will be observed that these cases are situated in buildings the windows of which open into the lanes so frequently referred to in the early part of the Report, and in buildings facing the east, there being less exposure to light and air than the other portion of the barracks. There has not been any general prevalence of the disease elsewhere in the barracks, the other cases being all scattered. Thus there have been no groups of cases in the Horse Square, on the east side of Royal Square, the north side of Palatine Square, except in the corner connected with the west side, the south side of Brunswick Square, nor in the cavalry soldiers' quarters north of the north side of the Horse Square. The isolated cases arising in these portions of the barracks are all of recent date, except that of Private Browne, of the 2nd Dragoon Guards, which occurred in 1881, and Private Herridge, of the 4th Dragoon Guards, which occurred in 1886.

Such isolated cases may be expected to arise among men quartered in the same buildings, where groups of cases occur. It will thus be seen that the disease has been only prevalent in an epidemic form among the officers, women, and children of the cavalry, and among the men located in certain portions of the infantry quarters. Isolated cases.

The cases of the cavalry officers may all be fairly attributed to the causes which we have shown to exist in connection with the cavalry mess; and those among the women and children are attributable to the constant use of the rather ill-kept latrines in the lane along the west side of the barracks.

In the case of the men among the infantry, we think the cause may reasonably be attributed to the facility given for the spread of the disease through the latrines used in common by all the men, together with the unfavourable hygienic conditions under which they are quartered.

We cannot, however, leave unnoticed the suspicious nature of the milk supplies, which, although we are unable to give it as a cause of infection, may have been a source of mischief, and one which should be provided against in future. Milk supply to be watched.

VI.—DEFECTS FOUND TO EXIST

The defects found to exist may, in our opinion, be summarised as follows:— Summary of defects.

1. The site of the barracks is only defective in that it stands on the gravel bed occupying the centre of the city, which is known to be difficult of drainage, and favourable to the spread of certain forms of disease, including enteric fever. Site.
2. The buildings are, in many places, in too close proximity to be consistent with the health of their inhabitants. Buildings.
3. There is a good deal of old timber about the barracks, especially in the floors of the barrack rooms. These floors are perpetually kept in a state of dampness by washing, which tends to maintain a damp atmosphere in the rooms and promotes further decay of the timber. Old timber.
4. The ventilation of many of the barrack rooms does not seem to be sufficient, in some instances the inlet being near to the ceiling, thus not making sufficient provision for circulation of the air. The windows are, as a rule, quite under the control of the men, and have neither perforated panes nor slips to prevent their complete closure. Ventilation.
5. The sewerage from the hospital containing the excreta of the enteric fever cases is allowed to pass into one of the main sewers of the barrack, which sewer is (or rather has been) ventilated in dangerous proximity to inhabited buildings. Sewerage from hospital.

Water closet near cavalry officers' mess and quarters.	6. A defective water-closet was found in close proximity to the mess room and quarters of the cavalry officers, and was used by one of the mess servants, who died of enteric fever. The state of this water-closet was in itself sufficient to account for the illness and death of the mess-waiter.
Connections of ditto.	7. The connections of the water-closet above-mentioned with the main sewer were found to be very defective; another near it was badly laid. These defective connections cast a doubt on some other work of a similar character in the barracks, made previous to the barracks coming under the charge of the present Engineer officers.
Latrines, infantry.	8. There is a concentration of excreta at a few fixed points, which, we think, is most undesirable. The latrines used by the infantry soldiers are badly planned, and permit the retention, for some considerable time, of solid excreta, which, in case of the latrines being used by persons infected by enteric fever, would tend to spread the disease among other men using the same latrines. The latrines used by the cavalry soldiers are of the same plan, but better constructed, yet nevertheless dangerous.
Cavalry.	
Urine tubs.	9. The urine tubs, used by the men at night, are made of wood, which it is impossible properly to cleanse. We found these offensive, even after being rinsed and scrubbed.
Women's latrines.	10. The latrines used by the women and children are of a bad pattern and liable to become foul, even when in good order, as all these met with were.
Removal of refuse.	11. The refuse removal arrangements are defective, and give rise to frequent nuisance. The dust-bins are in many cases badly situated, and their cleaning is the source of the diffusion of much dirt throughout the atmosphere. Some surface drainage gullies are used as slop-sinks and become offensive. In one place the surface of the ground was uneven, and allowed slush to accumulate.
Ventilation of sewers.	12. The arrangements for ventilating the sewers are dangerous, and likely to spread disease. The ventilating shafts are badly placed, and in dangerous proximity to inhabited houses. The ventilating gratings in Arbour Hill are dangerously placed, and admit of the passage of matters which tend to accumulate in the sewer underneath and cause obstructions.
Hospital arrangements.	13. The hospital arrangements are very unsatisfactory. The principle of treating enteric fever cases, or, indeed, cases of any infectious disease in hospitals in so many places is calculated to maintain centres of infection in various barracks. The practice of transferring patients suffering from infectious disease from one barrack to another is injurious.
Hospital at Arbour Hill unsatisfactory.	The buildings used for an hospital at Arbour Hill are not such as we find devoted to such a purpose in well-constructed modern hospitals. Many of the wards are small in extent and have low ceilings.

VII.—WITH THE VIEW OF REMOVING OR MITIGATING THE EVILS WHICH WE BELIEVE TO EXIST WE RECOMMEND:

Recommendations.	1. That, to prevent as far as possible the situation of the gravel bed at the lower portion of the barracks, we recommend a thorough sub-soil drainage of the whole site of the barracks, and extension of the dry area system which has recently been constructed around some of the buildings, and removing all irregularities and rendering the surface of the ground impervious. Whenever possible, it is desirable to have the ground likely to be polluted covered with some such material as the hygienic cement used at present in some parts of the barracks.
Sub-soil drainage.	
Removal of considerable portions of present buildings.	2. That considerable portions of the present buildings should be removed with the view of obtaining sufficient air space, and completely destroying the narrow lanes to which we have called attention. On Plan 2 are marked the buildings which we recommend should be removed, namely: the whole of the eastern side of Royal Square; the whole of the eastern side of the Horse Square; the whole of the eastern side of Cavalry Square; the eastern end of the block of buildings which separates Cavalry Square from the Horse Square; the riding-school to the north of Royal Square; the cook-houses near the riding-school; several small buildings marked to the north side of Palatine Square; several small buildings on the terrace to the north of the cook-houses and riding-school already mentioned.

The boundary wall along Arbour Hill, where marked, should be removed and replaced by railings; the walls between the boundary wall and the quarters should be lowered where possible. The magazines on the terrace, to the north, should be removed, and the terrace sloped down. The terrace to the western side of the barracks, in front of the officers' stables, should be sloped down; all the small buildings, at present situated in the lanes and yards, should be removed. The plan of the barracks as it would be after the proposed demolitions have been carried out is shown on Plan 3.

Removal of boundary wall along Arbour Hill.

The ground floor of the north side of Palatine Square should be disused for habitations and only utilised as stores.

As we are informed that the cavalry may be removed from the barracks as soon as accommodation can be provided elsewhere, we believe that ample space will then be available in which to provide accommodation in substitution of that furnished by the buildings we recommend should be abolished.

In redistributing the quarters, we advise that the portion appropriated for residence should be, as far as possible, on the higher portion of the ground.

3. That all very old timber should be removed, especially from the floors, and replaced with new wood, and that all floors, whether new or old, should be rendered impervious by saturation with some such substance as a solution of wax in paraffin, a preparation which enables the floor to be kept clean by dry-rubbing (with or without wax and turpentine) and occasional slight washing.

Removal of old timber and fresh treatment of floors.

4. That the barrack rooms should be ventilated by "Tobin's Tubes," or some contrivance which would cause a free circulation of fresh air from the inlets before reaching the outlets, and that slip-boards should be placed under the lower window sashes, so that permanent ventilation might take place at the "meeting rails" of the sashes; these slip-boards being firmly fixed, so that they could not be removed by the men.

"Tobin's Tubes" for ventilation.

5. That the system of drainage from the hospital should be so arranged that the sewage containing the discharges from patients suffering from infectious diseases should not be admitted to any of the general sewers of the barrack, and should be disinfected before admission to any sewer. This recommendation was contained in our preliminary report. All stone drains conveying sewage or connected with drains conveying sewage should be replaced by stone-ware pipes.

Re-arrangement of hospital drainage.

6. That the defective water-closets used by the servants of the cavalry officers' mess should be reconstructed, and all other water-closets looked to. This was recommended in our preliminary report, and has been already attended to.

Reconstruction of certain water-closets.

7. That the connections of all water-closets, latrines, urinals, sinks, &c., with the main sewer should be carefully examined by the smoke test, and all defects remedied. This work has already been carried out while this report was in preparation.

Examination of W.C. connections.

8. That the present system of trough latrines used by the soldiers should be discontinued, and wash-out closets of a simple pattern substituted.

Discontinuance of trough latrines.

9. That galvanised-iron urine receptacles should be substituted for the present wooden urine tubs.

Galvanised-iron urine receptacles.

10. That wash-out closets should be provided for the use of the women and children.

Wash-out closets.

11. That the ash-bins should be kept as far as possible from the windows of inhabited houses, and some method adopted for the removal of their contents which would cause less disturbance and less dust than that employed at present. That ordinary surface gully-traps should not be used as receptacles for slops and kitchen washings.

Position of ash-bins.

12. That the present system of ventilating the main sewers by shafts, against or in the immediate vicinity of inhabited buildings, should be discontinued, and that the ventilation by gratings over the sewers should also be given up; and that in future the sewers should be ventilated by single up-cast shafts placed so as to be clear of all buildings.

Improved system of ventilating main sewers

13. That proper measures should be taken in the Dublin Garrison generally for the isolation of cases of infectious disease, and that the present

Isolation of infectious diseases.

hospital for fever cases in Arbour Hill should be disused for such purpose, and a new hospital constructed, either there or elsewhere.

Care to be taken with regard to milk supplies.

14. That care be taken to procure supplies of pure milk for the barracks, as the milk hitherto provided was grossly adulterated, and might have contained the germs of infectious disease. Boiled milk is not likely to produce disease.

We believe if the foregoing recommendations are adopted that the health of the troops in the Royal Barracks will be much improved, and the predisposing causes of enteric fever in the barracks mitigated as far as possible.

We beg to remain,
Your obedient servants,

THOS. W. GRIMSHAW.
CHARLES A. CAMERON.

Colonel Marsh, R.E.,
&c., &c.

CASES of Enteric Fever in the Royal Barracks, including Arbour Hill Military Prison,
Hospital, &c.

Corps.	Regimental No.	Rank.	Name.	Admitted.	Discharged or Died.	Result.	Where Originated.
2nd D. Guards 57th Regt. ..	.. 401	Lieut. .. Private ..	Lambert .. Read, G. ..	1879 : 26.10.79 14.12.79	26.11.79 .. 18.12.79 ..	Recovered. To Portobello, but not on books.	Palatine Square.
2nd D. Guards	..	Servant ..	Baltine, Major	79			
Scots Greys	..	Lieut. ..	Mitchel-Henry	1880 : 2.10.80	30.11.80 ..	Recovered.	
"	..	" ..	Hamilton ..	18.10.80	7.11.80 ..	Died.	
"	..	" ..	Hibbert ..	80			
			Daughter of Gen. Glynn	80			
2nd D. Guards	..	Lieut. ..	Harris ..	1881 : 22.3.81	12.4.81 ..	Recovered.	
2nd D. ..	..	Private ..	Brown ..	81			
80th Regt. ..	..	" ..	Bourne ..	81			
		Capt. ..	Creek, D.A.A.G.	81			
1st Shrops. ..	2032	Private ..	Jones, F. ..	1882 : 20.5.82	To Portobello 25.5.82	"	" "
21st Hussars	1853	" ..	Dunne, R. ..	23.8.82	To Portobello 24.8.82	Died ..	No. 6 attic, Horse Square.
"	1611	" ..	Toomes, E. ..	8.82	To Portobello 24.9.82	Recovered	N.W. of Royal Square.
1st Devon ..	2507	" ..	Goodsland ..	23.10.82	To Portobello 25.10.82	Died ..	Ground floor, Royal Square.
1st K. R. R.	..	..	Mrs. E. Short	27.11.82	To Portobello 28.11.82		With the 1st Devon in R. Barracks.
"	117	Private ..	Welsh ..	4.12.82	To Portobello 7.12.82	Recovered	47 room, 3rd floor, Palatine Square.
21st Hussars	..	Lieut. ..	Richmond ..	82	22.12.82		
60th Rifles ..	..	Lieut. ..	Thistlethwaite	1883 : 15.10.83	18.12.83 ..	"	
1st K. R. R.	620	Lce.-Corp.	Gardiner ..	1.11.83	20.12.83 ..	"	41 room, 2nd floor, Palatine Square.
18th Hussars	..	Child and Nurse	Colonel Malet	6.83			
"	..	..	Wife of Sergt- Major				
1st K. R. R.	5626	Private ..	Bailey.. ..	1884 : 23.3.84	20.6.84 ..	"	47 room, 3rd floor, Palatine Square.
18th Hussars	..	Boy ..	Sefton ..	1885 : 8.6.85	To Portobello 15.6.85	"	Arbour Hill.
"	2545	Private ..	Creswell, H. ..	11.7.85	17.9.85 ..	"	R. B.
"	2814	" ..	Brown, J. ..	6.8.85	9.10.85 ..	"	4 attic, Horse Square.
2nd Border ..	1479	" ..	Walsh ..	1886 : 22.3.86	11.4.86 ..	Died ..	R. B.
"	..	" ..	Claydon ..	31.3.86			
"	1388	" ..	James.. ..	26.5.86	22.7.86 ..	Recovered	40 room, Palatine Square.
Lincoln Regt.	1458	" ..	Glinn ..	16.6.86	6.8.86 ..	Died ..	44D., Palatine Square.
Border Regt.	800	" ..	Parry ..	25.9.86	25.11.86 ..	Recovered	Not known, R. B.
4th D. Guards	..	Lieut. ..	Brinkley ..	6.10.86	25.12.86 ..	"	R. B., Palatine Square.
Lincoln Regt.	*459	Lce.-Corp.	Richardson ..	8.10.86	23.12.86 ..	Died ..	55 room, Palatine Square.
4th D. Guards	2906	Private ..	Herridge ..	30.10.86	18.2.87 ..	Recovered	Gar. Canteen.
"	..	Captain ..	Sandys ..	10.86			

CASES of Enteric Fever in the Royal Barracks, including Arbour Hill Military Prison, Hospital, &c.—*continued.*

Corps.	Regimental No.	Rank.	Name.	Admitted.	Discharged or Died.	Result	Where Originated.
4th D. Guards	873	Private ..	Woodman ..	1886 : 9.11.86	29.11.86 ..	Died ..	A house, Cavendish Square
Lincoln Regt.	120	Sergeant	Twilly.. ..	7.12.86	16.12.86 ..	" ..	46 room, Palatine Square.
M. S. Corps. .	7208	Private ..	Hitchison, R...	1887 : 25.1.87	7.3.87 ..	Recovered	Hospital, Arbour Hill.
4th D. Guards	..		Mrs. Walsh ..	6.3.87	13.4.87 ..	Recovered	1st floor.
"	..		Mrs. Greatwich	10.3.87	13.4.87 ..	"	"
Lincoln Regt.	1591	Private ..	Ashley, G. ..	7.5.87	27.6.87 ..	"	47 " room, Palatine Square, 1st floor.
"	156	"	Barrett, H. C. .	11.6.87			50 room, Palatine Square, 1st floor.
M. S. Corps. .	7164	"	Farrell, P. ..	16.6.87			7 room, H. T. house, Arbour Hill.
Lincoln Regt.	2807	"	Claydon, H. ..	8.7.87			44 room, Palatine Square, 2nd floor.
2nd Rl. High.	3097	"	McKenzie — ..	14.7.87			5 room, Royal Square, 2nd floor.
"	2887	"	Slater	15.7.87			3 room, Royal Square, 1st floor.
Lincoln Regt	1751	"	Coe	15.7.87			27 room, Palatine Square, 1st floor.
2nd Rl. High.	..	"	Todd	14.7.87			3 room, Royal Square, 1st floor.
"	3014	"	Robertson, J... ..	17.7.87			" "
"	2214	Corporal..	Michie, W. ..	17.7.87			" "
Lincoln Regt.	..	Private ..	Carlisle — ..	18.7.87			44 " room, Palatine Square, 2nd floor.
"	1762	"	Norton, G. ..	30.7.87			40 room, Palatine Square, 2nd floor.
"	1866	"	Frostich, E. ..	30.7.87			" "
2nd Rl. High.	2057	Lie.-Corp.	Mitchell, G. ..	2.8.87			2 room, Royal Square, ground floor.
Lincoln Regt.	1704	Private ..	Benham, R. ..	6.8.87			41 room, Palatine Square, 1st floor.*
"		" ..	Woodhouse, J.	26.8.87			52 room, Palatine Square.
4th D. Guards		" ..	Woods, A. E... ..	29.8.87			8 room, "C" block, Horse Square.
M. S. Corps. .		" ..	Syer, J. ..	31.8.87			"
2nd Rl. High.		" ..	Boyd, H. ..	15.9.87			"
4th D. Guards		Lie.-Corp.	Downes ..	16.9.87			3 attic, over 28 stable, Horse Square.
2nd Rl. High.	3179	Private ..	Norris.. ..	10.10.87			"D" house, Royal Square, 1st floor, 3 room.
"	..	Lie.-Corp.	Cameron ..	11.10.87			No. 6, "C" house, Royal Square.
"	3114	Private ..	Souter ..	13.10.87			"A" house, Royal Square, 1st floor, 3 room.
4th D. Guards	..	Lieut. ..	Woodwright..	10.87			A. A. Gen.'s Qrs., 2nd or top floor.

* Admitted with pneumonia on 17th July, day after he arrived from Pigeon House Fort.

THE COMMANDING ROYAL ENGINEER.

Sir,

With reference to our conversation at the Royal Barracks on August 11, 1887, and previous visits to those barracks, we have considered several questions which have a special relation to the condition of the sewer which drains the hospital and other premises in Arbour Hill, and the buildings situated on the western side of the Royal Barracks proper.

Preliminary Report.

Having regard to the facts ascertained during the course of the inquiry at present going on with respect to the sanitary condition of the Royal Barracks, we think it right not to lose any time in calling special attention to the defects in relation to this particular sewer, and making some recommendation for their early abatement.

Special attention called to sewer-draining hospital, &c

The following facts have been ascertained, and have certainly important bearings upon the question of the prevalence of enteric fever in that portion of the barracks connected directly or indirectly with this sewer.

1st. The sewer receives the drainage of the hospital in Arbour Hill where enteric fever cases are treated. Thus the excreta from the fever patients passes through the whole length of the west side of the barracks from end to end, and becomes a source of danger at each point where there is any communication between the sewer and the external air, if such communication opens in the immediate vicinity of places frequented by any of the inhabitants of the barracks.

Source of danger.

2nd. This sewer is ventilated by shafts and gratings, many of which open into the Royal Barracks and Arbour Hill premises. Of the shafts three are situated in the Royal Barracks proper—one being against the wall of the block of houses (A and B) in Cavalry Square containing the cavalry officers' mess, and the quarters of some of the officers. In this building cases of enteric fever occurred among the officers, and in a mess servant.

Method of ventilation considered defective.

On applying the smoke test to this shaft, we observed that the smoke in issuing from the shaft circulated in various directions, and fell below the level of the windows of the upper rooms, proving that the sewer gas issuing from this shaft might at any time take the same course and poison the atmosphere of these rooms, and possibly of the whole houses.

3rd. A second shaft rises to the ridge of the roof near the south-west corner of the Horse Square, and it terminates against a chimney stack in the immediate vicinity of one of the ventilators of the barrack rooms, through which, at any time, the sewer gas might enter, and possibly contaminate the atmosphere of the rooms below. This shaft was only erected three months ago, and no cases of enteric fever have arisen in this building.

4th. A third shaft near the recreation rooms, although objectionably situated, does not appear to be a source of great danger.

5th. Ventilating gratings exist in the sewer as it passes through the Arbour Hill premises. These gratings are directly over the course of the sewer, and as the roads are metalled with small shingle, the stones fall into the sewer, forming little dams across the current, which cause a considerable amount of deposit in the sewer.

Attached to the cavalry officers' mess and quarters are two sets of closets and latrines, one used by the men servants. This closet was found to be very badly constructed, the covering of the drain consisting of wood upon which the pans and traps were set. The wood was rotten, and allowed the abundant escape of sewer gas; the pipes connecting these latrines with the main sewer were badly laid, crooked, and leaky. The closets used by the officers were in good order and safe, and the pipe to the main, although badly laid and crooked, was safe and not leaky. A latrine in close proximity used by the women and children of the regiment, was not clean, but safe, and in good order.

Closets attached to cavalry officers' mess and quarters.

We recommend: 1st. That the hospital drains should be disconnected with the main sewer, and that a separate sewer (say a 9-inch pipe) for the hospital should be constructed independent of the main, and that all matters coming from the hospital should be thoroughly disinfected before admission to the sewer. The latter of these recommendations should be immediately carried out.

Disconnection of hospital drains recommended.

2nd. That the ventilators from the main sewer at the cavalry officers' mess and the corner of Cavalry Square should be *immediately* removed, and that at the recreation rooms only retained so long as to permit of the erection

Removal of certain ventilators advocated.

of a proper ventilating shaft, clear of all buildings, and with a constant upcast current. While this shaft is retained it should be lengthened, and it is now too close to the windows.

Abolition of ventilating grates of sewer. Reconstruction of latrines. Thorough examination of latrine, &c., connections.

3rd. That the ventilating grates of sewer now in the Arbour Hill premises should be abolished.

4th. That the latrines for the servants of the cavalry officers' mess should be entirely reconstructed.

5th. That a thorough examination should be made of all connections between latrines, urinals, sinks, &c., on the line of the main *western* sewer, and all defects remedied. This is necessary, as the defects discovered raise a suspicion as to the efficiency of the connections at all points along the sewer.

(Signed) THOS. W. GRIMSHAW.

(Signed) CHARLES A. CAMERON.

Dublin, August 13, 1887.

**Précis of a Report dated 23rd November, 1887, by
Sir C. A. Cameron, Superintending Medical
Officer of Health for Dublin, and Dr. Grim-
shaw, Registrar-General of Births, Deaths,
&c., on the Prevalence of Enteric Fever in the
Royal Barracks, Dublin.**

Circumstances connected with the prevalence of enteric fever in the Royal Barracks have been carefully considered, and assistance in the investigation has been obtained from the various departmental officers in charge of the district.

Correspondence upon the question and plans of the drains and buildings of the barracks and adjoining premises in Arbour Hill have been studied.

The report deals with the following heads :—

I.—SITE OF BARRACKS.

Reference
to page of
Report.

Said to be favourably situated, but buildings badly distributed. Geological structure and features of site described. Drainage rather difficult, and arrangements require special attention to make site a healthy one. Surroundings of barracks on the whole not unsatisfactory; the large open space in front conducive to healthiness, were it not for the effluvia from the Liffey, which cannot be considered advantageous.

3

Small tenement houses on the west carefully examined, and found in a healthy condition; but cases of enteric fever, resulting in one death, occurred in one adjacent to cavalry mess-room, and to the latrines used by the cavalry officers, servants, women, and children of the cavalry officers.

II.—PLAN AND STRUCTURE OF THE BUILDINGS.

Distribution peculiar, and not conducive to health of inmates. Dealt with in three groups.

4

1st. *The Eastern*.—Buildings described, interception of light and air pointed out, and the consequent injurious effects noticed. An arrangement more calculated to spread disease could scarcely be contrived. Atmosphere of an adjoining narrow lane close and offensive.

2nd. *The Central*.—Buildings described. Wall of riding-school shuts out a large amount of light and air. Accessories crowded together in an irregular and injurious manner, tending to prevent the free admission of light and circulation of air. Unhealthy condition of lane considered most detrimental.

5

3rd. *The Western*.—Similar unhealthy conditions prevail, especially with regard to another lane.

Structure of Buildings.

A great deal done in the way of modernising the old and badly-planned interior. Age of the buildings a source of difficulty in providing healthy conditions for inmates. Old timber in floors detrimental to health; made worse instead of better by frequent washings; waxing recommended. Stuffy smell observed in many rooms, especially those having windows opening towards the

6

lanes. Air in cavalry soldiers' quarters much purer (although situated over stables), due probably to the fact of their being only two storeys high, not looking into lanes, and having open roof ceilings, with roof ventilation. Cases of enteric fever in quarters occupied by cavalry soldiers are few. Inlets for fresh air too near ceilings; window ventilation altogether under control of men.

Reference
to page of
Report.

III.—SEWERS AND DRAINS.

- 6 Necessarily of a complicated and intricate character. There are four main sewers running down four lanes (already denoted), not similar in their course. These courses and the uses of the drains fully described.
- 7 *Old Drains.*—Difficult question to investigate. Remains of very few met with; none containing any recent sewage matters. Results of the examination of a large and very old sewer; no connection with any buildings traced. Dry deposit, entirely free from smell, found; no others discovered. In some places old drains still exist, and are in use: harmless when only carrying clean surface drainage, but sources of danger under other circumstances; pipes should be substituted. No grounds for believing that the health of the inhabitants of the barracks can be affected by neglected old drains. Commends the recent important drainage works carried out by the Royal Engineer Department, &c., which cannot fail to have a beneficial influence on the health of the troops quartered in the Royal Barracks.
- 7 *Closets, Latrines, Urinals, Sinks, &c.*—Connections in sewer No. 1 dealt with in preliminary report; similar matters on the other lines of sewers should be dealt with in the same manner. Working of the trough system of latrines used by the infantry not considered satisfactory; great risks run by healthy men in using these latrines after other men suffering from enteric fever. Dangerous from this point of view, and sufficient to spread disease. The latrines used by the cavalry somewhat better arranged, but open to similar objections. Closets used by cavalry officers and mess servants remarked on in preliminary report, see pages 25 and 26. No closets in other parts of the barracks found out of order, but application of smoke test to connections recommended and since carried out.
- 8 Latrines used by women and children of an unsatisfactory pattern; not out of order, but untidy, and in several cases not sufficiently clean. Complaints as to want of privacy should receive attention.
- 8 Wooden urine tubs most unsuitable. Galvanised-iron vessels considered superior. Practice of emptying foul water into gullies unsatisfactory. Repairs required to some parts of the surface of the barrack squares.
- 8 *Ventilation of Sewers and Soil Pipes.*—Carried out by means of gratings in the ground opening directly into the sewer, and by iron ventilating shafts placed against buildings or walls. The arrangement for each of the four sewers described. Danger attending the system as regards proximity of inhabited buildings or much frequented spaces pointed out.
- Ventilation of soil-pipes of water-closets seems to be effectually carried out, except in some isolated cases, viz., those used by the servants of the cavalry officers and the mess, and in the latrines for women and children, all of which should be properly ventilated, and supplied with fresh air inlets.

IV.—WATER SUPPLY, MILK SUPPLY, AND IMPURITIES OF THE AIR.

9 *Water Supply to the Barracks.*

Supplied by the pipe-water of the city; of good quality; taken from taps attached to the main-pipes, and not from cisterns. Water considered perfectly safe for all possible purposes.

Milk.

- 9 Specimens of the milk delivered at all the Dublin Barracks analysed on the

25th August, 1887, in most cases proved to be of very bad quality. Adulterations with water ranged from 13 to 56 per cent. at the Royal Barracks, and from 15 to 50 per cent. at other barracks. Some samples were of doubtful purity, and a few were fairly or decidedly good.

Unable to ascertain if there were in 1886-7 any cases of typhoid fever amongst the persons supplying milk to the Royal Barracks. Dairy yards found in a fairly good state, though not as perfect as could be desired. Supplied with Vartry (Dublin) pipe-water, not likely to cause typhoid fever.

Period of sending out the Dublin dairy cows to grass land. Coincidence of the occurrence of 46 out of 60 cases of typhoid fever in the Royal Barracks, during the months the cows were at grass. Possibility of the milk being adulterated at that time with impure water obtained from wells, streams, or ponds in the country considered.

Organisms in the Air of the Barracks.

Result of a comparison between the air of the Palatine Square and that of the confined space between Royal Square and Palatine Square. Method proposed by Dr. Percy Frankland adopted.

In central part of Square 74 micro-organisms per minute fell upon each square foot, and 202 in the space between the two Squares. The collection was made between three and four in the afternoon, but, had it taken place earlier in the day, when cooking and cleaning were going on, the difference would probably have been more marked.

V.—THE PREVALENCE OF DISEASE AND MORTALITY.

Necessity in discussing the prevalence of enteric fever in Royal Barracks, of considering not only the health of the troops therein, but its relation to troops stationed elsewhere, and to the civil population, and whether other forms of disease known to prevail under similar conditions to enteric fever have also prevailed in Royal Barracks.

Table showing the principal diseases in connection with sewer exhalations or sewer-gas contamination of the air annexed, 1883-87. It comprises enteric fever, diarrhoea, diphtheria and pneumonia, and shows 5 deaths from enteric fever, and 6 from pneumonia. Reasons for including the latter given.

Prevalence of diarrhoea not always brought to the notice of the medical authorities. Reference made to the tendency which certain forms of disease have to prevail on the littoral gravel bed in Dublin—shown to be true as regards cholera; means taken to test this fact in connection with enteric fever by comparison of a street list of deaths from that disease with a map upon which the outcrop of the littoral gravel bed was marked, specially prepared for the purpose at the R.E. Office.

Ratio for death-rate among the populations on and off the gravel, respectively, from Jan. 1, 1882, to May 31, 1887, found to be 1.5 and 1 (table annexed).

Further confirmation of the above, and expression of opinion that the situation of the barracks is to some extent favourable to the prevalence of enteric fever; a note made, however, that in the adjoining premises of the Blue-coat School there were very few cases of enteric fever. These cases attributed to the opening up of some old drains in adjoining premises (not the barracks).

Occurrence of cases among civil population adjoining the barracks do not seem, however, to denote any special prevalence of enteric fever in the immediate vicinity of the barracks, as compared with other portions of the city similarly situated.

Comparison of relative healthiness of the troops in Dublin with other places:—

Tables prepared showing relative mortality of the troops in the United Kingdom, in Ireland and in Dublin during the period 1881 to 1885; the relation between the mortality of the troops and the general population; the relative mortality among the troops from certain zymotic diseases, and from enteric fever especially.

STATIONS IN ALL
TABLES.

— 13
United Kingdom,
Ireland.
Belfast District.
Cork District.
Curragh District.
Dublin District.
Dublin Garrison.
Home and Wool-
wich District.

- The relation between the prevalence of zymotic disease and enteric fever, especially among the troops in Dublin, as compared with the troops generally in the United Kingdom and certain districts and localities.
- 13 Only ages dealt with in detail are those between 15 and 45, as nearly approximating the range of ages among the troops. Special importance of this arrangement, as enteric fever is confined almost entirely to persons who have not passed middle life—soldiers therefore liable. Reasons given why they should not be more liable to the disease than the general population; rather the contrary.
- 13 Table of comparison between troops in Dublin and troops elsewhere as regards prevalence and fatality of enteric fever.
Average rate of admissions to hospital per 1000 for three years 1883-5 in the Dublin garrison 3·5, as compared with 2·5 for Home and Woolwich districts, 1882-5, showing an excess of 1·0 in the Dublin rate.
- 14 Table showing *mortality* per 1000 strength from enteric fever; same stations. Death-rate among the troops in Dublin garrison considerably more than double that from the same cause among the troops generally.
- 14 Table showing *deaths* per 1000 strength from *all causes* (1881 to 1885); same stations.
Dublin garrison (1883-5) but slightly over the average of the troops in United Kingdom, and lower than Army rate in Ireland, and even in the Dublin district.
- 14 Table of *admissions*. Febrile zymotics per 1000 strength (1881-85); same stations. Dublin garrison showing the highest figure, viz., 42·5.
- 15 Table of *mortality* in reference to above. Average highest for Dublin, viz., 2·3 per cent. of admissions.
- 15 Table showing *mortality* from *enteric fever* in relation to *admissions* to the military hospitals; same stations (1881-1885).
Average rates per cent. for Dublin garrison 22·6, being lower than that for United Kingdom, 23·1.
- 15 Table showing for the *ages 15 years and upwards* the number of cases of enteric fever admitted into Cork Street Hospital, Dublin, during the five years ending 31st March, 1886, with the number of fatal cases and rate of mortality per cent. of admissions; average 12·4.
- 16 Table showing the *average annual mortality* during the five years 1881-5 amongst the troops stationed in various parts of the United Kingdom, compared as far as practicable with the average mortality for the same period amongst males aged 15 and under 45 in the general population of the same localities.
Death-rate among troops *generally* lower than that of general population, same ages.
From *febrile zymotics* about the same; rather lower in some cases.
From *enteric fever* higher.
Conclusions drawn from foregoing statement:—
- 16 1. General death-rate of the military as compared with the general population in Dublin extremely favourable.
2. Death-rate from febrile zymotics lower than that of the population generally; difference not so great as that between rates for all cases.
- 17 3. Death-rate from enteric fever much in excess of that of the civil population.
4. Enteric fever more fatal, and probably more prevalent, in the Army than in the population generally.
5. Excess of prevalence of enteric fever among troops in Dublin as compared with other Irish districts, London districts, Ireland and United Kingdom generally.
6. Similar condition exists regarding zymotics generally.
7. Forms of febrile zymotics among troops in Dublin garrison and Dublin military district are more severe or are treated under less favourable circumstances than elsewhere in the United Kingdom.
8. That, measured by the deaths per 100 admissions, enteric fever among troops in Dublin is more severe than among the troops in other parts of Ireland or in the London district, but *not* as severe as the Army average for the United Kingdom. Fever among troops more severe than among the general population in Dublin.
- Attention called to the remarkable fact that enteric fever seems to be more

prevalent among soldiers than among the civil population, although in other respects the health of the troops is better than that of the civil population.

Accounted for, probably, by the fact that the Army may be looked upon as a distinct community, living under special circumstances.

Difficulty of eradicating enteric fever when it gets a foothold in a community. Peculiar liability of this fever to attach itself to a particular locality. 17

Use of common latrines tends to maintain and multiply the poison of enteric fever in the Army. How healthy regiments are affected in this way. System of distribution of troops requires special precautions. Not surprising to find enteric fever appearing in any barracks, and it has prevailed from time to time in all the Dublin barracks. 17

Strongly recommended that a thorough cleansing and disinfection of all latrines, and sewers connected therewith, should take place on the departure of each regiment or a detachment from a barrack, before it is re-occupied. 17

Special distribution of the disease in the Royal Barracks considered. Comparison between the number of *cases* occurring in the Royal Barracks in each year, 1879-1887 (66 in all), with the number of *deaths* from enteric fever recorded in each of those years in the Dublin Registration District shows that the prevalence of enteric fever in Royal Barracks did *not* correspond with that among the civil population, but *vice versa*, except in the current year, in which there appears to be a severe epidemic both in the barracks and district. 18

Conclusion drawn that there are causes in existence in connection with the troops quartered in the Royal Barracks which tend to maintain the disease there independently of its general prevalence in Dublin. 18

Explanatory map annexed, showing the localities of origin of all the known cases of enteric fever. Cases found to be grouped in certain localities. Cases of earlier date grouped in Cavalry Square, and occurred among the officers, women, and children of the cavalry. One officer, who frequented the cavalry mess, but lived in Palatine Square, was also attacked. Other groups situated on west side of Palatine Square and on west side of the Royal Square, in buildings overlooking the unhealthy lanes frequently referred to; no other special groups—other cases all scattered. Isolated cases may be expected among men quartered in the same buildings where groups of cases occur. 19

Disease only prevalent in an epidemic form among the officers, women, and children of the cavalry, and among the men located in certain portions of the infantry quarters. Cases amongst officers fairly attributed to causes shown to exist in connection with cavalry mess; those among women and children to the constant use of the rather ill-kept latrines in the lane along the west side of barracks. Cases amongst men of the infantry through common use of latrines, and unfavourable hygienic conditions under which they are quartered. Attention called to the suspicious nature of the milk supplies, which, although not exactly a cause of infection, may have been a source of mischief, and one which should be provided against in future.

VI.—DEFECTS FOUND TO EXIST.

1. *Site of the Barracks*—only in standing on the gravel bed, difficult of drainage, and favourable to spread of certain forms of disease, including enteric fever. 19

2. *Buildings* in many places in too close proximity.

3. *Old timber* in floors kept in a state of dampness by washing, maintaining a damp atmosphere, and promoting further decay.

4. *Ventilation* insufficient; windows too much under control of the men.

5. *Sewerage* from hospital, containing excreta of the enteric fever cases, allowed to pass into one of the main sewers of the barrack, the sewer having been ventilated in dangerous proximity to inhabited buildings.

6. *A defective water-closet* near the mess-room and quarters of the cavalry officers. 20

7. *Connections* of above water-closet with main drain found very defective doubt implied as to efficiency of other similar connections.

8. *Concentration* of excreta at certain fixed points undesirable. *Latrines* used by infantry badly planned. Those used by cavalry better constructed, but nevertheless dangerous.

9. *Urine tubs* used at night, made of wood, cannot be properly cleaned. Found to be offensive even after being scrubbed.

10. *Latrines* used by women and children are of bad pattern, liable to become foul even when in good order.

11. *Refuse removal arrangements* defective. Dust-bins badly situated; some surface-drainage gullies are used as slop-sinks and become offensive. Surface of ground in one place uneven, and allowed slush to accumulate.

12. *Arrangements for ventilating sewers* dangerous, and likely to spread disease; ventilating shafts badly placed, and in dangerous proximity to inhabited houses.

13. *Hospital arrangements* very unsatisfactory. Principle of treating fever cases, or indeed cases of any infectious disease in hospitals in so many places, is calculated to maintain centres of infection in various barracks. Practice of moving patients suffering from infectious disease from one barrack to another injurious.

Buildings used for hospital in Arbour Hill not such as are found in well-constructed modern hospitals. Many of the wards are small and have low ceilings.

VII.—RECOMMENDATIONS.

1. A thorough subsoil drainage of the whole site of barracks, and an extension of the dry area system. Removal of all irregularities, and rendering surface of ground impervious—covering polluted ground with some such material as hygienic cement.

2. Removal of considerable portions of the present buildings; complete destruction of the narrow lanes to which attention has been called. Buildings to be removed are shown on Plan 2, viz., the whole of the eastern side of Royal Square; the whole of the eastern side of the Horse Square; the whole of the eastern side of Cavalry Square; the eastern end of the block of buildings separating Cavalry Square from the Horse Square; the riding-school north of Royal Square; the cook-houses near the riding-school; several small buildings marked to the north side of Palatine Square, and several small buildings on the terrace to the north of the cook-houses and riding-school already mentioned.

Removal of boundary wall along Arbour Hill where marked, and replacement by railings; lowering of wall between boundary wall and the quarters.

Removal of the magazines on the terrace to the north; the terrace to be sloped down; the terrace to the eastern side of the barracks in front of officers' stables to be sloped down. Removal of all the small buildings at present in the lanes and yards. (Plan 3 shows the barracks as it would be after proposed demolitions have been carried out.)

Ground floor of north side of Palatine Square to be disused for habitation and only utilised as stores.

If cavalry be removed, ample space will be available for the provision of accommodation in substitution of that furnished by the buildings proposed to be demolished.

In redistributing the quarters, the portion appropriated for residence should be on the higher part of the ground.

3. Removal of all very old timber—especially from floors; replacing with new wood, and all floors to be rendered impervious.

4. Ventilation of barrack rooms by "Tobin's tubes," or some contrivance which would cause a free circulation of air. Slip-boards to be placed under the lower window-sashes.

5. Drainage from hospital to be so arranged that sewerage containing discharges from patients with infectious diseases should not be admitted to any of the general sewers of the barrack, and should be disinfected before admission into any sewer

ROYAL BARRACKS DUBLIN.

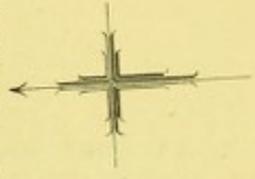
PUBLIC ROAD.

PALATINE SQUARE.

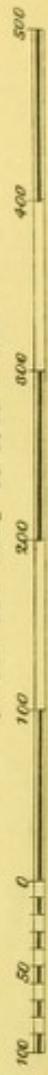
ROYAL SQUARE.

STABLE SQUARE.

CAVALRY SQUARE.

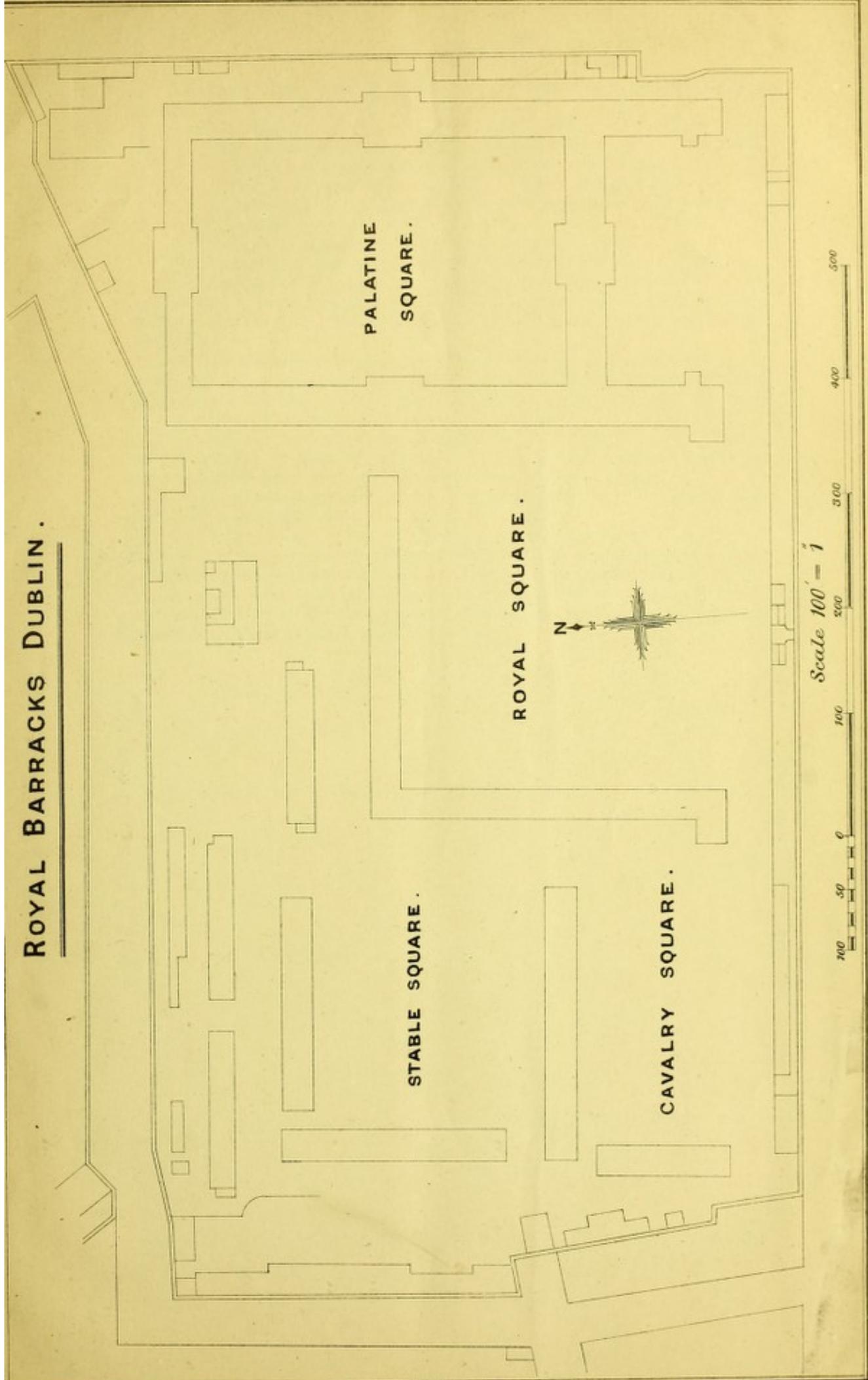


Scale 100 feet to one inch.



ALBION BRIDGEWAY DISTRICT

ROYAL BARRACKS DUBLIN.



DANCEFIELD & CO. ARCHT. 22 BEDFORD ST. COVENT GARDEN. 1854-55-1/88.

ВЕРХНЯЯ КОЛОНКА

ПОСРЕДНЯЯ КОЛОНКА

НИЖНЯЯ КОЛОНКА

ПОСРЕДНЯЯ КОЛОНКА

All stone drains conveying sewage, or connected with drains conveying sewage, to be replaced by stone-ware pipes

6. Reconstruction of defective water-closet used by servants of cavalry officers' mess, and all other water-closets to be looked to. (Since attended to.)

7. Examination of connections of all water-closets, latrines, urinals, sinks, &c., by the smoke test, and defects remedied. (Since carried out.)

8. Discontinuance of trough latrines, and substitution of wash-out closets of a simple pattern.

9. Substitution of galvanised-iron urine receptacles for tubs.

10. Provision of wash-out closets for the use of the women and children.

11. Ash-bins to be kept as far as possible from the windows of inhabited houses, and a better method contrived for the removal of their contents. Ordinary surface gully-taps not to be used as receptacles for slops and kitchen washings.

12. Discontinuance of present system of ventilating main sewers by shafts against, or near, inhabited buildings; the giving up of the ventilation by gratings over the sewers; sewers in future to be ventilated by single up-cast shafts, placed so as to be clear of all buildings.

13. The adoption of proper measures in the Dublin Garrison generally for the isolation of cases of infectious disease. Disuse of present hospital at Arbour Hill for fever cases, and the construction of a new hospital.

14. Care to be taken in regard to supply of pure milk. (*Boiled* milk not likely to produce disease.)

22

Concluding opinion: That if the foregoing recommendations are adopted, the health of the troops in the Royal Barracks will be much improved, and the predisposing causes of enteric fever in the barracks mitigated as far as possible.

Annexed is a table of cases of enteric fever in the Royal Barracks, including Arbour Hill, military prison, hospital, &c., giving the fullest particulars obtainable. (Period, 1879 to 1887.)

23 and 24

PRELIMINARY REPORT DATED 13TH AUGUST, 1887, REFERRED
TO OCCASIONALLY IN GENERAL REPORT.

25 Special attention called to defects in the condition of the sewer which drains the hospital and other premises in Arbour Hill, and the buildings situated on the western side of the Royal Barracks proper.

1. Source of danger said to be the passing of excreta from the fever patients through the whole length of the west side of the barracks from end to end.

2. Another source of danger arises from the ventilation of the sewer by shafts and gratings, many of which open into the Royal Barracks and Arbour Hill premises (proved by the application of the smoke test).

One shaft especially referred to as being against the wall of A and B houses in Cavalry Square, where some cases of enteric fever occurred.

3. Another shaft erected three months ago, near south-west corner of the Horse Square, considered dangerous.

4. A third shaft, near the recreation rooms, objectionably situated, but not a source of great danger.

5. Stones falling into the sewer through the ventilating gratings form little dams across the current, and cause considerable amount of deposit in the sewer.

6. Bad construction of closet used by the men-servants of cavalry officers' mess. Pipes connecting latrines with main sewer badly laid.

RECOMMENDATIONS.

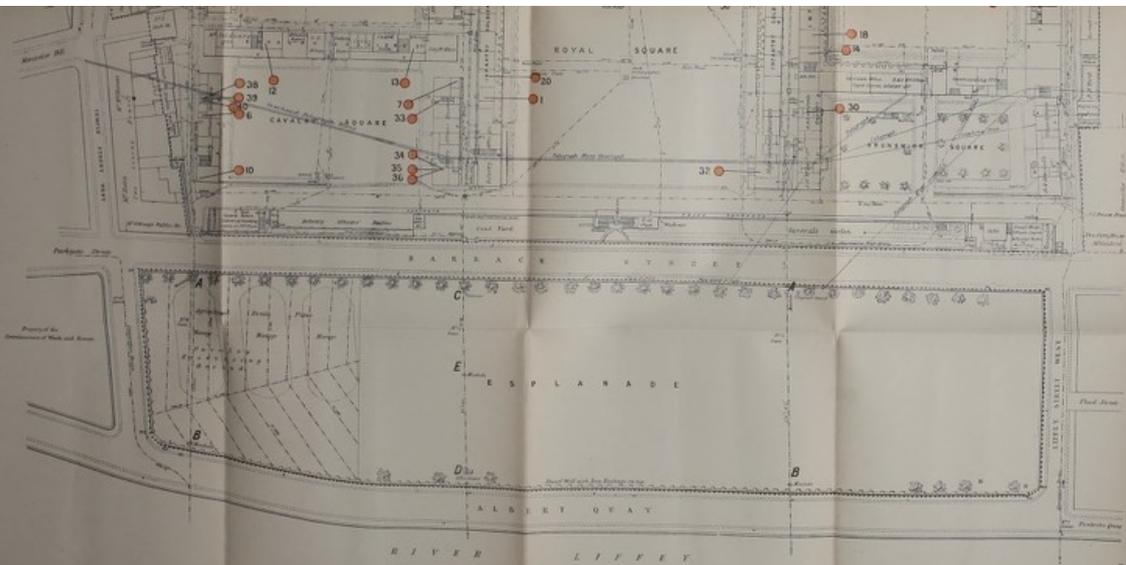
25 1. Hospital drains to be disconnected from main sewer, and separate sewer (9-in. pipe) to be constructed for the hospital independent of the main.

2. Ventilators from main sewer at cavalry officers' mess and corner of Cavalry Square to be immediately removed. That at the recreation room only retained so long as to permit of the erection of a proper ventilating shaft clear of all buildings, &c. Lengthening of shaft while retained advocated.

26 3. Abolition of ventilating-grates of sewer now in the Arbour Hill premises.

4. Entire reconstruction of latrines for servants of the cavalry officers' mess.

5. Thorough examination to be made of all connections between latrines, urinals, sinks, &c., on the line of the main *western* sewer, and all defects remedied.



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