Report on the epidemic of enteric fever in 1893, in the borough of Worthing, in Broadwater, and in West Tarring / by Charles Kelly.

REPORT ON THE EPIDEMIC

OF

ENTERIC FEVER

IN 1893,

IN THE

BOROUGH OF WORTHING,

IN

BROADWATER, AND IN WEST TARRING,

BY

CHARLES KELLY, M.D., F.R.C.P.,

MEDICAL OFFICER OF HEALTH FOR WEST SUSSEX.

PROFESSOR OF HYGIENE IN KING'S COLLEGE, LONDON.

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HEALTH DEPARTMENT,

TOWN HALL, WORTHING,

June 30th, 1894.

To the Town Council of the Borough of Worthing.

MR. MAYOR AND GENTLEMEN,

I herewith submit to you my report on the prevalence of enteric fever within the Borough and in the neighbouring villages of Broadwater and West Tarring during 1893.

It shows how the whole population was exposed to danger in consequence of the public water supply having become polluted, how area after area became effected, and how persistently the epidemic ran its course.

It further shows the difficulty that was found in determining the wholesomeness of a drinking water; of the three tests, the chemical, the bacteriological, and the clinical, the first and the second afforded but scanty help, while the third, the test on man himself, was the only one that led to a correct conclusion.

It emphasises the importance of carrying out as soon as possible the new waterworks which are now in progress, and which, when completed, will supply the Borough with good water taken from the Chalk Downs far away from any populous area.

The new drainage and sewerage works will include the construction of large reservoirs whence the sewage can be pumped out to sea, and thus any tide-locking will in future be avoided.

The West Worthing sewage will henceforth discharge into Worthing system, and pass into the sea at the eastern outfall.

These improvements will take some months before they are complete, but in the meantime the Borough has been in a very healthy state.

During the half-year just completed there has not been any death from enteric fever, and the general death-rate from all causes has only been at the rate of 12·5 per 1,000 persons living.

The story that I have to tell is already a story of the past.

I have to offer my thanks to all the officers of the Town Council for the information they have so kindly rendered; to Mr. R. Grevett, the Registrar of Births and Deaths; to Mr. E. H. Grant, and to Mr. Vail of Littlehampton, for assistance they have given me; and most of all to Mr. Gardner, Sanitary Inspector, whose valuable services during the epidemic I especially wish to record.

I have the honour to be,

Your Obedient Servant,

C. KELLY.

REPORT ON THE EPIDEMIC OF ENTERIC FEVER IN 1893,

IN THE

BOROUGH OF WORTHING, IN BROADWATER, AND IN WEST TARRING.

The great epidemic of enteric fever in 1893 began in the spring and lasted until the end of the year. It affected not only the Borough of Worthing, and the adjoining villages of Broadwater and West Tarring, but it was also met with in many adjacent parishes, and it spread in several cases to large towns and distant places.

The storm which was presently to burst with such severity, was preceded in the third and fourth weeks of April by a marked prevalence of diarrhœa which attacked persons of all ages and classes, but which did not prove fatal. No special notice was taken of this disturbance, and no clear facts are forthcoming as to its clinical history, but it was at the time put down as due to climatic changes, and perhaps to the very dry weather. It is mentioned here because a similar experience was met with at Arundel in the autumn of 1890, where an outbreak of enteric fever, due to polluted water, was distinctly preceded by severe attacks of diarrhœa a month or six weeks previously.

Diarrhœa is not a notifiable disease, but when it occurs in abundance in any particular district, and only to a limited extent, or not at all, in adjacent areas, it should henceforth be examined into with much care, as it may prove to be the precursor of more serious trouble.

It is not clear whether this antecedent diarrhœa bears any relation to enteric fever, whether it may be due to a limited action of the poison which hereafter is about to produce worse results, or whether it predisposes a community to enteric fever by setting up an altered condition of the bowel so as to render it favourably situated for further attack.

This, however, seems clear that many who had diarrhœa also suffered from enteric fever afterwards, but conversely numbers who had enteric fever did not suffer from previous diarrhœa.

At present our knowledge seems limited to the fact that just as in times of prevalence of diphtheria there are numerous instances of antecedent sore throats in the affected area, so with enteric fever there are antecedent cases of diarrhœa in the same area.

THE FOUR AREAS.

The areas affected by the epidemic will be best understood by reference to the coloured charts 1 and 2.

There are here four distinct divisions, which should be carefully noted, as the variations in each division of the water supply and sewerage arrangements will serve to explain the behaviour of the outbreak and the extent of its incidence. No town could have been better plotted out so as to show more clearly the facts whence the cause may be made more evident.

Worthing and West Worthing are to the south of the maps and they have the sea for their lower boundary. Immediately to the north are the parishes of Broadwater and West Tarring, places which are in direct and constant communication with the Borough of Worthing. They have some points in common with each other and with the Borough, but they belong to the East Preston Rural Sanitary District, and therefore they come under a different authority. Each of these two parishes retains in a marked degree the characteristics of rural or village life, yet in each there are areas on which are built houses of a suburban character, and fitted with arrangements for water supply and drainage such as one usually meets with in towns.

It will be seen hereafter that the outbreak chiefly affected those places which had been more recently built, and which were furnished with modern sanitary appliances.

Worthing and West Worthing were separate towns up to 1890, when they were united into the present Borough. Each of these towns has a separate water supply and sewerage system, and up to 1890 each was under a separate sanitary authority.

An examination of chart 1 will show that the whole of Worthing area and a part of Broadwater are supplied from the Worthing waterworks, while the rest of Broadwater is supplied from wells.

The whole of West Worthing area and a part of West Tarring are supplied from the West Worthing waterworks, while the rest of West Tarring is supplied from wells.

In Worthing and also in West Worthing there are a few wells still in use.

An examination of chart 2 will show that the sewerage arrangements of the four areas differ much from those of the water supply. The whole of Worthing and a part of West Tarring have a main system of sewerage which has an outfall to the sea at the east of the town.

The whole of West Worthing has a system of sewerage to itself, and the outfall is to the west of the town.

In the parish of Broadwater there is no public system of sewerage and in this respect it is quite distinct from the other three areas.

PREVIOUS HISTORY.

Enteric fever prevailed in Worthing in the year 1865, due, it was then thought, to defective sanitary arrangements. It was again prevalent in the autumn of 1880, when the outbreak in November occurred specially on those who drank milk from a certain dairy, at which dairy there was a shallow well which had become polluted with sewage. In September of that year, other cases were also met with due to sanitary defects and following upon a very heavy thunderstorm on August 26th, when 1·45 in. of rain fell in rather more than hour, and at a time when there was a high tide and the main sewer was tide-locked.

The history of that epidemic is given in my 7th annual report. Since 1880 there has been nothing to record in the four areas of any special interest.

The number of deaths since 1880 in each area are here given :—

Year.	Worthing.	West Worthing.	West Tarring.	Broadwater.
1881	1	—	—	—
1882	1	—	—	—
1883	2	2	—	—
1884	2	—	—	—
1885	3	—	—	—
1886	1	—	—	—
1887	1	—	—	—
1888	—	—	—	—
1889	2	—	—	—
1890	2	—	—	—
1891	—	—	1	—
1892	2	1	2	—
1893 (1st qrtr.)	2	—	3	—

This table shows that during 1892, and again early in 1893, there was some prevalence of enteric fever in West Tarring, and the facts are seen more clearly when the number of cases are taken into account.

The notifications received from August 3rd, 1890, when the Act came into operation, were thus recorded :—

Year.	Worthing.	West Worthing.	West Tarring.	Broadwater.
1890 (5 months)	9	1	—	—
1891	6	4	—	—
1892	4	16	15	2
1893 (1st quarter).	1	—	4	—

It is important to note that early in 1892 the adjacent districts of West Worthing and West Tarring were affected, and this small outbreak has been duly reported in my 19th annual report. Again in the winter of 1892-93 another series of cases were met with, few in number, but occurring in the same area of new houses in which the previous cases were recorded, and which later in the year was to be the scene of a more serious invasion.

After February 18th, 1893, no cases of enteric fever were notified in any one of the four areas up to the month of May.

Worthing was at that time very free from the disorder. No case had been notified from September 28th, 1892, up to February 18th, 1893, when one case was recorded in the centre of the town, and the

patient died on February 21st, from "inflammation of the lungs and typhoid fever."

A second death took place in Worthing Infirmary on January 17th from "typhoid fever and pneumonia," but this case was never notified, and some doubt existed as to its precise nature.

These two cases occurred several months before the epidemic, and the drainage from the houses in West Tarring passed down the main sewer a long way to the north of the waterworks.

There was, then, nothing in this previous history of the Borough to throw any light upon the outbreak which broke out in May.

COURSE OF THE EPIDEMIC.

TABLE II., giving the dates of notification, shows clearly the progress of the outbreak week by week. After May 8th the new cases followed each other with great rapidity, so that by June 9th, 284 persons had been attacked in Worthing, three in Broadwater, and one in West Tarring, who however had been removed there ill from a house in Worthing.

After June 9th there was a lull which lasted for three weeks. In the first week of July a second storm wave burst over the town, and on July 11th as many as 64 cases were notified in the twenty-four hours.

Chart 3 shows in a coloured and graphic form the rise and fall of the epidemic in Worthing, while charts 6, 7, and 8, show similar facts for Broadwater, West Worthing, and West Tarring.

In tables I. and II. the numbers of those who had probably caught the disease by drinking Worthing water are printed in words and the rest are printed in figures. The first six cases in West Worthing and the first ten cases in West Tarring could, I think, be attributed to having partaken of polluted water from the Worthing waterworks. After that time, the rest of those attacked were affected by drinking water from the West Worthing mains.

Each chart is made on a similar plan, and shows the cases notified from April 15th to November 17th, when the epidemic was practically over; the four cases occurring in December are entered, however, in tables I. and II.

It was soon found that a better idea of the rise and fall of the fever cases could be obtained by inquiring into the date of attack, and this information I obtained from the commencement.

Chart 4 shows the date of attack of each case in Worthing from April 15th to November 17th, and the curves, thus obtained, are more regular and uniform than when notifications only are taken into account. Charts 6, 7, and 8 give similar information for Broadwater, West Worthing and West Tarring. The general course of the curves is similar in each chart, but those cases notified appear, of course, at a later date than those attacked.

The "date of attack" may be defined as the day on which the patient first felt ill enough to go to bed, to send for the doctor, or to leave off work; it was not easy to make a more practical definition.

The tables and charts will make the incidence of the disease in each area more easy to understand than any written description.

The cases have been placed in four parallel columns so that the prevalence in the different areas at different periods of time may be readily traced.

TABLE I., showing for each area, in weekly periods, the "dates of attack" from April 15th to December 31st, 1893:—

Week ending		Worthing.	Broadwater.	West Worthing.	West Tarring.
April	21	4	—	—	—
„	28	5	1	—	—
May	5	52	—	—	one
„	12	101	2	—	—
„	19	74	—	—	—
„	26	32	—	—	—
June	2	16	—	—	—
„	9	8	2	—	—
„	16	22	—	—	—
„	23	37	—	—	—
„	30	93	3	two	three
July	7	298	9	two	three
„	14	150	10	one	two
„	21	75	2	one	one
„	28	37	1	4	3
August	4	73	3	20	18
„	11	49	3	10	9
„	18	29	1	1	5
„	25	18	—	4	2
September	1	12	—	—	—
„	8	17	—	7	1
„	15	24	—	2	—
„	22	5	—	—	1
„	29	5	—	—	1
October	6	5	1	1	2
„	13	1	—	—	3
„	20	4	—	—	—
„	27	5	2	—	—
November	3	3	—	—	—
„	10	2	1	2	—
„	17	1	—	1	—
„	18 to Dec. 31	4	1	—	—
Total		1,261	42	58	55

TABLE II., showing for each area, in weekly periods, the number of new cases of fever "notified" from April 29th to December 31st, 1893.

Week ending		Worthing.	Broadwater.	West Worthing.	West Tarring.
May	5	1	—	—	—
„	12	39	1	—	one
„	19	122	1	—	—
„	26	67	1	—	—
June	2	35	—	—	—
„	9	20	—	—	—
„	16	4	2	—	—
„	23	8	—	—	—
„	30	7	—	—	—
July	7	139	4	one	three
„	14	244	9	three	two
„	21	174	9	one	one
„	28	92	—	one	one
August	4	59	1	6	one, 6
„	11	63	5	20	16
„	18	57	3	7	9
„	25	29	1	3	6
September	1	14	—	3	1
„	8	13	—	4	1
„	15	14	—	3	—
„	22	19	—	1	—
„	29	12	—	1	1
October	6	5	—	—	3
„	13	3	1	1	—
„	20	3	—	—	—
„	27	6	—	—	1
November	3	2	—	—	—
„	10	4	—	—	1
„	17	2	3	3	1
„	24	—	—	—	—
December	1	—	—	—	—
„	1 to 31	4	1	—	—
Total		1,261	42	58	55

In the first portion of the outbreak and up to the end of July, the cases were confined to Worthing and Broadwater, but after that date there was a further extension to West Worthing and West Tarring under conditions presently to be described.

There was also a rise in Worthing in the week ending August 4th. From September 15th there was a rapid decline in the number of persons attacked, but this decline is not so visible in the table of notifications until the end of September. After this date there were very few cases recorded week by week, and by the end of the year the storm wave, so sudden in its outburst, so strange in its behaviour, so disastrous in its results, passed quietly away.

AGE AND SEX DISTRIBUTION.

Since, out of the 1,416 persons attacked with fever in the four areas, there were 665 males to 751 females, it might at first sight be supposed that the incidence of the disease was greatest amongst the latter class. This, however, is not the case.

By taking out the numbers at each age period for the Borough of Worthing it will be seen that there is a very great excess of females.

The corresponding figures cannot be given for West Tarring and Broadwater.

The following tables IV., and V., show the point very clearly.

Of the 6,878 males living in the Borough 619, or 90·0 per 1,000 were attacked; of the 9,728 females, 700 or 71·9 per 1,000 were attacked.

Charts 9 and 10 show the same facts in a graphic form.

The shaded portions in chart 9 show the population, and the coloured portions show the persons attacked.

Again, taking the number of cases and deaths in each of the four areas, it will be seen that the case mortality was equal to 13·27 of those attacked, being higher among females than males. The case mortality showed a great excess in West Worthing.

Charts 5, 6, 7, and 8 show in a graphic form for each area, the number of cases of each sex, their age distribution, and the dates of death for each sex at different ages.

TABLE III., showing for each area the number of cases, the number of deaths, and the case mortality:—

	Cases.			Deaths.			Case Mortality.		
	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.
Worthing ..	599	662	1,261	65	90	155	10·85	13·60	12·29
West Worthing	20	38	58	5	10	15	25·00	26·31	25·86
West Tarring ..	29	26	55	5	4	9	17·24	15·40	16·36
Broadwater ..	17	25	42	2	7	9	11·76	28·00	21·43
Total ..	665	751	1,416	77	111	188	11·58	14·78	13·27

TABLE IV., showing for each age period in groups of five years the number of *males* living in the Borough of Worthing, the number of those attacked, and the rate per 1,000.

Age period.	Number living at each age period.	Number of male persons attacked at each age period.	Rate per 1,000 living of those attacked at each age period.
0 to 5	892	52	58·3
5 „ 10	932	156	167·4
10 „ 15	973	142	145·9
15 „ 20	663	92	138·8
20 „ 25	489	53	108·4
25 „ 30	440	46	104·5
30 „ 35	444	19	42·8
35 „ 40	401	25	62·3
40 „ 45	333	9	27·0
45 „ 50	339	12	35·4
50 „ 55	242	4	16·5
55 „ 60	203	4	19·7
60 „ 65	147	1	6·8
65 „ 70	145	1	6·9
70 „ 75	116	2	17·2
75 „ 80	68	1	14·7
80 „ 85	40	—	—
85 „ 90	7	—	—
90 „ 95	4	—	—
95 „100	—	—	—
100 and upwards	—	—	—
Total	6,878	619	90·0

The table should be read thus: Out of 932 males living between the ages of five to ten years, 156 males, or 167·4 per 1,000 were attacked; out of 973 males living between the ages of ten to fifteen years, 142 males, or 145·9 per 1,000 were attacked, &c.

TABLE V., showing for each age period in groups of five years the number of *females* living in the Borough of Worthing, the number of those attacked, and the rate per 1,000.

Age period	Number living at each age period.	Number of female persons attacked at each age period.	Rate per 1,000 living of those attacked at each age period.
0 to 5	813	29	35·7
5 „ 10	902	124	137·4
10 „ 15	988	140	141·7
15 „ 20	1,058	131	123·8
20 „ 25	1,043	87	83·4
25 „ 30	818	65	79·5
30 „ 35	703	34	48·3
35 „ 40	603	32	53·1
40 „ 45	583	20	34·5
45 „ 50	515	12	23·3
50 „ 55	414	10	24·1
55 „ 60	328	6	18·3
60 „ 65	323	4	12·4
65 „ 70	239	2	8·4
70 „ 75	186	2	10·8
75 „ 80	123	1	8·1
80 „ 85	61	1	16·4
85 „ 90	25	—	—
90 „ 95	2	—	—
95 „ 100	—	—	—
100 upwards	1	—	—
Total	9,728	700	71·9

The table should be read thus: Out of 1,043 females living between the ages of twenty to twenty-five years, 87 females, or 83·4 per 1,000 were attacked; out of 818 females living between the ages of twenty-five to thirty years, 65 females, or 79·5 per 1,000 were attacked, &c.

METEOROLOGY.

I herewith give in some detail various tables showing the rainfall, the earth temperature, the amount of bright sunshine, the accumulated heat, and the climate of Worthing, because the exceptional weather of 1893 had, in my opinion, a considerable share in determining the course of the outbreak.

The coloured charts show in a graphic form the facts which are set forth in the printed tables.

The hours of *bright sunshine* in the South of England are here given for 1888 and 1893, and are contrasted with the mean number in the ten years, 1884-93.

	Mean 1884-93. Hours.	1888. Hours.	1893. Hours.
First Quarter	226	162	308
Second Quarter	572	453	739
Third Quarter	524	429	588
Fourth Quarter	199	196	240
Total	1521	1240	1875

The *accumulated heat*, *i.e.*, the number of day degrees above 42°F., is also given for the same periods.

	Mean 1884-93. Day deg.	1888. Day deg.	1893. Day degs.
First Quarter	191·7	83	302
Second Quarter	1003·6	858	1277
Third Quarter	1593·7	1422	1748
Fourth Quarter	447·5	513	472
Total	3236·5	2876	3799

The day degrees below 42°F. are not shown in the chart.

The hot, bright year 1893 is contrasted with the cool, dull year 1888, and the charts, if carefully examined, bring out very clearly the points of difference. The hours of bright sunshine do not sufficiently show the amount of heat, as very sunny weather might be associated with a cool temperature. The chart showing the accumulated heat is therefore given, by which it will be seen that there was a great prevalence of temperature all through the months when the epidemic was also prevalent; in the last three months of the year the fever cases declined in numbers, and the temperature was somewhat below the mean.

The results, as shown by the readings of the earth thermometer, are also of much interest, because the water in the mains must have been of a higher temperature than usual for many months in the year, and this may have favoured the growth and development of any microbes that may have played any part in the history of the outbreak.

The thermometer at Worthing is placed 1 foot below the surface of the ground, and the instrument is read off at 9 a.m. each day. In no previous year has there been so high a reading obtained in June. At Brighton the earth temperature is taken at a spot 4 feet below the surface. Dr. Newsholme has kindly furnished me with the following figures, which show that even at that depth the earth was much warmer than usual.

	Mean degrees.	Max. degrees.	Min. degrees.
January	40·7	43·0	39·5
February	42·8	44·0	41·0
March	45·0	46·5	43·5
April	49·0	52·0	47·0
May	54·0	55·8	52·0
June	57·8	59·0	56·0
July	60·2	61·0	58·8
August	62·2	63·4	61·0
September	60·6	62·0	58·5
October	57·0	58·6	55·2
November	50·9	55·0	48·0
December	46·7	48·0	45·8
Year	52·24	63·4	39·5

The year 1893 was marked by a prolonged period of drought which lasted from March 2nd to July 4th.

There were 106 days during these four months on which no rain fell, and on the remaining 18 days of this period, the amount that fell only measured 1·20 inch.

There was an average rainfall in January and February, but up to the end of June the amount was far below the average, and only 6·77 inches were registered in the first half of the year.

July was a wet month, but it was followed by a very dry August. The remaining four months of the year were wet, and 12·83 inches were then collected, an amount slightly in excess (0·33in.) of that which was registered in the first eight months.

Table VI. shows the rainfall and the number of rainy days in each month of 1893.

There were during the year 142 rainy days, and the total collection of rainfall amounted to 25·12 inches.

Table VI.—REGISTER OF RAINFALL IN 1893.

Kept at Ellesmere, Worthing, in the County of Sussex by C. Kelly.

Time of Observation, 9 a.m. Rain Gauge.—Diameter, 5in.; Height of top above Ground, 1ft.; Height of top above Sea Level, 26·16ft.

Date.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Date.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	
1	—	—	·08	—	—	—	—	·05	—	·03	·21	·05	1
2	—	·02	—	—	—	—	—	—	—	·22	·33	—	2
3	—	·10	—	—	—	—	—	·14	—	·01	·01	·01	3
4	—	—	—	—	—	·01	·74	·16	—	·18	·01	—	4
5	—	—	—	—	—	—	—	—	—	·38	·05	—	5
6	·05	·07	—	—	—	·04	—	—	·07	·18	—	·12	6
7	·03	·03	—	—	—	—	—	—	—	·32	—	04	7
8	·16	—	—	—	—	—	·03	—	·03	—	·01	·24	8
9	·52	—	—	—	—	—	—	—	·06	·54	—	·01	9
10	—	·22	—	—	—	—	·02	—	—	·08	—	·07	10
11	—	·06	—	—	—	—	·24	·02	—	1·95	—	—	11
12	·01	·04	—	—	—	—	—	—	—	—	—	·47	12
13	·05	·09	·08	—	—	—	·18	—	·23	·11	·06	·37	13
14	—	·05	—	—	—	—	—	—	·02	·02	·36	—	14

15	—	—	—	—	·02	—	·46	—	·04	·03	·04	—	15
16	·46	·14	·15	·06	·05	—	1·18	—	·46	·03	·24	—	16
17	·06	·04	·02	—	·12	—	·10	—	·09	·73	·06	—	17
18	·88	·40	—	—	·03	—	·02	—	—	—	·11	—	18
19	—	·06	—	—	·01	—	·65	—	·11	—	·01	·45	19
20	—	·71	—	·02	·06	—	·21	·02	—	—	—	·24	20
21	—	·04	—	—	—	—	—	·09	·02	—	—	—	21
22	—	·10	—	—	—	·18	—	·09	·34	·03	—	·17	22
23	—	—	—	—	—	—	·48	—	—	—	—	·01	23
24	·02	—	—	—	—	·02	—	—	1·01	—	—	·11	24
25	·01	·17	—	—	—	·07	—	—	1·01	·15	·14	—	25
26	·03	·05	—	—	—	·14	·41	—	—	·03	·05	—	26
27	—	·21	—	—	—	·12	—	—	—	—	—	·01	27
28	·03	·22	—	—	—	—	—	-	—	·02	·01	—	28
29	—		—	—	—	—	·23	—	—	—	·04	—	29
30	·03		—	—	—	—	—	—	—	—	·08	—	30
31	·33		—		—		—	·10		—		·01	31
Totals	2·67	2·82	0·33	0·08	0·29	0·58	4·95	0·67	3·49	5·04	1·82	2·38	
Tl. frm Jan 1.	26·7	5·49	5·82	5·90	6·19	6·77	11·72	12·39	15·88	20·92	22·74	25·12	

TABLE VII.—BRIGHT SUNSHINE.

Year.	Number of Hours.				Percentages of possible duration.			
	Jan. 1 to Mar. 31.	Jan. 1 to June 30.	Jan. 1 to Sept. 30.	Jan. 1 to Dec. 31.	Jan. 1 to Mar. 31.	Jan. 1 to June 30.	Jan. 1 to Sept. 30.	Jan. 1 to Dec. 31.
1884 ..	196	679	1,204	1,365	20	28	33	30
1885 ..	187	771	1,313	1,490	21	34	37	34
1886 ..	208	814	1,337	1,528	20	32	36	34
1887 ..	243	836	1,468	1,684	28	38	41	38
1888 ..	162	615	1,044	1,240	18	28	29	28
1889 ..	187	665	1,141	1,293	21	29	32	30
1890 ..	222	753	1,265	1,491	24	34	35	34
1891 ..	281	841	1,336	1,563	31	35	37	36
1892 ..	267	955	1,477	1,684	25	41	42	38
1893 ..	308	1,047	1,635	1,875	34	46	46	43
Mean ..	226	798	1,322	1,521	24·2	34·5	36·8	34·5

TABLE VIII.—ACCUMULATED HEAT.

Year.	Day degrees above 42° F.				Day degrees below 42° F.			
	Jan. 1 to Mar. 31.	Jan. 1 to June 30.	Jan. 1 to Sept. 30.	Jan. 1 to Dec. 31.	Jan. 1 to Mar. 31.	Jan. 1 to June 30.	Jan. 1 to Sept. 30.	Jan. 1 to Dec. 31.
1884 . .	330	1,288	3,041	3,495	119	185	185	310
1885 . .	202	1,133	2,694	3,055	345	402	405	573
1886 . .	107	1,034	2,748	3,348	555	590	590	760
1887 . .	179	1,162	2,729	3,033	453	524	524	836
1888 . .	83	941	2,363	2,876	517	577	577	701
1889 . .	149	1,300	2,843	3,277	427	448	448	624
1890 . .	254	1,227	2,802	3,285	271	305	305	758
1891 . .	155	1,128	2,658	3,144	515	565	565	721
1892 . .	156	1,161	2,685	3,053	490	554	554	759
1893 . .	302	1,579	3,327	3,799	353	373	373	559
Mean . .	191·7	1195·3	2789·0	3236·5	404·5	452·3	452·6	660·1

TABLE IX.—CLIMATE OF WORTHING.

Month.	Temperature.							Relative Humidity.	Amount of Cloud.	Rain.	
	Means.					Extremes.				Amount.	No. of Days.
	9 a.m.	Min.	Max.	Range.	Mean.	Min.	Max.				
	deg.	deg.	deg.	deg.	deg.	deg.	deg.	per cent.		inches.	
January	35·2	31·2	39·7	8·5	35·5	18·2	51·3	—	7·4	1·97	14
February	41·5	37·2	46·7	9·5	41·9	27·0	53·2	91	6·1	3·04	21
March	47·1	37·5	52·6	15·1	45·1	25·7	60·7	79	4·1	0·42	5
April	54·4	42·4	62·5	20·1	52·4	30·0	72·4	74	2·8	0·10	2
May	58·4	46·8	64·8	18·0	55·8	39·6	71·8	74	5·2	0·25	4
June	63·0	51·1	69·3	18·2	60·2	38·9	84·7	68	4·9	0·51	5
July	63·5	54·9	68·2	13·3	61·6	48·9	77·0	77	6·3	5·01	14
August	66·6	56·8	71·6	14·8	64·2	46·9	80·5	—	4·4	0·60	7
September	60·1	49·0	65·6	16·6	57·3	38·0	73·9	—	5·7	3·34	13
October	54·0	47·0	58·4	11·4	52·7	38·4	64·4	—	5·7	4·78	19
November	42·5	37·7	47·8	10·1	42·7	29·0	58·2	—	7·3	1·76	18
December	41·1	36·2	45·7	9·5	41·0	26·0	53·8	—	6·5	1·98	15

Year 1893	52·3	44·0	57·7	13·7	50·9	18·2	84·7	—	5·5	23·76	137
„ 1892	49·1	41·8	54·5	12·7	48·2	20·2	76·0	83	5·8	23.73	141
„ 1891	49·4	42·4	54·8	12·2	48·4	16·5	77·0	—	5·9	29·86	172
„ 1890	49·4	42·2	54·6	12·4	48·4	14·9	78·0	87	6·2	22·84	149
„ 1889	49·5	42·7	54·8	12·1	48·8	21·9	81·5	86	6·4	23·92	159
„ 1888	48·0	42·4	53·3	10·9	47·8	20·2	78·8	86	6·4	25·88	181
„ 1887	48·4	41·6	54·1	12·5	47·9	17·4	82·0	85	5·7	21·28	137
„ 1886	50·0	44·0	55·2	11·2	49·6	23·2	78·0	83	5·8	31·89	164
„ 1885	50·0	43·7	55·1	11·4	49·4	25·2	81·7	80	5.7	28·09	156
„ 1884	52·0	45·6	56·8	11·2	51·2	27·0	83·3	81	5·8	23·51	126
„ 1883	50·7	43·9	55·9	12·0	49·9	23·3	75·7	81	5·7	26·05	174
„ 1882	51·6	45·1	56·5	11·4	50·8	26·6	81·0	82	5·8	32·35	180
„ 1881	50·3	43·4	55·0	11·6	49·2	13·5	82·0	—	5·6	29·60	142

The above Table, up to the end of July, is taken from observations made by the late W. J. Harris, Esq., F.R.Met.Soc., who for many years past has kindly allowed me to make use of his records.

THE TEMPERATURE OF THE SOIL.

The temperature of the soil at 9 a.m., one foot below the surface of the ground at Worthing, was taken daily up to August by the late W. J. Harris, Esq., F.R.Met.Soc., and the results for each month for 1893, and also for a term of years, are here given :—

	1893.			1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Mean deg.	Max. deg.	Min. deg.	Mean deg.	Mean deg.	Mean deg.	Mean deg.	Mean deg.	Mean deg.	Mean deg.
Jan.	35·7	41·9	33·3	37·7	37·3	38·3	39·3	42·7	35·1	37·5
Feb.	42·0	44·6	39·2	36·7	39·2	37·2	38·7	40.1	39·3	40·4
March	44·7	46·9	41·1	39·1	40·3	39·0	40·6	42·6	40·6	39·6
April	51·8	56·8	47·0	48·1	45·2	44·0	47·2	47·3	45·1	47·1
May	58·5	61·6	54·6	55·1	55·1	52·2	56·6	55·8	52·6	53·1
June	63·7	70·5	57·9	60·4	59·4	58·0	62·5	58·6	56·9	59·8
July	65·0	69·0	60·5	64·1	64·4	60·1	62·7	60·3	62·1	61·6
Aug.	—	—	—	63·8	63·1	60·9	61·0	61·2	60·6	62·7
Sept.	—	—	—	61·6	57·2	58·4	58·6	59·9	59·7	58·6
Oct.	—	—	—	54·2	49·9	49·8	51·5	52·3	53·8	48·7
Nov.	45·2	50·7	40·6	47·1	44·4	49·0	47·2	49·9	48·8	47·9
Dec.	42·3	45·6	38·8	36·0	40·2	44·2	40·5	36·0	42·6	40·1
Year	—	70·5	33·3	50·6	49·3	49·3	50·5	50·3	48·9	49·8

It will thus be seen that the earth temperature in 1893 was much higher than usual from March to July, the difference from the mean of the seven years 1886-92 being very high for the months of May, June, and July.

	1886-92. °F.	1893. °F.	Difference. °F.
May ..	54·36 ..	58·55 ..	+ 4·19
June ..	59·37 ..	63·70 ..	+ 4·33
July ..	62·19 ..	64·98 ..	+ 2·79

From the 13th to the 23rd of June there was a marked rise in the earth temperature, the highest point being reached on June 20th.

The reading of the earth thermometer at 9 a.m. on four successive days is here recorded :—

	°F.
June 17	68·3
„ 18	68·8
„ 19	69·8
„ 20	70·5

These were the hottest days in the year, and the reading of the maximum thermometer in the four corresponding days was respectively 81·0°, 81·2°, 84·7°, and 83·7°.

On July 3rd, 4th, and 8th, the earth temperature was equal to 69°F., and it was also very high in the middle of August.

The very high readings in June are of importance in connection with the second portion of the outbreak.

MILK SUPPLY.

Whenever a household was invaded by the fever, a note was made of the source whence the milk supply was obtained. There are 15 milk vendors in Worthing, and, with few exceptions, the inhabitants of the four areas have their milk from one or other of them. A careful analysis was made of the customers supplied from each dairy, and of the relation in numbers between the persons attacked, the houses invaded, and the houses supplied. In none of the four areas did it appear that there was any special incidence of the disease amongst those who obtained their milk from any particular dairy. The persistence of the disease, the age and sex distribution of those attacked and the absence of any known disease amongst the dairy cows, negatived the idea of milk having taken any part in the causation of the fever. The escape of West Worthing and West Tarring from invasion, previous to the end of July, and the invasion of those areas in August, while in the other two areas supplied by many of the same vendors, the fever had been so prevalent, point to a similar conclusion.

The milk supply, therefore, may be excluded from further consideration.

SEWERAGE AND DRAINAGE.

The general plan of the sewerage arrangements can be seen on chart 2, where it will be seen that the whole of the Worthing sewers are coloured blue and that they discharge by a 30in. iron pipe into the sea, about 1½ miles east of Worthing Pier.

New sewers were laid down a few years ago in some streets to the north of the railway, where some new houses have been lately built on land between the old village of Broadwater and the town; these sewers join the Worthing system.

A considerable number of houses have within the last ten years been built in West Tarring, between the old village and the railway, and as this building land became developed, new sewers were laid down and these were also joined to the Worthing system. All the sewers coloured blue on chart 2 belong to one system, and discharge into the sea to the east. Many houses in the old village of West Tarring have cesspits or earth closets. West Worthing has a system of sewerage to itself and the outfall sewer discharges by an iron pipe about a mile to the west of the Worthing Pier.

These sewers are coloured red in the chart. There is no connection whatever between the two systems. Broadwater has no public system of sewerage, indoor water closets are rare, and the drainage is chiefly into cesspits, while house water is often utilised on the cottage garden.

Worthing and part of West Tarring are thus linked together as regards sewerage arrangements, while the other two areas of West Worthing and Broadwater are quite distinct. The appearance of the fever at the same time in Worthing and Broadwater does not harmonise with the view which some held that the sewers or sewer emanations were the cause of the outbreak, for in that case West Tarring and not Broadwater would have been attacked. The further outbreak in August which occurred at the same time in West Worthing and West

Tarring also negatives the idea that faulty sewers played any part in causing the disorder, for these places also are on quite different systems.

In 1878 a new main sewer was laid along the course of the Teville Stream; it is shown in chart 2 as a straight blue line extending from a point near the Worthing Railway Station in an easterly direction to a point in the brooks, east of Meadow Road, when it takes a more southerly direction, and ends at the outfall.

This brick barrel sewer is from 3ft. 6in. to 4ft. in diameter, and it was made of this size so as to be able to hold a large quantity of sewage whenever the outfall was tidelocked, a circumstance which occurred twice in every twenty-four hours. From this year the pumping at the old works ceased, and all the Worthing town sewerage flowed by gravitation to the sea.

The old works were disused in 1878, and the High Street sewer was diverted, so as to pass in a north-easterly direction to join the new main sewer; it is shown on chart 13 as a straight red line.

After these new works were completed, the old abandoned sewer was bricked across at two points, one between High Street and the Waterworks enclosure, and one between the enclosure wall and the sewage well; later on, it was partially filled up.

The sewage well and the chain pump well were filled up with earth, after the brick walls had been pulled down. In September, 1892, the carrier pipes from the old sewage well were removed as far as the south-east corner of the enclosure wall, and more recently fresh portions have been removed between this wall and Lyndhurst Road. In 1885, some of the 15in. pipes were removed in the north-east corner of the enclosure for a space of about ten feet; this space was then filled in with earth, and a brick wall set in cement was built across each exposed end. The removed portions are shown on chart 13 by blank spaces in the course of the dotted lines.

In connection with the sewerage arrangements there still remains for careful consideration the old system of sewers in and about the Waterworks enclosure. For this purpose charts 13 and 14 should be carefully studied. The plan of the Worthing Waterworks shows an enclosure of about two acres in extent, in which the three wells A, B, and C, are shown with the headings connecting each; these are all coloured blue. In 1857, a main system of sewerage and water supply was carried out by the old Local Board of Worthing

The sewage from the town was received by a main sewer which came down High Street, and terminated in a sumpt, 6ft. 2 in. by 2ft. 10in., and a sewerage well, 30 feet deep and 10 feet in diameter at the top, reduced to 6 feet at the bottom.

In this well there was placed a sewerage pump, consisting of three 15in. barrels, worked by steam power, and connected with the engine in the water tower by an iron shafting and driving gear, by which the sewage was pumped through an outfall sewer emptying itself into the sea, at a place two miles westward of the town, called Sea Mill Bridge. The works were carried out by Mr. (now Sir) Robert Rawlinson, and at the time they were considered very perfect of their kind.

Probably some alterations were afterwards carried out, for when the old works were abandoned, two chambers, as shown on chart 14, were filled up; they are said to have been 36 feet deep, one of which was called the sewage well, or sumpt, and the other was called the chain pump well; the first received the raw sewage which passed into the second well by a 15in. pipe which connected the two at the bottom. Thence the sewage was pumped from the sewage well by two pipes to the sewage farm which lay to the east of the town towards the brooks. One of these pipes was a 12in. iron rising main, and the other was a 15in. stoneware pipe. They are shown on chart 13 as red dotted lines proceeding from the wall of the waterworks enclosure towards Lyndhurst Road; the intervening portion was removed about 15 years before the outbreak. From the chain pump well there were three 15in. earthenware pipes which passed in a north-easterly direction to the Teville Stream, and acted as a storm overflow. They are shown on chart 13 as red dotted lines, broken near the enclosure wall where some pipes were removed in 1885, and then after passing beneath Park Road, the most southerly one is joined by a sewer in Park Road, which also receives the drainage from the Infirmary; this pipe is now connected to the main sewer; the other two remain as they were before, connected with the Teville Stream. Chart 14 shows these wells and pipes in section.

Although at first sight the wells and headings seem to be surrounded by a network of sewers, yet, in reality, these disused, abandoned tubes formed hollow spaces in the earth, cut off from any possible connection with the main sewer through which sewage was daily flowing. They were examined in the month of June, when the three 15-inch pipes within the enclosure were removed, but on no occasion was there any evidence to show that they played any part in the causation of the outbreak.

If they caused no harm anterior to 1878, when sewage was daily flowing through these channels, on what grounds can it be maintained that they were injurious in 1893, when during the interval of fifteen years, the clean earth around, or with which the pipes were partly filled, must have destroyed long ago anything harmful?

It has been said that the new main sewer to the west of the enclosure was in a leaky condition. This brick barrel sewer is surrounded with a layer of concrete, and when this outer backing or coating of concrete was removed there was some little oozing of sewage between the bricks, but there is no evidence that this leakage occurred in the ordinary condition, *i.e.*, before the concrete was removed. If such leakage were a matter of daily occurrence, the water in the various wells must have been liable to pollution for several years past, and especially at times of rainfall and very high tides, but the previous history of fever in the Borough shows that at any rate no harm resulted. If sewage could find its way into the water in any of the three wells, the chemist would doubtless have been able to detect its presence, and the fact that the water in May and June was found so pure from a chemical point of view must raise grave doubts as to sewage pollution being a cause.

The sewer on the east side of the enclosure was made with pug joints, and when the distal end was plugged, and the sewer filled with

water, some leakage occurred through the faulty joints, but a sewer, made with pug joints, is not in a leaky condition when there is a free course for the flow of sewage through it. The Infirmary drain was daily flushed during the latter half of May, and the month of June, with a 3in. hose, and on no occasion was any obstruction found. The fall in the sewer was good, and the sewage readily flowed down to the main sewer.

When there is a heavy rainfall coinciding in point of time with a high tide, *i.e.*, when the outfall sewer is tidelocked, then no doubt the sewage backs up in the main sewer even as far as Montague Street, and this has happened on several occasions within the last few years, but not since 1880 with any untoward results. This may have been due to the great increase in the number of ventilating shafts during the last thirteen years. But this is quite clear that from March 2nd to July 4th, there was no fall of rain whatever to cause any such result; so dry was the earth during this period that the little rain that fell was quickly absorbed by the ground at once, and it only served to lay the dust.

During all this period the barometer was steady, and rather higher than usual; there was no storm on any occasion, and there was certainly no specially high tide.

Therefore we have to meet this difficulty. Anterior to the epidemic there had been conditions of much rainfall and very high tides, which might have been favourable to leakage from the sewers, but without any evil effects resulting.

From March to July the opposite conditions existed, and yet a serious outbreak of fever arose. And for many years no change whatever has taken place in the arrangement of the sewers and drains in this area.

The only fresh work that has been carried out in this area was the driving of the new heading in the spring of 1893.

I cannot see that there is sufficient evidence to warrant one in accepting faulty sewers as a cause of the first part of the outbreak, still less can these faults explain the second part of the outbreak, as in the interval between the two the overflow pipes within the enclosure had been removed, and the Park Road sewer had been opened and relaid.

Nor can faulty sewers explain the outbreak in West Worthing and West Tarring during the month of August, when undoubtedly polluted water was the cause.

WATER SUPPLY.

Up to the year 1857, the inhabitants were supplied from wells, most of which were 20-25 feet in depth. The water bearing stratum is about 15-18 feet from the surface of the ground, but in very wet weather the water level has been found within 18 inches of the surface in houses to the north of the railway.

In 1857 the well marked A in Chart 13 was sunk to a depth of 67ft. 9in.; from the bottom of this well a borehole pipe was driven for another 300 feet. This well is lined with iron cylinders, but to increase

the supply, sixteen holes were afterwards bored in the cylinders at a depth of 60 feet from the surface, whereby an additional quantity of water was obtained.

As the town increased in size, and more water was needed, a second well, marked B on Chart 13, was sunk in 1867, to a depth of 111ft. 6in.; thence a pipe was driven for another 300 feet.

This new shaft was at first connected with well A by a syphon pipe, the short leg of which reached the bottom of well A, while the longer leg dipped to the bottom of well B ; the horizontal connection being at a depth of nearly 30 feet from the ground level. This syphon is no longer used, and in 1880, a new horizontal tunnel, 6ft. by 4ft. driven from the bottom of the well shaft A, directly connected A with B. This tunnel is 113 feet long, it is lined with brick set in cement, but each third brick is left out on each side at the bottom, so as to allow additional water to enter.

In 1885 the Local Board sank a well in the north-east corner of their land, but when it was sunk to a depth of 18½ feet the supply of water was so great that it was clear that the top of a fissure had been reached; this well was abandoned and filled up, while a fresh well, marked C in Chart 13, was in the same year dug to a depth of 72 feet, and at a distance of about 60 feet to the south-west of the now abandoned shaft. No borehole was made from the bottom of well C, as experience showed that more water was gained by driving headings into the chalk than by boring to any greater depth.

All these wells were dug in a confined area not more than two acres in extent, and each well gave an additional supply of water without in any way exhausting the other.

Chalk is not an uniform stratum, but it contains in its upper beds layers of flints which run in parallel courses six feet or more apart. The intervening chalk allows water to percolate slowly, but the fissures, in which the flints lie, allow water to flow along with great rapidity; the larger the fissure, the swifter and more abundant is the flow. A well, therefore, may be dug, or a heading may be driven, in the intervening chalk without obtaining any considerable quantity of water, but when a large fissure is reached, the rush of water may be one of great volume.

A section of the soil in the waterworks yard shows the following strata :—

	Ft.	In.
Made earth	3	6
Mould	2	0
Brick earth	2	0
Sandy loam	2	6
Sandy marl	5	6
Marl	1	0
Chalky marl	1	6
	18	0

Below this point the chalk is met with, containing in its upper portion numerous beds of flint.

Between the sea shore and the South Downs, there is a large deep trough running from east to west, and filled with tertiary beds and alluvial soil.

The water in the public wells at Worthing is derived from the rainfall which sinks into the Chalk Downs to the north of the town. It appears to flow in a direction from north-west to south-east. The waters in the chalk beds flow under the above-mentioned trough, and rising up again with a sharp bend they open on the porous surface just above the chalk, and flow away towards the sea.

Chart 14 shows the water level when no pumps are at work; the water, coloured blue, is seen to stand in the wells, and in a fissure to the right, at a point about 18 or 20 feet from the surface, and then it finds its own level into the surrounding soil.

There is no advantage in sinking a well too deep, for the flint beds or fissures, whence only any large volume of water can be obtained, do not extend to any great depth, probably not more than 80 or 100 feet.

In the grey chalk bed below, no fissures are met with.

An examination of Chart 14 will show that the new heading did not tap a new source; it merely brought into direct connection with well C a supply of water which for many years past had supplied that well in a small degree, but now in a greatly increased quantity.

Whatever source of pollution affected the abandoned well of 1885, could not have been influenced by the more abundant flow when the fissure was tapped some 50 feet lower, for the water was flowing rapidly in an upward direction.

The influence of this pressure at the deeper level was felt by the divers who went down on August 23rd in the vain effort to stop the opening in the fissure made on April 14th.

A strong solution of salt was, on August 17th, thrown down the abandoned well of 1885 which had previously been re-opened to a depth of 22ft. The water from well C was then chemically examined for chlorine and an enormous increase was soon afterwards found, but this only shows what I have stated above that the water in well C was drawn from an area which included the fissure at the bottom of the abandoned well.

When two powerful divers went down well C on August 23rd, to try to stop the opening at the extremity of the new heading, I noticed that air bubbled up through the water standing in the bottom of the abandoned shaft, and therefore at the upper limit of the column of water in the fissure; this was just what might have been expected.

The yield in January, 1893, was from 377,909 to 584,818 gallons with a daily average of 496,090 gallons; on thirteen occasions the tunnels were emptied. In February the supply was still short, and it varied from 471,090 to 533,454 gallons; on seven occasions the tunnels were emptied.

On March 6th the new work commenced, and on the 11th the men had finished bricking across the tunnel and fixing a 9in. sluice valve.

On March 13th, a fresh lot of men began to excavate for the new heading, and on the 16th, the night gang commenced to line the tunnel with bricks. The two gangs were quite distinct; as one set removed chalk and made the heading during the day, the other set followed and lined the heading during the night.

The heading had been driven 20 feet by March 2nd, and on the next day a pump was fixed for removing the air in the tunnel.

By the evening of April 13th the heading had been driven 68 feet into the chalk, but the lining brick wall only extended to 64 feet, and the arch was only completed for a length of 54½ feet.

The next day, April 14th, at 2.0 p.m., a fissure in the new tunnel was reached at a distance of 70 feet, and the water flowed into the heading very rapidly, so that the men hastened to escape, leaving behind them a pick, a shovel, and the pump.

Both engines were connected and ran 23 revolutions per minute, but the water still rose at the rate of 3 feet in 25 minutes, and the pump in the excavations was soon under water.

This pump and the tools were removed a few days afterwards by a diver sent down for the purpose.

The sluice valve which was fixed at the bottom of well C to prevent any water from this well, or from the new heading, passing into the tunnel leading to wells A and B, did not effect its purpose.

On Saturday afternoons and on Sundays, and also when the pump became blocked, the turbid water from the new heading was pumped up into the reservoir and also into the public mains. Many persons at this time frequently noticed that the drinking water was cloudy at intervals. Thus for some days previous to the fissure being struck the people were drinking in small quantities some of the water from the new heading. The reservoir also was receiving much dirty, chalky water which settled at the bottom and formed a sludge. This was the sludge which was afterwards found by Dr. Crookshank to be in a filthy state.

Two sets of men were employed in making the new heading. The day gang began to work on March 13th in excavating the chalk, while on March 16th the night gang begun to line the tunnel with bricks. There is no doubt that the works became polluted by the conduct of one or two of the night gang, who were not regular labourers in the town. Some of the men who had been at work there gave distinct evidence of this, and some of the day gang complained at times of the foul air in the cutting when they went down to work in the morning. This information was given at the very beginning of the outbreak, although for obvious reasons no one cared to come forward and complain.

I consider that this pollution was the main cause of the epidemic, and that it brought about a condition of the reservoir and service pipes which was potent for harm.

There is no evidence, however, that any one down in the well was suffering, or had been suffering, from enteric fever; but is such evidence necessary?

On May 2nd a sample of water, from the new heading, was sent to Dr. Dupré, F.R.S., for analysis, and received by him on May 3rd; the water stood in Well C within 27 feet of the surface of the ground, and the bottle was filled at the depth of about six inches from the level of the water. It was thought at the time that it would be better to take a sample from the bottom of the well at a spot as near as possible to the

opening of the new heading. The second sample was therefore taken on May 6th from Well C at a depth of 30 feet below the water level, and of 57 feet below the ground level. In a report dated May 6th Dr. Dupré remarks on the first sample that "The water is clear, almost colourless, inodorous, and yields no deposit on standing. It shows no indications of pollution by sewage or surface drainage, but has all the characteristics of a pure chalk water. It is rather hard, but not to an objectional degree, and becomes soft on boiling. It would, however, be improved for general domestic purposes, by being submitted to a process of softening."

In a report dated May 12th, Dr. Dupré remarks on the second sample that, "The water is clear, almost colourless, and inodorous. It gives no deposit on standing. The present sample is a distinct improvement on that of May 3rd, 1893, and the water has now all the characteristics of a pure chalk water, showing no signs of any pollution by sewage."

ANALYTICAL DETAILS.

	Sample 1 taken May 2, 1893.	Sample 2 taken May 6, 1893.
Appearance	Clear.	Clear.
Colour	Almost colourless.	Almost colourless.
Smell	Inodorous.	Inodorous.
Deposit	None.	None.
Nitrous acid	None.	None.
Phosphoric acid	Strong trace.	Trace.
Poisonous metals	None.	None.
Hardness before boiling	20·3 degrees Clark.	19·2 degrees Clark.
" after "	5·0 " "	4·7 " "
	Grains per gallon.	Grains per gallon.
Oxygen absorbed from permanganate	0·035.	0·006.
Total dry residue	27·16.	27·16.
Colour of "	White.	White.
Behaviour of residue on ignition	Darkens very slightly. Burns off very readily.	Darkens scarcely perceptibly.
Chlorine	2·73.	2·97.
Nitric Acid	1·44.	1·79.
Ammonia	0·00056.	0·00168.
Albuminoid Ammonia	0·0028.	0·0007.

An examination of the storage reservoir on the the top of the tower was made on May 14th, when the interior was found to be in a very dirty condition, and, besides some chalky ooze, there were several brown or dark patches of sludge. This reservoir had not been cleansed for four years.

Three samples were taken on May 15th for analysis, just previous to the emptying of the tank.

Sample A consisted of water taken close to the bottom of the tank without disturbing the sediment more than possible.

Sample B consisted of some dirty sludge taken from the bottom of the tank in places where a brown or black deposit was noticed.

A third sample of the ordinary water in daily use was taken, but the bottle was broken in transit; as a consequence another sample was taken on May 23rd from the bottom of the Well C, close to the new heading, at a depth of 72ft. 6in., the water in the well standing 29ft. 6in. below the ground level. The sample was marked C. These three samples A, B, and C, were sent to Professor Crookshank directly after they were collected, and his report dated May 29th, was received on the following day. This bacteriological report is here given :—

"These samples were examined with as little delay as possible, as a very considerable increase in the number of bacteria may occur if the samples be kept for several days before the analysis is commenced.

"I would lay special stress upon the fact that a bacteriological examination may demonstrate the presence of poisonous or of disease-producing bacteria when their detection would not be possible by any known method of chemical analysis.

"The contagia of such diseases as cholera, diphtheria, typhoid fever, may be present in such small numbers that no chemical analysis would give a suspicion of contamination, and yet being living organisms capable of increasing in a suitable environment with enormous rapidity, a very few once gaining access to the human subject will produce the grave disorders with which they are associated.

"The method which I have principally relied upon in investigating the Worthing water is as follows :—

"I avoided shaking up the samples as this would have disturbed the sludge and deposit in the samples which I shall refer to as B and C. One twentieth of a c.c. was added to nutrient gelatine which had been previously liquefied, and the water was thoroughly distributed in the cultivating medium. The liquefied gelatine was then poured out upon a sterilised glass plate and rolled out by means of a sterilised glass rod into an even layer. These plates were then transferred to sterilised glass dishes for protection from the bacteria in the air and kept at a temperature of about 20° C. for several days. The individual bacteria in the original sample of water are by this means distributed in the liquefied gelatine and when this sets each individual bacterium is fixed at one spot. Each bacterium multiplies rapidly by fission, giving rise to a colony which becomes visible to the naked eye or with the aid of a pocket lens, and by counting the number of colonies by means of a special apparatus we can estimate the number of bacteria present in a c.c. of the water sample—roughly speaking about 20 drops.

"I took note also of the general characters of the bacteria which were cultivated especially as regards the effect they produced upon the gelatine, and the formation of putrefactive odours.

"I also prepared cultures by using Petri's dishes, substituting agar-agar for gelatine, as organisms can then be grown at the temperature of the blood without the cultivating medium being liquefied. I also studied some of the most striking organisms by isolating them in pure cultures and by microscopical examination. The plate cultivations were

examined on the third and fifth days. I prefer the latter date for counting the colonies as they are then as a rule more easily visible, and this leads me to refer to one unavoidable objection to bacteriological examinations, viz., the time which must elapse before a report can be obtained. In studying these living microscopic plants, time must be given for their growth, and the rate of growth varies very considerably with different species.

"These samples (A, B, and C) were all examined by the methods I have described, and control experiments were made with drinking water in use in King's College.

"The plate cultivations and cultivations in Petri's dishes of samples A and B contained innumerable colonies, and on the fifth day the plates were completely liquefied.

"Colonies producing liquefaction showed themselves at a very early stage in large numbers, and there were numerous colonies of bacteria producing a green colour. On raising the dish which covered the plates the odour was extremely fœtid. I can only compare the plate cultivations obtained from samples A and B with cultures prepared from sewage water, or from water intentionally mixed with fœcal matter in the course of experiments upon the bacteria present in the excreta in health and disease. The numbers of colonies present could only roughly be estimated in millions.

"In sample C there were 118,000 bacteria to the c.c., with some odour of putrefaction on raising the dish cover, but this could not be compared with the extremely offensive odour generated by the cultures prepared from A and B.

"In the sample from the water in use at King's College there were less than 200 bacteria to the c.c.

"I could not use words strong enough in condemnation of the samples A and B. Such water if by chance contaminated with the germs of typhoid fever or Asiatic cholera would be a source of the gravest possible danger to the inhabitants of Worthing, and the only reason for hesitation in suggesting that such water might actually originate typhoid fever without contamination from a pre-existing case, is the uncertainty which still surrounds the question of the exact etiology of this disease.

"With regard to sample C the number of bacteria is far too high, containing as it does more bacteria than unfiltered Thames water in the worst month (December) and nearly as many as unfiltered water in the same month from the river Lea.

"Allowing for the excess of bacteria as in part the result of the time elapsing between taking the sample and its receipt and examination in London, I should strongly recommend that this water should be filtered before use for drinking purposes.

"In conclusion I would point out that we can only arrive at a just conclusion by taking all the evidence into account and that both the chemical and the bacteriological analysis must be considered side by side with the evidence obtained from the use of the water by the inhabitants of Worthing."

The above analysis shows that the public water supply during the middle of May was in a very foul state, and it strongly confirms what was before known by naked-eye examination, that not only was the tank in a filthy state, but that the water as it came from the new heading was very impure, for sample C was collected from the polluted source.

These three samples were examined after the outbreak had begun and with a full knowledge of the fever prevalence. It tells nothing of the presence of any typhoid bacillus, so it may be assumed that none was found, nor indeed does it give the names of any microbes, pathogenic or non-pathogenic.

It tells in no doubtful language that filth was present, but concerning the nature of the filth nothing is forthcoming.

On no other occasion was the tank found in a filthy condition.

In the early morning of May 15th, I went round in company with Mr. C. T. Gardner to examine several hydrants in the town, at a time when the pressure in the water mains was low.

In each case we found evidence of a most dirty condition of the hydrants, and no one who saw their condition before they were flushed out could fail to realise that the public service supply of water had somehow become seriously contaminated. Preparations were at once made to empty and clean out the reservoir, and treat the interior with hot limewash; this work was done on the night of May 15-16.

Attempts were also made to change the whole of the water in the mains by opening the hydrants, but this was not an easy thing to do, and although day after day flushing went on, it did not cause an efficient cleansing. The interior of many of the old pipes was rough and irregular, so that the ordinary flow of water did not detach adhering particles. There were several empty houses, and the water pipes supplying the cisterns must have contained impure water, which, when the pressure in the mains was low, flowed back again a short distance. There were hundreds of hydrants and sluice valves which also could not be effectually cleansed by flushing.

In addition, there were over forty dead ends in various parts of the town, many of them being several yards in length. Most of these dead ends had a hydrant box attached to them, which could be opened when occasion required; fifteen of them had no such ending, so that unless the ground were opened, and the pipe cut across, it could not be cleansed by flushing. When the number of new cases began to diminish in number towards the end of May, the number of men engaged in flushing was reduced, and the full significance of this danger was hardly sufficiently appreciated.

By the middle of July, hydrants were put on the remaining 15 dead ends, and they were all frequently opened and flushed. As late as June 21st this had not been done, for on that day a water main was laid bare in the New Steyne Road, the end of which was 17 feet from the nearest hydrant, and when the pipe was cut across it was found to be full of filthy water.

All these conditions prevented the due cleansing of the interior of the water mains by any extra flushing.

The tank or reservoir could be washed out, but there still remained more or less stagnant and fouled water in the pipes which could not be removed. Such limited areas would give plenty of opportunity for the development of any microbes which at any time when the pressure was altered might flow back into the larger pipes, and keep up pollution for a prolonged period.

The water in the suspected well C had much improved by June 5th, for millions of gallons must have been pumped out of it since May 22nd, when it was in a filthy condition. On June 5th two samples were taken from the bottom of well C at the same hour, and sent to King's College at once. One sample was examined bacteriologically by Professor Crookshank, and the other was examined chemically by Professor Thomson and Mr. Jackson.

By each observer excellent results were obtained and the water from each point of view was regarded as very pure.

I give here each report in full.

Bacteriological Report.

"This sample is described as having been taken at Worthing from the bottom of a well 72 feet deep. It was received in London about four hours afterwards and the examination commenced at once.

"Several plate cultivations were made and the colonies have been studied by microscopical examination.

"A sample of London water was examined under similar conditions.

"The Worthing well water produced 22 colonies for every 0·1 c.c. of the sample examined, that is to say there were 220 bacteria in a c.c. of these, 10 were colonies which liquefied the gelatine.

"The colonies were found, on microscopical examination, to be almost entirely the result of the growth of a common non-liquefying bacterium, and all were harmless microbes, occasionally present in the purest water.

"The sample of London drinking water examined simultaneously contained 1,500 colonies of bacteria in the c.c.

"I shall forward in the course of a few days photographs of these cultivations in illustration of the results of the examination.

"The water sample of June 5th, 1893, ranks from the bacteriological analysis in my opinion as very pure water, and it stands in marked contrast to previous samples which gave unquestionable evidence of contamination by filth."

Chemical Report.

"The water was clear and colourless, and free from unpleasant taste and smell. It was fully aerated. The residue obtained by evaporating the water was only slightly darkened on heating, and rapidly regained its white appearance.

"No smell was perceptible during the heating.

"The results of the analysis are as follows :—

Total solid residue	29 grs. per gall.
Hardness, by Clark's test	19 degrees.
Total calcium, expressed as calcium carbonate	18·26 grs. per gall.
Chlorine	2·9 " "
Poisonous metals	None.

	Pts. per million.	Grs. per gall.
Free ammonia	·018	·00126.
Albumenoid ammonia	·034	·00238.
Nitrates, expressed as nitric acid		1·26.
Nitrates		traces.
Oxygen consumed from permanganate in 6 hrs. at 80° fahr.		·14.

" From the results there is no evidence that the sample is anything but one of average purity. The hardness is high, as may be seen from the quantity of calcium present.

" The nitrates are a little high, but this is frequently found in chalk waters of acknowledged purity.

"On the whole the chemical analysis of the sample sent does not point to the water being unfit for drinking purposes."

This analysis corresponds very closely with those made by Dr. Dupré in the early part of May.

These favourable reports, together with the rapid diminution in the number of new cases notified, led most persons to consider that the outbreak was at an end. Probably many persons then ceased to boil water for a time as they considered themselves secure.

It appears, however, from an analysis made by Mr. F. A. Anderson, B.Sc., F.I.C., that the water in some of the pipes on June 9th was polluted, but this fact did not come to my knowledge until many months later. He received a sample of water drawn from a house near the centre of the town and situated in a street where there had been some cases of fever.

This sample was taken four days after the one which had been drawn from well C, and which was found by Dr. Crookshank to be pure.

The report somewhat confirms the view put forward above that the water in the pipes was still impure.

Mr. Anderson writes :—

" I obtained after three successive cultivations in beef peptone broth containing 0·75 per mille of carbolic acid a bacillus which had the following characteristics :—

" 1. Multiplies with extreme rapidity in beef peptone broth, either plain or containing 0·75 per mille of carbolic acid, the broth becoming turbid in from 10 to 14 hours after infection at the temperature of 22° C. The broth does not develop a scum upon its surface, but a deposit forms at the bottom of the test-tube.

"2. Examined under the microscope, the bacillus has the following forms:—

"(*a*) When grown in carbolized broth; diplococci or short diplobacilli; some rods also observed.

"(*b*) When grown in plain broth; rods of various lengths, rounded at the ends, the shorter ones sometimes constricted in the middle; in a fresh preparation they are in very active movement. A few longer filaments were also observed, but their significance is doubtful.

"3. Upon potato develops a colourless or slightly yellow growth after a few hours incubation at 37·C.

"4. Upon gelatine (plate culture) the colonies are circular, non-liquefying, whitish, thick, and opaque.

"*Conclusions.*—There is no doubt that the organism obtained is either the bacillus typhosus or the bacillus coli communis. The gelatine plate culture after three days had only developed colonies of one kind excluding one or two tufts of mucor or a similar mould, which very often appear, and are due to unavoidable air contamination during pouring. These colonies seem to agree more with bacillus coli communis than with bacillus typhosus.

"The discrimination of these two microbes is at present the most difficult problem in practical Bacteriology, so much so that many authorities regard them as identical or of identical origin.

"The occurrence of either form is very strong proof of contamination with fecal matter, and the coli communis is as valuable in this connection as the typhosus."

Conclusions.

The one fact which stands out clear and distinct above all others in the course of events which occurred prior to the epidemic, is to be found in the driving of the new heading some fifty feet or more beneath any old drain or sewer.

In connection with this work there is the undoubted fact that the water in this heading, before the fissure was reached on April 14th, was subject to fecal pollution.

That this polluted water did enter the public mains, and that it was also pumped up into the reservoir with a considerable quantity of dirty chalky ooze.

That from the middle to the end of April, before as yet the epidemic had declared itself, there was a large amount of diarrhœa among persons of all ages and both sexes in Worthing.

That from that time onwards until the second week of June there was marked prevalence of enteric fever in Worthing and Broadwater due to polluted water.

That in consequence of the cleansing of the reservoir and the flushing of the water mains, the public water supply had so far improved that a lull appeared in the number of fresh cases. That when

this lull occurred, and, in fact, when the cases at the end of May diminished in frequency, there was a partial cessation in the practice of flushing.

That no amount of flushing could effectually cleanse the water mains, because the numerous dead ends, the service pipes to empty houses, and the street hydrants and valves afforded facilities for the reception of foul water, which, when the pressure was removed, partially flowed into the purer main stream.

That the reservoir although cleaned out on May 15th and 16th, still received polluted water after that date, and gave an opportunity for the growth of pathogenic microbes which under conditions of rest and temperature may develop, as is well known, with enormous rapidity.

That this growth was rendered the more easy by the extreme heat in the middle of June, which raised the earth temperature to 70° F. or equal to 21° C., and the air temperature to 80° F. and upwards.

The second part of the epidemic was not a fresh outbreak, but an extension and development of the first part, under conditions which proved highly favourable to the formation of organisms which were potent for harm.

Action taken by the Sanitary Authority.

At a special meeting of the Sanitary Committee on May 15th, the following recommendations were made and adopted :—

To empty, cleanse, and hot limewash the reservoir on top of the water tower.

To cleanse and flush out the water mains, hydrants, and dead ends of the mains.

To flush the house drains and sewers.

To give public notice to the inhabitants to boil all water and milk previous to use.

To disinfect the excreta of infected patients.

To provide hospital accommodation, and nurses to attend the sick.

To submit samples of water to bacteriological analysis.

The Sanitary Committee at once adopted my recommendations but it must be borne in mind that they were not responsible for the construction of the new heading, or for the management of the waterworks; all new works of water supply or sewerage are carried out by a different Committee.

Similar action was also taken by the East Preston Rural Authority. Disinfectants were distributed gratuitously, and a sum of nearly £450 was expended. At the end of August this practice was discontinued, and only the hospitals were thereafter supplied.

The nursing and the hospital accommodation are given in more detail hereafter.

A diver was employed on July 29th in a vain attempt to stop the fissure in the new heading; and on August 23rd two very strong and experienced divers were also unsuccessful, as the force of the water was too great.

EXTENSION OF THE EPIDEMIC TO WEST WORTHING AND WEST TARRING.

But when the epidemic had spent its chief force in Worthing, there was a further extension of the disease in West Worthing and West Tarring, places which up to that date had hardly been affected.

The few cases which had been met with in these areas could be accounted for either by having been imported into the districts from Worthing, or they were amongst those persons who had had various opportunities of drinking unboiled water in Worthing.

On July 30th, one case was notified in West Tarring, on August 2nd, two more cases, and on August 4th, four. In the week ending August 11th, sixteen cases, in the week ending August 18th, nine cases, and in the week ending August 25th, six cases were notified; the number then rapidly decreased, there being only one more on August 30th, two in September, four in October, and two in November.

In West Worthing there was a similar experience. On August 3rd three cases were notified, and three more on August 4th.

In the week ending August 11th, twenty cases, in the week ending August 18th, seven cases were notified; in the next four weeks there were respectively, three, three, four, and three cases; in the second half of September there were two cases, in October one, and in November three cases.

Looking at the dates of attack it will be seen that the new outbreak began at West Tarring on July 24th, and at West Worthing on July 27th.

Charts 7 and 8, and tables I. and II. give the particulars of this outbreak. Here again neither the milk supply nor the sewerage arrangements afforded any clue as to the cause.

The only thing in common to these two areas was the water supply, which in each case is derived from the two wells of the West Worthing Waterworks Company.

A similar outbreak, but on a smaller scale, was recorded in my annual report for 1892, where it was shown that the cause of the disease was due to pollution of the water in the mains by means of defective hydrants.

West Tarring lies north of the West Ward, and it is separated from it by the Brighton Railway. Just north of the railway, a small suburb of new houses has sprung up within the last seven or eight years.

These houses drain into a sewer which connects with the Worthing system, and this is quite distinct from the sewerage system in the West Ward. The water supply to this new suburb is altogether from the West Worthing Waterworks Company, and this is the only point in common between the West Ward and West Tarring.

If now the cases of disease in these two places owned a common origin, suspicion must fall on the water supply. But it can be shown that the water, as supplied from the waterworks, was of exceptional

quality, and therefore there remained the possibility of subsequent contamination, *i.e.*, some source of pollution on its way from the pumping station to the dwelling house.

The general conformation of the ground is such that a ridge of slight elevation runs from east to west parallel to and south of the railway; it runs from Park Crescent on the east to St. Ronan's on the west. Nearly all the houses in the West Ward lie to the south of this gentle slope. All the houses in West Tarring lie to the north of it.

The waterworks are near Heene Terrace, and therefore they are on the southern side. The water mains follow the contour of the surface, so that they rise about sixteen feet when they reach the ridge, and passing over it, they decline slightly as they extend northwards. Upon the course of the mains numerous hydrants are attached. Each hydrant is fixed in a box and covered with an iron lid furnished with a keyhole, and placed so that the upper surface is level with the road. The hydrant consists of a short length of iron pipe connecting with the main below, and closed by a ball of ebonite which, when the pressure of water is sufficient, is forced against a flange of india-rubber, and so the escape of water is prevented.

This is true so long as there is enough pressure in the pipes, but when the pressure is removed the ball drops down, and then any impurities in the box can pass readily into the main and pollute the water supply. The system adopted in the West Ward is an intermittent, and not a constant one. During the long interval between 5 p.m. of one day and 6 a.m. of the next day, the water in the mains is changing its position.

From the top of the ridge it flows backwards in a southerly direction towards the waterworks, and it flows in a northerly direction towards Tarring on the other side. Thus there are long lines of mains which are empty of water for some hours, and then there is a chance of various impurities entering through the hydrants.

Chart 15 explains the position of affairs. I examined in 1892, and again in 1893, several of these hydrants between 5.30 a.m. and 6.30 a.m., *i.e.*, before the morning pumping had begun, and have found the ball down in every hydrant but three on the mains south of the ridge. The three which contained water were full because they lay lower than the rest, and the water could not get away.

All the water in the mains in the early hours of the morning is water which has been pumped into them the previous day, Many of the boxes were clean, but many were more than half filled up with dirty mud or silt, which had washed into them off the roads; often the ebonite balls were covered with dirt. It is obvious that any surface or road filth may thus enter the mains in wet weather, and a person may drink impure water which has been fouled at a distant point.

In dry or frosty weather it is most likely that nothing injurious can enter the pipes, but in wet weather, or when the frost breaks up, there is a certainty that dirty water enters. At West Tarring the condition of Beckett and St. Dunstan's Roads in 1892 was very bad, and for weeks pools of stagnant water were met with. A similar condition of things was seen at Thorn's Terrace, which lies close to Milton Street, Brunswick Road, and the Parade. Part of Mill Road and Belsize

Road has never been taken over by the authority, and the hydrants in all these roads are especially liable to pollution.

In West Tarring the fever only appeared in that portion of the village which lies immediately north of the railway and amongst houses of recent construction. These houses were all drained into the Worthing system of sewers and they obtained their water supply from the West Worthing main which was laid through this area in 1888. Those who lived in the older houses with their shallow wells and more primitive arrangements for the disposal of sewage escaped altogether.

During the year 1892 steps were taken to alter the defective hydrants in West Tarring to others of a more modern pattern, and so made and laid that surface water could not enter the mains. Thus before the summer of 1893 the rural sanitary authority had so far safeguarded the area under their control, but they had no power over the West Worthing area where pollution might still occur, but where nothing had been done to obviate the danger.

In West Worthing the houses in which the fever appeared in 1892, and again in 1893, were mostly those where the water in the mains ran back to its lowest level at night time, *i.e.*, when there was no pumping going on at the waterworks, and when, therefore, nearly all the water mains were empty.

Taking the ridge that runs from east to west as a central line, it may be said that the water remaining in the mains at the end of a day's pumping separated into two portions : one running north to the newly built portion of West Tarring, the other south to the houses in West Worthing which are near the sea.

Between these two places there was a large area in which the water pipes were empty during the hours in which there was no pumping. In the two areas in which water could still be found, such water must be for several hours in a somewhat stagnant condition, and as it ran back from the higher levels, it may have brought with it any impurities that could have entered it at various and distant points.

Chart 15 shows in a graphic form the ball hydrants under pressure and without pressure; on the right an enlarged section of a ball hydrant is drawn; the left half is shown filled with dirt and debris, while the right half is clear.

When, on July 17th, the West Worthing water was used to supply drinking water to Worthing, it was thought advisable to water the streets in West Worthing with Worthing water, so as to economise the supply, but no street in West Tarring was watered with Worthing water.

There was no street watering with West Worthing water from July 25th to August 8th, but, so far as my memory serves me, there was some partial street watering in West Worthing with Worthing water in the period July 18th—25th; this, however, is not now capable of proof. Unless the infective material entered the defective hydrants, and so gained access to the water supply, it is not clear how West Tarring could have been invaded at the same time.

The water, as it came from the West Worthing wells, was good, as shown by chemical analysis, and bacteriological examination gave negative results.

TEMPORARY SUPPLY OF WATER.

On July 17th, it was resolved to place in various parts of the town large galvanized iron tanks which could be filled with wholesome water from the West Worthing Waterworks, for the use of the public. The work was at once put in hand, and in a few days, about one hundred such tanks were distributed at convenient points throughout the town.

Each tank held either 100 or 150 gallons of water, and was raised on bricks about 18 inches above the pavement; a tap was provided to each, and a wooden cover fastened down by an iron bar.

Ten large water vans were obtained and were constantly engaged in this distribution of water. The vans were cleansed with boiling water before they were used for this purpose. The tanks were cleaned out at regular intervals.

This plan was found to be of great value, as every householder could obtain enough water for drinking purposes either by going to the nearest tank, or by drawing some from the van as it passed through the street.

The plan was also an economical one for the poor who were thus saved the necessity of boiling any water. During the very hot weather they were enabled to live in a cooler atmosphere, as there was no need for a fire in their small living rooms.

TEMPORARY WATER SUPPLY FROM BROADWATER.

In the meantime other steps were being taken to provide a good supply of water from the Chalk Downs at Broadwater, so that enough might be obtained to enable the old waterworks to be closed. A well was sunk in the chalk at the foot of the Downs, about a mile to the north of the town, on land in the possession of Mr. Harrison, of Lyon's Farm, who gave permission for this to be done free of any charge. To Alderman Cortis is due the credit of carrying out the idea, and the first bore was made by him at his own cost. When plenty of water was found, a second bore was made so as to increase the quantity, and mains were rapidly laid down from this new source to a spot in High Street, close to the old waterworks. Temporary engines were put up at Broadwater, and eventually a yield of about 600,000 gallons a day was obtained. On September 4th, the work was so far advanced that a hydrant could be placed on the High Street end of the new mains, and from this date five out of the ten water vans were filled from this source, the other five still obtaining water for some weeks longer from the West Worthing wells.

By September 22nd, the new temporary mains were joined on to the old mains, and a branch was also supplied to the reservoir on the top of the water tower. At 1.45 p.m. on September 22nd, the engine at the old waterworks was stopped, and from that date, no water has been pumped from any of the three wells, A, B, and C. The reservoir was to have been cleansed again before this new supply was admitted, but this was not done until September 27th, when about twenty men were employed in cleaning and limewashing the interior of the reservoir.

A reference again to table I. or to chart 4 will show that after September 15th there was a marked decline in the number of persons

attacked, and this was no doubt due in a great measure to the improved water supply. It is also to be observed that there was a slight but distinct rise in the number of attacks during the fortnight just preceding September 15th, and this in spite of the fact that at the time the town was very empty, as large numbers of families had left for a time. I think that this subsidiary rise was mainly due to the infectious nature of the disease, as many of these cases were in small houses, and inmate after inmate was attacked, so that the fever lingered in some dwellings for a period of several weeks.

There was throughout the epidemic ample evidence of the infective nature of enteric fever.

The full benefit of the new Broadwater supply was not felt until after September 27th, and even then there remained the question whether the mains themselves were in a clean state, and whether the new water might not become polluted, even in a minor degree, by the old pipes.

The question was answered by steady diminution in the number of fresh cases, and of those which were registered during October and November many occurred in houses where there had been previous cases of enteric fever. During this period the air and earth temperature was rather below the mean for the period.

The tanks and vans were still continued in use for many months, as it was not yet deemed safe to drink from any other source. The water after September 22nd was, for this purpose, wholly supplied from Broadwater, and no longer from West Worthing.

No chemical examination of the Broadwater supply was made, but several samples were taken for bacteriological analysis; in no case was the presence of any bacillus typhosus recorded.

I print these reports in full, because they not only give some results which may be of interest to others placed in like circumstances, but they also show the methods of procedure adopted in the course of the analysis.

On three different occasions samples were collected which are here called Series A, Series B, and Series C.

Series A consisted of two samples :—

I. The first was taken from the Worthing water mains, on November 29th; it was a mixture of water taken from nine houses in different streets where fever had been prevalent; each sample was drawn from a tap which came off directly from the main, and whence the water was allowed to run for a short time before the bottle was filled.

The nine samples mixed together in a clean stone jar, previously rinsed out with some of the water, formed a fair specimen of the drinking water at that date. At this time more than two months had elapsed since the polluted well C had been closed, and during the interval nothing but water from the temporary supply at Broadwater had passed through the reservoir or the mains. It ought, however, to be stated that on October 22nd freshly slaked lime was put in the reservoir, so as to produce a large quantity of lime water, which was passed through the mains in the course of the next day or two; this happened more than five weeks previous to the taking of the above samples.

The second sample was taken from the temporary water supply at Broadwater early on November 30th; it was collected in a clean stone jar previously rinsed out with some of the water.

On each sample Dr. Klein thus reports:—

"The two samples arrived in stone jars securely sealed; they were labelled:

"I. Sample of water taken from the Worthing water mains, this afternoon (November 29), between 3.30 and 5 p.m.

"II. Sample of water from the Broadwater temporary water supply, taken at 8 a.m. this morning (November 30).

"They arrived in the afternoon of November 30, and forthwith the following experiments were made:—

"Of each sample, after shaking well the contents of the jar, a measured quantity was taken and used for plate cultivation, in order to ascertain approximately the number of microbes present in the water and capable of growing in gelatine at a temperature of 20° C., that is, the temperature at which the plates are kept in the incubator. In order to get as near as possible the number of microbes present, two plates were made of each sample with ·1 c.c., and two with ·25 c.c., so that four plates were available of each sample. By this it was found that the number of microbes (growing on gelatine at 20° C.) was about the same in both samples I. and II. This number was, however, unexpectedly great, since a calculation based on the four plates for each sample yielded between 40,000 (forty thousand) and 50,000 (fifty thousand) microbes per each cubic centimetre of the water; this, it must be confessed, is a very large number of microbes for drinking water.

"A difference, which came out in these plate cultivations, existing between sample I. and II. is this:

"Sample one (I.) contained a large number of microbes liquefying the gelatine, whereas sample II. contained few liquefying organisms; in sample I. the number of liquefying microbes per 1 c.c. is about 10,000-12,000 whereas in sample II. the number of liquefying microbes is only 60 to 80 per 1 c.c.

"The liquefying microbes were found to be chiefly:—(a) bacillus fluorescens liquescens, common in most waters.

"Amongst the non-liquefying microbes a good many colonies were of the nature of micrococci, others of the nature of bacilli. Amongst these, those that are motile deserve the chief attention, because amongst the motile non-liquefying bacilli, which from their derivation would at once place the water under suspicion of unwholesomeness, the bacillus coli and the bacillus of typhoid, deserve the first importance. I have consequently tested in this direction, by subculture in the different media, a large number of the colonies from those plates, that is to say, making subcultures from the non-liquefying colonies of bacilli, which as regards size and aspect might be compared with the bacillus coli or bacillus of typhoid, but the subcultures yielded negative results. The growths which made their appearance in these subcultures were wanting in

some of the essential features by which either of those species could be identified. The conclusion therefore is justified that none of the non-liquefying colonies present in those plates were either bacillus coli or bacillus of typhoid.

" It must be obvious to anyone who has carefully considered the nature of water pollution, that if in any instance an undesirable pollution—say with human or animal excremental matter—does occur, the number of undesired or injurious microbes must, as a rule, owing to the amount of dilution, be comparatively very small, and therefore any attempt to discover these microbes in the water by the ordinary methods of making plate cultivations with small quantities of the water must needs lead to negative results. It is therefore necessary to use for the cultivations large volumes of the water.

" But here we are at once confronted with this difficulty ; supposing a large number of microbes are present in a given water—in the above samples there are present between 40,000 and 50,000 per 1 c.c.—it is clear that it is impossible to discover in the plates made with a small quantity of the water, as is usual, a particular microbe, if this be present only in comparatively very small numbers, say for instance, one of this kind of microbe in one cubic centimetre of the water. It is therefore necessary to search through a large bulk of water and this has been done in the present instance in the following manner.

" Sixteen hundred cubic centimetres, or a little over half the total quantity sent of the water of each sample, are driven through a sterile Berkfeld filter ; by this means the whole, or nearly the whole, of the particulate matter suspended in the water is intercepted on the outer surface of the filter ; this superficial layer is then carefully brushed off with a sterile brush into, and distributed in, 10 c.c. of sterile water, and of this distribution 1 c.c. was used for each culture tube and each culture plate, so that each tube and each plate received the particulate matter of 160 (one hundred and sixty) c.c. of the original water. Experience teaches that if to each tube or each plate, from a 5 per cent. solution of absolute phenol (carbolic acid), so much is added as to amount to 1 c.c. (of this 5 per cent. solution) per 100 c.c. of the culture medium, the growth of many microbes becomes greatly retarded or altogether inhibited ; but this medication has no injurious effect on the growth of either the bacillus coli or the bacillus of typhoid. Consequently, while many of the microbes—particularly the non-liquefying micrococci—are practically excluded, while others—the liquefying bacillus fluorescens and proteus—are greatly retarded, if there be any bacillus coli or bacillus of typhoid present, these have a chance of showing growth in the medicated medium. To show to what enormous extent the above addition of the phenol to the plates represses the growth of the microbes present in the original water, the following may serve as an illustration ; as stated above, 1 c.c. of the water sample II. contains between 40,000 and 50,000 microbes, amongst these 10-50 liquefying ones ; now, a plate in the above medicated condition inoculated with the particulate matter of 160 c.c. (see above filtration) yielded about 4,000 (four thousand) colonies, none were liquefying, whereas 160 c.c. of the original water ought to yield between six and eight millions of colonies, and amongst these between nine thousand and twelve thousand liquefying ones.

As stated above, the growth of the bacillus coli and bacillus of typhoid is not retarded or inhibited by the above addition of phenol to the culture medium, and I have therefore searched amongst the colonies that made their appearance in the medicated culture-media (each inoculated with the particulate matter of 160 c.c. of the original water) for colonies that in some way or other resembled those of either of the two species, but have not been able to discover any. Colonies which in aspect, in the size and shape of the bacilli constituting them, had a distant resemblance to the bacillus coli or the typhoid bacillus respectively, were subjected to subcultures; the growth that appeared in these did not show the fundamental characters by which either of these species could be identified."

Series B consisted of four samples taken in the afternoon of December 7th; each sample was taken as in series A.

No. 1 was from the reservoir on the top of the water tower.

No. 3 was from a house in Brunswick Road, supplied from the West Worthing Waterworks.

No. 4 was from a house in Montague Street, Central Ward, where there had been several fever cases.

No. 6 was from a cottage in Ham Lane, at the east-end of the borough.

Nos. 1, 4, and 6 were obtained from the Broadwater supply; Nos. 4 and 6 being drawn from the mains, while No. 1 was drawn from the reservoir, where the water may have been quiescent for a time.

No. 3 was from the independent supply at West Worthing. The precise spots whence these waters were taken were unknown to Dr. Klein. This difference of source explains the differences in the analytical results. No. 1 contains more microbes than the rest, because they had time and opportunity to develop there. The analysis of Nos. 4 and 6 are similar, and they all differ from No. 3, which came from a different source. The results are again negative as regards bacillus coli or bacillus typhosus.

I now give Dr. Klein's report on Series B.

"These four samples of water, labelled 1, 3, 4, and 6 respectively, were delivered here in sealed jars in the afternoon of December 8th. In the description of their source it is stated that 'They were taken from the Worthing water mains, between the hours of 3.15 and 4.30 p.m., on Thursday the 7th.'

"All four samples were subjected to bacterioscopic examination on precisely the same lines as described in my former report to you, and therefore need not again be stated.

"Sample 1 contained 8,800 microbes per 1 c.c., amongst these, 150 liquefying ones.

"Sample 3 contained 230 microbes per 1 c.c., amongst them, 50 liquefying.

"Sample 4 contained 600 microbes per 1 c.c., amongst them, 10 liquefying.

"Sample 6 contained 600 microbes per 1 c.c., amongst them no liquefying ones.

"Of sample 1 several suspicious looking colonies made their appearance in the plates, but on further examination by subcultures none of these presented the characters either of the bacillus coli or the typhoid bacillus.

"Of sample 3 one suspicious looking colony, which in subcultures did not present the characters of bacillus coli or bacillus typhosus.

"Of sample 4 and sample 6 two suspicious colonies in each were noticed, but they were not bacillus coli or bacillus typhosus, although it ought to be stated that these suspicious looking colonies in sample 4 and sample 6 were of a different character from those noticed in samples 1 and 3.

"These colonies of sample 4 and sample 6 had several characters in common with the true typhoid bacillus, but in other respects they differed from this latter: thus the suspicious looking colonies of samples 4 and 6 resembled the typhoid bacillus in their great motility, in size, in the inability to form gas bubbles in the depth of gelatine, in the aspect of the growth on gelatine on the surface and in the depth, in the slow growth and in the inability to curdle milk, but they differed from the typhoid bacillus in their not forming threads and chains, and in not growing well at higher temperatures (37° C.).

"On the whole I think I am justified in regarding the bacilli of samples 4 and 6 as not being the typhoid bacillus.

"I am unable to indicate why samples 4 and 6 should be different from 1 and 3, seeing that they were all derived from the water mains, but it is a fact that marked difference exists between sample 1 and the other three as regards the number of microbes present, and between 1 and 3 on the one hand, and 4 and 6 on the other as regards the character of the microbes."

The analyses of Series A and B did not seem to justify one in advising the public to leave off boiling the water, although numbers doubtless did no longer continue the practice; nor could one recommend the disuse of the street tanks and water vans, as there was still the danger arising from the mains not being yet free from pathogenic microbes.

Series C.—A third time the water was analysed but under altered conditions. On previous occasions each stone jar was new, clean and rinsed out with the water to be analysed. This time I sterilised the jars first by placing them, on January 29th, 1894, in an oven from 6.30 a.m. to 8 a.m., where they were exposed to a temperature of

160° F.-180° F. for nearly an hour-and-a-half. Each jar was of course one which had never been previously used. When the jars became quite cool, each was filled with water from one of the four sources mentioned below, and sent off at once. Water D had not been stored in a reservoir.

Dr. Klein sent the following report :—

"The four samples of water delivered on January 29th, were each contained in a jar well sealed, their description was :—

Sample A. From Broadwater Waterworks (Temporary Supply).
" B. From Town Reservoir of same water.
" C. From centre of Town (Ellesmere, Gratwicke Road).
" D. From Mains of West Worthing Water Company.

"All four samples had been collected in the morning of the same day, viz., on January 29th.

"The examination was carried out on precisely the same lines as those described in my former two reports, viz.:—

"I. Gelatine plates were made of the unfiltered water in order to ascertain approximately the number of microbes present per 1 c.c. of the water, and

"II. 1,600 c.c. of each sample were driven through a Berkfeld filter; after the conclusion of the filtering, the outside of the filter was brushed off, and this was used in definite amount for phenolated plates. Amongst the colonies that came up those that presented a similarity in aspect to the bacillus coli or typhoid were picked out and further examined by subcultures.

"1. It was ascertained that water A contained 68 microbes per 1 c.c., so that this water is of greater purity than when first examined; it ought to be stated at the same time that as regards the bare number of microbes per 1 c.c., this water comes within the admitted character of a good water, 100 microbes per 1 c.c. being the upper limit.

"Water B contained 912 microbes per 1 c.c., this proves, what has been repeatedly observed, viz., that by storing water the microbes present increase in number. Water B being the same as water A as to origin, but water B being taken from the reservoir, it follows that herein the microbes have multiplied fourteen-fold.

"Water C contained 164 microbes per 1 c.c., and water D contained 196 microbes per 1 c.c., that is to say, this West Worthing water (D) taken from the mains contained considerably more bacteria than that of the Broadwater Waterworks. But in order to satisfactorily compare the two waters it would be necessary for me to know whether this water D had been like water A, stored in a reservoir ; if so, then the comparison ought to be made between water C and water D, in this case also water D is as regards numbers inferior

to water C; if however water D has not been stored previously then its comparison should be made rather with water A, in this case water D is considerably inferior to water A.

"2. A considerable number of the colonies of the phenolated plates of all four samples was examined in subcultures, but none presented the fundamental cultural characters exhibited by the bacillus coli or the bacillus of typhoid fever, and I think it is justifiable to conclude that these two species were not present in 1,600 c.c. of either of the four samples."

This report is far more favourable than the preceding ones; it seems to me that the fairest way to obtain a good idea of the quality of a water is to cleanse the jar thoroughly by heat before using it for the collection of a sample.

In Series C as in Series B the storage of water increased the number of microbes present.

From this time onwards the water has been used freely, although many still make it a practice always to boil their drinking water.

The water vans ceased to run on February 7th, and the street tanks were removed on the same day.

The total absence of any fresh attacks of enteric fever for a period of six weeks was after all the best test that could be applied to show the wholesomeness of the Broadwater supply.

HOSPITAL ACCOMMODATION.

As there is no hospital in the Borough for infectious cases, the Worthing Infirmary Committee placed nine beds at the disposal of the Corporation for the reception of enteric fever patients on May 16th, and next day two hospital tents were ordered from Piggott, Brothers, and Co.; on May 19th they were erected in the course of a few hours, and on the evening of that day two patients were admitted into them.

Each tent, or marquee, was 30ft. by 16ft., capable of receiving eight patients, and furnished with double roof and walls made of uninflammable material, &c. Each tent in its complete state with floor and furniture cost £79 18s.

These tents were placed on a lawn in front of the Infirmary, and about 30 yards to the south. They answered their purpose very well, but they were found to be very hot within, even when free openings were made for admitting fresh air by lowering the side walls. Some benefit was found by syringing water over the outer roof, by which the temperature could be lowered four or five degrees.

The weather being so hot, the patients were practically lying in the open air all day, and no closeness was observable within, except in the

early morning before the tents were fully opened. Extra nurses were obtained who were placed under the Infirmary Matron, and the Infirmary itself was used as the administrative block, where all cooking, washing, &c., were done.

The Infirmary and the tents were only made use of in the first part of the epidemic, except for two cases which afterwards occurred amongst those connected with the staff, and which were admitted into the Infirmary.

The tent for males was closed on July 11th, and the tent for females was closed on July 21st ; any patients remaining were then removed into the Infirmary.

When the outbreak appeared again in July it was clear that more hospital accommodation was needed. For private or for Corporation cases three hospitals were opened, Richmond House on July 7th, the Traveller's Rest on July 17th, and Mr. Ralli's private hospital on July 26th. For parish cases, three other hospitals were also provided, Newland Road hospital on July 12th, Lyndhurst Road hospital on July 15th, and High Street hospital on July 18th.

These six buildings lent themselves readily for the purpose of conversion into a temporary hospital, and very little alteration was needed beyond clearing out the contents of a lodging house, a mission room, and a Chapel, and putting in the needful number of beds. In two buildings gas and water had to be laid on, but this was done in a few hours. The Lyndhurst Road Primitive Methodist Chapel was thus converted into a hospital within twelve hours, and 28 beds were ready to receive patients. Similar alacrity was shown in other cases, for every one worked hard in the midst of this emergency. In two or three days after each hospital was opened, all the beds were full, and for a time there was a great rush for admission. No doubt there was much overcrowding, but it was thought better to remove cases from their small cottages rather than leave them to infect the healthy who remained at home. Cubic space was of less importance, because the weather was dry and fine, so that the doors and windows could be left open all day and the patients were exposed to an ample supply of fresh air.

The following table shows the cases admitted into the hospitals, the number who recovered, the number who died, and the deaths per cent. of admissions.

It also shows the number of patients in the Borough who were treated at their own homes.

In all, 228 beds were provided, and 431 patients were received ; in admitting cases, preference was given to persons from ten to thirty-five years of age, for not only was the disease most prevalent at those ages, but they were among a class of persons who were either engaged in shops or in service and who could not be well nursed at their place of residence.

Hospital.	Cases.			Recovery.			Deaths.			No. of Beds.	Deaths per Cent. of Cases.		
	M.	F.	Tl.	M.	F.	Tl.	M.	F.	Tl.		M.	F.	Tl.
Infirmary	11	16	27	7	12	19	4	4	8	15	36·36	25·00	29·63
Infirmary Tents	8	15	23	7	14	21	1	1	2	16	12·50	6·66	8·70
Richmond House	22	39	61	21	35	56	1	4	5	36	4·54	10·25	8·20
Traveller's Rest	48	43	91	40	31	71	8	12	20	65	16·66	27·91	21·98
Ralli Hospital	9	7	16	9	7	16	0	0	0	10	0·00	0·00	0·00
Newland Road	27	43	70	23	30	53	4	13	17	33	14·81	30·23	24·28
Lyndhurst Road	30	25	55	25	22	47	5	3	8	28	16·66	12·00	14·54
High Street	46	42	88	44	38	82	2	4	6	25	4·35	9·52	6·82
Hospital Patients	201	230	431	176	189	365	25	41	66	228	12·43	17·83	15·31
Patients treated at Home	418	470	888	373	411	784	45	59	104		10·76	12·55	11·71
Total	619	700	1,319	549	600	1,149	70	100	170		11·30	14·28	12·89

The mortality was higher amongst those treated in hospital than amongst those treated at home. This was not because the worst cases were removed, the applications for admission came in too fast for any selection of cases, but it was greatly due in my opinion to the removal itself, whereby the patient was received in a more or less exhausted state. Experience has shown over and over again that in enteric fever nothing is more important than complete rest and quiet from the commencement of the attack ; no one can always tell in the early stage whether the disease is going to assume a severe form or not. Removal to the hospitals was a distinct benefit to the other inmates of the house, but it was not wholly an advantage to the individual removed.

Similar accommodation was provided in the two adjacent villages.

WEST TARRING.

The Reading Room was opened as a Hospital on July 14th, 1893, with accommodation for ten patients, and in this building 23 persons were treated. The Infant Schoolroom was opened as a Hospital on August 9th, 1893, and it was closed on September 12th, nine patients having been admitted.

Of these 32 patients, 6 died, so that the mortality was equal to 18·75 per cent. of those admitted.

The cost of each patient amounted to £15 5s.

BROADWATER.

The Reading Room in the village was converted into a hospital with two wards on the ground floor, and capable of holding ten patients. It was opened on July 20th and closed on September 20th, during which time 22 patients were admitted, of whom 13 came from the village, and 9 from the adjacent part of Worthing which lies north of the railway.

Six persons were admitted on July 20th and three more during the following three days; five came in on August 2nd, and seven more up to August 16th, after which date the admissions ceased. Three of the patients died, so that the mortality in the hospital was equal to 13·63 per cent. of those admitted. The total cost, including every expense, amounted to £263 12s. 10d., so that the charge for each patient amounted to £12. This sum does not include the after treatment of those who were sent to a convalescent home.

There were altogether 42 persons attacked with fever in the village, and of these 9, or 21·43 per cent. died.

There were, in addition, the nine urban cases treated in the Temporary Hospital, and the total cost of these fifty-one persons amounted to £533, or an average cost for each patient of £10 9s. This sum includes the maintenance and treatment of the patients not only during the illness, but during the period of convalescence at a home where they were sent for change of air.

NURSING.

Early in the epidemic the Worthing District Nursing Association, at the request of the Worthing Corporation, undertook the nursing of the sick at their own homes. Extra nurses were engaged, and as their duties were arduous and the distances great, pony carriages were hired, so that the sick might be visited at least once, if not twice a day. This plan answered very well in the first part of the outbreak, but when there were such a large number to be treated towards the end of July, it was thought desirable to scatter the nurses through the town where each could have a defined district in which she resided for the time. It had always been the rule of the Association to lodge the nurses at some central house, whence they could visit as occasion required. When the sudden rush of cases came on in July this plan was not found to answer, as there was too much overlapping of areas, and too much time was spent in going from place to place. The hire of pony traps alone amounted to more than £250.

A Committee was appointed, at a meeting held on the 5th August, to organise a special branch of the Worthing District Nursing Association, for the purpose of providing for the nursing of the Poor Law and Corporation patients suffering from enteric fever.

Miss Hopper was appointed Superintendent by the Committee on August 8th, and the work commenced on Monday, August 14th, the Borough being divided into fourteen districts, and a nurse stationed in each district.

The Association having no funds available for this extra work, an agreement was made with the East Preston Board of Guardians, for a payment of four shillings per week or any part of a week, for each Poor Law patient, the Town Council undertaking to pay the balance of the expenses. This liability was soon after transferred to the Committee of the "Mayor's Relief Fund."

From the 14th August to the 23rd October the number of patients amounted to 390; on the latter date 313 were convalescent, three were transfered to private nurses, 14 removed to hospitals, and 47 were handed over to the regular district nurses.

As evidence of the skilful care and attention of the nurses, it may be stated that there were 13 deaths, and that the death-rate of those attended amounted only to 3½ per cent.

The following were the number of patients on the register for each week, viz., August 20th, 279; August 27th, 241; September 3rd, 191; September 10th, 167; September 17th, 135; September 24th, 135; October 1st, 117; October 8th, 102; October 15th, 83; October 22nd, 64. The expenditure, deducting the amount paid for the women employed for night nursing, etc., amounted to £333 17s., which makes the average cost per patient per week slightly under 4s. 5d. Up to October 8th, the average cost was only about 4s. 0¾d., the increase during the last two weeks was owing to the Committee being unable to reduce the staff of nurses in the same proportion as the patients became convalescent, the districts being so scattered.

The receipts and expenditure of this special branch are here given:—

1893 RECEIPTS.	£	s.	d.	1893 EXPENDITURE.	£	s.	d.
				Arrears paid to Institutions and Nurses for fees, travelling expenses, &c., by the Special Branch before taking them over on			
August 19th. Worthing Corporation ...	44	8	5	August 14th	44	8	5
August 22nd to October 18th. Guardians East Preston Union	92	3	0	August 12th to October 25th. Fees to Nurses from August 12th to October 23rd ...	130	4	0
August 24th to October 23rd. Committee, Sick Poor Fund	255	0	0	Board and Lodging ...	122	16	7
				Laundry Expenses ...	12	13	
				Superintendent's Fees, Aug. 8th to Oct. 25th ...	23	2	0
				Hire of Carriage, 10 weeks	21	0	0
				Chemist's Account ...	9	17	4
				Nurses' travelling expenses	10	3	1
				Printing	0	16	9
				Registers, Case Books, and Charts	1	13	5
				Incidental expenses ...	1	10	10
				Women for night nursing, &c	13	6	0
	£347	3	0		£347	3	0

COST OF THE EPIDEMIC.

I now give, as briefly as possible, under main heads, the cost which the epidemic entailed upon the ratepayers of the districts in which the fever appeared.

1.—Borough of Worthing.

	£	s.	d.
Hospitals	3,742	18	4
Disinfectants, notification fees, &c.	683	1	1
Waterworks (temporary)	2,972	17	0
Water supply (temporary)	2,217	11	0
Other expenses	87	9	2

2.—East Preston Union.

Union Common Fund	2,639	6	3
Rural Sanitary Authority	277	19	7
Total	£12,621	2	5

In addition to these sums, the cost of extra relief to the poor is estimated at not less than £1,500.

There were several large sums expended by the liberality of the public which if they had not been given, would have been defrayed out of the rates. Thus, Mr. G. A. Ralli provided a hospital for sixteen patients at a cost of £444. Thus, again, Broadwater treated its own sick poor from money subscribed almost wholly from persons resident in the parish. In this way £500 were raised by private subscription.

The following figures give in more detail the various items of expenditure.

Borough of Worthing.

A detailed account of the expenditure incurred by the Worthing Corporation, consequent on the epidemic which occurred in the Borough during the year 1893 :—

	£	s.	d.	£	s.	d.
Hospitals—						
Rents of Buildings	493	2	4			
Medical assistance	581	0	0			
Wages and lodgings—Nurses	1,466	3	9			
Board of patients and nurses	1,339	18	2			
Drugs and medical appliances	190	19	6			
Tents, furniture, &c.	345	10	9			
Gas, coals, rates, and taxes	33	16	9			
Laundry work	162	2	8			
Hire conveyances of nurses and patients	298	9	7			
Stimulants	138	8	2			
Sundries	102	10	1			
	5,152	1	9			
Outstanding claims for rents and repairs, estimated at	98	0	0			
	5,250	1	9			
Less cash received for board, &c. of patients from East Preston Board of Guardians, &c. 1,462 3 5						
Sums due, estimated as recoverable 45 0 0						
	1,507	3	5			
				3,742	18	4
Disinfectants used in hospitals, sewers, and private drains				447	17	7
Notification fees				139	12	6
Analysts' Fees, water from well, mains, temporary supply, &c.				95	11	0
				4,425	19	5
Waterworks—						
Well sinking and boring for new water supply	317	0	0			
Providing and laying watermains	1,794	7	11			
Purchase and hire of machinery	611	14	1			
Erecting temporary engine and boiler sheds	116	2	1			
Water fittings and works in connection therewith	133	12	11			
				2,972	17	0

WATER SUPPLY—						
Water tanks and fittings	329	9	6			
Purchase of water for drinking, and flushing sewers	178	0	0			
Delivery of water for drinking purposes	864	1	6			
Extra labour for cleansing and flushing watermains	846	0	0			
				2,217	11	0
Costs incurred in attempts to shut off polluted water.				87	9	2
				£9,703	16	7

EAST PRESTON UNION.

The expenditure incurred by the East Preston Board of Guardians was on account of the three parochial hospitals in Worthing, the West Tarring Hospital, and for a nurse at Broadwater.

From July 12th to August 8th, all the parochial hospital expenses were defrayed by the Guardians; after that date an arrangement was made with the Worthing Corporation by which the Guardians paid according to a scale agreed upon by both parties.

The total amount paid out of the Union Common Fund up to August 8th was £941 16s. 11d., but of this sum the Worthing Corporation repaid £100 for furniture; after that date the charge on the Union Common Fund amounted to £1,797 9s. 4d., or a total cost of £2,639 6s. 3d.

The various items making up this expenditure are here set forth.

Charges defrayed from the Union Common Fund in connection with the Enteric Fever patients from July 12th to August 8th :—

	£	s.	d.
Furnishing	225	16	7
Nursing (wages, board, lodging, &c.) . .	364	9	6
Food	128	7	3
Stimulants			
Drugs	23	6	3
Washing	51	13	2
Maintenance of Hospitals	8	8	7
Fly Hire	36	9	0
Sundries	3	6	7
	£841	16	11

Charges defrayed from the Union Common Fund subsequent to August 8th :—

	£	s.	d.
Worthing Corporation for maintenance and nursing &c., of patients	1,253	11	7
Out-relief nursing	91	16	0
Medical Officers (extra assistance)	63	11	10
Relieving Officers (extra assistance)	37	13	1
Gratuities to Medical Officers	100	0	0
Rent of Newland Road Hospital	21	0	0
Rent of High Street Hospital	6	18	0
	1,574	10	6
Cost of a Nurse for Broadwater	34	0	0
Charges on account of West Tarring Hospital	181	18	10

Thus the total sum paid by the East Preston Guardians amounted to £2,639 6s. 3d. In addition, they paid, as the Rural Sanitary Authority, £277 19s. 7d. for the West Tarring Hospital, which thus cost altogether £466 18s. 5d. as a contribution from the public rates.

West Tarring.

The cost of the maintenance and treatment of the patients in West Tarring Hospital is here shown :—

	£	s.	d.
Furnishing	81	3	10
Nursing	155	11	2
Food and necessaries	125	15	7
Stimulants	28	1	4
Drugs	27	9	6
Medical attendance	30	0	0
Washing, &c.	30	9	6
Cleansing and painting	10	0	0
	488	10	11
Less contribution from patients	21	12	6
Charges defrayed from public rates	£466	18	5

Broadwater.

	£	s.	d.
Special Hospital Fund	263	12	10
Out-patients' Fund	90	15	3
	354	8	1
Home for convalescents	178	11	1
	£532	19	2

The sum of £34 was received from the East Preston Union Common Fund to pay for the services of a nurse; with this exception, the whole of the expenses in rural Broadwater were defrayed by public subscription; in addition, there were numerous gifts in kind which added greatly to the comfort of the patients.

MR. RALLI'S PRIVATE HOSPITAL.

	£	s.	d.
Rent	80	3	5
Nurses and ward maid	114	18	3
Housekeeping, coals, and gas	77	10	3
Furniture	43	3	2
Drugs and stimulants	38	15	5
Medical fees	69	0	0
Laundry	8	1	0
Convalescents	5	19	0
Stationery, cabs, telegrams, &c.	6	12	3
	£444	2	9

There were 16 patients treated between July 25th and October 17, and all were discharged convalescent.

The cost of each patient amounted to £27 15s.

The total amount raised for this hospital was £449 18s., and the balance of £5 15s. 3d. was, at the request of Mr. Ralli, handed over to the Provident and Poor Relief Society.

MAYOR'S RELIEF FUND.

The following report is an abstract of one published by the Committee of the Fund. It shows the large amount of liberality which the occasion brought forth, and the prudence with which the fund was managed. Not only were the sick poor assisted, but help was also given to those who suffered grievously through loss of business. The distribution of the fund shows a wide sympathy with human suffering.

The Committee was appointed on the 15th day of July, 1893, and for many weeks met daily.

The persons most particularly affected may be classified as follows:—Those in whose homes sickness prevailed, Lodging-house Keepers, Boatmen, Bath-chairmen, Small Fly Proprietors, Small Traders, and Labourers.

Efficient nursing was carried on by the District Nursing Association; the cost under this head was £310 4s. 1d., in addition to which the Committee provided, in several cases, Night Nurses for those who were unable to bear the cost, paying for the same £78 12s. 5d.

The class of Lodging-house Keepers caused the Committee the greatest anxiety, for above all others they had lost all source of income, they had no means of paying rent, rates, and taxes, and in many cases no means of obtaining food. The Committee saw that unless the rents, &c., could be met, they would be compelled to relinquish their homes or dispose of their furniture, the latter course practically rendering their homes unletable; in either case the result would be that many would never again be able to obtain a living in almost the only way open to them. It was felt that to pay rents the action of the Committee might be misconstrued as diverting the fund into unintended channels, or in in other words assisting landlords, but after anxious consideration, they decided to assist with rents in cases where landlords were willing to contribute a sum equal to that of the Committee

and signing an agreement not to interfere with the tenant before the summer of 1894, thus giving the tenant security of tenure and a chance of recovering from the depression. A large number of landlords gave 50 % and some more. By this means many tenants were relieved of all rent varying from three to six months and in some cases nine months. Under this head £2,002 1s. 4d. were expended, the landlords contributing an equal amount. The Committee feel the money could not have been better applied, and have the satisfaction of knowing their action is generally approved. Having saved their homes, and, where absolutely necessary, provided them with food and fuel, the Committee found it needful, in very many cases, to prevent furniture being sold, to pay rates and taxes; the amount expended under this head being £884 12s. 6d.

The class of small Fly Proprietors was also particularly affected. Their means of living practically ceased, and to many there appeared no alternative but to sell their horses; to obviate this, the Committee assisted their families and contributed towards keeping their horses through the winter.

The classes of Boatmen, Bath-chairmen, and small Traders were chiefly assisted with food and fuel by means of Relief Tickets, the total amount thereby expended being £1,084 18s.

The class of Labourers was more particularly affected by being out of employment in consequence of the stoppage of building operations, and the Committee considered they could be better dealt with by the Provident and Relief Society. With this object a sum of £206 9s. 10d. was contributed to that Fund. The Committee of that Society distributed coal once a week, and soup and bread twice, and, when necessary, three times a week during the winter.

In many cases, owing to sickness, members of Friendly, Burial, and Insurance Societies were unable to keep up their contributions, and, but for this Fund, would have been compelled to sacrifice their previous payments. The amount paid under this head was £40 2s.

The long and serious illness in many families entailed upon them heavy expenses for medical attendance, and the Committee, after due enquiry, assisted a large number by paying a portion of the accounts, ranging from 30 to 50 % according to the circumstances of particular cases, at a cost of £497 5s. 3d.

On the 11th July, the Committee of the Provident and Relief Society placed at the disposal of this Committee their Relief Kitchen in Grafton Road, for the distribution of necessaries to the sick. The Kitchen was open daily for 24 weeks, and entailed an expenditure of £1,128 7s. 5d.

The Committee, as far as possible, avoided relieving other than in kind, but money to the amount of £175 19s. 4d. was expended in assisting domestic servants and others, who (although having contracted illness in the town) were with their relatives in the country. The funds in each case were administered by some responsible person acting on behalf of the Committee.

The Committee, after being first satisfied no undue funeral expenses had been incurred and that the applicants were in need, assisted many to bear the cost of burial of deceased relatives, but in no case to more than 50 %; the amount thus expended being £38 10s.

As patients became convalescent it was of the utmost importance that for the purpose of accelerating their recovery they should receive the benefits to be derived from a change of air, and with this object arrangements were made for their reception at various places in the country, many going to their own relatives, the Committee helping with travelling expenses and maintenance; 230 were thus assisted at a cost of £353 14s. 7d.

Two houses were taken for the purpose of Convalescent Homes, one at Goring and one at 95, Marine Parade, Worthing, and a qualified nurse was placed in charge of each. 54 patients were admitted at Goring, and 127 at 95, Marine Parade. The cost of the Goring Home was £67 15s., that of 95, Marine Parade £371 10s. 10d.

Convalescent Children were received at Horniman's Home at the nominal charge of 2s. 6d. per head per week inclusive, and 54 were admitted at a cost of £17 7s. 6d.

Poor Law Convalescent Homes were established for the reception of those who had been treated in Hospital as Poor Law patients. They were mainly supported by a separate private fund, and were assisted to the extent of £180 0s. 8d.

Many patients were maintained by a separate fund raised by a Committee at Broadwater, and £30 was given them as a grant in aid.

Many patients were also treated at West Tarring, a separate fund being raised and administered by a local Committee; in aid thereof this Committee made a grant of £80.

The amount of £68 1s. 2d. was incurred at the Retreat Hospital for patients who, although not Poor Law patients, were not in a position to pay for maintenance and were assisted to the above extent.

It will also be seen that grants were made to the St. George's Poor Fund and the Worthing Needlework Society amounting together to the sum of £35.

The total amount received was £8,803 4s. 11d.

In addition to the sum of £8,803 4s. 11d. in money, many valuable gifts in kind were received, viz., Brandy, Port Wine, Whiskey, Valentine's Essence, Tea, &c., and also Toys for the Convalescent Children.

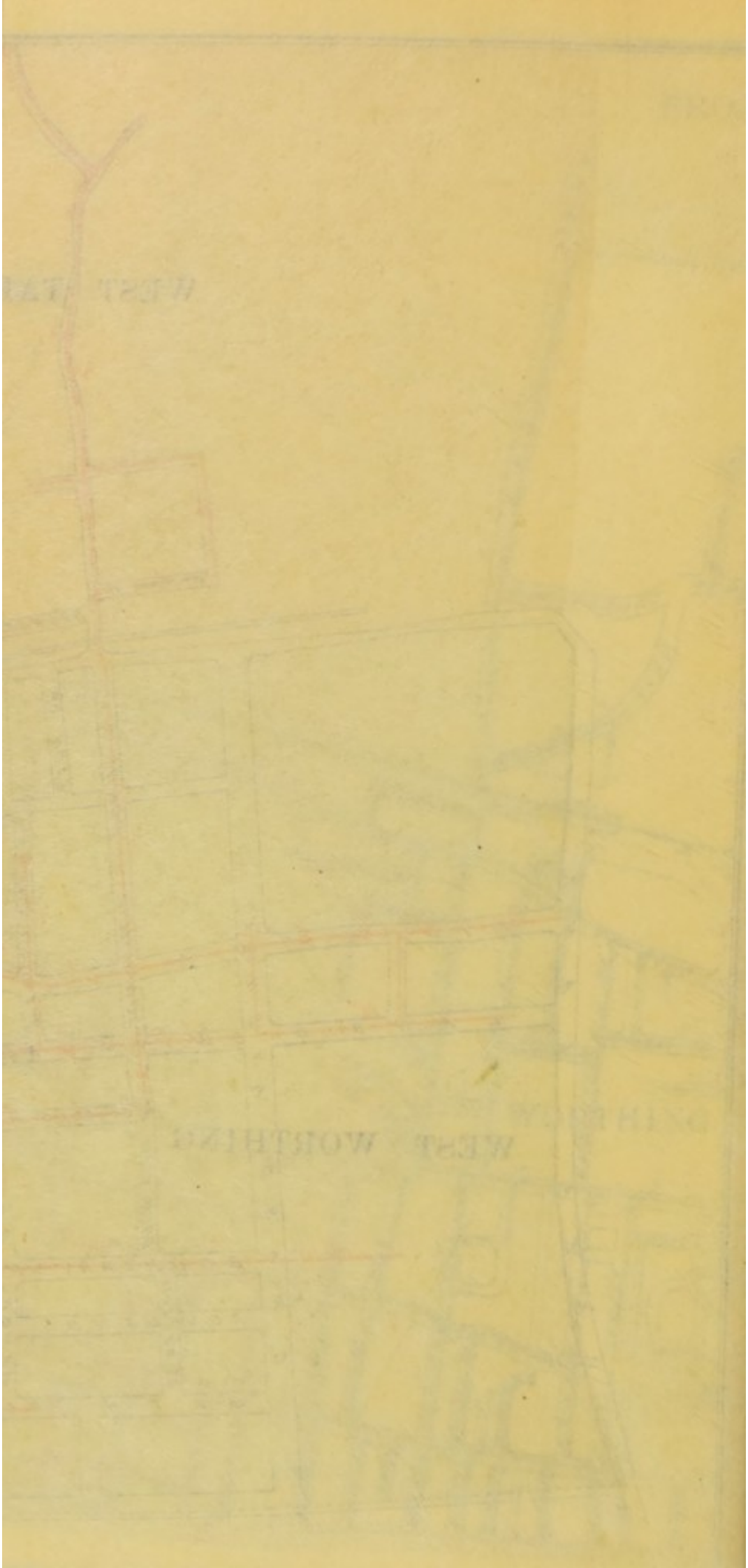
Many also made and forwarded articles of Bedding and Linen for the sick, and Clothing for the convalescents.

The total amount expended has been £7,812 0s. 6d., leaving a balance in hand of £991 4s. 5d., which sum the Committee purpose carrying forward to form the nucleus of a fund for the next winter.

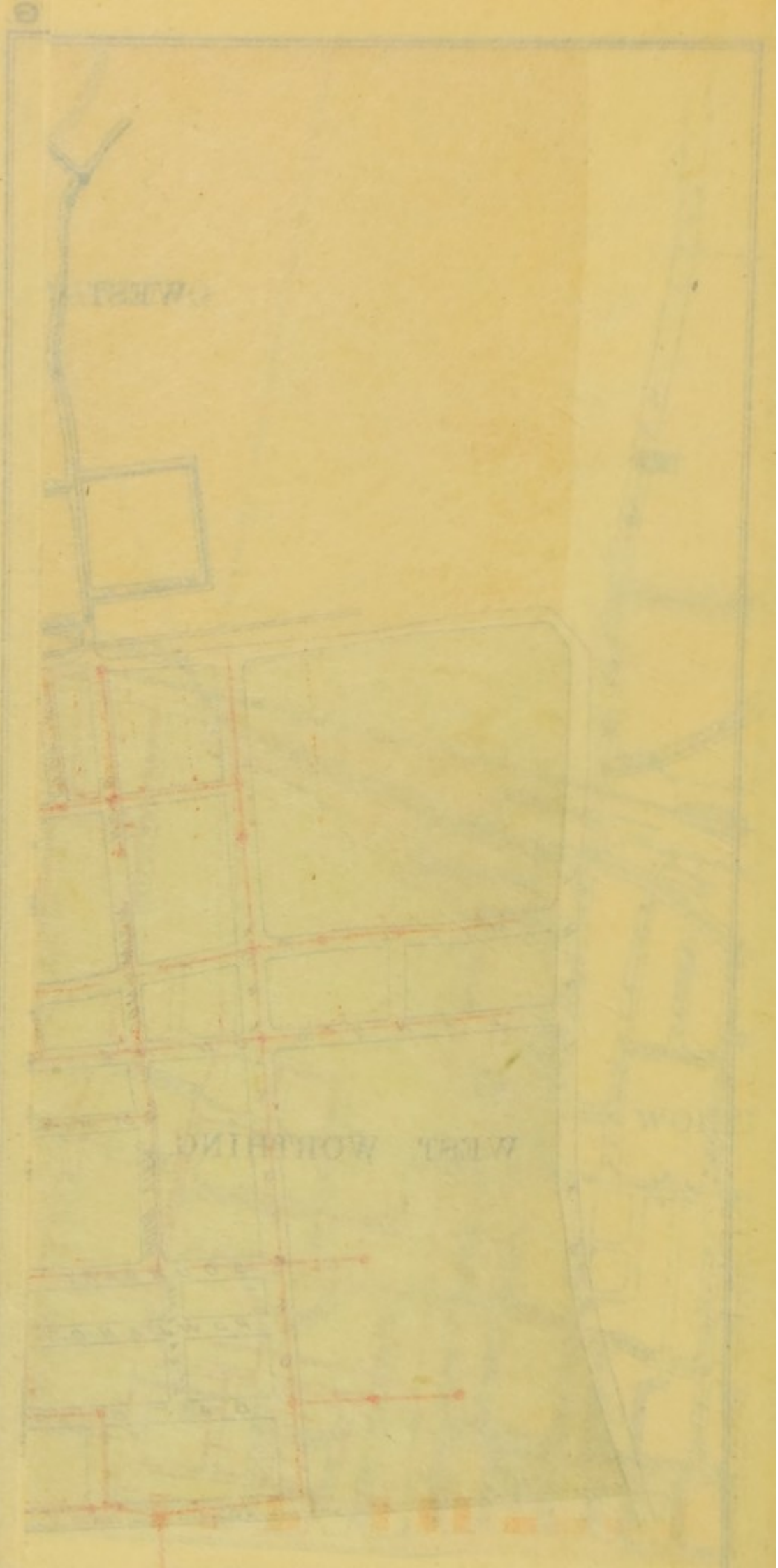
BOROUGH OF WORTHING.

PLAN OF WATER MAINS

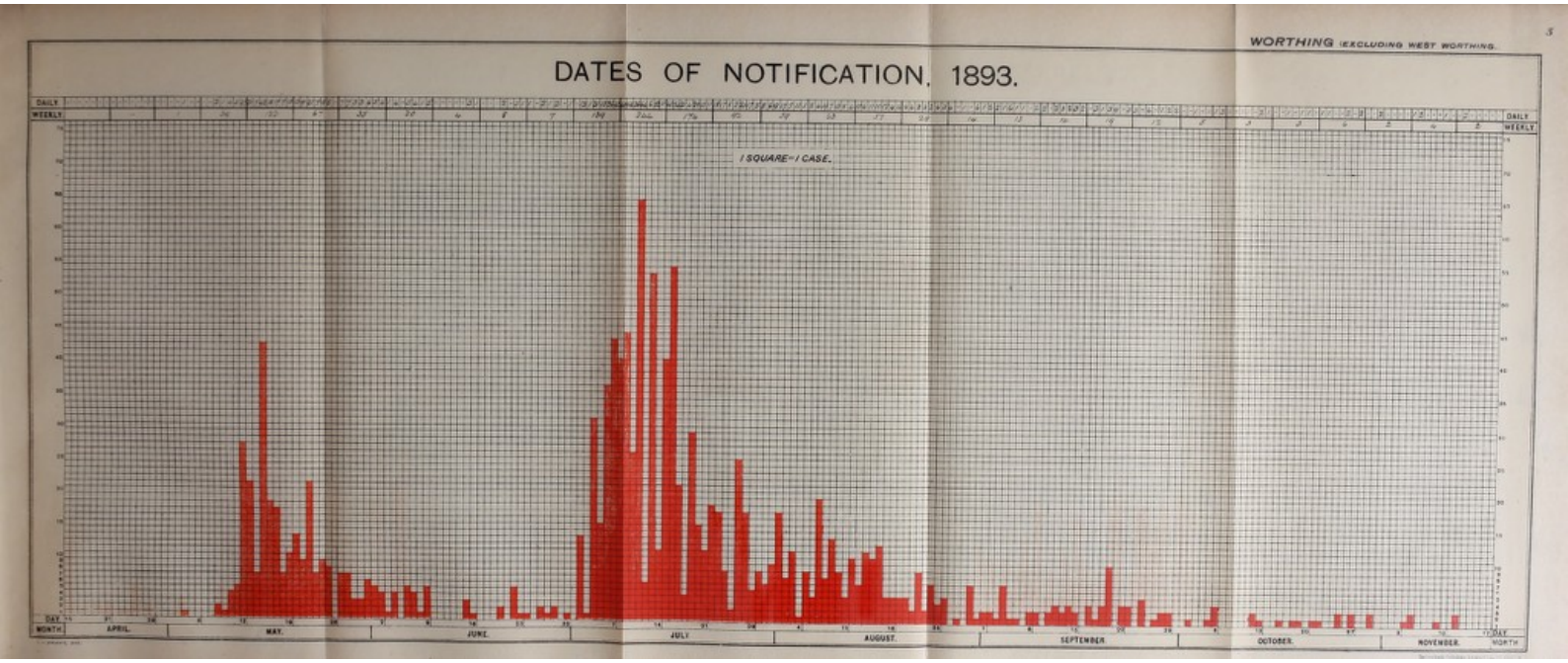
IN THE FOUR AREAS.

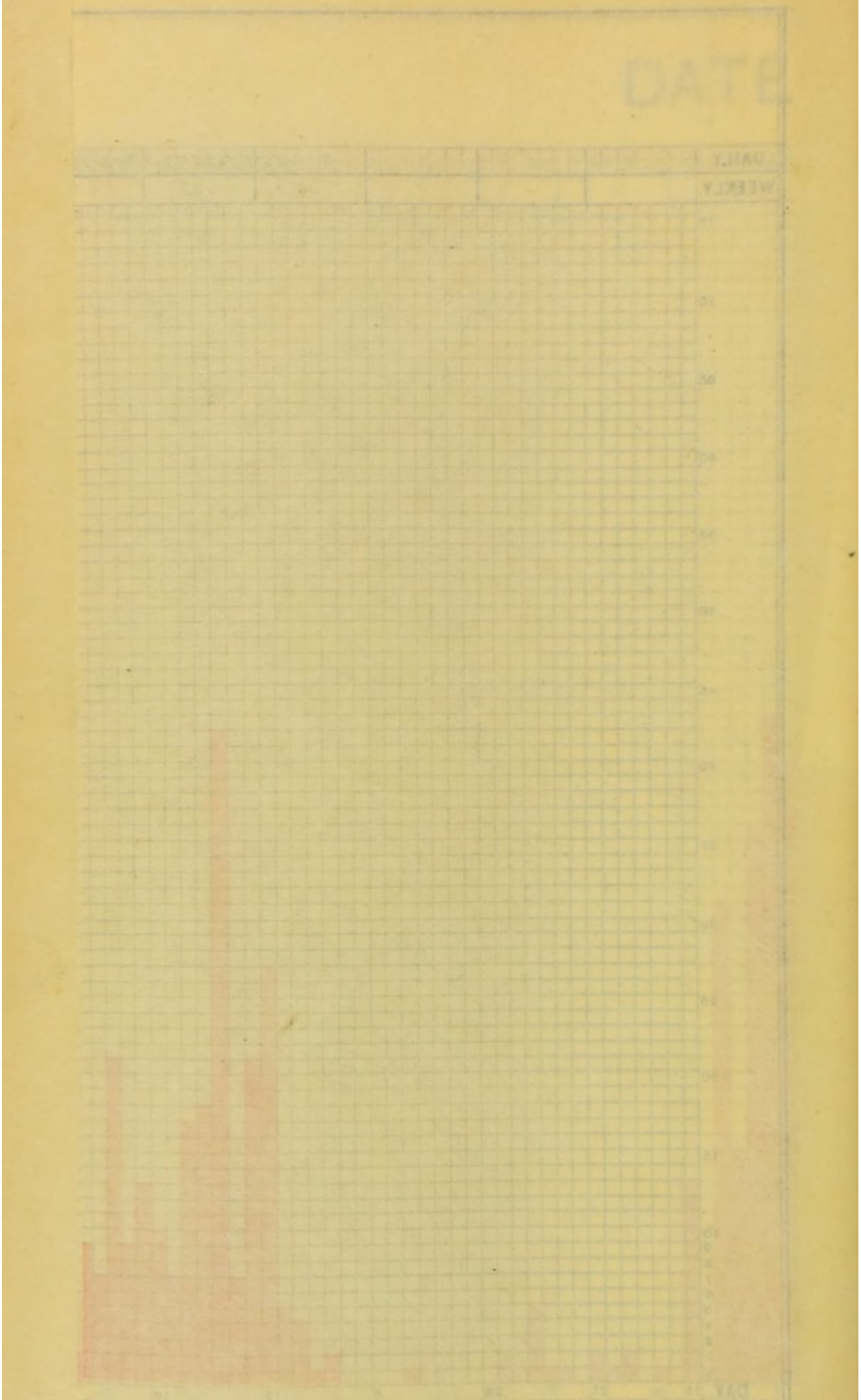



BROADWATER
WEST TARRING
WEST WORTHING
WORTHING
PLAN OF SEWERS
IN THE FOUR AREAS.
Scale



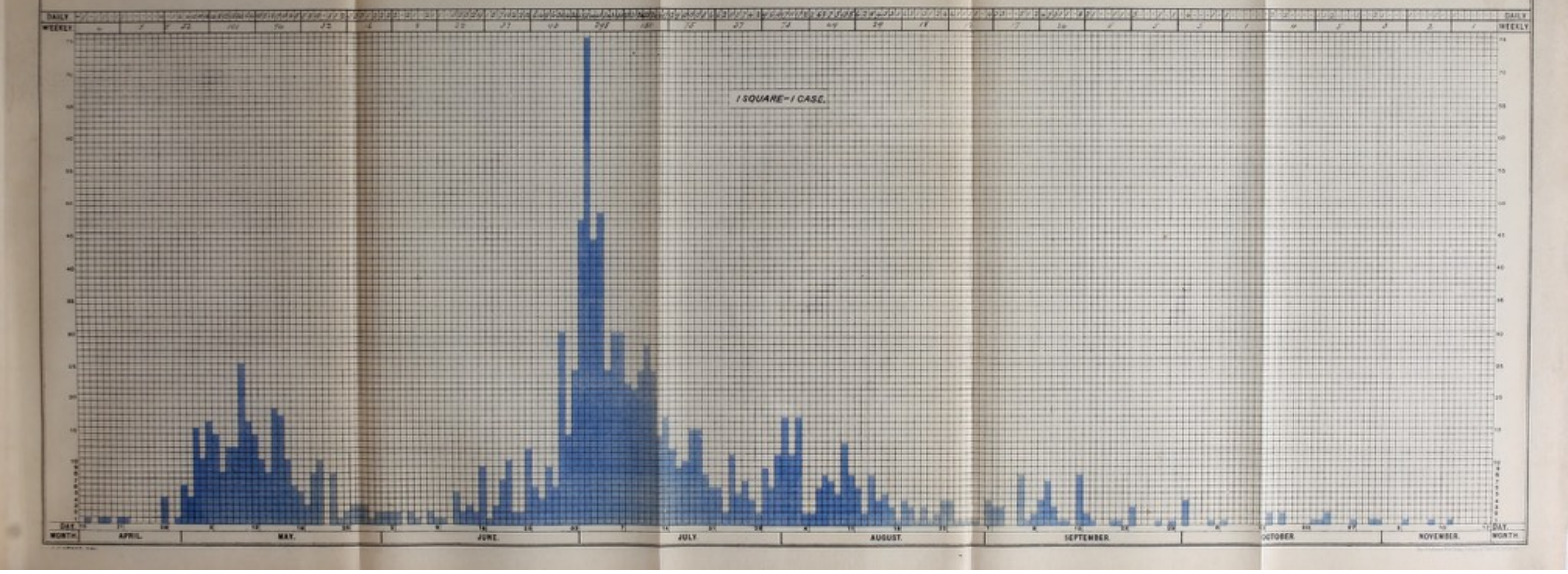
DATES OF NOTIFICATION, 1893.





WORTHING (EXCLUDING WEST WORTHING.)

DATES OF ATTACK, 1893.



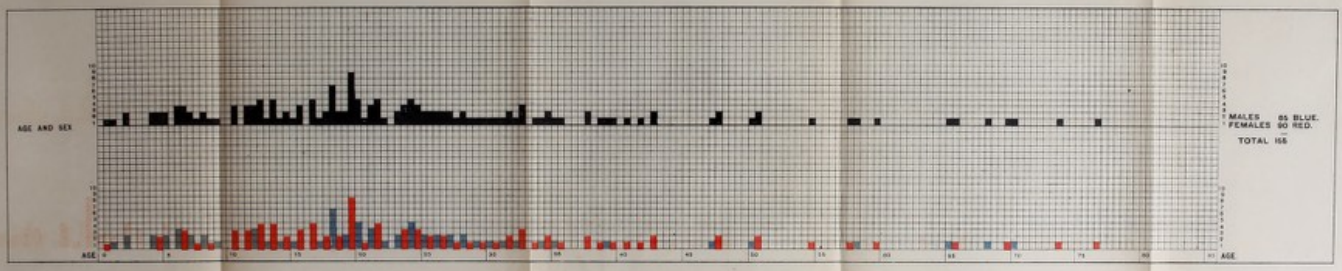
DATE

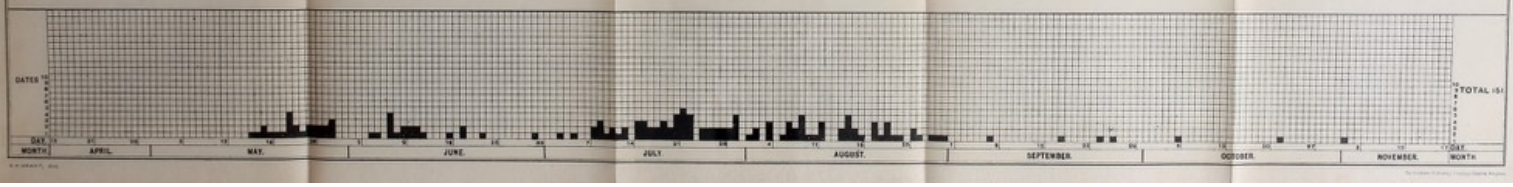
DAILY

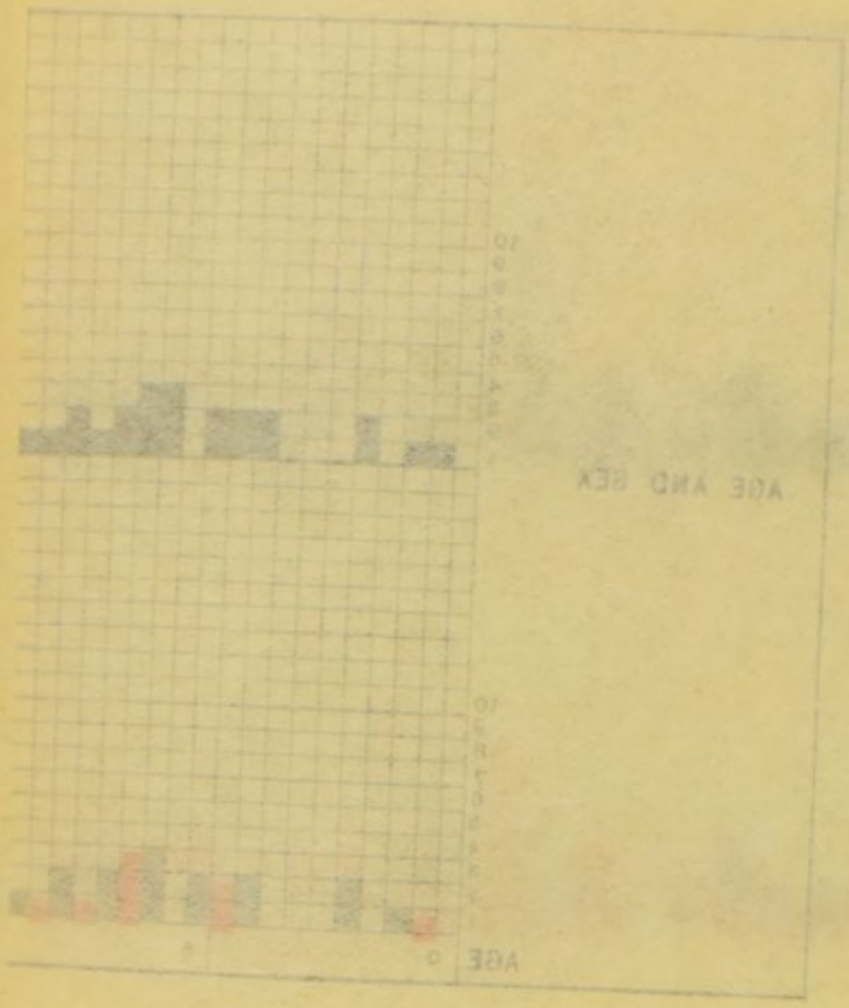
WEEKLY

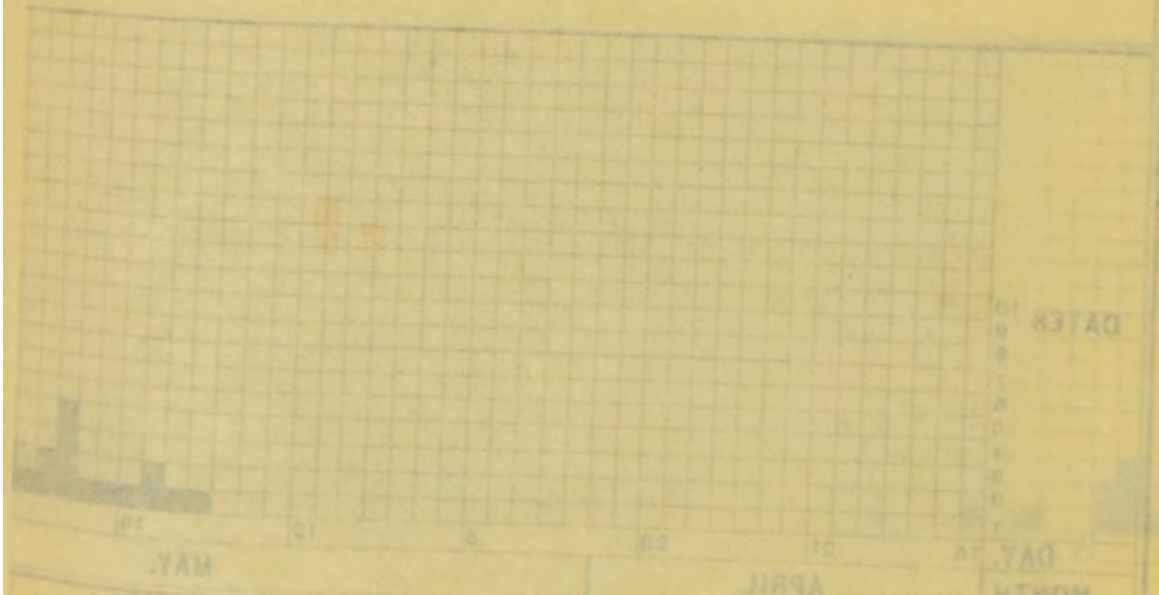
MONTH

ENTERIC FEVER DEATHS, 1893.






AGE AND SEX
AGE


DATES
MAY
APRIL

ENTERIC FEVER, 1893.

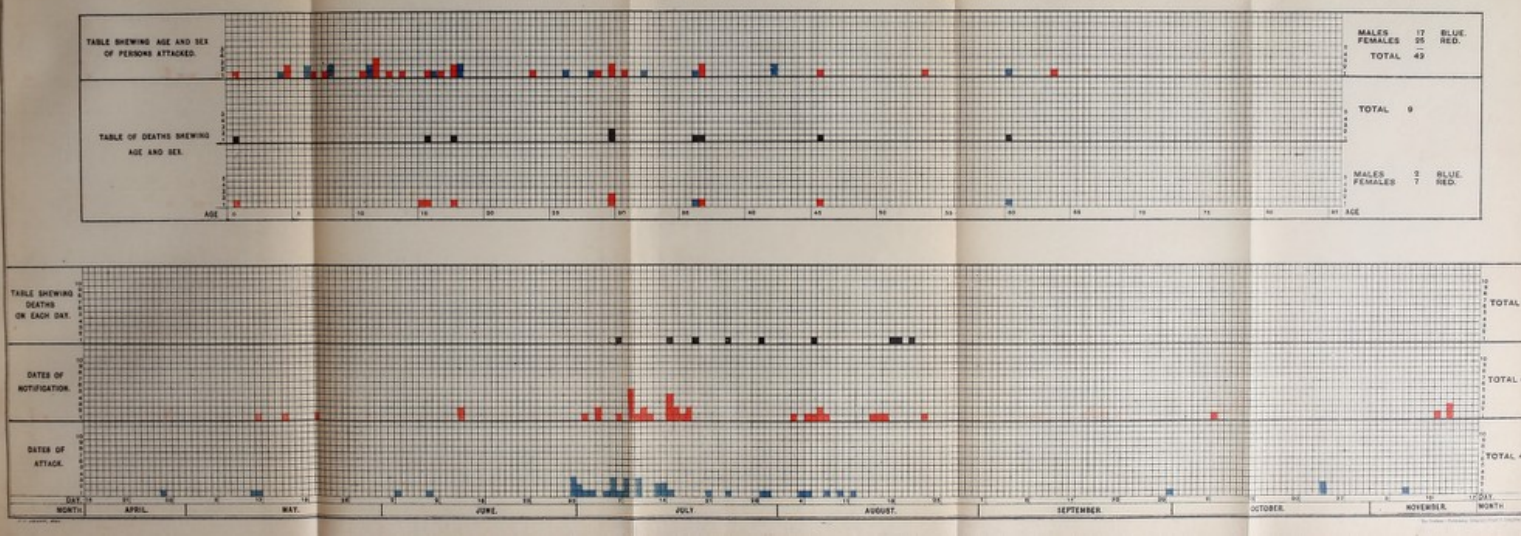


TABLE SHEWING AGE AND SEX
OF PERSONS ATTACKED.

TABLE OF DEATHS SHEWING
AGE AND SEX.

AGE

TABLE SHEWING
DEATHS
ON EACH DAY.

DATES OF
NOTIFICATION.

DATES OF
ATTACK.

MAY

APRIL

WEST WORTHING.

ENTERIC FEVER, 1893.

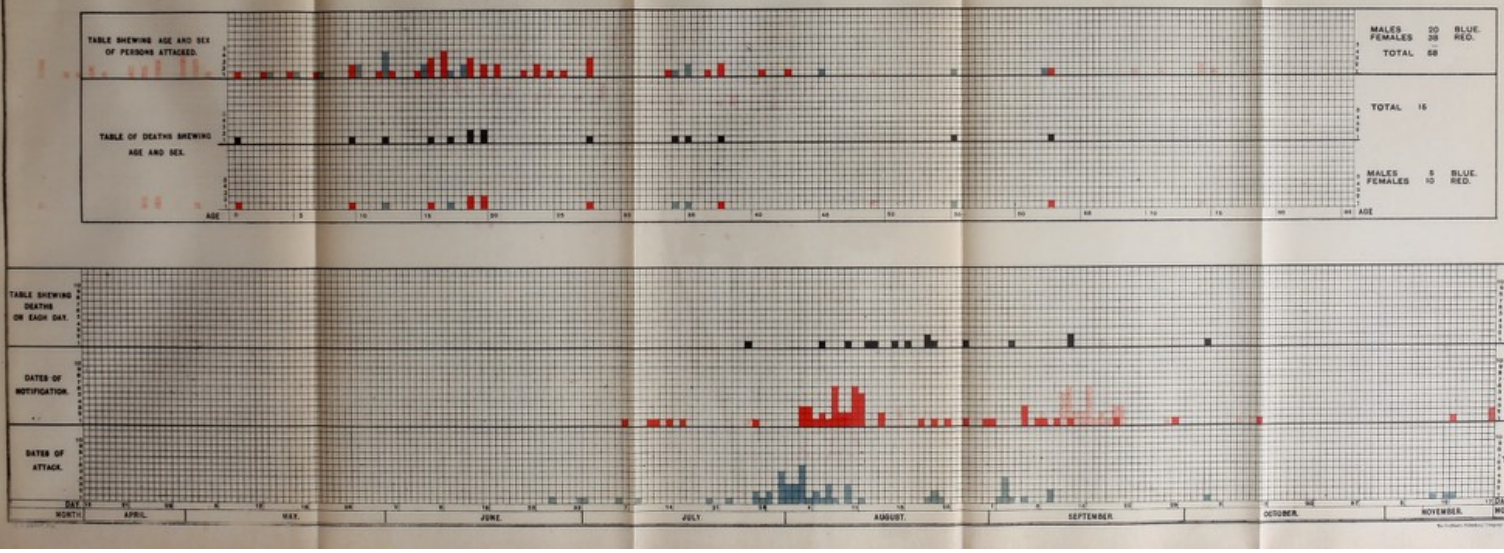


TABLE SHEWING AGE AND SEX
OF PERSONS ATTACKED

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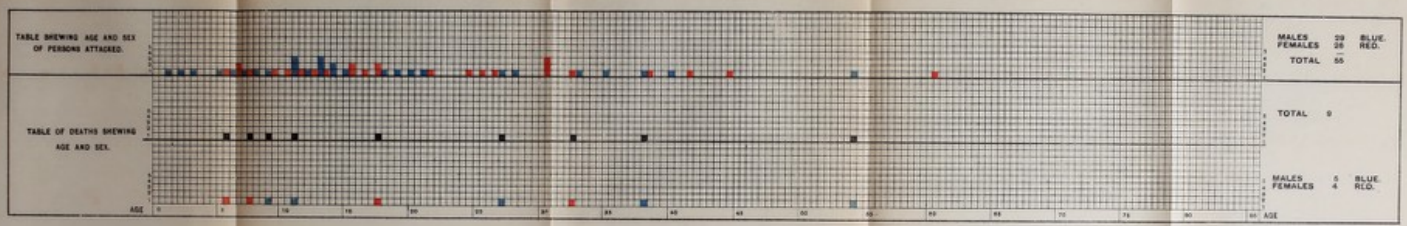
AGE AND SEX.

TABLE SHEWING
DEATHS
ON EACH DAY

DATES OF
NOTIFICATION.

DATES OF
ATTACK.

ENTERIC FEVER, 1893.



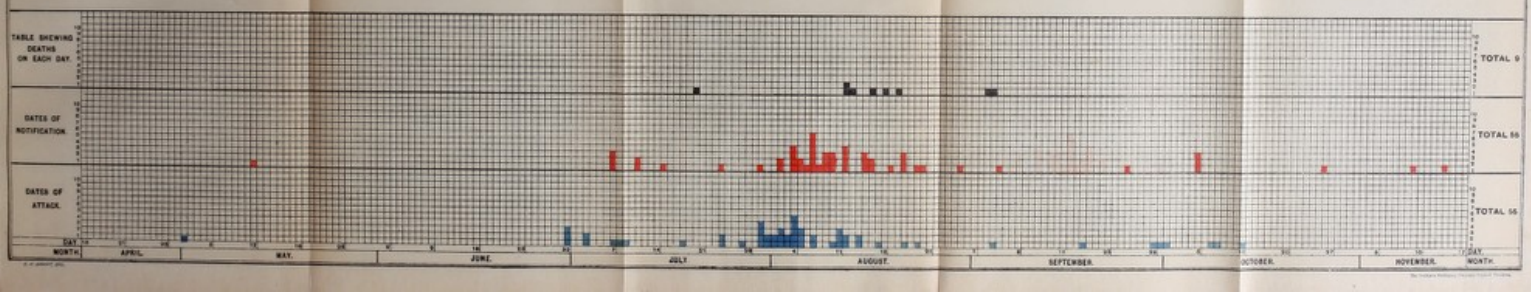


TABLE SHEWING AGE AND SEX
OF PERSONS ATTACKED.

TABLE OF DEATHS SHEWING
AGE AND SEX

AGE

TABLE SHEWING
DEATHS
ON EACH DAY

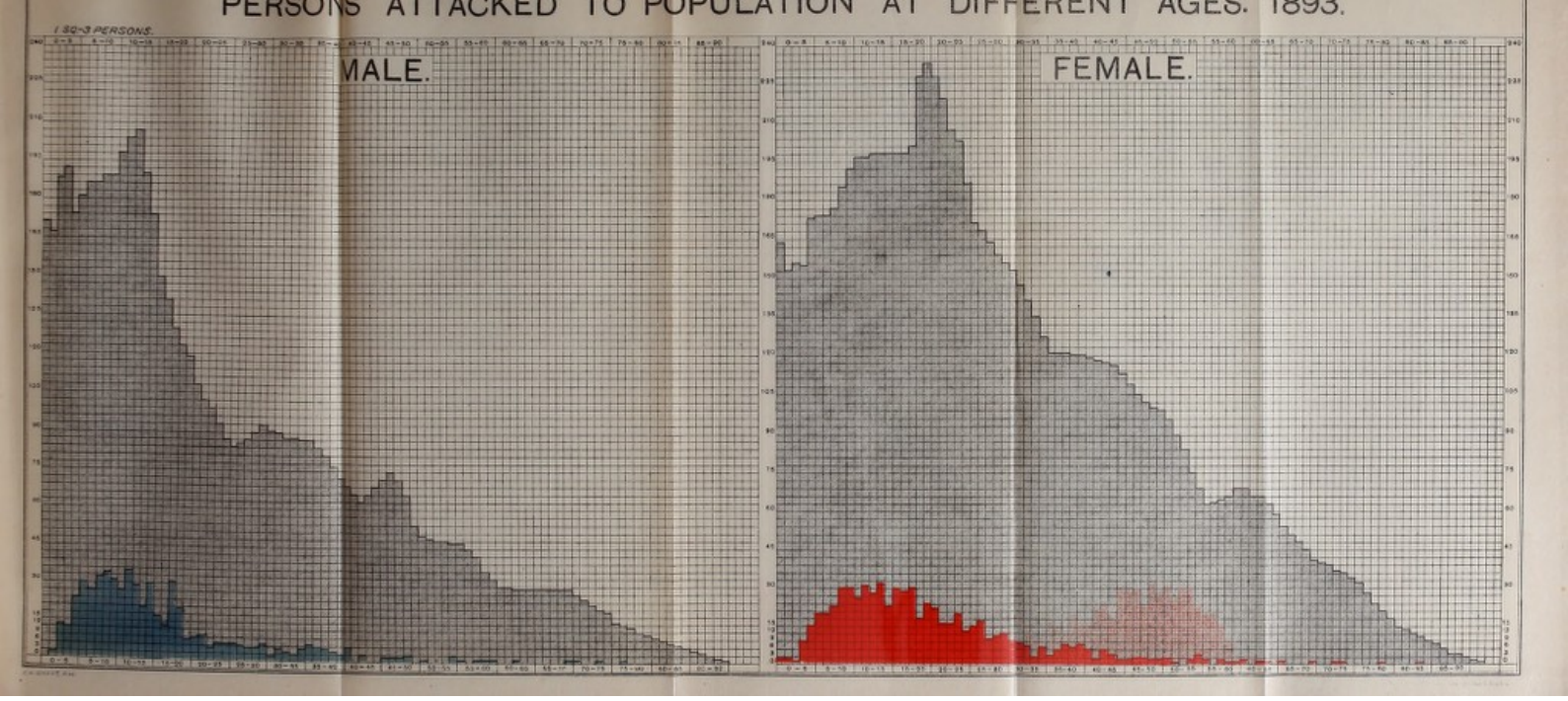
DATES OF
NOTIFICATION.

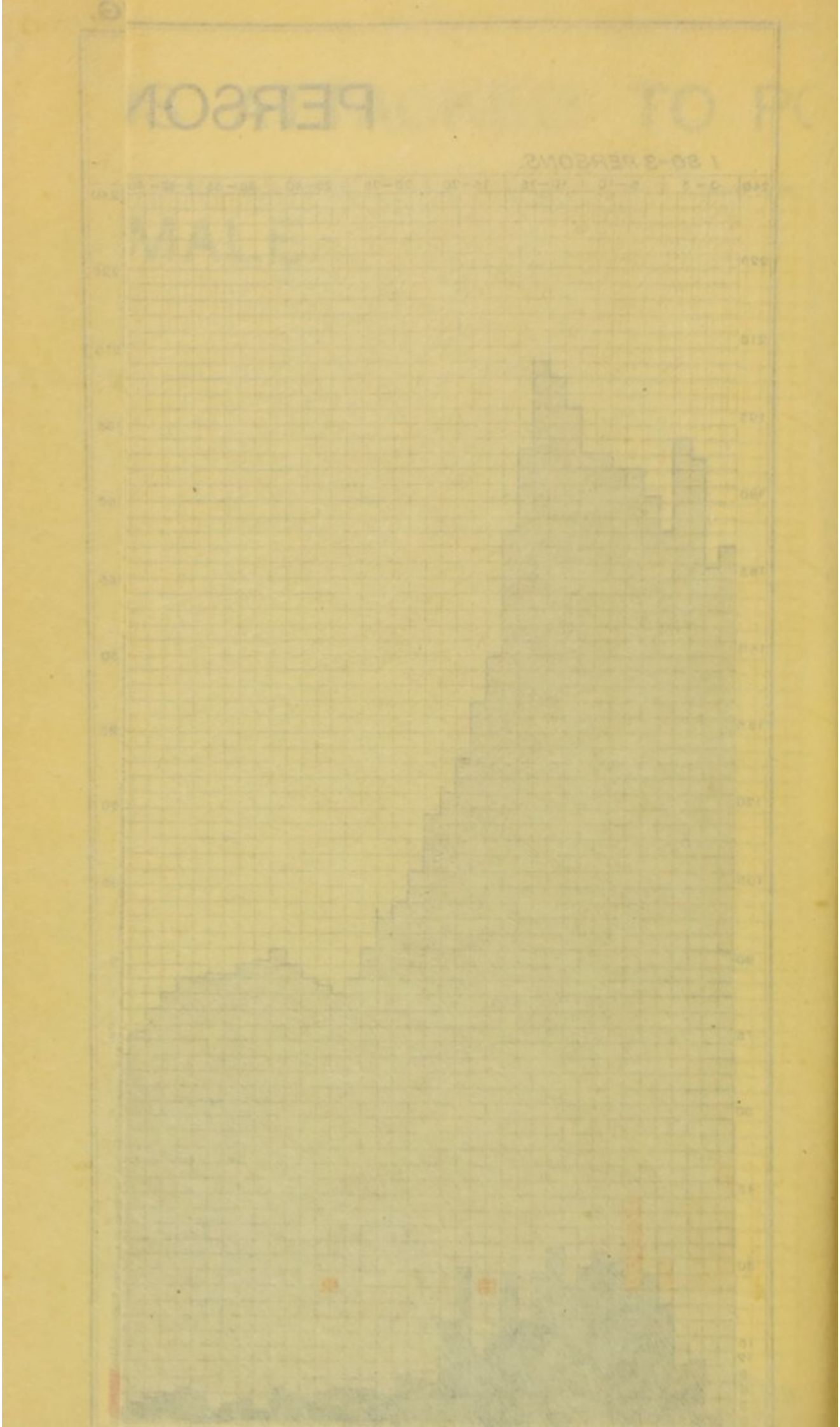
DATES OF
ATTACK

DAY

MAY

PERSONS ATTACKED TO POPULATION AT DIFFERENT AGES. 1893.

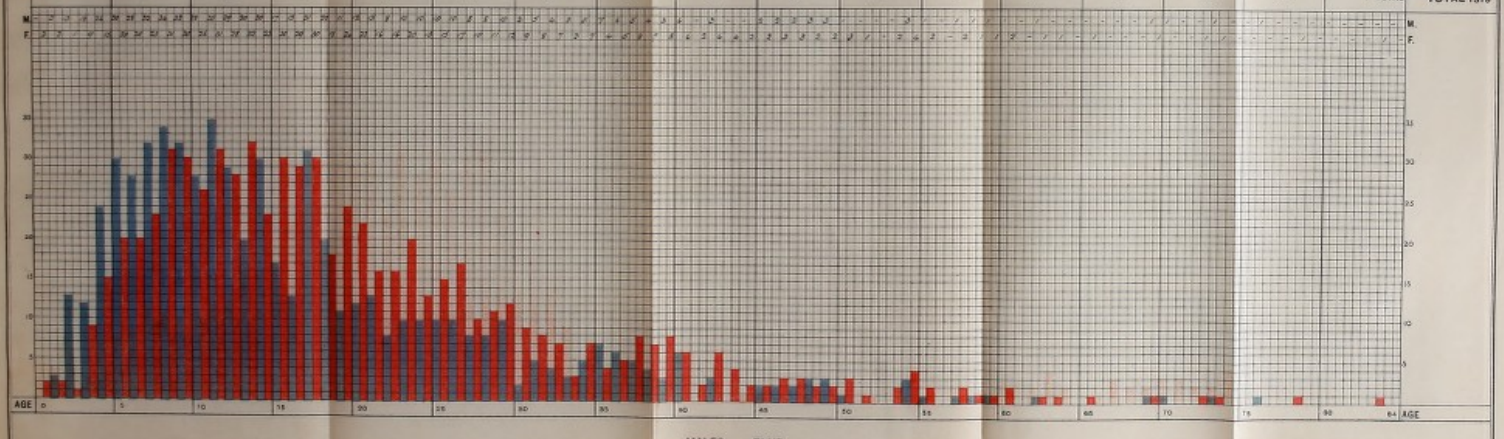




ENTERIC FEVER, 1893.

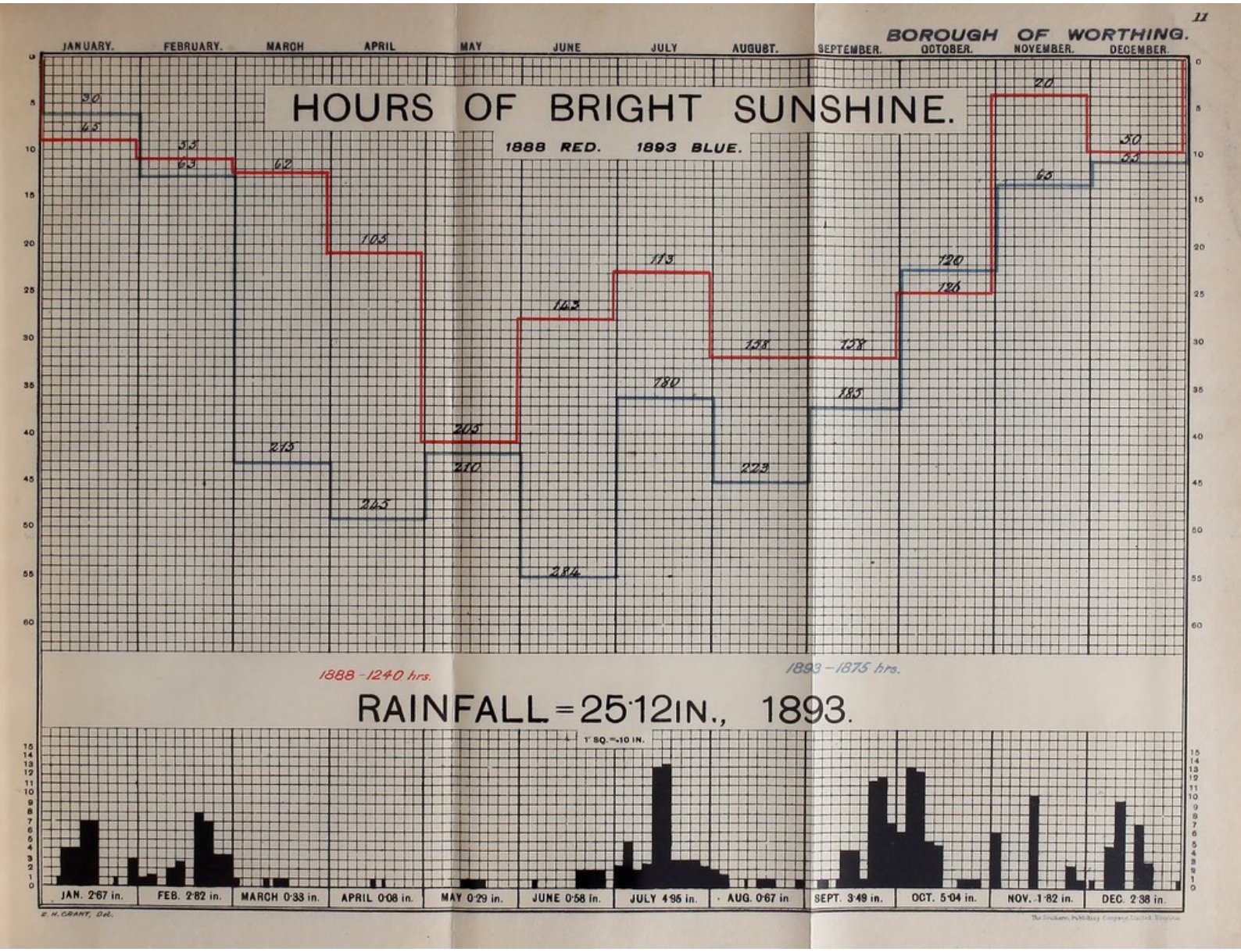
TABLE SHEWING AGE AND SEX.

	M. 58	136	142	92	53	46	19	25	8	12	4	4	1	1	2	1	♂ N.	MALES 819
	F. 39	124	140	131	87	65	34	32	20	12	10	6	4	2	3	1	♀ F.	FEMALES 700
	TOTAL 97	260	282	223	140	111	53	57	28	24	14	10	5	3	4	2	TOTAL	TOTAL 1319



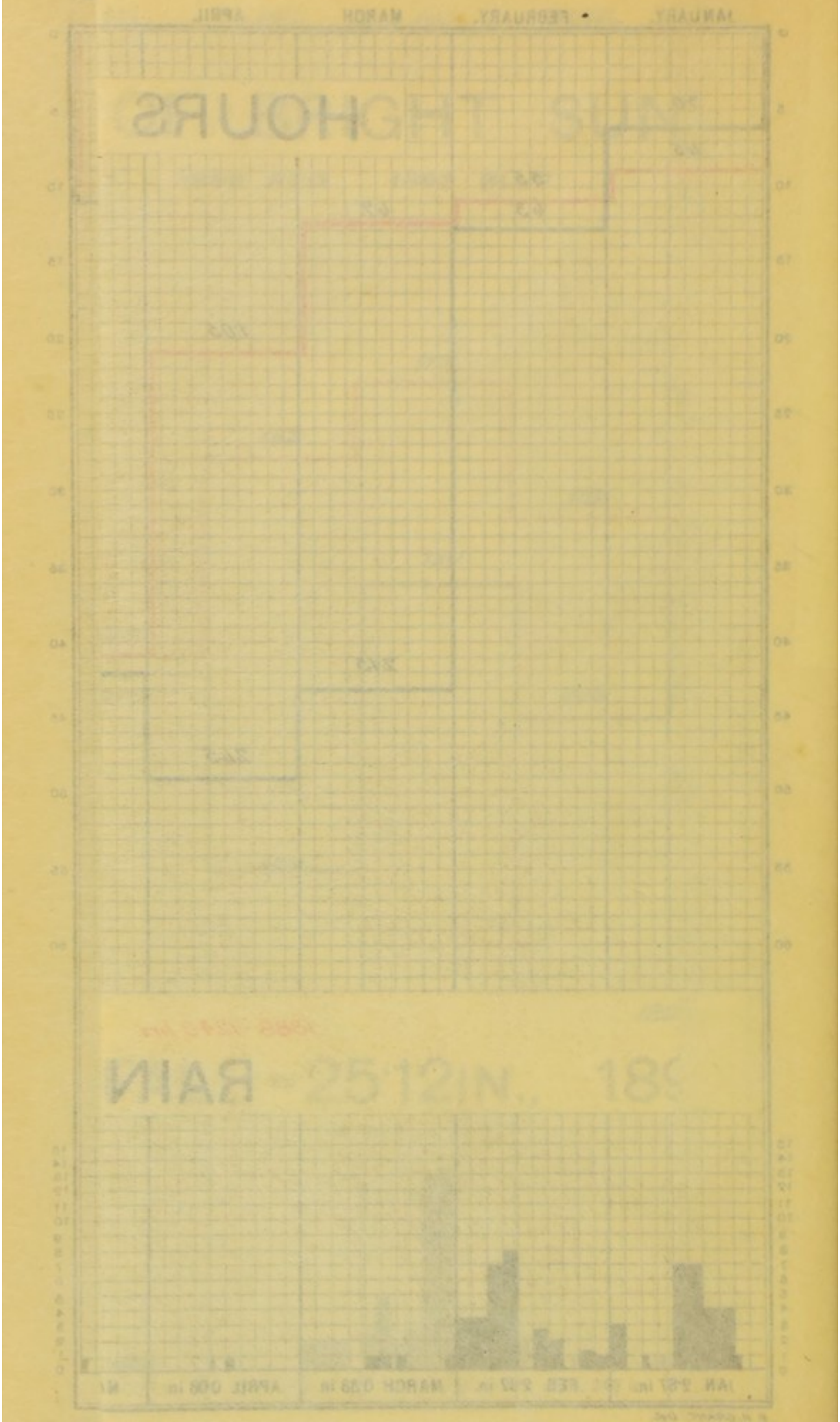
MALES BLUE.
FEMALES RED.

BOROUGH OF WORTHING.



RAINFALL = 25·12 IN., 1893.

E. H. GRANT, Del.



BOROUGH OF WORTHING.

ACCUMULATED HEAT.

1888 RED. 1893 BLUE.

EACH SQ. = 1 DAY DEGREE.

FIRST QUARTER.	SECOND QUARTER.	THIRD QUARTER.	FOURTH QUARTER.

0 5 10 15 20 25 30 35 40 45 50 55 65 70 75 80 85 90 95 100

70 65 60 55 50 45 40 35 30 25 20 15 10 5 4 3 2 1 0

1893 - 1748 day degrees.

1888 - 1422 day degrees.

1893 - 1277 day degrees.

1888 - 852 day degrees.

1888 - 513 day degrees.

1893 - 670 day degrees.

1893 - 302 day degrees.

1888 - 83 day degrees.

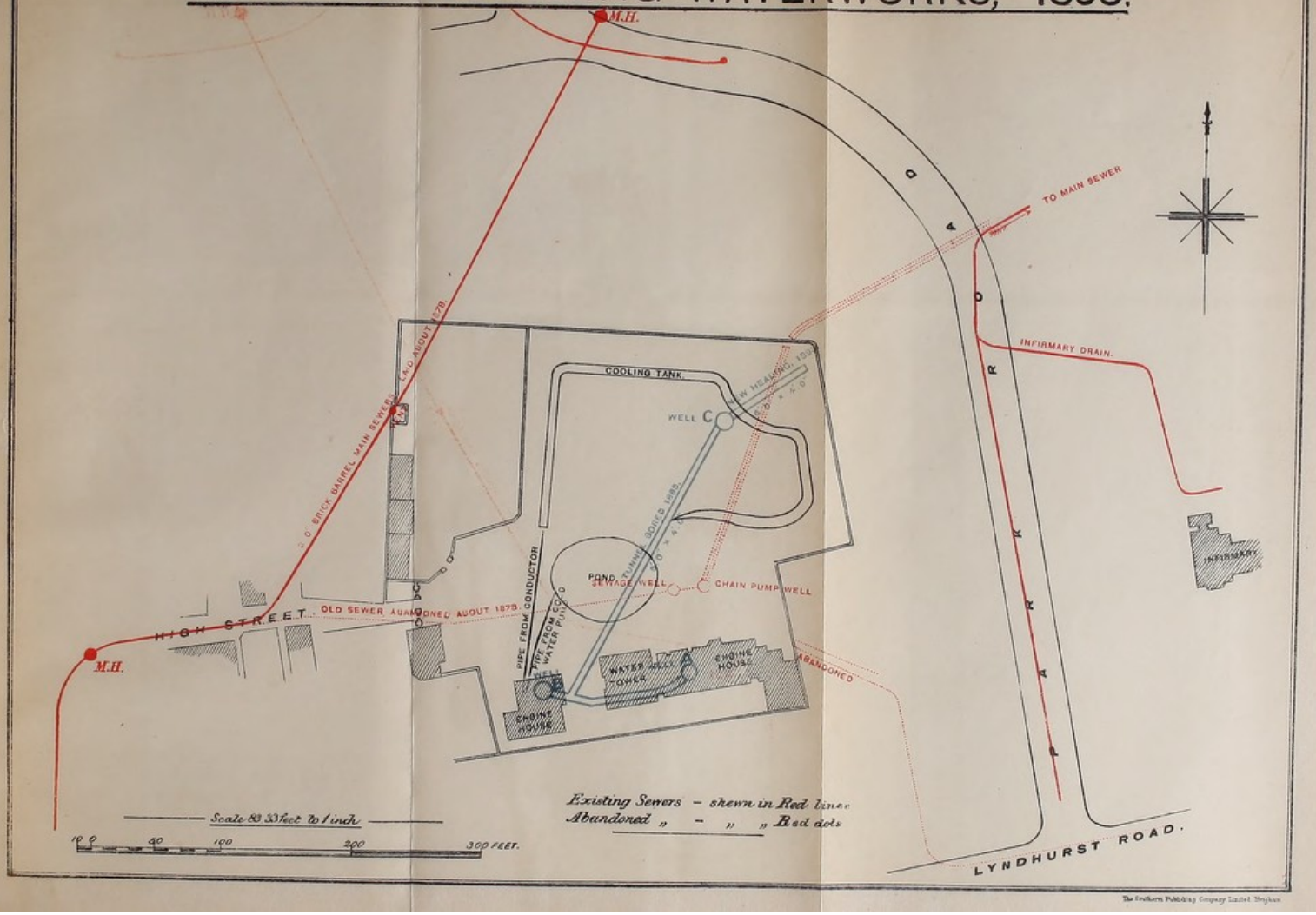
42° F.

1888-2876 day degrees.

1893-3799 day degrees.

E. H. GRANT, DEL.

PLAN OF WORTHING WATERWORKS, 1893.



The Southern Publishing Company Limited, Brighton

SECTION OF WORTHING WATERWORKS, 1893.

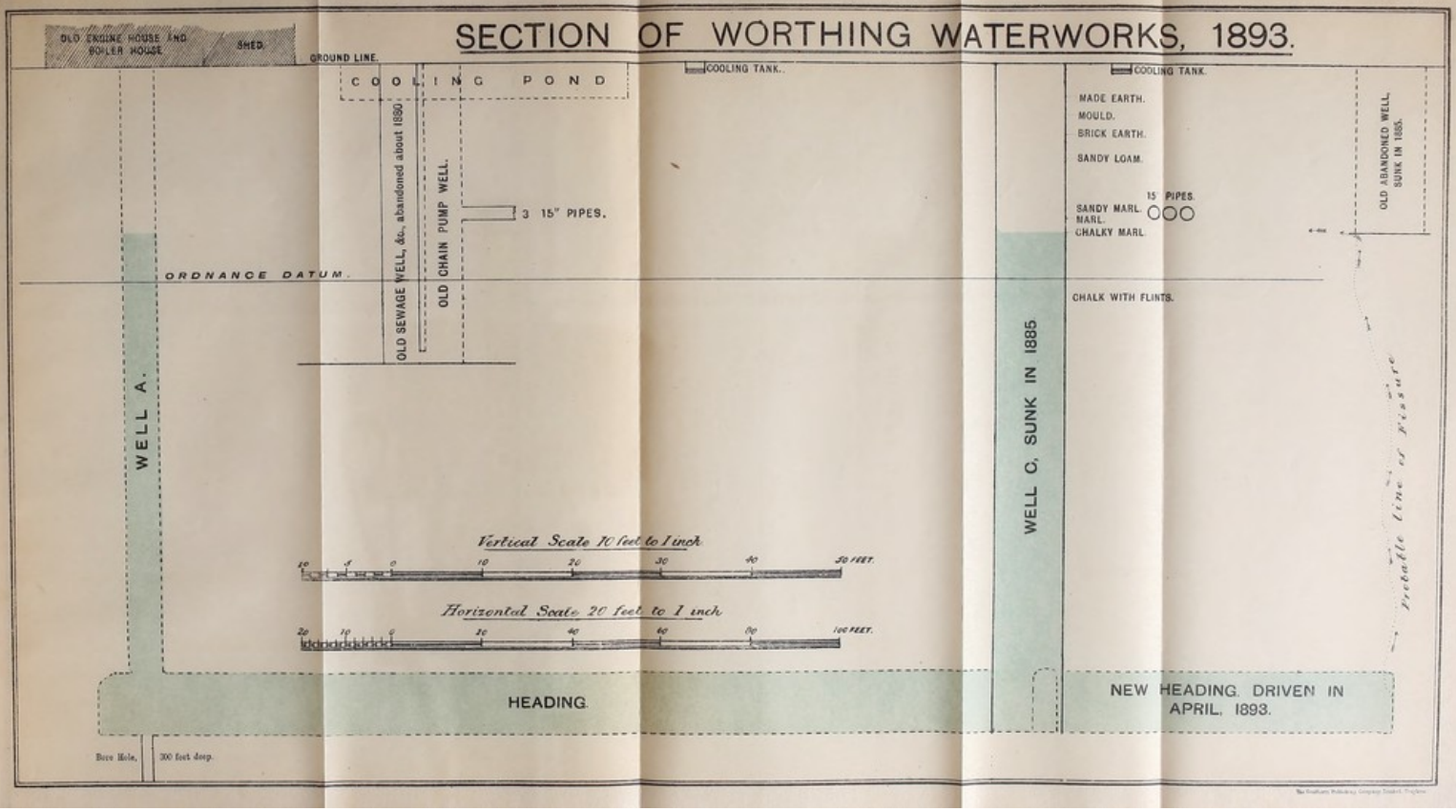
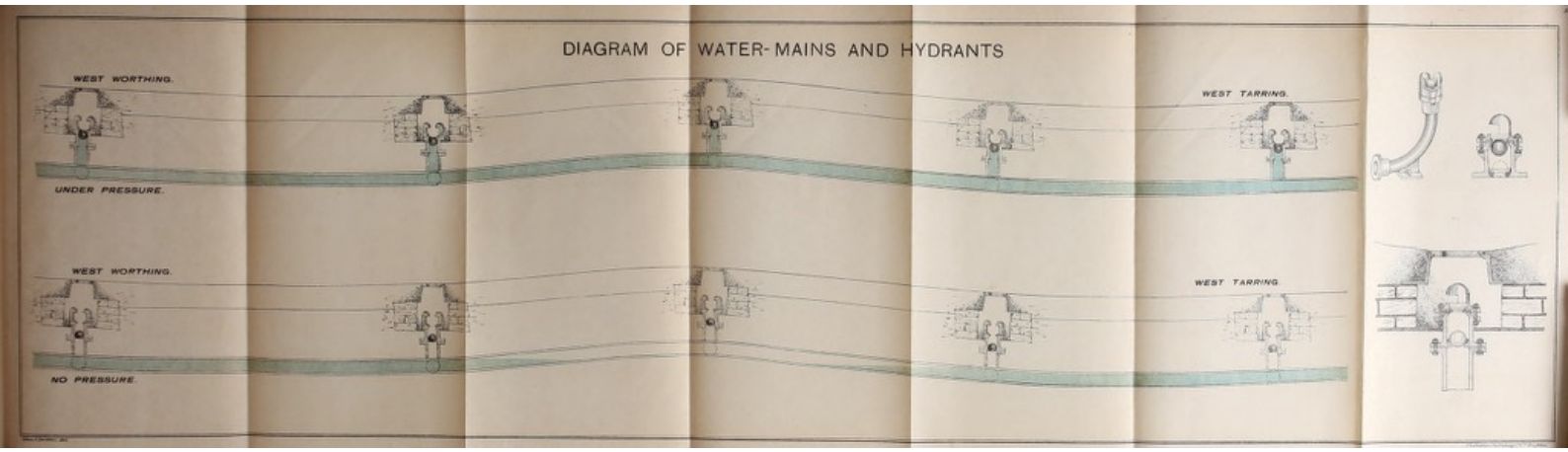


DIAGRAM OF WATER-MAINS AND HYDRANTS



WEST WORTHING.

UNDER PRESSURE.

WEST WORTHING.

NO PRESSURE.